University of Crete
School of Social Sciences
Department of Economics

<u>PhD Dissertation</u>:

"Equilibrium Exchange Rate Dynamics in the Enlarged Euro Zone: Prospects for Candidate EMU Countries."

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Abstract

This dissertation is an application in the area of Exchange Rate Economics. The first part of the thesis evaluates the theoretical and empirical literature on (equilibrium) exchange rate determination models as well as the theoretical and empirical tools for testing foreign exchange market efficiency. The second part of the thesis entails empirical applications on the perspective of EMU enlargement, paying attention to the notion of equilibrium exchange rates. In other words, the aim is to evaluate the integration process of the new EU country–members towards EMU. We argue that current exchange rate stability does not ensure future exchange rate stability. The sustainability of low exchange rate volatility requires the nominal exchange rate not to be highly and persistently away from its equilibrium rate. Evidence of linear and nonlinear reversion to PPP equilibrium as well as evidence that effective and bilateral exchange rates per euro are not highly misaligned implies that the candidate countries follow a normal integration process towards EMU.

Keywords: Equilibrium Exchange Rates; PPP; BEER; EMU Enlargement; Candidate EMU Countries

Acknowledgements

This dissertation is the outcome of a work of the last three years. However, I wish to talk about my undergraduate studies as well. It was about ten years ago; when as an undergraduate student I joined the Department of Economics at the University of Crete. At the beginning of my studies, it was not in my plans to study in a PhD level, neither to continue for postgraduate studies (MSc level). So, I would like to thank all of my teachers at the University of Crete for motivating me and making me love this science. Specifically, I am indebted to Associate Professor Christos Papazoglou for encouraging me to follow high quality postgraduate studies in Economics and Professor Athanasios Papadopoulos for advising me on my search of MSc programmes abroad. Furthermore, I would like to thank my teachers at the University of York. When it comes to my PhD studies, I am totally indebted to my PhD supervisor, Professor Athanasios Papadopoulos. Besides his excellent supervision, he offered to me the chance to develop both research and teaching experience. In addition, I wish to thank Professor Angelos Kanas for including me in the research project "Pythagoras II", which provided me financial support and the opportunity to develop my research skills. But above all, I am grateful to my parents, who are continuously by my side, offering financial and emotional support. Similarly, I wish to thank my brother and his wife for supporting me in a number of ways. Last but not least, I would like to express my special thanks to Maria, my fellow traveller in studies and in life.

CONTENTS

List of Figures

List of Tables

ΠΕΡΙΛΗΨΗ

Τον Μάιο του 2004 δέκα επιπλέον χώρες (Κύπρος, Μάλτα, Τσεχία, Πολωνία, Ουγγαρία, Σλοβενία, Σλοβακία, Λετονία, Λιθουανία και Εσθονία) προσχώρησαν στην Ευρωπαϊκή Ένωση (ΕΕ), ενώ από τον Ιανουάριο του 2007 η ΕΕ αποτελείται από 27 μέλη λόγω της ενσωμάτωσης της Βουλγαρίας και της Ρουμανίας. Το δεύτερο βήμα οικονομικής ολοκλήρωσης γι' αυτές τις χώρες είναι η ένταξή τους στην Οικονομική και Νομισματική Ένωση (ΟΝΕ) και η υιοθέτηση του ενιαίου νομίσματος. Προκειμένου να συμβεί αυτό, οφείλουν να ικανοποιήσουν τα κριτήρια σύγκλισης που ορίσθηκαν από την συνθήκη του Μάαστριχ. Σύμφωνα μ' αυτά τα κριτήρια, ο πληθωρισμός στις υποψήφιες χώρες δεν πρέπει να υπερβαίνει περισσότερο από 1,5% το μέσο πληθωρισμό των τριών κρατών-μελών με το χαμηλότερο πληθωρισμό (*κριτήριο πληθωρισμού)*. Εκτός αυτού, το μακροπρόθεσμο επιτόκιο δεν πρέπει να υπερβαίνει περισσότερο από 2% το μέσο επιτόκιο των τριών μελών με το χαμηλότερο επιτόκιο (*κριτήριο επιτοκίου)*. Έπειτα, η υποψήφια χώρα πρέπει να ενσωματώσει το νόμισμά της στο Μηχανισμό Συναλλαγματικών Ισοτιμιών (ΜΣΙ) ΙΙ τουλάχιστον δύο χρόνια πριν την είσοδό της στην ευρωζώνη. Κατά την περίοδο αυτή, η συναλλαγματική ισοτιμία του εγχωρίου νομίσματος έναντι του ευρώ πρέπει να κυμαίνεται μεταξύ του +/- 15% (*κριτήριο συναλλαγματικής ισοτιμίας)*. Τα ανωτέρω κριτήρια απεικονίζουν τη νομισματική πλευρά της οικονομίας. Αν και η ΟΝΕ είναι κυρίως νομισματική ένωση, δεν εστιάζει μόνο στα νομισματικά κριτήρια αλλά και στα δημοσιονομικά. Έτσι, το δημόσιο χρέος, ως ποσοστό του ΑΕΠ, δεν πρέπει να υπερβαίνει το 60%. Επιπλέον, το δημοσιονομικό έλλειμμα δεν πρέπει να ξεπερνά το 3% του ΑΕΠ.

Στο δρόμο προς την ΟΝΕ, οι υποψήφιες χώρες πρέπει να εφαρμόσουν ένα πλαίσιο νομισματικής πολιτικής σύμφωνο με τις αρχές της «κοινής νομισματικής περιοχής». Κοινός στόχος των πολιτικών αυτών είναι η επίτευξη και η συντήρηση της σταθερότητας τιμών και γενικά η προώθηση της μακροοικονομικής σταθερότητας. Εντούτοις, οι υποψήφιες χώρες δεν εφαρμόζουν ένα ομοιόμορφο καθεστώς νομισματικής πολιτικής. Οι περισσότερες επιλέγουν πολιτικές πληθωριστικού στόχου - Inflation Targeting – (Τσεχία, Ουγγαρία, Πολωνία, Σλοβακία, Σλοβενία, Ρουμανία, και Κύπρος), ενώ άλλες επιλέγουν πολιτικές στόχευσης της συναλλαγματικής ισοτιμίας - Exchange Rate Targeting - (Εσθονία, Λετονία, Μάλτα, Λιθουανία, και Βουλγαρία).

Υπό το καθεστώς πληθωριστικής στόχευσης η Κεντρική Τράπεζα αναγγέλλει ένα στόχο πληθωρισμού, τον οποίο είναι διατεθειμένη να επιτύχει. Ένα σημαντικό πλεονέκτημα αυτού του πολιτικού καθεστώτος είναι ότι η χώρα διατηρεί την αυτονομία της νομισματικής πολιτικής μέχρι την στιγμή της υιοθέτησης του ενιαίου νομίσματος. Από την άλλη πλευρά, υπό το καθεστώς συναλλαγματικής στόχευσης η Κεντρική Τράπεζα προσπαθεί να διατηρήσει το νόμισμά της σταθερό με το να επεμβαίνει στην αγορά συναλλάγματος. Συνήθως, οι χώρες στερεώνουν τις ονομαστικές συναλλαγματικές ισοτιμίες τους σε ένα νόμισμα μιας χώρας (ή σε ένα καλάθι νομισμάτων) με σαφώς χαμηλότερο ποσοστό πληθωρισμού. Το κύριο πλεονέκτημα αυτού του συστήματος είναι ότι οι χώρες υψηλού πληθωρισμού "εισάγουν" χαμηλό πληθωρισμό από τις χώρες χαμηλού πληθωρισμού. Αντίθετα, η απώλεια αυτονομίας της νομισματικής πολιτικής είναι ένα σημαντικό μειονέκτημα.

Η «αρχή της αδύνατης τριάδας» αναφέρει ότι μια χώρα πρέπει να εγκαταλείψει έναν από τους ακόλουθους τρεις στόχους: (α) σταθερότητα συναλλαγματικής ισοτιμίας, (β) αυτονομία νομισματικής πολιτικής και (γ) ενοποίηση χρηματιστηριακών αγορών. Δεδομένης της διεθνοποίησης των χρηματιστηριακών αγορών, οι χώρες πρέπει να επιλέξουν μεταξύ της σταθερότητας συναλλαγματικής ισοτιμίας και της νομισματικής ανεξαρτησίας. Σύμφωνα με αυτή την αρχή και σύμφωνα με τους νομισματικούς τους στόχους, οι Κεντρικές Τράπεζες εφαρμόζουν νομισματική πολιτική συμβατή με την ισχύουσα συναλλαγματική πολιτική έναντι του ευρώ. Αν και υπάρχει ευρύ φάσμα καθεστώτων συναλλαγματικής πολιτικής ανάμεσα στα δύο άκρα (ελεύθερα κυμαινόμενη και σταθερή ισοτιμία), οι επιλογές των υποψηφίων χωρών κυμαίνονται μεταξύ (α) σταθερής συναλλαγματικής ισοτιμίας με μηδενικό (ή πολύ στενό) εύρος διακύμανσης (Εσθονία, Λετονία, Μάλτα, Λιθουανία, Βουλγαρία), (β) πλήρως ελεύθερης συναλλαγματικής ισοτιμίας (Πολωνία, Ρουμανία) και (γ) ελεύθερης ισοτιμίας αλλά με ελεγχόμενο εύρος διακύμανσης (Τσεχία, Κύπρος, Ουγγαρία, Σλοβενία, Σλοβακία).

Ο Μηχανισμός Συναλλαγματικών Ισοτιμιών ΙΙ μεταξύ του ευρώ και των συμμετεχόντων εθνικών νομισμάτων κατηγοριοποιείται στο καθεστώς ελεύθερης ισοτιμίας με ελεγχόμενο εύρος διακύμανσης. Προς το παρόν μόνο η Εσθονία, η Κύπρος, η Λετονία, η Μάλτα, η Λιθουανία και η Σλοβακία συμμετέχουν στο Μηχανισμό Συναλλαγματικών Ισοτιμιών ΙΙ, ενώ η Σλοβενία είναι πλέον το $13^{ο}$ μέλος της ευρωζώνης. Μόνο δύο από αυτές (Κύπρος και Σλοβακία) έχουν διατηρήσει το εύρος διακύμανσης στο +/- 15%. Οι υπόλοιπες χώρες έχουν αναλάβει μονομερή υποχρέωση να διατηρήσουν τη ζώνη διακύμανσης ακόμα στενότερη. Συγκεκριμένα, η Λετονία έχει ορίσει το εύρος διακύμανσης στο +/- 1%, ενώ οι Εσθονία, Μάλτα και Λιθουανία έχουν δεσμευτεί ότι θα διατηρήσουν την κεντρική ισοτιμία, έναντι του ευρώ, αμετάβλητη.

Ο στόχος αυτής της διδακτορικής διατριβής είναι να αξιολογηθεί η σταθερότητα των νομισμάτων των παραπάνω χωρών, καθώς επίσης και η διαδικασία ολοκλήρωσής τους προς την ΟΝΕ δίδοντας έμφαση στην έννοια της ισορροπίας συναλλαγματικών ισοτιμιών. Συγκεκριμένα, προσπαθούμε να εξετάσουμε την πιθανότητα εμφάνισης στο μέλλον σημαντικών διακυμάνσεων στις συναλλαγματικές ισοτιμίες έναντι του ευρώ. Η σταθερότητα της συναλλαγματικής ισοτιμίας είναι κρίσιμη για την αποτελεσματικότητα της νομισματικής σύγκλισης στην ευρωζώνη. Σύμφωνα με τη θεωρία της «άριστης νομισματικής περιοχής» όσο λιγότερο ασταθής είναι η συναλλαγματική ισοτιμία, τόσο υψηλότερη είναι η δυνατότητα δύο χωρών να μοιραστούν το ίδιο νόμισμα.

Αυτή η διατριβή συμβάλλει προβάλλοντας τη σημασία της ισορροπίας συναλλαγματικών ισοτιμιών. Είναι ευρέως γνωστό ότι μια ιδιαίτερα υποτιμημένη ή υπερτιμημένη συναλλαγματική ισοτιμία δημιουργεί πληθωριστικές πιέσεις ή προβλήματα ανταγωνιστικότητας, αντίστοιχα, στην εγχώρια οικονομία. Επιπλέον, παρέχουμε έναν πιο «διατηρήσιμο» χαρακτήρα στη σταθερότητα της συναλλαγματικής ισοτιμίας. Με άλλα λόγια, υποστηρίζουμε ότι το κριτήριο σύγκλισης της συναλλαγματικής ισοτιμίας είναι αναγκαία αλλά όχι ικανή συνθήκη για τη σταθερότητα της συναλλαγματικής ισοτιμίας, και κατά συνέπεια για την επιτυχή είσοδο στην ΟΝΕ. Η λογική είναι ότι, ακόμα κι αν η συναλλαγματική ισοτιμία είναι την τρέχουσα περίοδο σταθερή αλλά, σημαντικά μακριά από το επίπεδο ισορροπίας της, η συναλλαγματική ισοτιμία πρόκειται να είναι ιδιαίτερα ασταθής στο μέλλον. Το κύριο επιχείρημα της παρούσας διατριβής είναι ότι η ισορροπία στην συναλλαγματική ισοτιμία επιτυγχάνεται μόνο εάν η ονομαστική συναλλαγματική ισοτιμία συμφωνεί με τις μακροχρόνια-ισορροπημένες τιμές των μακροοικονομικών μεταβλητών.

Ένας από τους στόχους αυτής της διατριβής είναι να αξιολογηθεί η λειτουργία των αντίστοιχων αγορών συναλλάγματος και η ευπάθειά τους σε πιθανές συναλλαγματικές κρίσεις. Συγκεκριμένα, πρέπει να γνωρίζουμε κατά πόσο οι αγορές αυτές λειτουργούν αποτελεσματικά, καθώς ενδείξεις μη αποτελεσματικής λειτουργίας αυξάνουν την πιθανότητα εμφάνισης κερδοσκοπικών επιθέσεων. Εντούτοις, η υπόθεση αμεροληψίας της προθεσμιακής ισοτιμίας (Forward Rate Unbiasedness Hypothesis) φαίνεται να μην είναι κατάλληλη στην περίπτωση που εξετάζονται αναπτυσσόμενες αγορές. Κι αυτό γιατί, σ' αυτές τις χώρες οι προθεσμιακές αγορές δεν είναι αναπτυγμένες και οι προθεσμιακές ισοτιμίες επηρεάζονται, σε ένα μεγάλο βαθμό, από τον κρατικό παρεμβατισμό. Έτσι, αυτή η διατριβή συμβάλλει με την παροχή ενός εναλλακτικού, αλλά κατάλληλου, θεωρητικού πλαισίου για τον έλεγχο αποτελεσματικότητας των αγορών συναλλάγματος, στην περίπτωση των αναπτυσσόμενων χωρών. Αυτή η προσέγγιση συνδυάζει την έννοια ισορροπίας των συναλλαγματικών ισοτιμιών με την υπόθεση αποτελεσματικότητας και δηλώνει ότι μια αγορά είναι αποτελεσματική, εάν η ισορροπία συναλλαγματικής ισοτιμίας εκμεταλλεύεται αποτελεσματικά όλες τις διαθέσιμες πληροφορίες. Μια εναλλακτική έκφραση είναι ότι αφ' ενός η ονομαστική συναλλαγματική ισοτιμία δεν πρέπει να είναι σημαντικά υποτιμημένη ή υπερτιμημένη και αφ' ετέρου να παρεκκλίνει από το επίπεδο ισορροπίας της μόνο παροδικά.

Παρακάτω ακολουθεί συνοπτική (ή σε ορισμένες περιπτώσεις εκτενής) περιγραφή των κεφαλαίων που απαρτίζουν την παρούσα διατριβή.[1] Τα κεφάλαια 2 έως 5 περιλαμβάνουν την παρουσίαση τόσο της θεωρητικής όσο και της εμπειρικής

[1] Η αρίθμηση των υπο-κεφαλαίων που χρησιμοποιούμε στην παρούσα περιληπτική αναφορά ταυτίζεται με την αρίθμηση του κορμού της διατριβής, έτσι ώστε να μην υπάρχει σύγχυση μεταξύ των κεφαλαίων της διατριβής και των αντίστοιχων συνοπτικών περιγραφών.

βιβλιογραφίας σχετικά με τα υποδείγματα συναλλαγματικών ισοτιμιών και αγορών συναλλάγματος. Επιπλέον, τα κεφάλαια 6 έως 9 αποτελούν το εμπειρικό τμήμα αυτής της διατριβής. Συγκεκριμένα, στο κεφάλαιο 6 εξετάζουμε την υπόθεση της Ισοδυναμίας Αγοραστικής Δύναμης – ΙΑΔ - (Purchasing Power Parity) για την περίπτωση 4 χωρών της Κεντρικής & Ανατολικής Ευρώπης (Τσεχία, Ουγγαρία, Πολωνία, Σλοβακία). Ομοίως, στο κεφάλαιο 7 εξετάζουμε την προσαρμογή 10 συναλλαγματικών ισοτιμιών έναντι του ευρώ (των χωρών που εισήχθησαν στην ΕΕ το Μάιο του 2004) ως προς την ισορροπία της ΙΑΔ. Στο κεφάλαιο αυτό χαλαρώνουμε την υπόθεση της γραμμικής προσαρμογής κι εκτιμούμε τόσο γραμμικά όσο και μη-γραμμικά υποδείγματα. Το κεφάλαιο 8 πραγματεύεται την εκτίμηση της ισορροπίας των νομισμάτων της Πολωνίας, της Ουγγαρίας, της Σλοβακίας και της Μάλτας μέσω των υποδειγμάτων BEER & PEER. Στο κεφάλαιο 9 παρουσιάζουμε μια εναλλακτική μέθοδο ελέγχου της υπόθεσης αποτελεσματικών αγορών και την εφαρμόζουμε εμπειρικά στις αγορές συναλλάγματος της Τσεχίας, Πολωνίας και Σλοβακίας. Τέλος, στο κεφάλαιο 10 παρουσιάζουμε συνοπτικά την βιβλιογραφία σχετικά με τις συναλλαγματικές κρίσεις κι επιχειρούμε να αναδείξουμε τους συνδέσμους μεταξύ ισορροπίας συναλλαγματικών ισοτιμιών, αποτελεσματικών αγορών και συναλλαγματικών κρίσεων.

2. Ισοδυναμία Αγοραστικής Δύναμης

Η Ισοδυναμία Αγοραστικής Δύναμης (ΙΑΔ) είναι βασισμένη στο «νόμο της μιας τιμής» (Law of One Price), σύμφωνα με την οποία οι τιμές δύο όμοιων αγαθών μεταξύ δύο χωρών πρέπει να είναι ίσες όταν μετατραπούν σε κοινό νόμισμα. Η συνθήκη της

ΙΑΔ παρουσιάζεται στην βιβλιογραφία σε δύο μορφές. Η μορφή της απόλυτης ΙΑΔ (absolute PPP) υπονοεί ότι η συναλλαγματική ισοτιμία μεταξύ των νομισμάτων δύο χωρών πρέπει να είναι ίση με την αναλογία των τιμών τους. Ωστόσο, οι Froot & Rogoff (1995) υποστηρίζουν ότι η απόλυτη ΙΑΔ δεν είναι δυνατόν να ισχύει ακόμα κι αν ο «νόμος της μιας τιμής» βρίσκεται σε ισχύ. Η απόλυτη ΙΑΔ μπορεί να ισχύει εάν υποθέσουμε ότι οι δύο χώρες έχουν τα ίδια ακριβώς καλάθια κατανάλωσης, το οποίο δεν είναι ρεαλιστική υπόθεση.

Από την άλλη πλευρά, σύμφωνα με την μορφή της σχετικής ΙΑΔ (relative PPP), η συναλλαγματική ισοτιμία και οι σχετικές τιμές πρέπει να μεταβάλλονται με την ίδια αναλογία. Με άλλα λόγια, οι διακυμάνσεις της συναλλαγματικής ισοτιμίας πρέπει να αντισταθμίζονται από τις μεταβολές του σχετικού επιπέδου τιμών. Η μορφή της σχετικής ΙΑΔ επιτρέπει στους ερευνητές να αποδείξουν ότι η υπόθεση της ΙΑΔ είναι αληθινή ακόμα κι αν οι χώρες έχουν πολύ διαφορετικά ποσοστά πληθωρισμού.

Εντούτοις, δεν υπάρχει στην εμπειρική βιβλιογραφία ισχυρή ένδειξη ότι οι μεταβολές της συναλλαγματικής ισοτιμίας είναι ανάλογες προς τις μετατοπίσεις του σχετικού επιπέδου τιμών. Αυτό το φαινόμενο είναι γνωστό ως ο «γρίφος της ισοδυναμίας αγοραστικής δύναμης» (PPP puzzle), το οποίο μπορεί να αναλυθεί σε δύο επιμέρους γρίφους. Ο πρώτος περιγράφει τις μεγάλες αποκλίσεις από την ισορροπία ΙΑΔ (PPP equilibrium) κατά την βραχυχρόνια περίοδο ενώ ο δεύτερος αντιστοιχεί στην πολύ αργή σύγκλιση στην ισορροπία ΙΑΔ, γεγονός που αποδυναμώνει την επαλήθευση της συνθήκης ΙΑΔ κατά την μακροχρόνια περίοδο. Η δυσκαμψία τιμών κατά την βραχυχρόνια περίοδο μπορεί να εξηγήσει την αδυναμία εμπειρικής εφαρμογής της συνθήκης ΙΑΔ (Dornbusch, 1976), ωστόσο θα περιμέναμε πλήρη εφαρμογή της κατά την μακροχρόνια περίοδο, όπου οι τιμές γίνονται εύκαμπτες. Αντίθετα, εμπειρικές μελέτες δείχνουν υψηλές εκτιμήσεις «ημι-ζωής» (half-life) που ισοδυναμούν με καθυστερημένη σύγκλιση στην ισορροπία ΙΑΔ.

Ένα ευρύ φάσμα οικονομετρικών τεχνικών έχει χρησιμοποιηθεί στην βιβλιογραφία προκειμένου να ελεγχθεί η εμπειρική εφαρμογή της υπόθεσης ΙΑΔ κατά την μακροχρόνια περίοδο. Μελέτες που βασίζονται στον έλεγχο μοναδιαίας ρίζας (unit root) στην πραγματική συναλλαγματική ισοτιμία δεν παρουσιάζουν ενθαρρυντικά στοιχεία για την επαλήθευση της ΙΑΔ (π.χ. Alba & Park, 2003 και Holmes, 2000). Αυτό μπορεί να οφείλεται στην χαμηλή ισχύ των συγκεκριμένων ελέγχων. Από την άλλη πλευρά, μονομεταβλητοί και πολυμεταβλητοί έλεγχοι συνολοκλήρωσης (cointegration) παρουσιάζουν καλύτερα αποτελέσματα, αλλά και πάλι η συνθήκη της ΙΑΔ δεν φαίνεται να ισχύει σε όλες τις περιπτώσεις (π.χ. Wang, 2000).

Οι ερευνητές μπορούν να αυξήσουν την ισχύ των ελέγχων τους είτε χρησιμοποιώντας μεγαλύτερο εύρος χρονολογικών δεδομένων (long span of data) – π.χ. Lothian & Taylor (1996) – είτε χρησιμοποιώντας μεθόδους εξατομικευμένων δεδομένων (panel data methods). Μελέτες που εξετάζουν την ύπαρξη μοναδιαίας ρίζας και συνολοκλήρωσης σε εξατομικευμένα δεδομένα (panel unit root & panel cointegration, αντίστοιχα) παρουσιάζουν περισσότερο ικανοποιητικά αποτελέσματα, ωστόσο κι εδώ η απόρριψη της συνθήκης ΙΑΔ δεν είναι ασυνήθιστο φαινόμενο (π.χ. Basher & Mohsin, 2004 και Drine & Rault, 2003).

Εκτός από την χαμηλή ισχύ κάποιων οικονομετρικών τεχνικών, η ασθενής ένδειξη εμπειρικής εφαρμογής της συνθήκης ΙΑΔ μπορεί να οφείλεται στην ύπαρξη απότομων μεταβολών στις χρονολογικές σειρές (structural breaks) καθώς επίσης και στην μη-γραμμική συμπεριφορά των συναλλαγματικών ισοτιμιών και των μακροοικονομικών μεταβλητών. Η ύπαρξη απότομης μεταβολής (structural break) στην πραγματική συναλλαγματική ισοτιμία μπορεί να θεωρηθεί ως αρνητική ένδειξη για την επαλήθευση της υπόθεσης της ΙΑΔ. Ωστόσο, στην περίπτωση κατά την οποία η υπόθεση της μοναδιαίας ρίζας στην πραγματική ισοτιμία απορρίπτεται, όταν τουλάχιστον μια απότομη μεταβολή έχει αξιολογηθεί, σημαίνει ότι η πραγματική συναλλαγματική ισοτιμία ακολουθεί το «λευκό θόρυβο» (white noise process). Σ' αυτή την περίπτωση, μια νέα μορφή της συνθήκης ΙΑΔ βρίσκεται σε ισχύ, η οποία ονομάζεται «οιωνεί-ΙΑΔ» - "quasi-PPP" - (Hegwood & Papell, 1998). Τέλος, πρόσφατες εμπειρικές μελέτες που εξετάζουν τη μη-γραμμική συμπεριφορά των συναλλαγματικών ισοτιμιών (π.χ. Taylor κ. α., 2001 και Sarno κ. α., 2004) κατάφεραν να λύσουν τον γρίφο της ΙΑΔ, παρουσιάζοντας ταχύς διαδικασίες σύγκλισης προς την ισορροπία ΙΑΔ.

3. Υποδείγματα Προσδιορισμού Συναλλαγματικών Ισοτιμιών

Το κεφάλαιο αυτό περιγράφει συνοπτικά τις βασικές θεωρητικές αρχές και την εμπειρική εφαρμογή τριών παραδοσιακών υποδειγμάτων προσδιορισμού συναλλαγματικών ισοτιμιών. Το Μονεταριστικό υπόδειγμα (monetary model) των Frenkel (1976), Kouri (1976) και Mussa (1976, 1979) - γνωστό κι ως υπόδειγμα ευκαμψίας τιμών (flexible-price model) - είναι το παλαιότερο υπόδειγμα συναλλαγματικών ισοτιμιών. Το κύριο χαρακτηριστικό αυτής της προσέγγισης είναι η ευκαμψία τιμών τόσο στην μακροχρόνια όσο και στη βραχυχρόνια περίοδο, αλλά και η επικέντρωση στην εξέταση της αγοράς χρήματος. Σύμφωνα με το υπόδειγμα αυτό, η ονομαστική συναλλαγματική ισοτιμία είναι συνάρτηση της σχετικής προσφοράς χρήματος, του σχετικού εισοδήματος και της επιτοκιακής διαφοράς. Μια υψηλότερη αύξηση στην εγχώρια προσφορά χρήματος αναμένεται να υποτιμήσει το εγχώριο νόμισμα. Το αυξανόμενο απόθεμα χρήματος αυξάνει το εγχώριο επίπεδο τιμών, γεγονός που καθιστά τα εγχώρια αγαθά λιγότερο ανταγωνιστικά. Κατά συνέπεια, η ζήτηση εγχωρίων αγαθών μειώνεται ενώ η ζήτηση για ξένα αγαθά αυξάνεται. Έτσι, το εγχώριο νόμισμα υποτιμάται.

Μια σχετικά υψηλότερη αύξηση στο εγχώριο εισόδημα πρόκειται να ανατιμήσει το εγχώριο νόμισμα. Η αύξηση του εισοδήματος προκαλεί αύξηση στην εγχώρια ζήτηση χρήματος και δεδομένης της προσφοράς χρήματος σταθερής, δημιουργείται υπερβάλλουσα ζήτηση εγχωρίου χρήματος. Η ισορροπία στην αγορά χρήματος θα αποκατασταθεί εφόσον τα οικονομούντα άτομα μειώσουν τις δαπάνες τους για κατανάλωση. Έτσι, το εγχώριο επίπεδο τιμών μειώνεται και μέσω της συνθήκης ΙΑΔ επέρχεται μείωση στην συναλλαγματική ισοτιμία (δηλαδή το εγχώριο νόμισμα ανατιμάται).

Αντίθετα, μια μεγαλύτερη αύξηση στο επιτόκιο της εγχώριας οικονομίας αναμένεται να προκαλέσει αύξηση της συναλλαγματικής ισοτιμίας. Συγκεκριμένα, το υψηλότερο επιτόκιο θα μειώσει τη ζήτηση χρήματος και δεδομένου ότι η προσφορά χρήματος παραμένει αμετάβλητη, προκαλείται υπερβάλλουσα προσφορά χρήματος. Μέρος της υπερβάλλουσας προσφοράς χρήματος υπερθερμαίνει την εσωτερική κατανάλωση, γεγονός που δημιουργεί ανοδικές τάσεις στο εγχώριο επίπεδο τιμών. Κατά συνέπεια, τα ξένα αγαθά είναι προτιμητέα από τα εσωτερικά, καθώς είναι φθηνότερα. Το εμπορικό ισοζύγιο επιδεινώνεται και η συναλλαγματική ισοτιμία αυξάνεται, δηλ. το εγχώριο νόμισμα υποτιμάται.

Το υπόδειγμα του Dornbusch, γνωστό κι ως υπόδειγμα δυσκαμψίας τιμών (sticky-price model), αποτελεί ειδική περίπτωση του μονεταριστικού υποδείγματος. Το υπόδειγμα αυτό, όπως παρουσιάσθηκε από τον Dornbusch (1976), υποθέτει μεταξύ άλλων πλήρη κινητικότητα κεφαλαίων (που σημαίνει ότι ισχύει η συνθήκη του Ακάλυπτου Αρμπιτράζ Επιτοκίου – ΑΑΕ), πλήρη απασχόληση και δυσκαμψία τιμών κατά την βραχυχρόνια περίοδο. Το υπόδειγμα του Dornbusch συχνά αναφέρεται κι ως «υπόδειγμα υπερακόντισης» (overshooting model) επειδή βραχυχρόνια η τρέχουσα συναλλαγματική ισοτιμία έχει την τάση να υπερακοντίζει την μακροχρόνια ισορροπία της. Αυτό σημαίνει ότι η συναλλαγματική ισοτιμία βρίσκει τα επίπεδα ισορροπίας της μόνο κατά τη μακροχρόνια περίοδο. Στη βραχυχρόνια περίοδο, η συναλλαγματική ισοτιμία είναι εκτός ισορροπίας λόγω της αργής προσαρμογής των τιμών.

Όπως στην περίπτωση του μονεταριστικού υποδείγματος (με ευέλικτες τιμές), η αύξηση της εγχώριας προσφοράς χρήματος αναμένεται να υποτιμήσει το εγχώριο νόμισμα. Το διάγραμμα 3.4. (Κεφάλαιο 3, ενότητα 3.2.1, σελ. 65) απεικονίζει τις επιπτώσεις μιας επεκτατικής νομισματικής πολιτικής και περιγράφει το φαινόμενο της υπερακόντισης. Στο σημείο Α, οι αγορές χρήματος και αγαθών βρίσκονται σε ισορροπία. Όμως, η αύξηση της ονομαστικής προσφοράς χρήματος προκαλεί αύξηση και της πραγματικής προσφοράς χρήματος γιατί το επίπεδο των τιμών είναι σταθερό κατά την βραχυχρόνια περίοδο. Αυτό προκαλεί την πτώση των επιτοκίων στην εγχώρια οικονομία και την διολίσθηση του εγχωρίου νομίσματος. Το νέο (βραχυχρόνιο) σημείο ισορροπίας είναι το σημείο Β, όπου η ονομαστική συναλλαγματική ισοτιμία έχει υπερακοντίσει την μακροχρόνια ισορροπία της. Για παράδειγμα, αύξηση της προσφοράς χρήματος κατά 1% επιφέρει υποτίμηση περισσότερο από 1%. Αυτό συμβαίνει γιατί, λόγω της βραχυχρόνιας δυσκαμψίας τιμών, η νομισματική επέκταση επηρεάζει μόνο την αγορά συναλλάγματος. Στο σημείο B, η υπερβάλλουσα ζήτηση για εγχώρια αγαθά (λόγω της πτώσης του επιτοκίου και της διολίσθησης του νομίσματος) δημιουργεί ανοδικές τάσεις στο εγχώριο επίπεδο τιμών. Έτσι, κατά την μακροχρόνια περίοδο (όπου οι τιμές προσαρμόζονται ευέλικτα) η πραγματική προσφορά χρήματος μειώνεται και το επιτόκιο αυξάνεται. Η μετακίνηση από το σημείο B στο C δείχνει την ανατίμηση του εγχωρίου νομίσματος. Το σημείο C αποτελεί το σημείο μακροχρόνιας ισορροπίας, όπου και οι δύο αγορές (χρήματος και αγαθών) βρίσκονται σε ισορροπία.

Το υπόδειγμα του χαρτοφυλακίου (Portfolio Balance model, Branson 1977) εισάγει ένα ευρύ φάσμα περιουσιακών στοιχείων, όπως εγχώριο χρήμα, εγχώρια και ξένα χρεόγραφα. Οι υποθέσεις του υποδείγματος αυτού διαφοροποιούνται από τις υποθέσεις των δύο προηγούμενων υποδειγμάτων. Έτσι, το υπόδειγμα του χαρτοφυλακίου δεν βασίζεται στην υπόθεση του Ακάλυπτου Αρμπιτράζ Επιτοκίου (Uncovered Interest Parity). Με άλλα λόγια, τα εγχώρια και τα ξένα χρεόγραφα δεν είναι τέλεια υποκατάστατα. Αυτό σημαίνει ότι οι εγχώριοι επενδυτές επιλέγουν ένα διαφοροποιημένο χαρτοφυλάκιο (diversified portfolio) περιουσιακών στοιχείων, επιτυγχάνοντας αυτό τον συνδυασμό εγχωρίου χρήματος και εγχωρίων και ξένων χρεογράφων που μεγιστοποιεί τα επενδυτικά τους κέρδη.

Σύμφωνα μ’ αυτό το υπόδειγμα, αυτές οι επενδυτικές κινήσεις προσδιορίζουν την βραχυχρόνια τιμή της ονομαστικής συναλλαγματικής ισοτιμίας, η οποία με την σειρά της καθορίζει την ισορροπία του ισοζυγίου τρεχουσών συναλλαγών (current account equilibrium). Έστω ότι η βραχυχρόνια συναλλαγματική ισοτιμία συνδυάζεται με πλεονασματικό ισοζύγιο τρεχουσών συναλλαγών, το οποίο μπορεί να εξαλειφθεί με ένα ανάλογο έλλειμμα στο ισοζύγιο κίνησης κεφαλαίων (capital account). Αυτό σημαίνει ότι οι επενδυτές συσσωρεύουν ξένα χρεόγραφα με συνέπεια να επηρεάζεται η τιμή της τρέχουσας συναλλαγματικής ισοτιμίας. Άρα, είναι φανερό ότι η μακροχρόνια ισορροπία της συναλλαγματικής ισοτιμίας επιτυγχάνεται μόνο όταν το ισοζύγιο τρεχουσών συναλλαγών βρίσκεται σε πλήρη ισορροπία.

Όσον αφορά την εμπειρική εφαρμογή αυτών των υποδειγμάτων, οι εμπειρικές μελέτες δεν υποστηρίζουν ξεκάθαρα την εφαρμογή τους στα πραγματικά δεδομένα. Για παράδειγμα, κάποιες ερευνητικές μελέτες έχουν αποδείξει ότι το μονεταριστικό υπόδειγμα είναι αξιόπιστο εργαλείο κατά την μακροχρόνια περίοδο (π.χ. MacDonald & Taylor, 1994a), ενώ άλλες εμπειρικές εφαρμογές αποτυγχάνουν να αποδείξουν την ύπαρξη συνολοκλήρωσης μεταξύ της ονομαστικής συναλλαγματικής ισοτιμίας και των προσδιοριστικών μακροοικονομικών μεταβλητών (π.χ. Cushman, 2000). Άλλες μελέτες, ενώ αποδέχονται την μακροχρόνια ισχύ του υποδείγματος, δεν καταφέρνουν να δείξουν ότι το μονεταριστικό υπόδειγμα μπορεί να εξηγήσει την βραχυχρόνια συμπεριφορά των συναλλαγματικών ισοτιμιών (π.χ. Papadopoulos & Zis, 2000).

Το υπόδειγμα της υπερακόντισης φαίνεται να έχει καλύτερη εμπειρική εφαρμογή. Αν και δεν υπάρχει ξεκάθαρο πόρισμα για την ισχύ του υποδείγματος, οι περισσότερες εμπειρικές μελέτες υποστηρίζουν την εμπειρική του εφαρμογή (π.χ. Papell, 1988). Άλλες εμπειρικές μελέτες είτε αποτυγχάνουν να θεμελιώσουν τις θεωρητικές υποθέσεις του υποδείγματος (π.χ. Faust & Rogers, 2000), είτε βρίσκουν ενδείξεις υπερακόντισης αλλά κάποιες από τις εκτιμημένες μακροοικονομικές μεταβλητές δεν είναι στατιστικά σημαντικές (π.χ. Driskill, 1981).

Από την άλλη πλευρά, η εμπειρική εφαρμογή του υποδείγματος χαρτοφυλακίου είναι ισχνή τόσο στο πλήθος των εμπειρικών μελετών όσο και στα ποιοτικά τους αποτελέσματα (π.χ. Backus, 1984). Ένας από τους λόγους είναι η έλλειψη κατάλληλων δεδομένων (data), κυρίως για τις αναπτυσσόμενες χώρες, καθώς επίσης και οι «ισχυρές» του υποθέσεις που δεν ισχύουν πάντα στην πραγματικότητα. Για παράδειγμα, δεν είναι ρεαλιστική η υπόθεση ότι οι ξένοι επενδυτές δεν επενδύουν σε χρεόγραφα της εγχώριας χώρας.

Τέλος, το κεφάλαιο αυτό υπονοεί ότι η εμπειρική εφαρμογή των παραπάνω υποδειγμάτων είναι υπό αμφισβήτηση. Λιγότερο αμφισβητήσιμη είναι η εφαρμογή του υποδείγματος του Dornbusch, κυρίως λόγω των ρεαλιστικών του υποθέσεων (π.χ. βραχυχρόνια δυσκαμψία τιμών). Ωστόσο, η συμβολή των υποδειγμάτων αυτών στην Διεθνή Μακροοικονομική Θεωρία είναι αξιοσημείωτη. Αφ’ ενός, το υπόδειγμα του Dornbusch εξηγεί πώς είναι δυνατόν το εγχώριο νόμισμα να ανατιμάται μετά από μια αύξηση της προσφοράς χρήματος (λόγω του φαινομένου της υπερακόντισης) κι αφ’ ετέρου, το υπόδειγμα χαρτοφυλακίου συμβάλει ουσιαστικά με την ενσωμάτωση των περιουσιακών στοιχείων στον προσδιορισμό της συναλλαγματικής ισοτιμίας.

4. Υποδείγματα Ισορροπίας Συναλλαγματικών Ισοτιμιών

Η έννοια της ισορροπίας της συναλλαγματικής ισοτιμίας είναι πολύ σημαντική τόσο για τις αναπτυσσόμενες όσο και για τις αναπτυγμένες χώρες. Κι αυτό γιατί, μια «λανθασμένη» τιμή της συναλλαγματικής ισοτιμίας μπορεί να επιφέρει σημαντικά προβλήματα στην εγχώρια οικονομία. Για παράδειγμα, ένα υποτιμημένο νόμισμα εισάγει υψηλό πληθωρισμό στην εγχώρια οικονομία, ενώ ένα υπερτιμημένο νόμισμα καθιστά την εγχώρια οικονομία λιγότερο ανταγωνιστική στο διεθνές εμπόριο. Συγκεκριμένα, στην περίπτωση των αναπτυσσόμενων χωρών, μια υπερτιμημένη συναλλαγματική ισοτιμία εγκυμονεί κινδύνους για πιθανές μελλοντικές συναλλαγματικές κρίσεις. Όπως είδαμε στις προηγούμενες ενότητες, τόσο τα παραδοσιακά υποδείγματα προσδιορισμού συναλλαγματικών ισοτιμιών όσο και η συνθήκη της ΙΑΔ δεν αποτελούν ισχυρά εμπειρικά εργαλεία για την εκτίμηση της συμπεριφοράς των συναλλαγματικών ισοτιμιών, γεγονός που καθιστά επιτακτική την ανάγκη αναζήτησης πιο αποτελεσματικών εργαλείων.

Ο Williamson (1985) παρουσιάζει μια εναλλακτική προσέγγιση προσδιορισμού συναλλαγματικών ισοτιμιών, κατάλληλη για μεσοχρόνια ανάλυση, η οποία ονομάζεται «Θεμελιώδης Ισορροπία Συναλλαγματικής Ισοτιμίας» (Fundamental Equilibrium Exchange Rate – FEER). Αυτή η προσέγγιση υποστηρίζει ότι η συναλλαγματική ισοτιμία βρίσκεται στα επίπεδα ισορροπίας της μόνο όταν ικανοποιείται η συνθήκη της ταυτόχρονης εσωτερικής κι εξωτερικής ισορροπίας. Η συνθήκη της εσωτερικής ισορροπίας (internal balance) ικανοποιείται όταν επιτυγχάνεται η υψηλότερη δυνατή απασχόληση σε συνδυασμό με ελεγχόμενο πληθωρισμό (στην εγχώρια οικονομία). Ωστόσο, ο Williamson προσδίδει στην συνθήκη της εξωτερικής ισορροπίας (external balance) διαφορετική έννοια απ' αυτή της συνολικής ισορροπίας (overall balance). Σύμφωνα με την παραδοσιακή της μορφή, η εξωτερική ισορροπία επιτυγχάνεται όταν η ανισορροπία στο ισοζύγιο τρεχουσών συναλλαγών εξισορροπείται από κεφαλαιακές ροές. Αντίθετα, ο Williamson ορίζει ότι η εξωτερική ισορροπία πρέπει να ταυτίζεται με ισορροπία στο ισοζύγιο τρεχουσών συναλλαγών κι όχι με συνολική ισορροπία. Έτσι, *«ο* *στόχος πρέπει να είναι η επίτευξη ισορροπίας στο ισοζύγιο τρεχουσών συναλλαγών που θα επιτρέπει κεφαλαιακή ροή σε τέτοιο ποσοστό που θα είναι διατηρήσιμο και επιθυμητό, και κατά συνέπεια συμβατό με μακροοικονομική ισορροπία, κι όχι η εξουδετέρωση όλων των ανισορροπιών»* (Williamson, 1994, p: 183).

Άρα, η FEER είναι αυτή η συναλλαγματική ισοτιμία που εξισώνει το ισοζύγιο τρεχουσών συναλλαγών σε επίπεδα πλήρους απασχόλησης με διατηρήσιμες (sustainable) κεφαλαιακές ροές. Καθώς το διατηρήσιμο ισοζύγιο κίνησης κεφαλαίων προσδιορίζεται από τα επιθυμητά επίπεδα συνολικής αποταμίευσης κι επένδυσης, η FEER μπορεί να θεωρηθεί ως η συναλλαγματική ισοτιμία που εξισώνει το ισοζύγιο τρεχουσών συναλλαγών με την ισορροπία αποταμίευσης – επενδύσεων. Κατά συνέπεια, η ανάλυση μεταφέρεται στην εξέταση των προσδιοριστικών παραγόντων της αποταμίευσης και της επένδυσης.

Οι συναλλαγματικές ισοτιμίες παρουσιάζουν σημαντική μεταβλητότητα και σε αρκετές περιπτώσεις είναι δύσκολη η πιστοποίηση μιας μακροχρόνιας σχέσης ισορροπίας μεταξύ της συναλλαγματικής ισοτιμίας και των μακροοικονομικών μεταβλητών. Έτσι, λόγω των προβλημάτων που οι ερευνητές συχνά αντιμετωπίζουν στις οικονομετρικές τους μελέτες, η προσέγγιση FEER φαίνεται να είναι χρήσιμο εργαλείο καθώς δεν βασίζεται αποκλειστικά στην άμεση οικονομετρική ανάλυση. Ωστόσο, ένα από τα σημαντικά μειονεκτήματα του υποδείγματος αυτού είναι ότι κάποιες από τις μεταβλητές που χρησιμοποιεί δεν επηρεάζουν άμεσα την συναλλαγματική ισοτιμία. Επιπλέον, η FEER είναι μεσοχρόνια κι όχι μακροχρόνια ισορροπία.

Το υπόδειγμα της «Μπιχεβιοριστικής Ισορροπίας Συναλλαγματικής Ισοτιμίας» (Behavioural Equilibrium Exchange Rate – BEER), το οποίο παρουσιάστηκε από τους

Clark & MacDonald (1998), περιλαμβάνει την άμεση οικονομετρική μελέτη της συμπεριφοράς της συναλλαγματικής ισοτιμίας, η οποία προσδιορίζεται από τις μακροοικονομικές μεταβλητές.[2] Η προσέγγιση αυτή δεν βασίζεται σε κάποιο θεωρητικό υπόδειγμα και η ισορροπία της συναλλαγματικής ισοτιμίας καθορίζεται από τις μακροχρόνιες – διατηρήσιμες (sustainable) τιμές των μακροοικονομικών μεταβλητών. Ωστόσο, οι περισσότερες ερευνητικές μελέτες έχουν υπόψη τους τη συνθήκη της ταυτόχρονης εσωτερικής κι εξωτερικής ισορροπίας. Όπως και στην περίπτωση του υποδείγματος FEER, η συνθήκη της εσωτερικής ισορροπίας απαιτεί χαμηλό πληθωρισμό και πλήρη απασχόληση. Η συνθήκη της εξωτερικής ισορροπίας χαρακτηρίζεται από μία κατάσταση κατά την οποία οι επενδυτές είναι αδιάφοροι μεταξύ εγχωρίων και ξένων χρεογράφων, υπονοώντας την ισχύ της συνθήκης του Ακάλυπτου Αρμπιτράζ Επιτοκίου (ΑΑΕ). Επομένως, αν και συγκεκριμένο θεωρητικό υπόδειγμα δεν απαιτείται, η συνθήκη ΑΑΕ αποτελεί θεμελιώδη αρχή του υποδείγματος BEER.

Οι Clark & MacDonald (1998) εκτιμούν ότι οι πηγές απόκλισης της συναλλαγματικής ισοτιμίας από την ισορροπία της είναι: (α) παροδικοί παράγοντες που επηρεάζουν την συναλλαγματική ισοτιμία μόνο κατά την βραχυχρόνια περίοδο, (β) ένας διαταρακτικός όρος και (γ) αποκλίσεις των μακροοικονομικών μεταβλητών από τα μακροχρόνια επίπεδα ισορροπίας τους.

Το υπόδειγμα BEER είναι ένα αξιόπιστο υπόδειγμα προσδιορισμού συναλλαγματικής ισοτιμίας κυρίως γιατί η συναλλαγματική ισοτιμία είναι συνάρτηση μεταβλητών με

[2] Η απόδοση του όρου «μπιχεβιοριστικός» είναι στα πρότυπα του όρου «μονεταριστικού» (βλ. “monetary model”). Επιπλέον, ο όρος είναι δανεισμένος από την επιστήμη της Ψυχολογίας, όπου σύμφωνα με την «Μπιχεβιοριστική Θεωρία» το περιβάλλον του παιδιού επηρεάζει σημαντικά την συμπεριφορά του. Έτσι κι εδώ, το μακροοικονομικό περιβάλλον είναι αυτό που προσδιορίζει την συμπεριφορά της συναλλαγματικής ισοτιμίας.

άμεση επίδραση στην συμπεριφορά της. Με άλλα λόγια, η ισορροπία της συναλλαγματικής ισοτιμίας προσδιορίζεται από τις διατηρήσιμες τιμές αυτών των μεταβλητών κι όχι από την γενική μακροοικονομική ισορροπία. Αντίθετα, η υψηλή μεταβλητότητα των συναλλαγματικών ισοτιμιών, μπορεί να προκαλέσει προβλήματα στην αξιοπιστία των οικονομετρικών τεχνικών. Κυρίως στην περίπτωση αναπτυσσόμενων χωρών, το παραπάνω αποτελεί σημαντικό μειονέκτημα της προσέγγισης BEER.

Το υπόδειγμα της «Φυσικής Πραγματικής Συναλλαγματικής Ισοτιμίας» (Natural Real Exchange Rate – NATREX), το οποίο παρουσιάστηκε από τον Stein (1994), είναι κι αυτό συμβατό με την συνθήκη της ταυτόχρονης εσωτερικής κι εξωτερικής ισορροπίας. Ομοίως με το υπόδειγμα FEER, η προσέγγιση NATREX εξισώνει το διατηρήσιμο ισοζύγιο τρεχουσών συναλλαγών με την ισορροπία αποταμίευσης – επένδυσης, καθιστώντας την μεσοχρόνια ισορροπία. Ωστόσο, η συναλλαγματική ισοτιμία NATREX δεν είναι μόνο μεσοχρόνια ισορροπία αλλά και μακροχρόνια γιατί είναι συμβατή και με ισορροπία χαρτοφυλακίου.

Στη μεσοχρόνια ισορροπία το κεφαλαιακό απόθεμα και οι οφειλές προς το εξωτερικό (foreign debt) είναι εξωγενείς, ενώ στην μακροχρόνια ισορροπία είναι ενδογενείς. Η μεσοχρόνια ισορροπία απαιτεί εσωτερική κι εξωτερική ισορροπία, ενώ αντίθετα η μακροχρόνια ισορροπία, εκτός από τις παραπάνω συνθήκες, απαιτεί ότι: (α) οι καθαρές τοποθετήσεις σε ξένα χρεόγραφα είναι σταθερές, (β) το απόθεμα κεφαλαίων είναι σταθερό, (γ) τα εγχώρια και ξένα επιτόκια είναι ίσα, και (δ) δεν υπάρχουν σημαντικές αλλαγές στα συναλλαγματικά διαθέσιμα, δηλαδή δεν υπάρχουν κερδοσκοπικές κινήσεις.

Η προσέγγιση NATREX συγκεντρώνει σημαντικά πλεονεκτήματα έναντι των άλλων προσεγγίσεων. Συγκεκριμένα, σημαντικό στοιχείο αποτελεί το γεγονός ότι η NATREX είναι κατάλληλη τόσο για μεσοχρόνια όσο και για μακροχρόνια ανάλυση. Επιπλέον, η εισαγωγή των χρεογράφων στο υπόδειγμα επιτρέπει στην ισορροπία NATREX να αποτελεί ισορροπία με δυναμική αποθέματος – ροής (dynamic stock-flow equilibrium). Τέλος, ένα σημαντικό μειονέκτημα της προσέγγισης αυτής είναι η αναντιστοιχία μεταξύ θεωρητικών κι εμπειρικών μεταβλητών. Συγκεκριμένα, μεταβλητές όπως το κεφαλαιακό απόθεμα και οι οφειλές προς το εξωτερικό είναι δύσκολο να μετρηθούν, κυρίως στην περίπτωση των αναπτυσσόμενων χωρών.

5. Αποτελεσματικότητα Αγοράς Συναλλάγματος

Ο Fama (1970) ορίζει ότι μια αγορά είναι «ασθενώς αποτελεσματική» (weakly efficient) όταν δεν είναι δυνατόν κανείς να πετύχει μη-κανονικά κέρδη (abnormal profits) χρησιμοποιώντας μόνο το ιστορικό παρελθόν των τιμών. Αν στις πληροφορίες που έχει στην διάθεσή του προστεθούν δημόσια ανακοινώσιμες πληροφορίες (π.χ. σχετικά με την εγχώρια προσφορά χρήματος, το εγχώριο επιτόκιο, κ.τ.λ.), αλλά παρ’ όλα αυτά είναι αδύνατη η επίτευξη υπερκερδών, τότε η αγορά χαρακτηρίζεται ως «ημι-ισχυρώς αποτελεσματική» (semi-strong efficient). Τέλος, αν είναι αδύνατον κάποιος να πετύχει υπερκέρδη χρησιμοποιώντας οποιαδήποτε δημόσια ή ιδιωτική πληροφορία, τότε η αγορά είναι «ισχυρώς αποτελεσματική» (strong efficient).

Η υπόθεση της αποτελεσματικής αγοράς (efficient market hypothesis) μπορεί να εφαρμοστεί τόσο στις αγορές χρήματος και κεφαλαίου όσο και στις αγορές συναλλάγματος. Σύμφωνα με τον ορισμό του Fama (1984), μια αγορά συναλλάγματος είναι αποτελεσματική όταν η τρέχουσα συναλλαγματική ισοτιμία αντανακλά πλήρως όλες τις διαθέσιμες πληροφορίες. Ένας γενικότερος ορισμός δίδεται από τον Jensen (1978). Μια αποτελεσματική αγορά αντλεί τις διαθέσιμες πληροφορίες μέχρι το σημείο όπου το οριακό όφελος χρήσης των πληροφοριών δεν ξεπερνά το οριακό κόστος συγκέντρωσής τους. Η υπόθεση αποτελεσματικότητας της αγοράς συναλλάγματος (Foreign Exchange Market Efficiency Hypothesis) συνήθως ταυτίζεται με την υπόθεση αμεροληψίας της προθεσμιακής ισοτιμίας (Forward Rate Unbiasedness Hypothesis), καθώς σε μια αποτελεσματική αγορά η προθεσμιακή ισοτιμία (forward rate) πρέπει να είναι αμερόληπτος εκτιμητής της προσδοκώμενης μελλοντικής ισοτιμίας (spot rate) όταν υπάρχει ουδετερότητα κινδύνου. Όμως, ο Fama (1984) υποστηρίζει ότι η προθεσμιακή ισοτιμία περιλαμβάνει ένα ασφάλιστρο κινδύνου (risk premium), το οποίο είναι ίσο με την διαφορά εγχωρίου και ξένου επιτοκίου και ουσιαστικά αντισταθμίζει τον κίνδυνο των ξένων χρεογράφων.

Οι περισσότερες εμπειρικές μελέτες, που έχουν ασχοληθεί με αυτό το ζήτημα, δεν παρουσιάζουν ενθαρρυντικά στοιχεία για την ισχύ της υπόθεσης της αποτελεσματικότητας των αγορών συναλλάγματος. Κάποιες από αυτές χρεώνουν την απόρριψη της υπόθεσης αυτής στην ύπαρξη ενός ασφάλιστρου κινδύνου στην προθεσμιακή ισοτιμία. Για παράδειγμα οι Fama (1984), Baillie & Bollerslev (1989), Naka & Whitney (1995) έχουν βρει την ύπαρξη ενός μεταβλητού ασφαλίστρου κινδύνου. Ομοίως, ο Taylor (1989) δεν μπορεί να αποδώσει την αποτυχία ισχύς της υπόθεσης στις μη-ορθολογικές προσδοκίες των επενδυτών. Αντίθετα, αυτή οφείλεται στην εμφάνιση του ασφάλιστρου κινδύνου.

Από την άλλη πλευρά, εμπειρικές μελέτες - όπως αυτές των Frankel & Froot (1987) και Hai κ. α. (1997) – δεν μπορούν να αποδώσουν την μη επαλήθευση της υπόθεσης αποτελεσματικότητας στην ύπαρξη κάποιου ασφάλιστρου κινδύνου. Στο ίδιο μήκος κύματος είναι και τα συμπεράσματα της επισκόπησης της εμπειρικής βιβλιογραφίας που επιχειρεί ο Engel (1996). Τέλος, οι Liu & Maddala (1992) υποστηρίζουν ότι η επαλήθευση ή μη αυτής της υπόθεσης εξαρτάται σε μεγάλο βαθμό από την συχνότητα των δεδομένων, η οποία δεν μπορεί να είναι η ίδια για όλες τις αγορές.

Ωστόσο, η απόρριψη της παραπάνω υπόθεσης δεν σημαίνει πάντα ότι η εξεταζόμενη αγορά δεν είναι αποτελεσματική. Η αποτυχία επαλήθευσής της μπορεί να οφείλεται είτε σε οικονομετρικά προβλήματα (misspecification problems) ή στην προβληματική διάρθρωση του θεωρητικού υποδείγματος (bad model problem – Fama, 1991). Ένα επίσης σημαντικό ολίσθημα τόσο σε θεωρητικό όσο και σε εμπειρικό πλαίσιο είναι το κενό που υπάρχει στην βιβλιογραφία σχετικά με την εφαρμογή αυτής της υπόθεσης σε αναπτυσσόμενες αγορές συναλλάγματος. Το χρηματοπιστωτικό σύστημα των χωρών αυτών δεν είναι αναπτυγμένο και οι προθεσμιακές αγορές (αν αυτές υπάρχουν) επηρεάζονται, σε μεγάλο βαθμό, από τον κυβερνητικό παρεμβατισμό. Συνεπώς, λόγω της έλλειψης αξιοπιστίας των προθεσμιακών ισοτιμιών, η υπόθεση αμεροληψίας της προθεσμιακής ισοτιμίας (FRUH) δεν αποτελεί χρήσιμο θεωρητικό κι εμπειρικό εργαλείο όταν εξετάζονται αναπτυσσόμενες χώρες.

6. Η Συνθήκη Ισοδυναμίας Αγοραστικής Δύναμης στις Χώρες της Κεντρικής κι Ανατολικής Ευρώπης

Αυτό το κεφάλαιο εξετάζει την ισχύ της υπόθεσης ΙΑΔ στην περίπτωση τεσσάρων χωρών της Κεντρικής & Ανατολικής Ευρώπης (Τσεχία, Ουγγαρία, Πολωνία και Σλοβακία), οι οποίες πρόσφατα έγιναν νέα μέλη της ΕΕ. Ο στόχος αυτής της μελέτης είναι διττός. Πρώτον, ερευνούμε αν η συνθήκη ΙΑΔ είναι ισχύουσα συνθήκη ισορροπίας στην περίπτωση αυτών των αναπτυσσόμενων χωρών και στη συνέχεια, προσπαθούμε να αποσαφηνίσουμε τις εμπορικές σχέσεις των χωρών αυτών με την ΕΕ, τις ΗΠΑ και τους υπόλοιπους εμπορικούς εταίρους. Γι' αυτό το λόγο, για κάθε χώρα χρησιμοποιούμε δύο διμερείς συναλλαγματικές ισοτιμίες (ως προς το ευρώ και το δολάριο) και ένα δείκτη σταθμισμένης συναλλαγματικής ισοτιμίας (effective exchange rate), που μετρά την αξία του εγχωρίου νομίσματος σε σχέση με ένα καλάθι νομισμάτων. Με άλλα λόγια, η μελέτη αυτή συμβάλει με την εξέταση της συνθήκης ΙΑΔ ως βασικής σχέσης ισορροπίας συναλλαγματικών ισοτιμιών. Δεδομένης της επικείμενης ενσωμάτωσης των παραπάνω χωρών στη ζώνη του ευρώ, αναμένουμε ισχυρές εμπορικές σχέσεις με τα κράτη-μέλη της ΕΕ. Οι ισχυροί εμπορικοί σύνδεσμοι αποδεικνύονται με την αποδοχή της συνθήκης ΙΑΔ, καθώς αυτή υπονοεί έλλειψη εμπορικών προστριβών κι εμποδίων στις μεταξύ τους εμπορικές σχέσεις. Έτσι, η ομαλή εισαγωγή των χωρών αυτών στην ΟΝΕ απαιτεί, μεταξύ άλλων, την ισχύ της ΙΑΔ μεταξύ των υποψηφίων χωρών και των χωρών της ευρωζώνης.

Αρχικά, εφαρμόζουμε δύο εναλλακτικές μεθόδους ελέγχου μοναδιαίας ρίζας (ADF & PP) στις διμερείς πραγματικές συναλλαγματικές ισοτιμίες και στον δείκτη σταθμισμένης πραγματικής συναλλαγματικής ισοτιμίας. Όπως έχουμε αναφέρει στο κεφάλαιο 2, η υπόθεση της ΙΑΔ θα ισχύει αν καταφέρουμε να απορρίψουμε την υπόθεση της μη-στασιμότητας της πραγματικής συναλλαγματικής ισοτιμίας. Ακόμα κι αν ο «Νόμος της Μιας Τιμής» δεν βρίσκεται σε ισχύ, η υπόθεση της ΙΑΔ θα ισχύει αν η πραγματική ισοτιμία ακολουθεί μια διαδικασία σύγκλισης προς τον μέσο (mean reverting process). Με άλλα λόγια, οι αποκλίσεις της συναλλαγματικής ισοτιμίας από την ισορροπία της ΙΑΔ πρέπει να είναι μόνο παροδικές.

Τα αποτελέσματα δείχνουν, όσον αφορά τις διμερείς ισοτιμίες, ότι μόνο στην περίπτωση της Πολωνίας μπορούμε να ισχυριστούμε την ισχύ της υπόθεσης ΙΑΔ. Επιπλέον, η σταθμισμένη πραγματική συναλλαγματική ισοτιμία του Πολωνικού ζλότυ (zloty) είναι χρονικά στάσιμη, που σε συνδυασμό με τα παραπάνω αποδεικνύει τις ικανοποιητικές εμπορικές σχέσεις της Πολωνίας με τους εμπορικούς της εταίρους. Ωστόσο, τα ίδια ικανοποιητικά αποτελέσματα δεν ισχύουν για τις υπόλοιπες χώρες. Παρ' όλο που οι σταθμισμένες πραγματικές ισοτιμίες της Σλοβακικής και της Τσεχικής κορώνας (crown) είναι χρονικά στάσιμες, η ύπαρξη μοναδιαίας ρίζας στις διμερείς ισοτιμίες τόσο της Τσεχίας όσο και της Σλοβακίας υποδηλώνει ότι οι εμπορικές σχέσεις με τρίτους εμπορικούς εταίρους είναι περισσότερο αναπτυγμένες από την εμπορική συναλλαγή των δύο αυτών χωρών με δύο βασικούς εταίρους, όπως οι ΗΠΑ και η ΕΕ. Στην περίπτωση της Ουγγαρίας, η υπόθεση της μοναδιαίας ρίζας δεν μπορεί να απορριφθεί σε καμία μορφή πραγματικής συναλλαγματικής ισοτιμίας.

Ωστόσο, οι συμβατικές μέθοδοι ελέγχου μοναδιαίας ρίζας είναι μη αποτελεσματικές στην περίπτωση που η χρονολογική σειρά περιέχει κάποια απότομη διαρθρωτική αλλαγή (structural break). Σύμφωνα με το κεφάλαιο 2, ελέγχουμε την ισχύ της υπόθεσης της «οιωνεί-ΙΑΔ» (quasi-PPP) στις πραγματικές ισοτιμίες όπου η μη-στασιμότητα δεν έχει απορριφθεί. Γι' αυτό τον έλεγχο χρησιμοποιούμε τη μεθοδολογία του Perron (1997), της οποίας κύριο πλεονέκτημα είναι η δυνατότητα που δίδεται στον ερευνητή να προσδιορίζει ενδογενώς την χρονική στιγμή της απότομης αλλαγής. Τα αποτελέσματα του ελέγχου δείχνουν ότι η υπόθεση της μη-στασιμότητας απορρίπτεται σε μια μόνο περίπτωση. Συγκεκριμένα, η υπόθεση της «οιωνεί-ΙΑΔ» ισχύει για την πραγματική συναλλαγματική ισοτιμία της Τσεχικής κορώνας έναντι του ευρώ. Αυτό συνεπάγεται ότι αν και η ισοτιμία αυτή ήταν χρονικά-στάσιμη, μια απότομη αλλαγή στην κλίση της σειράς ήταν υπεύθυνη για την εξαγωγή λανθασμένων συμπερασμάτων.

Παρακάτω εφαρμόζουμε ένα πολυμεταβλητό έλεγχο συνολοκλήρωσης, βασισμένο στη μέθοδο του Johansen (1988). Σε πρώτη φάση απαιτείται η ύπαρξη μιας ισχύουσας μακροχρόνιας σχέσης ανάμεσα στην ονομαστική συναλλαγματική ισοτιμία, το εγχώριο και το ξένο επίπεδο τιμών, η οποία μπορεί να πιστοποιηθεί με την εύρεση τουλάχιστον μιας σχέσης συνολοκλήρωσης. Αυτή είναι η «αναγκαία» συνθήκη για την ικανοποίηση της υπόθεσης της ΙΑΔ στη μακροχρόνια περίοδο. Αν αυτή ικανοποιείται, τότε η «ικανή» συνθήκη για την ισχύ της ΙΑΔ απαιτεί αναλογία στις μεταβολές των εγχωρίων και ξένων τιμών. Αν μόνο η αναγκαία συνθήκη ικανοποιείται, τότε η συνθήκη ΙΑΔ ισχύει στην «ασθενή» της μορφή. Επιπλέον, αν και οι δύο συνθήκες ικανοποιούνται, τότε η ΙΑΔ ισχύει στην «ισχυρή» της μορφή.

Τα αποτελέσματα δείχνουν την ύπαρξη τουλάχιστον μιας σχέσης συνολοκλήρωσης για όλα τα εκτιμημένα υποδείγματα διανύσματος αυτοπαλινδρόμησης (Vector Autoregressive – VAR - models). Ωστόσο, η υπόθεση της αναλογικότητας επαληθεύεται σε 6 από τις 8 περιπτώσεις. Κατά συνέπεια, η «ισχυρή» μορφή της υπόθεσης ΙΑΔ ισχύει γι΄ αυτά τα 6 υποδείγματα, ενώ για τα υπόλοιπα 2 μόνο η «ασθενής» μορφή της βρίσκεται σε ισχύ. Αυτό συμβαίνει στις συναλλαγματικές ισοτιμίες του Ουγγρικού φιορίνι (forint) και της Σλοβακικής κορώνας (crown) έναντι του ευρώ. Αντίθετα, οι αντίστοιχες διμερείς ισοτιμίες ως προς το Αμερικάνικο δολάριο είναι συμβατές με την «ισχυρή» μορφή της υπόθεσης ΙΑΔ. Αυτό το γεγονός υποδηλώνει την σημαντική επιρροή της Αμερικανικής οικονομίας σ’ αυτές τις χώρες, παρ’ όλο που αποτελούν μέλη της ΕΕ. Ωστόσο, μπορεί αυτό να σημαίνει ότι, κατά την τρέχουσα περίοδο, οι χώρες αυτές εξακολουθούν να έχουν στενότερες εμπορικές σχέσεις με τις ΗΠΑ παρά με την ΕΕ; Η απάντηση στο ερώτημα δεν μπορεί να είναι κατηγορηματικά θετική ή αρνητική. Αυτό που ισχυριζόμαστε είναι ότι η παρούσα ανάλυση χαρακτηρίζει καλύτερα τις παρελθούσες, κι όχι τις τρέχουσες, εμπορικές σχέσεις. Επομένως, απαιτούνται περισσότερα δεδομένα (δηλαδή, νέες παρατηρήσεις) προκειμένου να εντοπίσουμε την αυξημένη εμπορική δραστηριότητα, και τις συνέπειές της, μεταξύ των υποψήφιων χωρών και της ΕΕ.

Συγκρίνοντας τα αποτελέσματα από τις μεθόδους ελέγχου μοναδιαίας ρίζας με αυτής του πολυμεταβλητού ελέγχου συνολοκλήρωσης, παρατηρούμε ότι η τελευταία μέθοδος παρουσιάζει περισσότερο ικανοποιητικά αποτελέσματα για την ισχύ της συνθήκης ΙΑΔ κατά τη μακροχρόνια περίοδο. Επιπλέον, δεν μπορούμε να αποδώσουμε την αδυναμία επαλήθευσής της στην εμφάνιση απότομων μεταβολών (breaks), καθώς η συνθήκη της «οιωνεί-ΙΑΔ» ικανοποιείται σε μία μόνο περίπτωση. Έτσι, επικεντρώνοντας την ανάλυση στην μέθοδο της συνολοκλήρωσης, μπορούμε να αποδεχθούμε την ΙΑΔ ως μια ικανή συνθήκη ισορροπίας των συγκεκριμένων συναλλαγματικών ισοτιμιών. Επιπλέον, το γεγονός ότι η συνθήκη ΙΑΔ ισχύει μεταξύ των υποψήφιων χωρών και της ευρωζώνης, υπονοεί την ύπαρξη ισορροπίας στην συναλλαγματική τους ισοτιμία έναντι του ευρώ καθώς επίσης και τις αναπτυγμένες εμπορικές τους σχέσεις. Κατά συνέπεια, αυτή η μελέτη παρουσιάζει ενθαρρυντικά στοιχεία για την ομαλή ένταξή τους στην ΟΝΕ.

7. Μη-Γραμμική Προσαρμογή Συναλλαγματικών Ισοτιμιών στην Διευρυμένη Ευρωζώνη

Ως φυσική συνέχεια του προηγούμενου κεφαλαίου ελέγχουμε την ισχύ της υπόθεσης ΙΑΔ για 10 υποψήφιες - προς ένταξη στην ΟΝΕ - χώρες (για την περίοδο 1990 – 2006), καθώς επίσης και για τα κράτη-μέλη της Ευρωζώνης (για την περίοδο 1980 – 1998). Καθιστώντας το ευρώ ως νόμισμα αναφοράς (numeraire currency), εφαρμόζουμε γραμμικές και μη-γραμμικές μεθόδους. Συγκεκριμένα, οι εκτιμήσεις του γραμμικού υποδείγματος ADF συγκρίνονται με τις εκτιμήσεις του μη-γραμμικού υποδείγματος αυτοπαλινδρόμησης με αυτο-διεγειρόμενο κατώφλι (Self-Exciting Threshold Autoregressive – SETAR - model). Η συνεισφορά της παρούσης μελέτης έγκειται στην σημαντικότητα που αποδίδεται στην ισχύ της συνθήκης ΙΑΔ για την ομαλή ένταξη των υποψηφίων χωρών στην ευρωζώνη. Επιπλέον, η εκτίμηση του μη-γραμμικού υποδείγματος μας δίνει την δυνατότητα να προσεγγίσουμε την πραγματική διαδικασία σύγκλισης προς την ισορροπία της ΙΑΔ. Τέλος, συγκρίνοντας τα αποτελέσματα της ανάλυσης για τις υποψήφιες χώρες με την ανάλυση για τις χώρες της Ευρωζώνης, παρέχουμε μια εικόνα για την πρόοδο οικονομικής ολοκλήρωσης στην Ευρώπη, καθώς επίσης και προσδοκίες για την διαδικασία ενσωμάτωσης των υποψηφίων χωρών στην ΟΝΕ.

Ιστορικά, ο Heckscher (1916) ήταν ο πρώτος που αναφέρθηκε στην μη-γραμμική συμπεριφορά των συναλλαγματικών ισοτιμιών λόγω του συναλλακτικού κόστους. Το συναλλακτικό κόστος, που μπορεί να αφορά το μεταφορικό κόστος, δασμούς και μη-δασμικούς φόρους, επηρεάζει άμεσα την διαδικασία του αρμπιτράζ αγαθών και κατά συνέπεια την ισχύ της υπόθεσης ΙΑΔ. Όπως είδαμε και στο κεφάλαιο 2, ο «νόμος της μιας τιμής» υποστηρίζει ότι δύο όμοια αγαθά - σε δύο χώρες – πρέπει να έχουν την ίδια τιμή αν αυτή μετατραπεί στο ίδιο νόμισμα. Η λογική πίσω από το «νόμο της μιας τιμής» είναι ότι το αρμπιτράζ αγαθών εξισώνει τις τιμές. Ωστόσο, η ύπαρξη συναλλακτικού κόστους καθιστά το αρμπιτράζ μη-κερδοφόρο.

Σύγχρονα θεωρητικά υποδείγματα (O'Connell, 1998a και Obstfeld & Taylor, 1997) δείχνουν ότι τα συναλλακτικά κόστη δημιουργούν μια ζώνη αδράνειας για την πραγματική συναλλαγματική ισοτιμία, μέσα στην οποία το αρμπιτράζ είναι ζημιογόνο. Εμπειρικά, τέτοιου είδους μη-γραμμική συμπεριφορά μπορεί να εκτιμηθεί με υποδείγματα που επιτρέπουν στους αυτοπαλίδρομους συντελεστές να μεταβάλλονται στο χρόνο. Τέτοια υποδείγματα είναι γνωστά ως «Υποδείγματα Αυτοπαλινδρόμησης Κατωφλίου» (Threshold Autoregressive – TAR – models).

Σύμφωνα με τα θεωρητικά υποδείγματα, τα υποδείγματα TAR επιτρέπουν την ύπαρξη μιας ζώνης αδράνειας μέσα στην οποία δεν γίνεται καμία προσαρμογή στις συναλλαγματικές ισοτιμίες. Έτσι, η πραγματική συναλλαγματική ισοτιμία είναι μη-στάσιμη εντός της ζώνης αδράνειας. Αντίθετα, το αρμπιτράζ γίνεται κερδοφόρο και η διαδικασία προσαρμογής της συναλλαγματικής ισοτιμίας είναι στάσιμη έξω απ' αυτή τη ζώνη. Αυτό συνεπάγεται ότι οι αποκλίσεις από την ισορροπία της ΙΑΔ θα είναι εξακολουθητικές αν αυτές είναι μικρές και θα περιορίζονται συνεχώς αν αυτές είναι μεγάλες.

Το γραμμικό υπόδειγμα ADF παρουσιάζει αποτελέσματα που υποστηρίζουν την στασιμότητα των πραγματικών συναλλαγματικών ισοτιμιών των υποψηφίων χωρών έναντι το ευρώ (βλ. Κεφ. 7, πίνακας 7.1., σελ. 193). Αν και αυτό αποτελεί επαλήθευση της συνθήκης ΙΑΔ, οι αντίστοιχες εκτιμήσεις «ημι-ζωής» αποδεικνύουν ότι οι συναλλαγματικές ισοτιμίες συγκλίνουν πολύ αργά προς την ισορροπία της ΙΑΔ (βλ. Κεφ. 7, πίνακας 7.5., σελ. 200). Για παράδειγμα, οι αποκλίσεις της ισοτιμίας Κυπριακής λίρας/ευρώ θα μειωθούν κατά 50% σε περίπου 69 μήνες.

Όσον αφορά τα αποτελέσματα του ίδιου υποδείγματος για τις χώρες-μέλη της ευρωζώνης (για την περίοδο 1980-1998), όλες οι πραγματικές συναλλαγματικές ισοτιμίες έναντι του ευρώ, εκτός των Γαλλικού φράγκου/ευρώ και Ολλανδικού φιορίνι/ευρώ, ακολουθούν «τυχαίο περίπατο» (random walk). Ακόμα και στις περιπτώσεις όπου η συνθήκη ΙΑΔ φαίνεται να επαληθεύεται, η διαδικασία προσαρμογής είναι εξαιρετικά αργή. Αναφέρουμε ενδεικτικά ότι οι εκτιμήσεις «ημι-ζωής» στις παραπάνω ισοτιμίες υπονοούν μείωση των αποκλίσεων κατά το ήμισυ σε 36 χρόνια.

Η σημαντική αυτή καθυστέρηση στην προσαρμογή των συναλλαγματικών ισοτιμιών μπορεί να είναι παραπλανητική και να οφείλεται στα μη-γραμμικά χαρακτηριστικά των χρονολογικών σειρών. Είναι γεγονός ότι τα γραμμικά υποδείγματα ελέγχου μοναδιαίας ρίζας μεροληπτούν υπέρ της αποδοχής της υπόθεσης μη-στασιμότητας όταν η σειρά χαρακτηρίζεται από μη-γραμμική συμπεριφορά. Έτσι, είναι χρήσιμο να εξετάσουμε αν το γραμμικό υπόδειγμα αυτοπαλινδρόμησης ή το μη-γραμμικό υπόδειγμα TAR χαρακτηρίζει την συμπεριφορά των συναλλαγματικών ισοτιμιών. Τα αποτελέσματα (βλ.

Κεφ. 7. πίνακας 7.3, σελ. 197) δείχνουν ότι η υπόθεση γραμμικότητας μπορεί να γίνει δεκτή μόνο για τις περιπτώσεις της Εσθονίας και της Ουγγαρίας. Επιπροσθέτως, η μοναδική πραγματική συναλλαγματική ισοτιμία (από το σύμπλεγμα των χωρών της Ευρωζώνης) που ακολουθεί γραμμική προσαρμογή είναι αυτή της Ιταλικής λιρέτας έναντι του ευρώ.

Για όλες τις υπόλοιπες πραγματικές συναλλαγματικές ισοτιμίες εκτιμούμε ένα συμμετρικό υπόδειγμα αυτοπαλινδρόμησης με αυτο-διεγειρόμενο κατώφλι τριών καθεστώτων [symmetric 3-regime SETAR($l=6, q=2, d$)]. Η τάξη του αυτοπαλίνδρομου σχήματος (l) είναι ίση με 6, ενώ ο αριθμός των κατωφλίων είναι ίσος με 2. Το συμμετρικό 3-regime SETAR υπόδειγμα είναι ισοδύναμο του 2-regime SETAR, αν υποθέσουμε συμμετρία στα εξωτερικά καθεστώτα. Συνεπώς, αν ϑ είναι το μοναδικό κατώφλι (2-regime), το διπλό κατώφλι (3-regime) χαρακτηρίζεται από $(-\vartheta, \vartheta)$. Η παράμετρος καθυστέρησης (d) υποδηλώνει την καθυστερημένη αντίδραση της αγοράς στις αποκλίσεις της συναλλαγματικής ισοτιμίας από την ισορροπία της ΙΑΔ.

Σε σύγκριση με το γραμμικό υπόδειγμα, η διαδικασία προσαρμογής των συναλλαγματικών ισοτιμιών είναι αισθητά ταχύτερη όταν το μη-γραμμικό υπόδειγμα εκτιμάται. Κατά μέσο όρο, το γραμμικό υπόδειγμα αναφέρει μείωση των αποκλίσεων στο 50% σε περίπου 62 μήνες (5 χρόνια), ενώ η αντίστοιχη περίοδος για το μη-γραμμικό υπόδειγμα είναι μόλις 18 μήνες (1,5 χρόνια). Συγκεκριμένα, ο γραμμικός εκτιμητής της «ημι-ζωής» για την ισοτιμία Κυπριακής λίρας/ευρώ είναι περίπου 69 μήνες και ο αντίστοιχος μη-γραμμικός εκτιμητής είναι 12 μήνες. Η ταχύτερη διαδικασία σύγκλισης παρατηρείται στην περίπτωση της Πολωνίας (5 μήνες), ενώ στον αντίποδα η λιγότερο ταχύς μη-γραμμική διαδικασία παρατηρείται για την Σλοβενία (56 μήνες).

Όσον αφορά το σύμπλεγμα των χωρών της ευρωζώνης (για την περίοδο 1980-1998), η υπόθεση της μη-στάσιμης σειράς εντός της ζώνης αδράνειας και της στασιμότητας έξω απ' αυτήν επαληθεύεται για δύο μόνο πραγματικές συναλλαγματικές ισοτιμίες (Φιλανδικό μάρκο/ευρώ και Πορτογαλικό εσκούδο/ευρώ). Οι υπόλοιπες πραγματικές συναλλαγματικές ισοτιμίες βρέθηκαν μη-στάσιμες τόσο εντός όσο κι εκτός της ζώνης αδράνειας.

Συμπερασματικά, το κεφάλαιο αυτό ενισχύει την άποψη ότι οι υποψήφιες χώρες πρόκειται να έχουν ομαλή ένταξη στην ΟΝΕ. Οι ενδείξεις υπέρ της ισχύος της υπόθεσης ΙΑΔ και η ταχεία διαδικασία σύγκλισης των ισοτιμιών προς την ισορροπία δηλώνουν ότι οι εξεταζόμενες συναλλαγματικές ισοτιμίες (έναντι του ευρώ) ακολουθούν πορεία ισορροπίας. Τέλος, η αποτυχία επαλήθευσης της συνθήκης ΙΑΔ στην περίπτωση των μελών της ευρωζώνης, δεν μπορεί να σημαίνει ότι κατά την τρέχουσα περίοδο η οικονομική ολοκλήρωση στην Ευρώπη είναι ανεπαρκής. Ακόμα, δεν μπορούμε να ισχυριστούμε ότι οι αποκλίσεις τιμών μεταξύ των μελών της ΟΝΕ είναι μεγαλύτερες σε σχέση μ' αυτές μεταξύ των υποψηφίων χωρών και της ευρωζώνης. Αυτό που μπορούμε να ισχυριστούμε είναι ότι σήμερα η Ευρώπη είναι πιο ενοποιημένη σε σύγκριση με το παρελθόν, γεγονός που ανταποκρίνεται στις αυξημένες εμπορικές σχέσεις μεταξύ των μελών της ΕΕ.

8. Εκτίμηση Ισορροπίας Συναλλαγματικής Ισοτιμίας για τα εν δυνάμει κράτη-μέλη της ΟΝΕ

Σ' αυτό το κεφάλαιο, εξετάζουμε την πιθανότητα εμφάνισης στο μέλλον σημαντικών διακυμάνσεων στις συναλλαγματικές ισοτιμίες των υποψηφίων – προς ένταξη στην ΟΝΕ - χωρών. Συγκεκριμένα, υπολογίζουμε την ισορροπία της σταθμισμένης ονομαστικής συναλλαγματικής ισοτιμίας για την Πολωνία, την Ουγγαρία, τη Σλοβακία και τη Μάλτα. Η συνεισφορά αυτής της μελέτης στην εμπειρική βιβλιογραφία διεύρυνσης της ΟΝΕ έγκειται στην εναλλακτική απόδοση ερμηνείας του κριτηρίου σταθερότητας της συναλλαγματικής ισοτιμίας. Με άλλα λόγια, η προσέγγισή μας δέχεται το κριτήριο συναλλαγματικής ισοτιμίας (κριτήριο σύγκλισης του Μάαστριχ) ως αναγκαία αλλά όχι ικανή συνθήκη για την ένταξη των υποψηφίων χωρών στην ΟΝΕ. Η λογική είναι ότι εάν η συναλλαγματική ισοτιμία παρουσιάζει αυτήν την περίοδο σταθερότητα αλλά βρίσκεται σημαντικά μακριά από το επίπεδο ισορροπίας της, τότε αναμένεται να είναι ασταθής στο μέλλον. Επιπλέον, ένα υψηλό ποσοστό απόκλισης από την ισορροπία μπορεί να προκαλέσει μακροοικονομική αστάθεια, επειδή η ασταθής συναλλαγματική ισοτιμία έχει δυσμενείς επιπτώσεις στους μακροοικονομικούς δείκτες.

Η ισορροπία της συναλλαγματικής ισοτιμίας υπολογίζεται μέσω των υποδειγμάτων Μπιχεβιοριστικής Ισορροπίας Συναλλαγματικών Ισοτιμιών (BEER) και Μόνιμης Ισορροπίας Συναλλαγματικών Ισοτιμιών (PEER), όπως παρουσιάσθηκαν από τους Clark & MacDonald (1998) και MacDonald (2000). Όπως το κεφάλαιο 4 επεξηγεί, η προσέγγιση BEER αντιστοιχεί στην άμεση οικονομετρική ανάλυση της συμπεριφοράς της συναλλαγματικής ισοτιμίας. Η ισοτιμία BEER υπολογίζεται όταν οι πραγματικές τιμές των μακροοικονομικών μεταβλητών αντικαθίστανται από τις μακροχρόνιες τιμές ισορροπίας τους.

Αφ' ετέρου, η ισοτιμία PEER μπορεί να θεωρηθεί ως ειδική προσέγγιση της παραπάνω ισοτιμίας. Σύμφωνα με την προσέγγιση BEER, η συναλλαγματική ισοτιμία είναι συνάρτηση τόσο παροδικών όσο και μόνιμων παραγόντων. Η προσέγγιση PEER διαφέρει από την BEER υπό την έννοια ότι η ισορροπία συναλλαγματικής ισοτιμίας είναι συνάρτηση μόνο των μεταβλητών που έχουν μόνιμη επίδραση σε αυτήν. Έτσι, αποσυνθέτουμε τις μακροοικονομικές μεταβλητές σε μόνιμα και παροδικά συστατικά, τα οποία μόνιμα συστατικά καθορίζουν την ισορροπία της συναλλαγματικής ισοτιμίας.

Στην θεωρητική εξειδίκευση του υποδείγματός μας, η σχέση 8.6 (Κεφ. 8., σελ. 218) φανερώνει ότι η τρέχουσα τιμή της σταθμισμένης ονομαστικής συναλλαγματικής ισοτιμίας εξαρτάται από την διαφορά του εγχωρίου επιτοκίου από το διεθνές επιτόκιο και από τις προσδοκίες για την μελλοντική τιμή της συναλλαγματικής ισοτιμίας. Η προσδοκώμενη τιμή της συναλλαγματικής ισοτιμίας, η οποία μπορεί να θεωρηθεί κι ως η μακροχρόνια τιμή της, είναι συνάρτηση των προσδοκώμενων τιμών των μακροοικονομικών μεταβλητών. Έτσι, εκτός από την επιτοκιακή διαφορά, η μακροχρόνια συναλλαγματική ισοτιμία εξαρτάται από ένα διάνυσμα μακροοικονομικών μεταβλητών, αποτελούμενο από τους εγχώριους όρους εμπορίου, την διακράτηση ξένων χρεογράφων από εγχώριους επενδυτές και τη διεθνή τιμή του πετρελαίου.

Η οικονομετρική εκτίμηση βασίζεται κυρίως στη μέθοδο συνολοκλήρωσης του Johansen (1988). Σύμφωνα μ' αυτή τη μεθοδολογία, η αποδοχή τουλάχιστον ενός διανύσματος συνολοκλήρωσης στο εκτιμημένο υπόδειγμα VAR υποδηλώνει ότι η συναλλαγματική ισοτιμία και οι μακροοικονομικές μεταβλητές σχηματίζουν μια μακροχρόνια σχέση ισορροπίας. Αυτό σημαίνει ότι οι μακροοικονομικές μεταβλητές είναι σε θέση να ερμηνεύσουν τη συμπεριφορά της συναλλαγματικής ισοτιμίας κατά τη μακροχρόνια περίοδο. Έτσι, κανονικοποιώντας το διάνυσμα συνολοκλήρωσης, λαμβάνουμε την εξίσωση ανοιγμένης μορφής (reduced-form) με εξαρτημένη μεταβλητή την συναλλαγματική ισοτιμία. Ωστόσο, η ισχύς αυτής της εξίσωσης απαιτεί την αποδοχή της υπόθεσης της «ασθενούς εξωγένειας» (weak exogeneity). Αυτό σημαίνει ότι όλες οι ανεξάρτητες μεταβλητές της εξίσωσης της συναλλαγματικής ισοτιμίας πρέπει να είναι εξωγενείς ως προς την εξαρτημένη μεταβλητή. Με άλλα λόγια, η υπόθεση αυτή επιβεβαιώνει ότι η πορεία σύγκλισης προς την ισορροπία οφείλεται αποκλειστικά σε διορθωτικές κινήσεις της ίδιας της συναλλαγματικής ισοτιμίας. Η ανοιγμένη μορφή της εξίσωσης της συναλλαγματικής ισοτιμίας εκτιμά την μακροχρόνια τιμή της συναλλαγματικής ισοτιμίας, η οποία χαρακτηρίζεται ως «τρέχουσα ισορροπία». Σύμφωνα με το υπόδειγμα BEER (PEER), η «ολική ισορροπία» προκύπτει από την χρήση των μακροχρόνιων τιμών (μόνιμων συστατικών) των μακροοικονομικών μεταβλητών. Η εξαγωγή των μακροχρόνιων τιμών ισορροπίας γίνεται με το φίλτρο των Hodrick & Prescott (1997), ενώ η αποσύνθεση των μεταβλητών σε παροδικά και μόνιμα συστατικά γίνεται με την μέθοδο των Gonzalo & Granger (1995).

- Πολωνικό ζλότυ

Όπως φαίνεται από το διάγραμμα 8.3. (Κεφ. 8, σελ. 238), η τρέχουσα σταθμισμένη ονομαστική συναλλαγματική ισοτιμία είναι κυρίως υπερτιμημένη. Η καμπύλη BEER δείχνει ότι οι μακροχρόνιες τιμές των μακροοικονομικών μεταβλητών υπονοούν χαμηλότερη ισοτιμία από την τρέχουσα. Μοναδική περίοδος υποτίμησης είναι αυτή μεταξύ του 1998 και του 2001. Από το 2002, η συναλλαγματική ισοτιμία του ζλότυ κατέρχεται, ακολουθώντας τις τάσεις της ισοτιμίας BEER. Είναι επίσης προφανές ότι η καμπύλη PEER αναφέρει ακόμα χαμηλότερη συναλλαγματική ισοτιμία, το οποίο φαίνεται και στην σημαντική διαφορά ανάμεσα στις δύο εκτιμήσεις ισορροπίας. Αν και οι δύο προσεγγίσεις συμφωνούν ότι το ζλότυ είναι υπερτιμημένο, η προσέγγιση PEER αναφέρει πολύ μεγαλύτερο ποσοστό απόκλισης από την ισορροπία.

Σύμφωνα με την εκτίμηση της BEER, η τρέχουσα συναλλαγματική ισοτιμία βρίσκεται κοντά στα επίπεδα ισορροπίας της, καθώς το υψηλότερο ποσοστό υπερτίμησης είναι 8% και κατά μέσο όρο αποκλίνει κατά 2%. Αντίθετα, η προσέγγιση PEER αναφέρει υψηλότερο ποσοστό υπερτίμησης στο 25% και μέσο όρο απόκλισης στο 13%. Είναι όμως απαραίτητο να τονισθεί ότι και οι δύο καμπύλες απόκλισης (BEER-based misalignment & PEER-based misalignment) ακολουθούν καθοδική πορεία (προς το μηδέν), υπονοώντας την διαδικασία σύγκλισης του ζλότυ προς την ισορροπία. Στο τέλος της περιόδου, η απόκλιση BEER είναι μόλις 1%, ενώ η αντίστοιχη απόκλιση PEER έχει μειωθεί στο 7%. Η διαφορά ανάμεσα στις δύο εκτιμήσεις ισορροπίας υπονοεί ότι η ισοτιμία BEER εμπεριέχει και κάποια παροδικά στοιχεία.

- Ουγγρικό Φιορίνι

Σ’ αυτή την περίπτωση, όπως φαίνεται από το διάγραμμα 8.6 (Κεφ. 8, σελ. 243), οι δύο προσεγγίσεις παρουσιάζουν αισθητά διαφορετικά αποτελέσματα. Η προσέγγιση BEER δείχνει ότι το φιορίνι δεν αποκλίνει σημαντικά από τα επίπεδα ισορροπίας του. Ενώ το μέγιστο ποσοστό υπερτίμησης είναι 20%, ο μέσος όρος απόκλισης περιορίζεται στο 10%. Από το 1994 η καμπύλη BEER ακολουθεί ανοδική πορεία, εννοώντας την ανάγκη ανατίμησης του ουγγρικού νομίσματος. Από την άλλη πλευρά, η τρέχουσα τιμή του νομίσματος συνεχίζει την πορεία υποτίμησης μέχρι το 2001. Απ' αυτό το σημείο και μετά, η τρέχουσα συναλλαγματική ισοτιμία βρίσκεται αρκετά κοντά στην ισορροπία της, καθώς στο τέλος της περιόδου το ποσοστό απόκλισης είναι λιγότερο από 10%.

Η ισοτιμία PEER είναι ξεκάθαρα πιο χαμηλή από την ισορροπία BEER. Αυτή η διαφορά δεν αποτελεί έκπληξη καθώς σημαντικό ποσοστό των όρων εμπορίου και της τιμής πετρελαίου χαρακτηρίζεται από παροδικά συστατικά (βλ. Πίνακα 8.15, Κεφ. 8, σελ. 242). Με άλλα λόγια, η διαφορά αυτή είναι συνέπεια των υψηλών ποσοστών παροδικών στοιχείων που ενσωματώνονται στην ισοτιμία BEER. Συγκεκριμένα, το ποσοστό απόκλισης BEER δεν υπερβαίνει το 30%, ενώ αντίθετα η καμπύλη απόκλισης PEER δείχνει ότι η υπερτίμηση του φιορίνι είναι υψηλή και επίμονη (μέσος όρος υπερτίμησης 60%).

- Σλοβακική κορώνα

Η ισοτιμία BEER δείχνει ότι η Σλοβακική κορώνα ήταν αρχικά υπερτιμημένη αλλά στη συνέχεια παρουσιάζει ένα μικρό βαθμό υποτίμησης. Αυτή η αλλαγή δεν οφείλεται στην δραματική μεταβολή της συναλλαγματικής ισοτιμίας αλλά στο γεγονός ότι η υπερτίμηση – σύμφωνα με την BEER – ακολουθεί καθοδικές τάσεις. Καθ' όλη τη διάρκεια της περιόδου η τρέχουσα συναλλαγματική ισοτιμία παρουσιάζει σταθερότητα, ενώ η ισοτιμία BEER υπονοεί ανατιμητικές τάσεις για το Σλοβακικό νόμισμα. Από την άλλη πλευρά, η ισοτιμία PEER υποστηρίζει ότι η τιμή της κορώνας θα έπρεπε να είναι υψηλότερη τόσο από την τρέχουσα τιμή της όσο και από την ισοτιμία BEER. Κατά συνέπεια, η Σλοβακική κορώνα ήταν υποτιμημένη για όλη την περίοδο εκτίμησης σε αντίθεση με τον ισχυρισμό της προσέγγισης BEER όπου η περίοδος υποτίμησης διαδέχεται την περίοδο υπερτίμησης (βλ. Διάγραμμα 8.9, Κεφ. 8, σελ. 247).

Επίσης, σύμφωνα με την προσέγγιση BEER η Σλοβακική κορώνα ήταν αρχικά υπερτιμημένη αλλά στο τέλος της περιόδου ήταν πολύ κοντά στα επίπεδα ισορροπίας της. Συγκεκριμένα, ενώ η απόκλιση της συναλλαγματικής ισοτιμίας (σύμφωνα με την μεθοδολογία BEER) ήταν αρχικά 50%, αυτή συρρικνώθηκε στο 7%, φανερώνοντας την διαδικασία σύγκλισης προς την ισορροπία. Αντίθετα, η προσέγγιση PEER δείχνει μια διαδικασία απομάκρυνσης από την ισορροπία καθώς η κορώνα ήταν αρχικά πολύ κοντά στα επίπεδα ισορροπίας της (απόκλιση μόλις κατά 5%) αλλά στο τέλος της περιόδου βρέθηκε να είναι σημαντικά υποτιμημένη (απόκλιση κατά 50%). Κατά μέσο όρο, η Σλοβακική κορώνα αποκλίνει από την ισορροπία της κατά 10% και 30% σύμφωνα με τις προσεγγίσεις BEER και PEER αντίστοιχα.

- Λίρα Μάλτας

Όπως φαίνεται στο διάγραμμα 8.12 (Κεφ. 8, σελ. 252), αν και η καμπύλη BEER υπονοεί υψηλότερη τιμή από αυτή της τρέχουσας συναλλαγματικής ισοτιμίας, ο βαθμός απόκλισης της λίρας από την ισορροπία δεν είναι υψηλός. Το υψηλότερο ποσοστό απόκλισης παρατηρείται στο 2^{ο} τρίμηνο του 1993, ενώ ο μέσος όρος απόκλισης δεν ξεπερνά το 1%. Το γεγονός ότι στο τέλος της περιόδου η τρέχουσα τιμή της λίρας αποκλίνει κατά μόλις 0,01% από την ισοτιμία BEER, αναδεικνύει τον ισχυρισμό ότι η λίρα Μάλτας είναι πλήρως ισορροπημένη.

Η προσέγγιση PEER, σύμφωνη με το υπόδειγμα BEER, δείχνει ότι η συναλλαγματική ισοτιμία ήταν ασθενώς υποτιμημένη. Το υψηλότερο ποσοστό υποτίμησης δεν ξεπερνά το 4%, ενώ ο μέσος όρος απόκλισης είναι 3%. Οι καμπύλες των ισοτιμιών BEER και PEER δεν διαφέρουν σημαντικά, γεγονός που υπονοεί το χαμηλό ποσοστό παροδικών συστατικών της ισοτιμίας BEER. Πραγματικά, πάνω από το 80% και των τριών μεταβλητών, που προσδιορίζουν την ισοτιμία BEER, είναι μόνιμα συστατικά (βλ. Πίνακα 8.25, Κεφ. 8, σελ. 252).

Συμπερασματικά, η ανάλυση αυτή φανερώνει ότι οι τρέχουσες τιμές των σταθμισμένων ονομαστικών συναλλαγματικών ισοτιμιών που εξετάσαμε δεν αποκλίνουν σημαντικά από τα επίπεδα ισορροπίας τους. Κατά συνέπεια, δεν αναμένουμε μεγάλες διακυμάνσεις στις παραπάνω συναλλαγματικές ισοτιμίες, που θα σήμαινε και αδυναμία ικανοποίησης του σχετικού κριτηρίου σύγκλισης. Στο σημείο αυτό είναι αναγκαίο να αναφέρουμε ότι το κριτήριο σύγκλισης του Μάαστριχ δεν αναφέρεται στις σταθμισμένες συναλλαγματικές ισοτιμίες αλλά στις διμερείς ισοτιμίες έναντι του ευρώ. Ωστόσο, η προσέγγισή μας υποστηρίζει ότι μια ασταθής σταθμισμένη συναλλαγματική ισοτιμία μπορεί να προκαλέσει ανισορροπία και αστάθεια στις διμερείς ισοτιμίες, όπως αυτής έναντι του ευρώ. Επομένως, τα αποτελέσματα αυτής της μελέτης μας επιτρέπουν να ισχυριζόμαστε ότι οι συγκεκριμένες υποψήφιες χώρες μπορούν να ικανοποιήσουν το κριτήριο συναλλαγματικής σταθερότητας. Έτσι, η ένταξη των παραπάνω χωρών στην ΟΝΕ αναμένεται αφ’ ενός να είναι ομαλή κι αφ’ εταίρου να μην προκαλεί προβλήματα στην σταθερότητα του ευρώ.

9. Ισορροπία Συναλλαγματικών Ισοτιμιών και Αποτελεσματικότητα Αγορών Συναλλάγματος

Στο Κεφάλαιο 5 ασχοληθήκαμε με την υπόθεση της αποτελεσματικότητας των αγορών συναλλάγματος και αναλύοντας τις ιδιότητες των εμπειρικών μελετών ισχυριστήκαμε ότι αν και η υπόθεση αμεροληψίας της προθεσμιακής ισοτιμίας είναι χρήσιμο εργαλείο για αναπτυγμένες αγορές, αυτή δεν αποτελεί αξιόπιστο κριτήριο όταν εξετάζονται αναπτυσσόμενες αγορές. Στο παρών κεφάλαιο επιχειρούμε να αναδείξουμε μια νέα προσέγγιση ελέγχου της υπόθεσης αποτελεσματικών αγορών για αναπτυσσόμενες χώρες. Η μέθοδος αυτή βασίζεται στην εκτίμηση ισορροπίας συναλλαγματικών ισοτιμιών εφαρμόζοντας την προσέγγιση BEER. Η αγορά συναλλάγματος θα είναι αποτελεσματική αν η τιμή της συναλλαγματικής ισοτιμίας αντανακλά όλες τις διαθέσιμες πληροφορίες. Αν αυτό ισχύει, η τρέχουσα τιμή της συναλλαγματικής ισοτιμίας δεν θα αποκλίνει σημαντικά από την τιμή ισορροπίας της.

Η προτεινόμενη μέθοδος, η οποία επικεντρώνεται στην εξέταση των στατιστικών χαρακτηριστικών της απόκλισης από την ισορροπία[3], εφαρμόζεται εμπειρικά σε τρεις χώρες της Κεντρικής & Ανατολικής Ευρώπης (νέα μέλη της ΕΕ). Σε κάθε περίπτωση, χρησιμοποιούμε διμερείς συναλλαγματικές ισοτιμίες έναντι του ευρώ. Η συνεισφορά αυτής της μελέτης έχει διττή υπόσταση. Πρώτον, εξετάζουμε αν οι διμερείς ισοτιμίες έναντι του ευρώ βρίσκονται σε ισορροπία και δεύτερον, προτείνουμε ένα νέο θεωρητικό κι εμπειρικό πλαίσιο κατάλληλο για τον έλεγχο της υπόθεσης αποτελεσματικότητας αναπτυσσόμενων αγορών συναλλάγματος. Όσο γνωρίζουμε τη σχετική εμπειρική

[3] Η απόκλιση από την ισορροπία ορίζεται ως διαφορά της ισοτιμίας BEER από την τρέχουσα τιμή της συναλλαγματικής ισοτιμίας.

βιβλιογραφία, αυτή είναι η πρώτη φορά όπου η έννοια της ισορροπίας συναλλαγματικών ισοτιμιών εφαρμόζεται στον έλεγχο της παραπάνω υπόθεσης.

Όπως είδαμε στο Κεφάλαιο 8, η προσέγγιση BEER δεν απαιτεί συγκεκριμένο θεωρητικό πλαίσιο. Στην παρούσα μελέτη συνδυάζουμε το υπόδειγμα BEER με τις υποθέσεις του Μονεταριστικού υποδείγματος. Συγκεκριμένα, οι μεταβλητές που καθορίζουν την συμπεριφορά της συναλλαγματικής ισοτιμίας και της ισορροπίας της είναι η σχετική προσφορά χρήματος, το σχετικό εισόδημα και ο σχετικός πληθωρισμός ανάμεσα στις δύο χώρες (βλ. Σχέσεις 9.1 και 9.2, Κεφ. 9, σελ. 258).[4]

Όσον αφορά την υπόθεση της αποτελεσματικότητας, η απόκλιση από την ισορροπία δεν πρέπει να είναι σημαντικά υψηλή. Αυτή η υποχρέωση είναι προφανής καθώς ένα υψηλό ποσοστό απόκλισης θα σήμαινε ότι η τρέχουσα τιμή της συναλλαγματικής ισοτιμίας δεν είναι συμβατή με τις μακροοικονομικές μεταβλητές. Ωστόσο, το κριτήριο αυτό δεν είναι αρκετό γιατί δεν είναι σαφές ποιο ποσοστό θεωρείται υψηλό. Έτσι απαιτείται ένα πιο συγκεκριμένο κριτήριο, το οποίο αφορά την στατιστική ανάλυση της χρονοσειράς απόκλιση. Συγκεκριμένα, αν η απόκλιση είναι μη-στάσιμη [δηλαδή, I(1)], τότε υπονοείται ότι παρελθούσες τιμές μπορούν να χρησιμοποιηθούν στην πρόβλεψη μελλοντικών τιμών. Δηλαδή, όταν μια σειρά ακολουθεί «τυχαίο περίπατο», τότε παρελθόντα σοκ έχουν συνεχή επιρροή στις τρέχουσες τιμές της. Κατά συνέπεια, η απόκλιση εμπεριέχει μη-αξιοποιημένες πληροφορίες, οι οποίες μπορούν να αξιοποιηθούν για την πραγματοποίηση υπερκερδών. Με άλλα λόγια, οι διαθέσιμες πληροφορίες δεν αξιοποιούνται αποτελεσματικά από την τρέχουσα και την ισορροπία της

[4] Στο συγκεκριμένο υπόδειγμα χρησιμοποιούμε μια τροποποίηση του μονεταριστικού υποδείγματος. Έτσι, αντί για την επιτοκιακή διαφορά, χρησιμοποιούμε την πληθωριστική διαφορά.

συναλλαγματικής ισοτιμίας. Σ’ αυτή την περίπτωση, η αγορά συναλλάγματος χαρακτηρίζεται ως μη-αποτελεσματική.

Αντίθετα, μια αποτελεσματική αγορά συναλλάγματος απαιτεί την στασιμότητα της χρονοσειράς απόκλιση, δηλαδή πρέπει να είναι I(0). Αυτό σημαίνει ότι η απόκλιση δεν εμπεριέχει κάποια σημαντική πληροφορία που μπορεί να ερμηνεύσει (ή να προβλέψει) την μελλοντική τιμή της. Όλες οι διαθέσιμες πληροφορίες έχουν αξιοποιηθεί από την τρέχουσα και την τιμή ισορροπίας της συναλλαγματικής ισοτιμίας (BEER). Επιπλέον, αυτό σημαίνει ότι η τρέχουσα συναλλαγματική ισοτιμία είναι σύμφωνη με τις μακροχρόνιες τιμές των μακροοικονομικών μεταβλητών. Η αγορά συναλλάγματος αναφέρεται ως αποτελεσματική καθώς αξιοποιεί αποτελεσματικά όλες τις διαθέσιμες πληροφορίες. Με άλλα λόγια, η στασιμότητα της απόκλισης υπονοεί ότι η τρέχουσα συναλλαγματική ισοτιμία αποκλίνει κατά παροδικά μόνο συστατικά από την τιμή ισορροπίας της (δηλαδή ακολουθεί το «λευκό θόρυβο»). Σ’ αυτή την περίπτωση, η χρονοσειρά της απόκλισης ακολουθεί πορεία σύγκλισης προς το μέσο, φανερώνοντας μια διαδικασία ισορροπίας.

Είναι πολύ σημαντικό να γνωρίζουμε αν η συναλλαγματική ισοτιμία οδηγείται στην ισορροπία από τις ίδιες τις δυνάμεις της αγοράς ή καθοδηγείται μέσω κυβερνητικών παρεμβάσεων. Έτσι, χρησιμοποιούμε δύο τύπους συναλλαγματικής ισοτιμίας: (α) την επίσημη ισοτιμία έναντι του ευρώ, η οποία ανακοινώνεται από την Κεντρική Τράπεζα, και (β) την σταυροειδή ισοτιμία έναντι του ευρώ, η οποία βασίζεται στην ισχύ της υπόθεσης τριγωνικού αρμπιτράζ. Επίσης, η τελευταία αγνοεί τις θεσμικές παρεμβάσεις στην αγορά συναλλάγματος. Αν οι δύο μορφές ισοτιμίας ταυτίζονται, τότε υπονοείται ότι η επίσημη ισοτιμία προσδιορίζεται χωρίς σημαντικές θεσμικές παρεμβάσεις. Από την άλλη πλευρά, σημαντική απόκλιση στις δύο ισοτιμίες σημαίνει ότι η Κεντρική Τράπεζα παρεμβαίνει στην αγορά συναλλάγματος για να διορθώσει την όποια ανισορροπία. Όμως, οι παρεμβάσεις στην αγορά συναλλάγματος δεν είναι συμβατές με την υπόθεση της αποτελεσματικότητας, έστω κι αν οδηγούν την τιμή της συναλλαγματικής ισοτιμίας στην ισορροπίας της. Με άλλα λόγια, οι παρεμβάσεις βοηθούν την αγορά να επιτυγχάνει «φαινομενική» αποτελεσματικότητα. Κι αυτό γιατί οι παρεμβάσεις αποτελούν ένδειξη αδυναμίας της αγοράς να αξιοποιήσει αποτελεσματικά όλες τις διαθέσιμες πληροφορίες.

Η ύπαρξη μιας απότομης μεταβολής (structural break) στην χρονοσειρά της απόκλισης μπορεί να επηρεάσει την ισχύ των ελέγχων μοναδιαίας ρίζας. Έτσι, αν λαμβάνοντας υπόψη την παρουσία μιας τουλάχιστον απότομης αλλαγής καταφέρουμε να δείξουμε ότι οι μη-στάσιμες (σύμφωνα με τους συμβατούς ελέγχους μοναδιαίας ρίζας) σειρές ακολουθούν τελικά το «λευκό θόρυβο», τότε η συγκεκριμένη αγορά συναλλάγματος χαρακτηρίζεται ως «οιωνεί-αποτελεσματική». Αυτός ο όρος σημαίνει ότι ένα σοκ μπορεί να προκαλέσει μόνο παροδική αναποτελεσματικότητα. Η διαδικασία σύγκλισης προς την ισορροπία συνεχίζεται ύστερα από μια πολύ σύντομη διακοπή. Τέλος, εξετάζουμε την πιθανότητα η χρονοσειρά της απόκλισης να χαρακτηρίζεται από γενική μη-γραμμική συμπεριφορά.

Η εκτίμηση της ισοτιμίας BEER γίνεται με την μεθοδολογία του κεφαλαίου 8, με την διαφορά ότι το διάνυσμα των ανεξάρτητων μεταβλητών περιλαμβάνει τις μεταβλητές του μονεταριστικού υποδείγματος.[5] Τα αποτελέσματα δείχνουν ότι, κατά μέσο όρο, το Πολωνικό ζλότυ αποκλίνει από την ισορροπία κατά 4%. Το υψηλότερο ποσοστό

[5] Στην περίπτωση της Τσεχίας εκτιμούμε δύο υποδείγματα VAR, καθώς η επίσημη συναλλαγματική ισοτιμία δεν ταυτίζεται με την σταυροειδή ισοτιμία. Κατά συνέπεια, τα δύο υποδείγματα εξάγουν διαφορετικά ποσοστά απόκλισης από την ισορροπία.

υπερτίμησης είναι 10% και παρατηρείται τον Ιούνιο του 2001. Στο τέλος της περιόδου (Δεκέμβριος του 2005), το ζλότυ είναι υποτιμημένο κατά 3%. Όσον αφορά την Τσεχική κορώνα, η απόκλιση της σταυροειδούς ισοτιμίας παρουσιάζει μεγαλύτερη μεταβλητότητα από αυτή της επίσημης ισοτιμίας. Το υψηλότερο ποσοστό υπερτίμησης είναι 6,5% για την σταυροειδή ισοτιμία, ενώ το αντίστοιχο ποσοστό για την επίσημη ισοτιμία είναι 2%. Το υψηλότερο ποσοστό υποτίμησης είναι 4% και 3% για την σταυροειδή και την επίσημη ισοτιμία αντίστοιχα. Όμως, κατά μέσο όρο οι δύο αποκλίσεις είναι ίσες (2%). Η Σλοβακική κορώνα, κατά μέσο όρο, αποκλίνει από την ισορροπία της κατά λιγότερο από 1% (0,7%). Το υψηλότερο ποσοστό απόκλισης παρατηρείται στο τέλος της περιόδου (Δεκέμβριος του 2005). Ενώ η ισοτιμία BEER υπονοεί σταθερότητα για την ισοτιμία της κορώνας έναντι του ευρώ, η τρέχουσα συναλλαγματική ισοτιμία παρουσιάζει ανατιμητικές τάσεις. Κατά συνέπεια, στα τέλη του 2005 η κορώνα βρίσκεται να είναι υπερτιμημένη κατά 2%.

Στη συνέχεια ελέγχουμε την υπόθεση γραμμικότητας στις εκτιμημένες αποκλίσεις, χρησιμοποιώντας τον έλεγχο του Terasvirta (1994). Συγκεκριμένα, εξετάζουμε την υπόθεση ότι το γραμμικό αυτοπαλίνδρομο (AR) υπόδειγμα είναι καταλληλότερο του μη-γραμμικού αυτοπαλίνδρομου υποδείγματος ομαλής μετάβασης (Smooth Transition Autoregressive – STAR – model). Τα αποτελέσματα (βλ. Πίνακα 9.5. Κεφ. 9, σελ. 278) ενισχύουν την υπόθεση ότι οι εκτιμημένες αποκλίσεις ακολουθούν γραμμική διαδικασία προσαρμογής. Επομένως, μπορούμε να βασιστούμε στην εφαρμογή γραμμικών υποδειγμάτων.

Προκειμένου να ενισχύσουμε την αξιοπιστία του ελέγχου μας εφαρμόζουμε τρεις εναλλακτικές μεθόδους ελέγχου μοναδιαίας ρίζας. Στις δύο απ’ αυτές (ADF & PP) η υπόθεση μηδέν υποθέτει ότι η χρονοσειρά έχει μοναδιαία ρίζα, ενώ στην τρίτη μέθοδο (KPSS) η υπόθεση μηδέν αντιστοιχεί στην στασιμότητα της σειράς. Τα αποτελέσματα (βλ. Πίνακες 9.6 & 9.7, Κεφ. 9, σελ. 279) δείχνουν ότι η απόκλιση στην περίπτωση της Πολωνίας είναι στάσιμη [δηλαδή I(0)], ενώ στην περίπτωση της Σλοβακίας είναι μη-στάσιμη [δηλαδή I(1)]. Με άλλα λόγια, ενώ η πρώτη σειρά ακολουθεί «λευκό θόρυβο», η δεύτερη ακολουθεί «τυχαίο περίπατο». Κατά συνέπεια, σύμφωνα με τον προτεινόμενο ορισμό, η πρώτη αγορά δεν είναι αποτελεσματική επειδή η απόκλιση περιλαμβάνει πληροφορίες που δεν είναι συμβατές με την ισορροπία της συναλλαγματικής ισοτιμίας. Από την άλλη πλευρά, η αντίστοιχη αγορά της Πολωνίας είναι αποτελεσματική επειδή όλες οι διαθέσιμες πληροφορίες έχουν αξιοποιηθεί από την ισορροπία της συναλλαγματικής ισοτιμίας.

Όσον αφορά την αγορά της Τσεχίας, η απόκλιση της επίσημης συναλλαγματικής ισοτιμίας ακολουθεί «τυχαίο περίπατο», γεγονός που υπονοεί ότι η αγορά είναι μη-αποτελεσματική. Αντίθετα, η στασιμότητα της απόκλισης της σταυροειδούς ισοτιμίας δηλώνει την αποτελεσματική λειτουργία της αγοράς συναλλάγματος. Ωστόσο, οφείλουμε να επικεντρωθούμε στις πληροφορίες που απορρέουν από την επίσημη ισοτιμία. Επομένως, η αγορά συναλλάγματος είναι μη-αποτελεσματική λόγω των κυβερνητικών παρεμβάσεων. Αν και αυτές οι παρεμβάσεις οδηγούν την ισοτιμία πιο κοντά στα επίπεδα ισορροπίας της, αποτελούν πηγή αναποτελεσματικότητας για την αγορά. Οι κερδοσκόποι μπορούν να προβλέψουν την αντίδραση των νομισματικών αρχών και να τοποθετηθούν στην αγορά συναλλάγματος εκμεταλλευόμενοι αυτές τις πληροφορίες, οι οποίες δεν είναι συμβατές με τις μακροοικονομικές μεταβλητές. Είναι σημαντικό να τονίσουμε ότι η απόκλιση της σταυροειδούς ισοτιμίας είναι υψηλότερη απ’ αυτή της επίσημης ισοτιμίας.

Έτσι, θα αναμέναμε ισχυρότερες ενδείξεις αναποτελεσματικότητας στην σταυροειδή κι όχι στην επίσημη ισοτιμία. Το γεγονός αυτό ενισχύει την άποψη ότι το μέγεθος της απόκλισης δεν μπορεί να είναι ο μοναδικός παράγοντας που καθορίζει την αποτελεσματική λειτουργία μιας αγοράς.

Παρ' όλο που η μη-γραμμική συμπεριφορά - στη μορφή ομαλής μετάβασης μεταξύ πολλαπλών κατωφλίων - έχει απορριφθεί, παρακάτω εξετάζουμε την επίδραση μιας απότομης αλλαγής (structural break) στην συμπεριφορά της συναλλαγματικής ισοτιμίας. Έτσι, εφαρμόζουμε τον έλεγχο μοναδιαίας ρίζας του Perron (1997) στις χρονοσειρές που έχουν βρεθεί μη-στάσιμες. Λαμβάνοντας υπόψη την παρουσία μιας απότομης αλλαγής, τα αποτελέσματα (βλ. Πίνακα 9.8. Κεφ. 9, σελ. 281) δείχνουν ότι η απόκλιση της ισοτιμίας Τσεχικής κορώνας/ευρώ εξακολουθεί να είναι μη-στάσιμη. Αντίθετα, η υπόθεση μη-στασιμότητας στην απόκλιση της ισοτιμίας της Σλοβακικής κορώνας/ευρώ μπορεί να απορριφθεί με την παρουσία μιας απότομης αλλαγής. Συνεπώς, η τελευταία αγορά συναλλάγματος είναι «οιωνεί-αποτελεσματική».

Συμπερασματικά, κατά μέσο όρο η συναλλαγματική ισοτιμία Πολωνικού ζλότυ/ευρώ αποκλίνει από την ισορροπία της κατά 4%, η ισοτιμία Τσεχικής κορώνας/ευρώ αποκλίνει κατά 2%, ενώ η ισοτιμία Σλοβακικής κορώνας/ευρώ αποκλίνει κατά μόλις 1%. Οι εκτιμήσεις αυτές ικανοποιούν τη συνθήκη του χαμηλού ποσοστού απόκλισης. Ωστόσο, το ύψος της απόκλισης δεν αποτελεί μοναδικό κι αξιόπιστο κριτήριο. Σύμφωνα με την προτεινόμενη μεθοδολογία, η χρονοσειρά της απόκλισης πρέπει να χαρακτηρίζεται από μια στάσιμη διαδικασία σύγκλισης προς την ισορροπία. Απορρίπτοντας την εφαρμογή ενός μη-γραμμικού υποδείγματος ομαλής μετάβασης, τρία γραμμικά υποδείγματα ελέγχου μοναδιαίας ρίζας παρουσιάζουν την Πολωνική αγορά ως αποτελεσματική, την Τσεχική ως μη-αποτελεσματική και την Σλοβακική ως «οιωνεί-αποτελεσματική».

10. Ισορροπία Συναλλαγματικών Ισοτιμιών, Αποτελεσματικότητα Αγορών Συναλλάγματος και Συναλλαγματικές Κρίσεις

Το κεφάλαιο αυτό παρουσιάζει συνοπτικά τις βασικές θεωρητικές κι εμπειρικές μελέτες της βιβλιογραφίας των συναλλαγματικών κρίσεων. Οι συναλλαγματικές κρίσεις μπορεί να συμβαίνουν είτε λόγω μακροοικονομικών ανισορροπιών (βλ. Krugman, 1979 και Flood & Garber, 1984) είτε λόγω αυτο-εκπληρούμενων προσδοκιών (βλ. Obstfeld, 1986 και Ozkan & Sutherland, 1995). Επιπλέον, μια συναλλαγματική κρίση μπορεί να προκληθεί από μια κρίση στο χρηματοπιστωτικό σύστημα της χώρας, και αντίστροφα (βλ. Kaminsky & Reinhart, 1999).

Ο στόχος του κεφαλαίου αυτού είναι να εξετάσουμε την αντίδραση των νομισματικών αρχών όταν παρατηρούνται σημαντικά υπερτιμημένα ή υποτιμημένα νομίσματα. Όταν η αγορά συναλλάγματος είναι αποτελεσματική, τότε οι νομισματικές αρχές δεν έχουν λόγο επέμβασης στη λειτουργία της αγοράς. Ωστόσο, η απάντηση δεν είναι ξεκάθαρη όταν οι αγορές δεν είναι αποτελεσματικές. Μια άποψη είναι ότι οι νομισματικές αρχές πρέπει να επεμβαίνουν για να διορθώνουν την ανισορροπία και να εξουδετερώνουν τις πηγές αναποτελεσματικότητας. Από την άλλη πλευρά, οι παρεμβάσεις στην αγορά συναλλάγματος μπορεί να είναι επικίνδυνες για την σταθερότητα του εγχωρίου νομίσματος. Ο Krugman (1979) αναφέρει ότι αν οι νομισματικές αρχές παρεμβαίνουν στην αγορά συναλλάγματος για να προστατέψουν το εγχώριο νόμισμα από την υποτίμηση, τότε σε κάποια χρονική στιγμή θα υπάρξει μαζική απώλεια συναλλαγματικών διαθεσίμων. Όταν παρεμβαίνουν για να εμποδίσουν την ανατίμηση του νομίσματος, μπορεί να προκαλέσουν υπέρμετρη αύξηση του πληθωρισμού. Όταν οι αρχές σταματήσουν να υπερασπίζονται το νόμισμα, λόγω των παραπάνω περιορισμών, οι κερδοσκοπικές επιθέσεις προκαλούν υψηλή κερδοσκοπική πίεση στο νόμισμα, καθιστώντας το περισσότερο ευάλωτο σε μια πιθανή συναλλαγματική κρίση.

Επομένως, οι νομισματικές αρχές πρέπει να εξετάζουν τις τρέχουσες μακροοικονομικές συνθήκες πριν αποφασίσουν τον τρόπο με τον οποίο θα υποστηρίξουν το νόμισμά τους. Αν η νομισματική πολιτική είναι χαλαρή, η οικονομική δραστηριότητα ασθενής και το πολιτικό σύστημα ασταθές, τότε οι αρχές πρέπει να αποφεύγουν οποιαδήποτε επέμβαση καθώς οι κερδοσκόποι θα επιτεθούν στο νόμισμα. Στο κεφάλαιο 9 εξετάσαμε τρεις ευρώ-αγορές συναλλάγματος. Η Πολωνική αγορά είναι αποτελεσματική, γεγονός που υποστηρίζει την άποψη ότι καμία παρέμβαση δεν είναι απαραίτητη. Ομοίως, οι νομισματικές αρχές της Σλοβακίας πρέπει να αποφύγουν τις παρεμβάσεις καθώς η αγορά παρουσιάζει κάποια μορφή αναποτελεσματικότητας μόνο προσωρινά. Αντίθετα, η αγορά της Τσεχίας είναι μη-αποτελεσματική. Ωστόσο, ποια θα πρέπει να είναι η αντίδραση της Κεντρικής Τράπεζας; Ένα υπερτιμημένο ή υποτιμημένο νόμισμα προκαλεί προβλήματα ανταγωνιστικότητας ή πληθωριστικές πιέσεις αντίστοιχα. Από την άλλη πλευρά, οι διορθωτικές παρεμβάσεις στην αγορά συναλλάγματος αποτελούν ενδείξεις μη-αποτελεσματικής λειτουργίας της αγοράς. Όταν η αγορά δεν είναι αποτελεσματική, τότε υπάρχουν ευνοϊκές συνθήκες για επιτυχημένες κερδοσκοπικές πιέσεις, οι οποίες οδηγούν σε συναλλαγματική κρίση. Δεδομένου ότι η

Τσεχία εκτελεί επιτυχημένες οικονομικές και πολιτικές μεταρρυθμίσεις, και σε συνδυασμό με την σφικτή νομισματική της πολιτική, μπορούμε να ισχυριστούμε ότι μια ελεγχόμενη διορθωτική παρέμβαση δεν θα αποτελέσει σημαντικό κίνδυνο για την Τσεχική κορώνα.

11. Επίλογος

Ο κύριος στόχος αυτής της διατριβής ήταν να αξιολογηθεί, δίδοντας έμφαση στις στην συμπεριφορά της συναλλαγματικής ισοτιμίας, η ενταξιακή πορεία των νέων κρατών - μελών της ΕΕ προς την ΟΝΕ. Δείξαμε ότι η τρέχουσα σταθερότητα της συναλλαγματικής ισοτιμίας δεν εξασφαλίζει μελλοντική σταθερότητα. Ο διατηρήσιμος χαρακτήρας της χαμηλής μεταβλητότητας δεν είναι συμβατός με υψηλές και μόνιμες αποκλίσεις της συναλλαγματικής ισοτιμίας από τα επίπεδα ισορροπίας της.

Το πρώτο μέρος της διατριβής (κεφ. 2 έως 5) παρουσίασε τη θεωρητική κι εμπειρική βιβλιογραφία σχετικά με τα υποδείγματα συναλλαγματικών ισοτιμιών. Πρώτον, εξετάσαμε την υπόθεση της ΙΑΔ ως μια μακροχρόνια συνθήκη ισορροπίας. Η εμπειρική βιβλιογραφία παρουσιάζει μεικτά συμπεράσματα. Όταν οι απότομες αλλαγές (structural breaks) και η μη-γραμμική συμπεριφορά των συναλλαγματικών ισοτιμιών βρίσκονται στο επίκεντρο, η ΙΑΔ φαίνεται να είναι ισχύουσα συνθήκη ισορροπίας. Δεύτερον, η εμπειρική εφαρμογή των παραδοσιακών υποδειγμάτων προσδιορισμού συναλλαγματικών ισοτιμιών (μονεταριστικά υποδείγματα και υπόδειγμα χαρτοφυλακίου) δεν είναι ικανοποιητική. Ωστόσο, το μονεταριστικό υπόδειγμα του Dornbusch φαίνεται να έχει σχετικά καλύτερη εμπειρική εφαρμογή.

Η ισχνή εμπειρική εφαρμογή των παραπάνω υποδειγμάτων προκάλεσε την ανάγκη ανάπτυξης νέων σύγχρονων υποδειγμάτων, τα οποία είναι γνωστά ως υποδείγματα Ισορροπίας Συναλλαγματικών Ισοτιμιών. Το υπόδειγμα FEER αποτελεί μεσοχρόνια ισορροπία, συμβατή με εσωτερική κι εξωτερική ισορροπία. Τα υποδείγματα BEER και PEER αποτελούν βραχυχρόνια ισορροπία, ενώ το υπόδειγμα NATREX αναφέρεται σε μεσοχρόνια και μακροχρόνια ισορροπία. Το υπόδειγμα NATREX φαίνεται να είναι το πλέον κατάλληλο, ειδικά για αναπτυσσόμενες χώρες, γιατί αποτελεί ισορροπία με δυναμική αποθέματος – ροής (dynamic stock-flow equilibrium). Ωστόσο, οι «ισχυρές» υποθέσεις και η αναντιστοιχία μεταξύ θεωρητικών κι εμπειρικών μεταβλητών καθιστούν την άμεση οικονομετρική ανάλυση (υποδείγματα BEER και PEER) πιο εφικτή μεθοδολογία. Όσον αφορά την υπόθεση της αποτελεσματικής αγοράς, η πλειονότητα των εμπειρικών μελετών δεν υποστηρίζει την ισχύ της.

Στο εμπειρικό μέρος της διατριβής, το κεφάλαιο 6 δείχνει ότι η μέθοδος πολυμεταβλητής συνολοκλήρωσης παρουσιάζει καλύτερα αποτελέσματα, για την ισχύ της υπόθεσης ΙΑΔ, σε σχέση με την μέθοδο μονομεταβλητού ελέγχου μοναδιαίας ρίζας. Αν και εξετάσαμε τρεις μορφές συναλλαγματικών ισοτιμιών για την Ουγγαρία, την Πολωνία, την Τσεχία και την Σλοβακία, το κύριο ενδιαφέρον εστιάζεται στις διμερείς ισοτιμίες έναντι του ευρώ. Τα αποτελέσματα δείχνουν ενδείξεις ισορροπίας των συναλλαγματικών ισοτιμιών και αναπτυγμένων εμπορικών σχέσεων μεταξύ των παραπάνω χωρών και της ευρωζώνης.

Στο κεφάλαιο 7 εξετάσαμε την διαδικασία προσαρμογής 10 διμερών ισοτιμιών έναντι του ευρώ, δίδοντας έμφαση στην ισχύ της συνθήκης ΙΑΔ και στις εμπορικές σχέσεις μεταξύ των υποψηφίων χωρών και της ευρωζώνης. Η χαρακτηριστική διαφοροποίηση αυτής της μελέτης απ' αυτή του κεφαλαίου 6 είναι ότι εφαρμόσαμε τόσο γραμμικά όσο και μη-γραμμικά υποδείγματα. Η διαπίστωση της μη-γραμμικής συμπεριφοράς υπονοεί ότι η αληθινή διαδικασία σύγκλισης προς την ισορροπία χαρακτηρίζεται από το μη-γραμμικό υπόδειγμα SETAR. Τα αποτελέσματα δείχνουν ότι όλες οι πραγματικές συναλλαγματικές ισοτιμίες είναι συμβατές με την υπόθεση της ΙΑΔ, ενώ οι χαμηλές τιμές «ημι-ζωής» υπονοούν ότι οι συναλλαγματικές ισοτιμίες ακολουθούν διαδικασία σύγκλισης προς την ισορροπία.

Στο κεφάλαιο 8 εξετάσαμε αν η αξία των νομισμάτων της Ουγγαρίας, Πολωνίας, Σλοβακίας και Μάλτας είναι σημαντικά υπερτιμημένη ή υποτιμημένη. Το κύριο συμπέρασμα είναι ότι δεν αναμένουμε σημαντικές μελλοντικές μεταβολές στην αξία των νομισμάτων αυτών, καθώς οι σταθμισμένοι δείκτες τους βρίσκονται κοντά στα επίπεδα ισορροπίας τους. Ομοίως, το κεφάλαιο 9 δείχνει ότι οι ισοτιμίες (έναντι του ευρώ) της Τσεχικής κορώνας, της Σλοβακικής κορώνας και του Πολωνικού ζλότυ δεν αποκλίνουν σημαντικά από τα επίπεδα ισορροπίας τους. Ακόμα, σύμφωνα με τον ορισμό της αποτελεσματικής αγοράς (όπως προτείνεται στο κεφ. 9), το ποσοστό απόκλισης από την ισορροπία δεν μπορεί να αποτελέσει μοναδικό κριτήριο για τον χαρακτηρισμό μιας αγοράς συναλλάγματος ως αποτελεσματική. Έτσι, εξετάζοντας την στασιμότητα των χρονοσειρών απόκλισης, δείξαμε ότι η Πολωνική αγορά είναι αποτελεσματική, η Σλοβακική είναι «οιωνεί-αποτελεσματική» και η Τσεχική είναι μη-αποτελεσματική. Ως συνέχεια αυτής της μελέτης, το κεφάλαιο 10 δείχνει ότι στις αποτελεσματικές αγορές (Πολωνικό ζλότυ/ευρώ και Σλοβακική κορώνα/ευρώ) δεν υπάρχει λόγος για οποιαδήποτε παρέμβαση στην αγορά συναλλάγματος, ενώ στις μη-αποτελεσματικές αγορές (Τσεχική κορώνα/ευρώ) οι νομισματικές αρχές πρέπει να είναι πολύ προσεκτικές όταν παρεμβαίνουν στην αγορά, καθώς οι παρεμβάσεις κάνουν το νόμισμα ευάλωτο στις κερδοσκοπικές επιθέσεις.

Γενικά, οι εμπειρικές διαπιστώσεις της παρούσης διδακτορικής διατριβής αφήνουν να εννοηθεί ότι οι υποψήφιες χώρες ακολουθούν ομαλή ενταξιακή πορεία προς την ΟΝΕ. Τα αποτελέσματα υπέρ της ισχύος της συνθήκης ΙΑΔ (κεφ. 6 & 7) δείχνουν απουσία εμπορικών τριβών κι ενδείξεις αναπτυγμένων εμπορικών σχέσεων ανάμεσα στις υποψήφιες χώρες και την ΕΕ. Επιπλέον, η ταχύς διαδικασία σύγκλισης των πραγματικών ισοτιμιών προς την ισορροπία φανερώνει την προσαρμογή ισορροπίας των ονομαστικών ισοτιμιών, η οποία είναι συμβατή με τις μεταβολές των σχετικών τιμών. Ακόμα, το γεγονός ότι η αξία των επιλεγμένων νομισμάτων δεν διαφέρει σημαντικά από τα επίπεδα ισορροπίας τους, δηλώνει ότι οι σταθμισμένοι δείκτες ονομαστικής συναλλαγματικής ισοτιμίας (κεφ. 8) και οι διμερείς ισοτιμίες έναντι του ευρώ (κεφ. 9) συμφωνούν με τις διατηρήσιμες τιμές των μακροοικονομικών μεταβλητών. Επομένως, δεν αναμένουμε σημαντικές μεταβολές τόσο στις σταθμισμένες όσο και στις διμερείς συναλλαγματικές ισοτιμίες. Με άλλα λόγια, αυτές οι διαπιστώσεις επιτρέπουν τον ισχυρισμό ότι οι υποψήφιες χώρες, που εξετάστηκαν σ' αυτή τη διατριβή, θα ικανοποιήσουν το κριτήριο συναλλαγματικής ισοτιμίας του Μάαστριχ, καθώς επίσης και το πιο ισχυρό κριτήριο της διατηρήσιμης σταθερότητας της συναλλαγματικής ισοτιμίας (όπως παρουσιάστηκε στην παρούσα διατριβή). Κατά συνέπεια, η επικείμενη ένταξη των χωρών αυτών στην ΟΝΕ πρόκειται να είναι ομαλή και δεν αναμένεται να επηρεάσει αρνητικά την σταθερότητα του ενιαίου ευρωπαϊκού νομίσματος.

ΑΠΟΔΟΣΗ ΒΑΣΙΚΩΝ ΕΝΝΟΙΩΝ ΚΑΙ ΠΡΟΤΕΙΝΟΜΕΝΗ ΑΠΟΔΟΣΗ ΝΕΩΝ ΟΡΩΝ ΣΤΗΝ ΕΛΛΗΝΙΚΗ ΓΛΩΣΣΑ

Autocorrelation	Αυτοσυσχέτιση
Behavioural Equilibrium Exchange Rate	Μπιχεβιοριστική (ή Συμπεριφοριστική) Ισορροπία Συναλλαγματικής Ισοτιμίας
Cointegration method	Μέθοδος Συνολοκλήρωσης
Cross Exchange Rate	Σταυροειδής Συναλλαγματική Ισοτιμία
Desired Equilibrium Exchange Rate	Επιθυμητή Ισορροπία Συναλλαγματικής Ισοτιμίας
Effective Exchange Rate	Δείκτης Σταθμισμένης Συναλλαγματικής Ισοτιμίας
Efficient Market Hypothesis	Υπόθεση Αποτελεσματικής Αγοράς
Error Correction model	Υπόδειγμα Διόρθωσης Σφάλματος
Foreign Exchange Market Efficiency Hypothesis	Υπόθεση Αποτελεσματικότητας της Αγοράς Συναλλάγματος
Forward Rate Unbiasedness Hypothesis	Υπόθεση Αμεροληψίας της Προθεσμιακής Ισοτιμίας
Fundamental Equilibrium Exchange Rate	Θεμελιώδης Ισορροπία Συναλλαγματικής Ισοτιμίας
Half-life	Ημι-ζωή
Homoskedasticity	Ομοσκεδαστικότητα
Law of One Price	Νόμος της Μιας Τιμής
Mean Reverting Process	Διαδικασία Σύγκλισης προς το Μέσο
Natural Real Exchange Rate	Φυσική Πραγματική Συναλλαγματική Ισοτιμία
Normality	Κανονικότητα
Overshooting model	Υπόδειγμα Υπερακόντισης
Panel Data method	Μέθοδος Εξατομικευμένων Δεδομένων

Permanent Equilibrium Exchange Rate	Μόνιμη Ισορροπία Συναλλαγματικής Ισοτιμίας
Portfolio Balance model	Υπόδειγμα Χαρτοφυλακίου
Purchasing Power Parity	Ισοδυναμία Αγοραστικής Δύναμης (ΙΑΔ)
Quasi- PPP	Οιωνεί – ΙΑΔ
Random Walk	Τυχαίος Περίπατος
Reduced-form equation	Εξίσωση Ανοιγμένης Μορφής
Risk Neutrality	Ουδετερότητα Κινδύνου
Risk Premium	Ασφάλιστρο Κινδύνου
Self-Exciting Threshold Autoregressive model	Αυτοπαλίνδρομο Υπόδειγμα με Αυτο-διεγειρόμενο Κατώφλι
Smooth Transition Autoregressive model	Αυτοπαλίνδρομο Υπόδειγμα Ομαλής Μετάβασης
Structural break	Απότομη Μεταβολή
Threshold Autoregressive model	Αυτοπαλίνδρομο Υπόδειγμα Κατωφλίου
Time Series Stationarity	Στασιμότητα Χρονολογικής Σειράς
Uncovered Interest Parity	Ακάλυπτο Αρμπιτράζ Επιτοκίου
Unit Root Test	Έλεγχος Μοναδιαίας Ρίζας
Vector Autoregressive model	Διανυσματικό Αυτοπαλίνδρομο Υπόδειγμα
Weak Exogeneity	Ασθενής Εξωγένεια
White Noise	Λευκός Θόρυβος

1. Introduction

In May 2004 ten additional countries (Cyprus, Malta, Czech Republic, Poland, Hungary, Slovenia, Slovakia, Latvia, Lithuania and Estonia) joined the European Union (EU), while since January 2007 EU has been a union of 27 members due to the introduction of Bulgaria and Romania into EU. The second step of economic integration for these countries is the membership of Economic and Monetary Union (EMU) and the adoption of the single currency. In order to join EMU, they ought to satisfy some criteria known as Maastricht convergence criteria. According to these criteria, inflation rate should not exceed by more than 1.5% the average inflation of the three members with the lowest inflation rate in EU (*inflation criterion)*. Besides, the long-term interest rate should not exceed by more than 2% the average interest rate of the three members with the lowest interest rate in EU (*interest rate criterion)*. Next, the candidate country has to join Exchange Rate Mechanism (ERM) II at least two years before entering the euro zone. Under this period, the domestic currency must be pegged to euro and to fluctuate no more than +/- 15% (*exchange rate criterion)*. The above criteria reflect the monetary side of the economy. Although EMU is mainly a monetary union, it does not focus only on monetary criteria but also on fiscal criteria. So, the ratio of the general government deficit to GDP should not be higher than 3% (*government deficit criterion)*. Finally, the ratio of public debt to GDP should be lower than 60% (*public debt criterion)*.

On the road to EMU, candidate countries should apply a monetary policy framework consistent with the principles of the common currency area. As Tavlas (1994) argues, the participation in a currency area is not a sufficient condition to ensure reputation (i.e.

credibility). What is needed is support from the appropriate monetary policy. A common aim of those policies is the achievement and maintenance of price stability and in general the promotion of macroeconomic stability in the domestic economy. However, candidate countries do not apply a uniform monetary policy regime. Most of them choose an Inflation Targeting (IT) regime (Czech Republic, Hungary, Poland, Slovakia, Slovenia, Romania, and Cyprus)[1] while others choose an Exchange Rate Targeting (ERT) regime (Estonia, Latvia, Malta, Lithuania, and Bulgaria).

Under the inflation targeting regime the central bank announces an inflation target, which the later is determined to achieve. A major advantage of this policy regime is that the country retains the autonomy of its monetary policy until the time of adoption of the single currency. On the other hand, under the exchange rate targeting regime the central bank attempts to retain its currency stable, i.e. nominal exchange rate stability, by intervening in the forex market. Usually, countries peg their nominal exchange rates to a currency of a country (or to a basket of currencies) with remarkably lower inflation rate, which is called as “anchor country”. The main advantage of this policy regime is that high inflation countries “import” low inflation from the anchor country. In contrast, the loss of monetary policy autonomy is a significant disadvantage.

The “principle of the impossible trinity” states that countries must give up one of three goals: (i) exchange rate stability, (ii) monetary policy autonomy and (iii) financial market integration. Given that financial markets become more and more integrated internationally, countries have to choose between exchange rate stability and monetary independence. In line with this principle and according to their policy objectives, central banks apply their monetary policy by choosing the appropriate exchange rate regime vis-

[1] Slovenia is not any more a candidate country as since 1/1/2007 is the newest member of EMU.

à-vis euro. Although a wide range of exchange rate regimes between the two bands (free float and truly fixed) exists, candidate countries' choices lay among (i) a fixed to central parity regime with zero (or very narrow) fluctuation band (Estonia, Latvia, Malta, Lithuania, Bulgaria), (ii) a free floating regime (Poland, Romania) and (iii) a managed floating regime (Czech Republic, Cyprus, Hungary, Slovenia, Slovakia).[2]

Exchange Rate Mechanism II (ERM II) between the euro and participating national currencies fall in the category of managed floating exchange rate regimes. At the moment only Estonia, Cyprus, Latvia, Malta, Lithuania and Slovakia participate in ERM II. Only two of them (Cyprus and Slovakia) have retained the +/- 15% fluctuation band.[3] The rest of the countries have undertaken a unilateral commitment to keep the fluctuation band even narrower. Specifically, Latvia allows the lats vis-à-vis euro exchange rate to fluctuate within +/- 1%. Estonia, Malta and Lithuania have declared that they will maintain their exchange rates vis-à-vis euro unchanged at the central parity.

More analytically, Czech crown was pegged to a basket of currencies until early 1996. In 1997 Czech Republic abandoned the fixed peg exchange rate regime and since then Czech crown has been determined under a managed floating exchange rate regime. This means that although crown vis-à-vis euro can fluctuate; the Central Bank retains the right of intervention in the forex market to smooth excessive fluctuations. Czech Republic does not participate in ERM II and the central parity of the crown per euro has not been yet determined. Although, fluctuations in the crown/euro exchange rate are inside the hypothetical band of +/-15%, the exchange rate has been relatively highly

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[2] For an analytical presentation and discussion of the alternative exchange rate regimes, see Stockman (1999) and Tavlas (2003).

[3] Slovenia, before adopting euro, followed the same policy.

volatile. In recent years, Czech crown in nominal and real terms follows an appreciation trend against euro.

Estonia participates in ERM II since June 2004 with a central parity per euro 1EURO = 15.6466 EKK. Although the exchange rate can fluctuate within the band of +/- 15%, Estonia has undertaken a unilateral obligation to keep the exchange rate unchanged to the central parity. This implies a fixed exchange rate regime and a currency board arrangement, which has been established at the monetary policy reform of 1992. The Estonian kroon was fixed to Deutsche mark, and since 1999 the kroon was fixed to euro. The nominal kroon/euro exchange rate exhibits low volatility, while the real exchange rate is close to its historical averages (from 1999 onwards).

Exchange rate policy in Cyprus has changed a lot of times. In general, the exchange rate was used as an anchor of achieving low inflation and macroeconomic stability. For the period 1960-1972, Cyprus pound was pegged to the UK pound and for a short time (1972-1973) it was pegged to US dollar. From 1973-1992, Cyprus pound was pegged to a basket of currencies, while from 1992 Cyprus currency was pegged to ECU (1CYP=1.7086ECU). At the birth of the European currency (1/1/1999), Cyprus pound was pegged to euro (1CYP=1,7086EURO) within a fluctuation band of +/- 2.25%. However, in 2001 this band became wider (+/-15%). Since May 2005 Cyprus pound is included in the ERM II with unchanged central parity (1CYP=1,7086EURO) and the same fluctuation band (+/-15%). In recent years, Cyprus applies a stable exchange rate policy against euro, which is reflected to the very low exchange rate volatility since 2004.

The Latvian lats participates in ERM II since May 2005. The central rate of the lats per euro is set at 0.702804. Since 1994 Latvian lats was pegged to SDR currency basket.

In January 2005 and prior to the membership of ERM II, Latvia abandoned this regime and fixed its currency to euro. After its introduction into ERM II, Latvia adopted a unilateral obligation to keep exchange rate fluctuation within a band of +/-1%. As a consequence, since 2005 exchange rate volatility vis-à-vis euro has remained in low levels.

During the period 1991 – 2001, the Hungarian forint was determined under a crawling peg exchange rate regime. Since September 2001, this regime has been replaced by a fixed central parity against euro. The central parity is 282.36 forints per euro while the fluctuation band has been extended from +/-2.5% to +/-15%. Hungary is not currently a member of the ERM II but the forint vis-à-vis euro fluctuates around the central rate within the band of +/-15%. Nevertheless, the forint/euro has been relatively highly volatile.

Malta participates in ERM II since May 2005. The central rate was set at 0.4293 Maltese liras per euro with a standard fluctuation band of +/- 15%. However, Malta has declared that it will maintain the exchange rate per euro unchanged at the central parity. Prior to its participation in ERM II, the Maltese lira was pegged to a basket of three currencies (US dollar, UK pound, and euro). In line with the above unilateral commitment (i.e. no deviation from the central parity), the lira/euro exchange rate exhibits no volatility at all after the entry into ERM II and very low volatility before the entry.

Polish zloty does not currently participate in ERM II and since 2000 the zloty is determined freely vis-à-vis euro. Polish authorities have chosen a free float exchange rate regime against any other currency, but they retain the right of intervention in the forex market in line with the applied inflation targeting policy. During the free float period, the zloty/euro exchange rate has been highly volatile. It is indicative that during 2002-2004 the zloty/euro deviated by about 19%. Furthermore, after 2004 the exchange rate does still exhibit high volatility.

Slovakia participates in ERM II since November 2005. The central parity was set at 38.4550 crowns per euro but due to downward pressures on the exchange rate (appreciation trends of the crown) and the high degree of exchange rate volatility the central rate of the Slovak crown was revalued by 8.5%. So, since March 2007 the Slovak crown vis-à-vis euro can fluctuate within the band of +/- 15% around the new central rate (1EURO = 35.4424 SKK). Slovakia applies a managed floating regime and an inflation targeting policy since October 1998. At this time, Slovakia abandoned the fixed exchange rate regime with a narrow fluctuation band (+/- 0.5% - +/- 7%), due to the increased pressures on the fixed rate as a result of the Russian currency crisis.

Lithuania has been participating in ERM II since June 2004. Even though the Lithuanian litas against euro can fluctuate within the band of +/-15% around the central parity (1EURO = 3.45280 LTL), Lithuanian authorities have adopted a unilateral commitment to retain the exchange rate fixed at the central parity. The same policy had been applied prior to the ERM II participation as well. This explains the stability of the litas/euro exchange rate both in pre and post ERM II periods.

In May 2006 the European Central Bank (ECB) and the European Commission (EC) examined Lithuania and Slovenia in terms of their status on the road to EMU. Both institutions reported that Slovenia's status could allow Slovenia to adopt euro. On 1 January 2007, Slovenia became the 13th member of the euro zone. The Slovenian tolar has been participating in ERM II since June 2004 with central parity of 239.64 tolars per euro. Prior to its participation in ERM II, Slovenia adopted an exchange rate policy against euro, which was gradually depreciating the tolar vis-à-vis euro. Since joining ERM II, the tolar/euro exchange rate has been very close to the central rate indicating very low volatility.

On 1 January 2007, Bulgaria and Romania became the new country-members of the EU. Bulgaria has adopted a currency board regime by fixing the Bulgarian lev to the Deutsche mark (for the period 1997-1999) and euro (1999 onwards). The lev is pegged to 1.95583 per euro and the Central Bank has adopted a unilateral obligation to maintain the lev/euro exchange rate fixed to the above rate. On the other hand, Romania has adopted an inflation targeting regime compatible with a floating exchange rate vis-à-vis euro.

The aim of this PhD thesis is to evaluate those countries' exchange rate dynamics and their integration process towards EMU by laying emphasis on the equilibrium value of the exchange rate. Specifically, we attempt to examine the likelihood of emergence of significant exchange rate fluctuations in the future for the candidate EMU countries. Exchange rate stability is crucial for the effectiveness of monetary convergence to the euro zone. In line with the theory of optimum currency area the lower exchange rate volatility, the higher the ability of two countries to share a common currency.

This dissertation contributes by shedding light on the importance of equilibrium exchange rates. It is well known that a highly misaligned exchange rate creates inflationary pressure or competitiveness problems to the domestic economy. Additionally, we provide a more sustainable character to the exchange rate stability. In other words, we argue that the exchange rate convergence criterion is a necessary but not sufficient condition for exchange rate stability, and as a consequence for successful entry into EMU. The intuition is that, even if the exchange rate is currently stable but, significantly away from its equilibrium rate, the exchange rate is going to be highly unstable in the future.[4] The main argument of the present thesis is that the equilibrium exchange rate is achieved only if the nominal exchange rate is in line with the sustainable values of the macroeconomic fundamentals.

One of the concerns of this thesis is to evaluate the operation of the examined forex markets and their vulnerability to possible currency crises. To be specific, we need to know whether these markets are efficient, because in the presence of inefficiency there is room for speculative attacks. However, the Forward Rate Unbiasedness Hypothesis (FRUH) seems not to be suitable, when emerging markets are examined. This is because forward markets are not well-developed and the forward rates are highly regulated by governments. So, this thesis contributes by providing an alternative, but appropriate, framework for testing forex market efficiency, in the case of developing countries. This approach combines the concept of equilibrium exchange rates with the efficiency hypothesis and states that a forex market is said to be efficient, if the equilibrium exchange rate efficiently exploits all the available information. An alternative expression is that the nominal exchange rate should not be significantly misaligned and deviate from its equilibrium rate by only transitory components.

[4] Actually, exchange rate volatility corresponds to short-run fluctuations of the exchange rate around its long-run trends. Exchange rate misalignment refers to a significant deviation of the observed exchange rate from its equilibrium rate. Both notions are closely related with each other. This is because a highly misaligned exchange rate is going to be highly volatile at present and in the future in order to find its equilibrium rate (by its own forces or by government interventions in the forex market).

A starting point is convergence to Purchasing Power Parity in the long run as a baseline of equilibrium exchange rate. The following chapter presents the basic concept of the PPP hypothesis and reviews the recent empirical findings. Chapter 3 presents a theoretical and empirical literature review on traditional exchange rate determination models (flexible-price Monetary model, Dornbusch model, Portfolio Balance model), while chapter 4 presents the up-to-date exchange rate determination models, known as equilibrium exchange rate models (FEER, BEER, NATREX, etc). Chapter 5 deals with the issue of foreign exchange market efficiency. It presents the theoretical framework of the FRUH and the empirical findings of relevant studies.

Chapters 6 to 9 encompass the empirical part of this PhD thesis. In chapter 6, we test the validity of the PPP hypothesis for selected CEEC (Czech Republic, Hungary, Poland and Slovak Republic). In addition to signs of equilibrium exchange rate, the evidence in favor of PPP hypothesis implies well-developed trade relations and absence of trade frictions. So, by applying univariate unit root tests (with and without structural breaks) as well as a multivariate cointegration test, we attempt to define those countries' trade linkages between euro area, US and the rest of the world. In chapter 7, we relax the linearity assumption and the evidence of nonlinear adjustment in real exchange rates dictates the estimation of a nonlinear SETAR model. By applying both a linear ADF test and a nonlinear SETAR model, we test the validity of PPP hypothesis for 10 prospective EMU members (those entered in May 2004) for the period 1990 – 2006 as well as for the former EMU members for the period 1980 – 1998. For both clusters of countries, euro is taken as the numeraire currency. The estimation of the nonlinear SETAR model gives us the opportunity to estimate the true reverting process towards equilibrium and, by comparing the evidence of the candidate countries with this of the current EMU members, to generate implications for the progress of economic integration in Europe and expectations for the candidates' assessing process towards EMU.

In chapter 8, we estimate the equilibrium rate of the nominal effective exchange rate for Poland, Hungary, Slovak Republic and Malta through the BEER and PEER approaches. This chapter entails the main aim of this thesis, i.e. to examine the likelihood of emergence of significant exchange rate fluctuations in the future, giving a more attractive character to the exchange rate stability criterion. However, the Maastricht exchange rate criterion does not deal with effective exchange rates. A successful entry into EMU requires stability in the bilateral rate against euro. We argue that an unstable effective exchange rate may entail instability in bilateral exchange rates, such as this against euro.

Chapter 9 proposes an alternative way of testing Foreign Exchange Market Efficiency Hypothesis for developing countries. The FOREX market will be efficient, if fully reflects all available information. If this holds, the actual exchange rate will not deviate significantly from its equilibrium rate. Moreover, the spot rate should deviate from its equilibrium rate by only transitory components (i.e. it should follow a white noise process). Considering a Logistic Smooth Transition Autoregressive (LSTAR) model we test whether a nonlinear STAR model or a linear autoregressive model should be estimated. This test is applied to three euro markets vis-à-vis Czech crown, Slovak crown and Polish zloty. This chapter shows that there is a strong connection among equilibrium rates, market efficiency and currency crises. So, in chapter 10, we briefly review the currency crisis literature and we provide implications for the forex markets considered in chapter 9. Finally, chapter 11 concludes by evaluating our empirical findings and providing inspirations for further research.

2. Purchasing Power Parity

Many theoretical and empirical studies that attempted to explain and predict the behaviour of exchange rates have used as groundwork the Purchasing Power Parity (PPP) hypothesis. PPP condition has been used as a theory of exchange rate determination and as a condition of long run equilibrium. Although classical economists such as John Stuart Mill, Alfred Marshall discussed the idea of Purchasing Power Parity, Gustav Cassel (1921, 1922) was the first who introduced PPP as an empirical tool, employing this condition as a means for setting relative gold parities. At the end of World War I, a financial problem raised. The World Financial System, after the collapse of the gold standard system, was unable to reset exchanges rates. Gustav Cassel introduced PPP as a tool of calculating exchange rates. His intuition was the calculation of cumulative CPI inflation rates from 1914 and given these inflation differentials to calculate exchange rates consistent with PPP hypothesis.

Purchasing Power Parity is based on the Law of One Price (LOP), which states that goods prices among domestic and foreign countries should be equal once they are converted to a common currency. This can be expressed as follows:

$$p_{i,t} = e_t \cdot p_{i,t}^{*} \tag{2.1}$$

where $p_{i,t}$ is the domestic price of good i at time t, $p_{i,t}$* corresponds to the foreign price of good i at time t and e_t is the nominal exchange rate at time t, which can be shown as the foreign currency in terms of home currency prices. Purchasing Power Parity hypothesis is presented in the literature in two versions. The absolute version implies that the exchange rate between the currencies of two countries must be equal to the ratio of their price levels:

$$\sum p_{i,t} = e_t \sum p_{i,t}^{*} \tag{2.2}$$

Froot & Rogoff (1995) argue that Absolute PPP is not possible to hold even if LOP does hold. Absolute PPP may hold if we assume that the two countries have identical consumption baskets, which is not a realistic assumption.[5] Moreover, as Rogoff (1996) points out, there is a problem with the data that are available to measure absolute PPP. This is because there are no available indices for an internationally standardized basket of goods. These facts force researchers to study the Relative PPP form. This version states that exchange rates and price ratios must change in the same proportion. In other words, exchange rate fluctuations must be offset by changes in relative price levels. The following expression presents the relative form of PPP hypothesis:

$$\frac{\sum p_{i,t}}{\sum p_{i,t-1}} = \left[\frac{e_t}{e_{t-1}}\right] \cdot \left[\frac{\sum p_{i,t}^{*}}{\sum p_{i,t-1}^{*}}\right] \tag{2.3}$$

The Relative PPP allows researches to find evidence that PPP holds even if countries have very different inflation rates. However, there is no strong evidence in the empirical literature that exchange rate movements are proportional to price level shifts. This is known as Purchasing Power Parity Puzzle[6]. This phenomenon can be decomposed into two puzzles. The first one exists when large deviations from PPP are present in the short run and the second corresponds to the very slow convergence to PPP equilibrium. This

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[5] Engel (1999) finds that exchange rate fluctuation is better explained by changes in relative prices of traded goods. Imbs et al (2002) explain this finding in terms of sectoral heterogeneity. This is higher among traded goods than among nontraded goods.

[6] To find more about PPP puzzle, see Rogoff (1996) and Obstfeld & Rogoff (2000).

has negative implications for the validity of PPP hypothesis in the long run. In fact, many researchers have found evidence of convergence to long run PPP with high measures of "half-life" (three to five years).[7] Isard (1977) examined disaggregated data on US, German, Canadian and Japanese exports and found that deviations from PPP hypothesis are large and persistent and reflect nominal exchange rate movements. Similar results are derived from Giovannini (1988) using data for US and Japanese commodity prices and Frenkel (1981) who states that PPP deviations are high for industrialized countries during the 1970s. On the contrary, Frenkel (1978) found that for a number of hyperinflationary countries PPP is an appropriate condition for any exchange rate determination model. But, this does not hold if hyperinflation is not the case[8].

There is a plethora of studies in the literature that attempt to give an answer to these puzzles. Traditional studies (Dornbusch, 1976) mention that short run deviations are caused by price stickiness. But, if this is the case, we would expect evidence of convergence to PPP equilibrium when prices become flexible. Edison (1987) points out that PPP holds if the following conditions are satisfied: (i) *symmetry* between the domestic and the foreign country, (ii) *proportionality* between exchange rates and relative prices, and finally (iii) *exclusiveness*. The last one is satisfied only if relative prices are the exclusive determinants of the exchange rate. However, his study on the UK pound/US dollar exchange rate failed to accept the exclusiveness assumption. As long run PPP holds, exchange rate movements are explained only by movements in relative prices. This

[7] "Half-life" is the necessary time for deviations to diminish by one half. For example, if half-life is 3 years, deviations will be reduced to one half in 3 years. Hence, the real exchange rate will find its equilibrium in 6 years.

[8] Note that his model suffers from econometric specification problems. Specifically, he did not check the statistical properties of the error term and those of the variables.

means that other factors, such as transaction costs, tariff and non-tariff barriers prevent PPP condition to be valid in the long run. Based on the Balassa (1964) & Samuelson (1964) effect, rich countries have higher prices than poor countries. This is not due to higher overall productivity in the developed economy. The latter is more productive only in its traded goods sector. If the exchange rate is fixed, any increase of productivity in the traded goods sector (in the rich country) does not increase the price level, because it is fixed to the world level. But, wages in the traded goods sector increase. Employees in the non-traded goods sector will demand higher wages equal to those of the traded goods sector. But now, the price level in the non-traded goods sector increases. As a result, the overall price level of the rich country rises.

2.1 Testing PPP Hypothesis: Empirical Literature Review

Purchasing Power Parity hypothesis can be tested by employing numerous alternative methodologies. Some studies apply univariate unit root tests on real exchange rates, while others apply more powerful panel unit root tests. Some researchers apply univariate (Engle & Granger, 1987), multivariate (Johansen, 1988) and panel cointegration techniques on the relationship between nominal exchange rates and relative prices. Others examine the validity of PPP hypothesis under the presence of structural breaks in the exchange rates. This is possible for developing, emerging and transition economies, which the recent years perform significant structural reforms. Moreover, when long span of data are used, both flexible and fixed exchange rate regimes may exist, implying the presence of a break at the time of the regime switch. Kocenda (2001) examines the presence of breaks in the currencies of 11 developing countries against US dollar and Deutsche mark (1991-1997) by the Vogelsang's (1997) approach.[9] There is no strong evidence of breaks in the Central European Countries. In contrast, the evidence is strong in Balkan and Baltic countries. In general, structural breaks in exchange rates are present in less stable economies. This study stresses the importance of breaks in developing countries. Given that in the presence of breaks conventional unit root tests are biased against rejecting non-stationarity, structural breaks cannot be ignored when testing PPP hypothesis. In line with the presence of structural breaks, some studies show that convergence to PPP equilibrium may be a non-linear instead of a linear mean reverting process. Below, we present the basic characteristics of these studies and their results categorized in groups according to their theoretical and econometric specification.

2.1.1. Univariate Unit Root Tests

Even if the Law of One Price (LOP) does not hold, PPP will be valid if the real exchange rate follows a mean reverting process. In other words, PPP deviations should be transitory. This is confirmed by accepting the stationary nature of the real exchange rate. In contrast, if non-stationarity cannot be rejected for the real exchange rate, PPP cannot be accepted. This subsection includes studies that perform univariate unit root tests on real exchange rates with and without structural breaks. The presence of structural breaks in real exchange rates is itself a negative sign for the validity of PPP. On the other hand, a rejection of unit roots in real exchange rates, when breaks exist, implies a mean reverting process. These two findings are indeed contradictory. The above contradiction yields to a

[9] This method allows for detecting a break at an unknown date, without imposing any restrictions on the nature of the data.

new version of PPP, which is called by Hegwood & Papell (1998) as "quasi-long run PPP" - henceforth quasi PPP.[10]

Obstfeld & Rogoff (2000) using an Augmented Dickey-Fuller (ADF) regression find that for monthly data (1973-1995) all exchange rates among Canada, France, Germany, Japan and the United States are accompanied by slow mean reversion. To be specific, the mean half-life among the estimated exchange rates is about $3_{1/4}$ years. Thus, convergence to PPP is very slow. The problem that arises is that it is very difficult to distinguish between an exchange rate that follows a random walk and a stationary exchange rate, which is slowly mean reverting.

Abuaf & Jorion (1990) examine a panel of ten industrialized countries. The data set is filled with monthly observations (from 1973 to 1987) for exchange rates and consumer price indices. They estimate a first-order autoregressive –AR (1) – model in levels[11]. But, the drawback of this model is that conventional test statistics are not applicable. Power can be increased by extending the Dickey-Fuller test to a system of univariate autoregressions, estimated by General Least Squares (GLS). The authors apply a multivariate test (estimating a system of equations), which is more informative than univariate tests. The empirical results support this point of view. Univariate Ordinary Least Squares (OLS) autoregressions are unable to reject the random walk hypothesis. On the contrary, the restricted GLS autoregressions reject the random walk hypothesis, providing positive implications about long run PPP. This comes in contradiction with

[10] Quasi PPP is referred to a situation in which the breaks create only transitory shocks.

[11] Dickey & Fuller (1979) have pointed out that autoregressive regressions in levels may be more powerful than regressions in first differences. This can be viewed as a main point of failure of previous studies to reject the random walk hypothesis.

previous studies, which were unable to reject the hypothesis that real exchange rates follow a unit root process. This may be due to low power of their tests.

Similar results are derived from Lothian & Taylor (1996) who using a long data set aim to test the stationary nature of the real exchange rate. They use annual data for US dollar/UK pound and French frank/UK pound exchange rates and their Wholesale Price Indices (WPI). The main point of this empirical work is its long data set, which covers the period from 1791 to 1990. The econometric framework is supported by two methodologies: a Unit-Root test and a univariate autoregressive process. For the full sample, the unit root hypothesis is rejected but for the floating period (after World War II) the hypothesis that the exchange rate follows a random walk process cannot be rejected. This may be due to the low power as the sample is now reduced. Estimating an AR(1) process, for the full sample period, they find that non-stationarity can be rejected. Hence, PPP hypothesis is valid in the long run.

Bahmani-Oskooee & Mirzai (2000) construct nominal and real effective exchange rates on a quarterly basis for 20 developing countries from 1973:1 to 1997:3 to test PPP hypothesis. They avoid relying on the ADF test because of its low power. In contrast, they test the stationary nature of the real effective exchange rates through the KPSS test. When a constant is included PPP is rejected, but when a trend is included unit root hypothesis is rejected. As a result, PPP can be accepted. In order to test robustness of their test, they apply an ADF test as well. Indeed, KPSS test supports better PPP than ADF test does.

Although this test manages to accept PPP, other studies mainly based on the ADF test fail to reject the unit root hypothesis. For example, Aggarwal et al (2000) cannot reject, via an ADF test, that the real exchange rates of 7 Asian currencies against Japanese Yen (1974:1-1997:4) do not follow a random walk process. In contrast, when structural breaks are allowed, the evidence is more supportive for PPP.[12] Although, stationarity cannot be accepted for all the exchange rates, there is evidence of quasi PPP. Moreover, they test the case of a different base country. When US dollar, Deutsche mark or the Australian dollar are used as base currencies, PPP cannot be accepted. This fact implies that Asian economies are more oriented towards Japan rather than US and Europe.

Sabate et al (2003) examine PPP under the existence of two structural breaks for the peseta-sterling exchange rate (1870-1935). Conventional Unit Root tests (such as ADF, P-P) do not reject the null of non-stationarity. In contrast, under the presence of either one or two breaks, the null of a unit root is rejected. Thus, given the presence of two breaks, the real exchange rate follows a white noise process. In other words, quasi PPP is accepted.

On the other hand, quasi PPP cannot be accepted in the case of Croatia. Payne et al (2005) examine two real effective exchange rates (PPI-based and RPI-based) for Croatia, during 1992:1 – 1999:10 (monthly observations), in the presence of possible structural breaks. They apply a minimum Lagrange Multiplier (LM) unit root test by Lee & Strazicich (2003) – henceforth, L-S test.[13] They do not pre-determine breaks in the exchange rate, but these are identified endogenously by the L-S test. They find the

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[12] They use a test proposed by Perron-Vogelsang (1992) and extended by Clemente et al (1998) to find the presence of possible breaks. While the former allows for only one break, the latter test allows for more than one break in the mean. Here, they find evidence of two breaks.

[13] They state that this test is robust because the possibility of breaks is included not only to the alternative but also to the null hypothesis. Other tests such as Zivot & Andrews (1992) and Lumsdaire & Papell (1997) assume no breaks under the null. However, by rejecting the null of the above tests we cannot be sure that the relevant variable is stationary. Strictly speaking, this implies that there is no unit root without breaks.

presence of two breaks between 1992 and 1993. However, non-stationarity of each of the real effective exchange rates cannot be rejected. As a consequence, PPP hypothesis does not hold.

2.1.2. Cointegration-based studies

These tests try to find any valid long run relationship between nominal exchange rates and relative prices. PPP hypothesis will be valid in the long run if a long run relationship exists. In other words, the above variables should be cointegrated. A univariate cointegration test (Engle-Granger 2-step procedure) requires the error term to be covariance stationary. A multivariate cointegration test (Johansen's technique) requires the existence of at least one cointegrating vector. Some studies stop short at this requirement, while others impose the restrictions of symmetry and proportionality on the implied reduced-form equation. The unrestricted cointegration test is known as weak-form PPP and if the above conditions are satisfied, strong-form PPP does hold.

Corbae & Ouliaris (1988), applying cointegration techniques, test the Absolute PPP version for the US dollar exchange rate against the Canadian dollar, French frank, UK pound, Japanese Yen, Italian lira, and Deutsche mark. They use monthly exchange rates and Consumer Price Indices for the period July 1973 – September 1986. The unit root hypothesis is tested by two approaches: the ADF test and the Phillips-Perron Z statistic. Both approaches imply that the null of no cointegration cannot be rejected. Therefore, Absolute PPP does not hold in the long run. Another study in that field with no so clear results is that of Enders (1988). The author examines monthly data (1960 – 1986) of US dollar real exchange rates against Deutsche mark, Canadian dollar, Japanese Yen and the relative Wholesale Price Indices. He finds evidence of cointegration in the case of US – Japan exchange rate under a fixed exchange rate regime, but cointegration is not supported for US – Canada exchange rate under a floating regime. However, this does not establish the general statement that PPP is more easily accepted under fixed exchange rate regimes. As Enders (1988, p. 508) concludes, *"PPP performs equally well, or equally poorly, in both time periods"*.

Under the same framework, Patel (1990) fails to reject the hypothesis of no cointegration. His study is applied to the US dollar exchange rate against UK's, Canada's, Germany's, and Netherlands' currencies. Quarterly data for exchange rates and Producer Price Indices have been used for the period 1974 – 1986. In most cases, no cointegration cannot be rejected, which means that long run PPP does not hold. Further, Patel (1990) shows that PPP is not an appropriate anchor for forecasting purposes.

MacDonald (1993) develops a multivariate cointegration technique to test the long run relationship between exchange rates and relative prices. He makes a distinction between the strong–form and the weak–form Purchasing Power Parity. As mentioned above, the former form holds if at least one cointegrating vector exists and the proportionality condition is satisfied. The weak-form PPP requires just a valid cointegrating relationship between exchange rates and prices with no restrictions on the properties of the cointegrating vectors. The data set covers monthly observations of exchange rates and prices of a panel of countries from January 1974 to June 1990.[14] For

[14] The panel consists of US, Canada, France, Germany, UK, and Japan. Both CPI and WPI are included in the data set. When WPI is preferred, the results are more supportive of the existence of cointegration. For example, cointegration is rejected in the Canadian dollar/Japanese yen exchange rate when CPI is used. On the contrary, cointegration is accepted when WPI is used. Froot & Rogoff (1995) explain that this is because CPI has a higher non-traded goods component than WPI.

most of the examined cases, the weak-form PPP is supported. For the full sample, strong-form is rejected because the homogeneity hypothesis is not accepted. But, for the European countries strong-form PPP is accepted.

Mahdavi & Zhou (1994) examine the weak-form PPP in 13 developing and high inflation countries from 1973 to 1991. Univariate unit root tests show that the variables are difference stationary, while others are I(2). Applying a multivariate cointegration test and estimating an Error Correction Model they find supporting evidence of PPP in 8 out of the 13 cases. Stronger evidence exists in relatively high inflation countries.

Salehizadeh & Taylor (1999) test the strong version of PPP for 27 developing countries (base country is US) for the period 1975:1-1997:9 (monthly observations). The necessary condition of at least one cointegrating vector is satisfied for all of the 27 cases. In contrast, the proportionality and symmetry conditions cannot be accepted. Thus, only the weak-form PPP can be accepted. The authors state that this finding is sufficient because cointegration is really difficult to hold when developing countries are involved. So, the evidence of a long run relationship is equivalent to the validity of PPP in the long run. Similarly, Wang (2000) finds evidence of one cointegrating vector for Indonesia, Korea, Philippines and Thailand, and two vectors for Singapore and Japan.[15] However, restrictions in the cointegrating equations cannot be accepted in any case. Furthermore, Diamandis (2003) finds a valid long run relationship between exchange rates (per US dollar) and price levels in four Latin American countries, during 1973-1993. This study is quite different since PPP hypothesis is tested in the parallel foreign exchange market instead of the official one.

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[15] Of course, Japan cannot be handled as a developing country. The exchange rates are per US dollar for a period from 1973-1996. So, the financial crisis in Asia (1997) is not included in the examined period.

As mentioned above it is difficult to confirm a valid long run relationship when developing countries are the case. This is because of structural changes, exchange rate regimes switch, transaction costs, etc. These facts imply that structural breaks may occur in the exchange rates. The presence of breaks seems more possible and important when financial crises occur in the estimated period. Indeed, Zurbruegg & Allsopp (2004) apply multivariate cointegration techniques, by allowing the presence of structural breaks, to test PPP in Asian countries in a period including the financial crisis of 1997. They test the presence of breaks by Inoue's (1999) test.[16] Only for Japan there is evidence of two breaks (1991, 1997). For the rest of the panel, only one break is found (located in 1997). PPP is tested by Johansen et al (2000) cointegration technique. They find one cointegrating vector for all the cases except Malaysia, Indonesia and Singapore, in which two vectors are found. They conclude that PPP is a valid long run relationship in the case of Japan, South Korea, Malaysia, Singapore and Thailand. In contrast, PPP cannot be accepted for Honk Kong, Indonesia and Philippines.

2.1.3. Panel Data Studies

Panel data analysis consists of unit root tests in a panel framework as well as panel cointegration techniques. Since univariate unit root tests suffer from low power, researchers can increase power either by using a longer span of data or by employing panel unit root tests. However, Papell & Theodoridis (2001) stress the importance of the choice of the numeraire currency. They argue that the choice of the base country (i.e. numeraire currency) in panel unit root tests does matter. The criteria for selecting the

[16] This test determines endogenously the number of breaks. It is consistent with cointegration analysis, as it can determine a cointegrating rank in the presence of breaks.

appropriate base country are: (i) exchange rate volatility, (ii) geographic distance and (iii) openness. However, by performing a panel unit root test with 21 different numeraire currencies, they find that only exchange rate volatility and distance are significant criteria. Thus, evidence to PPP is sensitive to the selection of the numeraire currency.

Alba & Park (2003) examine real exchange rates of 65 developing and 15 developed countries (against US dollar) in terms of PPP hypothesis. A univariate unit root test fails to reject the null of non-stationarity. Besides, they perform a panel unit root test by Levin et al (2002) – hereafter, LLC test - and they find that for the full sample (1976-1999) unit root hypothesis cannot be rejected. Thus, PPP does not hold. By dividing the estimated period into two sub-periods, they manage to find evidence of PPP only after 1980. Moreover, they find that PPP can be more easily accepted for more open and high inflation economies. Finally, consistent with the Balassa-Samuelson hypothesis, PPP is accepted for low growth panels, but it fails in high-growth economies. Under a similar framework, Oh (1996) examines 150 exchange rates, including exchange rates of 88 developing countries. When it comes to developing countries, they find that PPP is valid when the whole period is examined (1950-1990). But, when the examined period is split into fixed and flexible exchange rate regimes, PPP cannot be accepted.

Holmes (2000) tests PPP for 27 African developing countries from 1974 to 1997 through a panel unit root test.[17] A univariate unit root test (ADF) cannot confirm that real exchange rates are covariance stationary. In contrast, the Im et al (2003) test –

[17] He applies the IPS test. He states that this is more appropriate than Quah's (1994) test, which does not allow for heterogeneity across countries. Moreover, O'Connell (1998b) shows that panel tests have low power because of the presence of autocorrelation. The IPS test solves the serial correlation problem by assuming heterogeneity across the variables in the panel.

henceforth, IPS test - finds that PPP is accepted for the whole panel. Moreover, PPP is strongly accepted for high inflation countries but rejected for low inflation countries.

Besides to panel unit root tests, researchers employ cointegration tests in a panel framework. Nagayasu (1998) tests the validity of PPP for 16 African parallel exchange rates against US dollar.[18] He applies a multivariate cointegration technique but PPP cannot be accepted. However, a panel cointegration approach by Pedroni (1995) accepts the semi-strong PPP.[19] Similarly, Boyd & Smith (1999) find that for 25 developing countries (nominal currencies per US dollar) from 1966 to 1990, univariate unit root tests and conventional cointegration techniques fail to support PPP. In contrast, by using panel data analysis and by constraining coefficients to be equal across countries, there is much more evidence in favor of PPP. Basher & Mohsin (2004) apply panel unit root tests, multivariate cointegration as well as panel cointegration tests to check PPP in 10 Asian countries (national currencies per US dollar from 1980 to 1999). Panel unit root tests, such as LLC and IPS, cannot reject the null of non-stationary real exchange rates. Moreover, the Johansen cointegration technique does not provide evidence of any long run relationship. The results do not differ when Pedroni's (1995) panel cointegration test is applied. Thus, PPP cannot be accepted.

Drine & Rault (2003) examine panels of 73 developed and developing countries from 1964 to 1998. These countries are classified in separate panels based on (i) the level of development and geographic zone, (ii) the exchange rate regime and (iii) the inflation

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[18] Recall Diamandis' (2003) study, which examines PPP in parallel foreign exchange markets by conventional cointegration techniques.

[19] According to MacDonald & Marsh (1994), when the restrictions in the cointegrating space can be accepted, then PPP is accepted in its semi-strong version. Moreover, Pedroni's (1995) test allows for finding evidence of cointegrating vectors even if variables are heterogeneous.

level. A panel unit root test (IPS) shows that PPP is accepted for developed but not for developing countries. A panel cointegration analysis, based on Pedroni (1995), shows that PPP does not hold in developing countries. Moreover, they find that PPP is more easily accepted in high inflation countries, while the exchange rate regime does not matter.

2.1.4. Nonlinear models

Linear models may be inappropriate for testing PPP, especially in developing countries, because of the existence of significant trade costs, structural reforms, etc, which cause structural breaks in exchange rates. This means that exchange rates may follow a non-linear process rather than a linear one. So, unit root tests are biased when a linear model, instead of the true non-linear, is estimated. In line with this statement, Taylor (2001) spots two econometric pitfalls in testing for PPP hypothesis: (i) Temporal Aggregation and (ii) Linear Specification. The former corresponds to the use of low frequency data. When the process is daily and the data sample covers weekly or monthly observations, convergence will be slower under low frequency data. The problem is that we omit useful data and information.

The second pitfall holds if exchange rate adjustments are characterized by nonlinear dynamics. Under a linear specification, the adjustment speed of PPP deviations is constant and the main task is the estimation of the half-life. If a linear model is estimated using nonlinear data, the results will be misleading. Indeed, Obstfeld & Taylor (1997) and other researchers have found evidence of significant nonlinearities. Heckscher (1916) first introduced the idea that adjustments may be nonlinear because of transaction costs.

Other sources of nonlinearity, shown in the literature, are the heterogeneity of opinion in the foreign exchange market (Kilian & Taylor, 2003), Central Banks' policy (Taylor, 2004) and the differences in technology and preferences (O'Connell & Wei, 2002).

Researchers model nonlinearities in real exchange rates through the estimation of models that allow the autoregressive parameter to vary. These models are known as Threshold Autoregressive (TAR) models.[20] The TAR model allows for a transaction costs band within which no adjustment takes place. Outside the band, arbitrage becomes profitable and the process becomes stationary autoregressive. This means that PPP deviations will be persistent if they are small and mean reverting if they are large. Balke & Famby (1997) called this model as a "Band-TAR" model.

Taylor & Taylor (2004) mention that there is no unique transaction cost and many threshold barriers are more possible to exist. To manage this problem, Smooth Transition Autoregressive -STAR- (Granger & Terasvirta, 1993) models are applied. In these models, adjustments are smooth and in contrast to TAR models, they take place in every period (inside and outside the band). Michael et. al. (1997) and Taylor (2001) argue that STAR models are more appropriate than TAR, because adjustments are smooth and it is unlikely that agents' behaviour changes simultaneously. Hence, adjustments may be smooth rather than discrete. Obstfeld & Taylor (1997) present two more threshold models. The Equilibrium Threshold Autoregressive (EQ-TAR) model differs from the

[20] Another set of nonlinear models implies that the autoregressive parameters are subject to Markov Regime-Switching (Hamilton, 1989). Kanas & Genius (2005), by applying a Markov volatility regime switching ADF test, find that the US/UK real exchange rate is stationary when the exchange rate is low volatile, and non-stationary when it is highly volatile. Bergman & Hansson (2005) find that six major currencies against US dollar are characterized by a 2-state Markov-Switching AR(1) model as the unique regime autoregressive model is rejected by the data.

TAR in the way of reversion. This is toward to the center of the band, and not to its edges. The reversion, under the Returning-Drift Threshold Autoregressive (RD-TAR) model, is of the form of random walk with a drift outside the bands.

Taylor et. al. (2001) examine the validity of PPP hypothesis among US, UK, Germany, France and Japan for the period from January 1973 to December 1996. They test the random walk hypothesis by univariate and multivariate unit root tests. The former cannot reject the hypothesis that real exchange rates are nonstationary. Hence, under a univariate unit root test, PPP hypothesis is rejected.[21] When it comes to the multivariate tests, they apply (i) the MADF test (Taylor & Sarno, 1998) which is analogous to ADF test, (ii) the $MADF_{\tau}$ test which allows a deterministic linear trend, and (iii) the Johansen' s Likelihood Ratio (JLR) test which has been proposed by Taylor & Sarno (1998).[22] The multivariate unit root tests, with one voice, provide significant evidence of a mean reverting process as unit root hypothesis is rejected. However, by estimating an Exponential STAR (l=d=1) model[23], they find significant evidence of nonlinear mean reversion. Moreover, for larger shocks, mean reversion is faster. This implies that for large PPP deviations, half-life estimates are low. In contrast, small deviations produce high half-life periods.

Under the same theoretical and empirical framework, Michael et al (1997) examine whether deviations from PPP exhibit a nonlinear behaviour over time. As nonlinearity is

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[21] The authors, using Monte Carlo simulations, provide evidence that the univariate unit root tests are low in power.

[22] Taylor & Sarno (1998) suggest an alternative null hypothesis which states that at least one of the series is a nonstationary process. If N cointegrating vectors exist among N real exchange rate series, at least one of the series should be I(1). When all series are stationary, the null is rejected.

[23] l and d stand for the lag length of the autoregressive process and the delay parameter, respectively.

confirmed, they estimate an ESTAR model by nonlinear least squares.[24] For the full sample, the estimated ESTAR model shows that small deviations entail a random walk behaviour, but large deviations cause a mean reverting process. This means that the larger the deviation from PPP, the faster the convergence to equilibrium.

A similar study in the framework of PPP deviations under a nonlinear specification is that of Sarno et al (2004). They show that transportation costs or "iceberg" costs (an amount of the good is melt when shipped) create a bound for the exchange rate within which the marginal cost of arbitrage is higher than the marginal benefit. They apply a TAR model in which the threshold variable is the lagged dependent variable (s_{t-d}). This specification is known as Self Exciting TAR (SETAR) model.

Once again, the parameters need to be estimated are the autoregressive vector (l), the delay parameter (d), and the threshold parameter (ϑ). Moreover, the significance of the nonlinear specification should be tested against the alternative of a linear model. This test, based on Hansen's methodology (Hansen, 1997), supports the rejection of the linear autoregressive model against the TAR model. Using a Monte Carlo analysis, they found that the power of the test is high if the lag length of the TAR model and the value of autoregressive vector are relatively small. The estimated TAR model implies a lag length equal to 8 (l = 8), and the delay parameter to vary between 1 and 8 (d ~ D[1, 8]).[25] The threshold parameter (ϑ) takes values between 0.0 and 0.2 ($\vartheta \sim \Gamma[0.0, 0.2]$). When ϑ =

[24] The data set includes monthly data on WPI for the UK, the US, France, Germany and their spot exchange rates. The estimated period is from 1921 to 1923 for German data and from 1921 to 1925 for the rest. In two cases, annual data have been used (UK/US, 1791-1992 and UK/FR, 1802-1992).

[25] However, economic intuition suggests low values of d. This is because large values of the delay parameter correspond to slow reaction to deviations from PPP.

0.0, there is no transaction cost and the domestic markets are internationally fully integrated.

The TAR model is estimated by sequential conditional least squares (Hansen, 1997). The results show that transaction costs differ among countries and goods sectors.[26] For example, Japan faces lower transportation cost than European countries, when both importing from the US. They show that real exchange rates follow a unit root process within the band. Outside the band, the process is stationary. Furthermore, they provide a measure of the speed of convergence to equilibrium. For the outer regime, the average half-life is about 2 years. These results are consistent with the validity of long run PPP hypothesis.

In many standard autoregressive models, the convergence speed is low, which indicates the existence of high half-life periods. This is a result of the lack of power of those tests as they ignore the presence of nonlinearities. Obstfeld & Taylor (1997) argue that the solution is to transform the standard AR(1) model to a TAR model, which is parameterized by an autoregressive length (l), an arbitrary number of thresholds (q), and an arbitrary delay parameter (d). They set l=1, q=2, d=1 [TAR(1,2,1)] and using the Monte Carlo analysis they test the significance of the TAR model against the linear AR(1) model.

The use of inappropriate models causes misleading implications. An erroneous use of the standard AR(1) model, yields to higher half-life periods and slower convergence

[26] The data set includes six countries (US, UK, Germany, France, Italy, Japan) and nine goods sectors. Prices reflect to the difference between the logarithm of value added at current prices and the logarithm of value added at the base year's prices (1990). Using quarterly data from 1974 to 1993, they estimate five bilateral US dollar exchange rates.

speed. Indeed, using monthly disaggregated and aggregated CPI's for 32 countries worldwide - from 1980 to 1995 - they found that the convergence speed estimated by a linear autoregressive model implies too large half-life estimates, but the convergence speed estimated by a TAR model indicates a 12-month half-life period. Moreover, they provide measures of economic distance and they state that distance is positively related to the threshold value. In other words, the variability of deviations from PPP is positively related to distance. Their results imply that deviations in the outer band generate lower half –life estimates, supporting the theoretical framework of the threshold autoregressive model.

To sum up, this subsection deals with the estimation of exchange rate adjustments when transaction cost and other sources of nonlinearity influence the exchange rate behaviour. So far, we have seen that based on a TAR model, small deviations from PPP follow a random walk process (inside the band) and large deviations are mean reverting (outside the band). This is consistent with Kilian & Taylor (2003, p.104) view: *"nonlinear mean reversion in the real exchange rate can be detected statistically only following unusually large departures from equilibrium"*. However, the story is not always that. In contrast to other studies, there is evidence that *"large PPP deviations do not display a stronger tendency to mean revert than small deviations"* (O'Connell, 1998a, p.72).

O'Connell (1998a) applies two models in order to test the nonlinear specification.[27] Firstly, he estimates an EQ-TAR model in which two null hypotheses are tested. Under

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[27] The data sample covers the period 1973 –1995, within which 18 countries (US, UK, Austria, Denmark, France, Germany, Netherlands, Norway, Sweden, Canada, Japan, Finland, Greece, Ireland, Spain,

the first null, real exchange rates follow a random walk process, while the second null states that real exchange rates follow an unconditional AR(1) process. The alternatives state that deviations from PPP are mean reverting. Secondly, he estimates a nonlinear regression model in which a higher order term is added to the standard ADF regression. The null hypotheses between these two tests coincide.

The estimated EQ-TAR model implies that in some cases, large deviations are not mean reverting (in contrast, they are more persistent than small deviations). As a consequence, transaction costs - which are assumed to be responsible for high deviations from PPP - do not explain the PPP puzzle. Identical results are derived from the nonlinear regression model. Nonetheless, large deviations are mean reverting only in the case of a panel of some European countries. But, increasing the panel with more countries, the previous statement is no more valid. Further, this explanation (i.e. that transaction costs explain the PPP puzzle) is meaningless for the failure of PPP in the post Bretton-Woods period.

Sarno (2000) examines bilateral exchange rates of 11 developing countries (Middle East) against US dollar for the post Bretton-Woods period. Linearity is rejected in 8 out of the 11 cases. So, he estimates an ESTR model by Non-Linear Least Squares and tests whether an ESTR or an ESTAR model is more appropriate.[28] The results imply that the ESTR is more suitable. In terms of the PPP hypothesis, he finds that real exchange rates

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Australia, New Zealand and South Africa) are examined. Moreover, four different price indices have been used (VAD, UCL, PPI and CPI).

[28] Writing the ESTR model in first differences and imposing restrictions on it, the ESTR becomes an ESTAR model. If the restrictions do not hold, tested by a LR test statistic, the ESTAR is misspecified.

follow a non-linear mean reverting process towards PPP equilibrium. Moreover, he finds that PPP is more easily accepted in case of large variations in relative prices.

Similarly, Liew (2003) tests PPP under the framework of a non-linear unit root test proposed by Kapetanios et al (2003).[29] A preliminary conventional ADF test fails to reject the unit root hypothesis in all the cases except for Indonesia. However, a non-linear unit root test rejects this hypothesis in any case apart from Philippines. Thus, PPP is accepted. In other words, real exchange rates follow a non-linear mean reverting process.

Finally, Calderon & Duncan (2003) apply univariate linear unit root tests (ADF, PP, KPSS) as well as univariate and multivariate cointegration techniques in the case of Chile. Two types of exchange rates are examined. They employ a bilateral exchange rate of the national currency vis-à-vis US dollar and an exchange rate of the national currency against a basket of currencies (US dollar and UK pound). Conventional tests manage to confirm the validity of PPP. Furthermore, they test the presence of structural breaks by a non-linear TAR model. They find a statistically significant break in 1973 consistent with PPP equilibrium. They state that the breakpoint in 1973 can be attributed to trade and financial liberalization strategies in Chile.

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[29] This test examines the presence of non-stationarity against a non-linear but stationary ESTAR process. Moreover, Liew does not apply this test to the real exchange rate. In contrast, this is applied to the exchange rate deviation from PPP. If PPP deviation is stationary, the exchange rate is mean reverting, consistent with PPP. A similar study is this of Razzaghipour et al (2001), which through graphical and statistical analyses finds evidence of a mean reverting process in PPP divergence for 5 Asian currencies against US dollar for a period including the Asian financial crisis.

2.2 Concluding Remarks

Although Gustav Cassel (1921, 1922) proposed Purchasing Power Parity as a tool of exchange rate determination, the empirical evidence does not fully support this view. A wide range of econometric techniques has been used in the literature to test the validity of PPP hypothesis in the long run. Univariate unit root tests cannot provide supportive evidence of the PPP condition (see for example, Alba & Park, 2003 and Holmes, 2000). This is due to the low power of those tests. On the other hand, univariate and multivariate cointegration studies provide somewhat better results, but PPP cannot be accepted in all cases (see for example Wang, 2000).

Researchers can increase power by using either long span of data (see for example, Lothian & Taylor, 1996) or panel data methods. Panel unit root tests and panel cointegration techniques provide more satisfactory evidence. However, rejections of PPP equilibrium are not missing (see for example Basher & Mohsin, 2004). The same holds for panel cointegration studies, such as Drine & Rault (2003). Moreover, panel unit root tests are valid only if there is no cross sectional dependence (O'Connell, 1998b). As Papell & Theodoridis (1998) point out, PPP is sensitive to the choice of the numeraire currency. Besides, evidence of PPP seems to depend on the US dollar trend. PPP is stronger when US dollar appreciates and weaker when US dollar depreciates (Papell, 2002).

Any rejection of the PPP hypothesis can be attributed, apart from the low power of the applied tests, to the following reasons: (i) Balassa-Samuelson effect: developing countries have been experiencing fast growing rates, (ii) transactions cost, (iii) tariff and no-tariff barriers, (iv) price instability, (v) appreciation trend of capital flows, (vi) government intervention in forex markets, (vii) structural reforms and (viii) exchange rate regime switch (when long span of data are used, it is sensible to find both fixed and flexible exchange rate regimes over the estimated period).

All the above factors are responsible for the presence of structural breaks in exchange rates. The presence of structural breaks in real exchange rates is a negative sign for the validity of PPP. On the other hand, a rejection of unit roots in real exchange rates, when breaks are considered, implies a mean reverting process. If this is the case, the quasi-PPP is accepted (Hegwood & Papell, 1998). Univariate unit root tests and cointegration techniques are able to confirm the validity of PPP when structural breaks are modeled. (see for example, Zurbruegg & Allsopp, 2004, Sabate et al, 2003 and Aggarwal et al, 2000). Finally, in line with the presence of structural breaks, some studies find that real exchange rates follow a non-linear mean reverting process. Given the nonlinear adjustment, a Threshold Autoregressive (TAR) model allows for a transaction costs band within which no adjustment takes place. Outside the band, arbitrage becomes profitable and the process becomes stationary autoregressive. Small deviations from PPP follow a random walk process, and large deviations are mean reverting. Taylor et. al. (2001), Sarno et. al. (2004), Obstfeld & Taylor (1997) among others support this view, finding that large deviations imply low half-life estimates. In contrast, small deviations cause high half-life periods. But, O'Connell (1998a) provides a different point of view. He finds that large deviations are more persistent than small deviations, implying higher estimates of half-life in the outer regime.

To conclude, this chapter presents the basic theoretical notion of the Purchasing Power Parity hypothesis and reviews the recent empirical findings in the literature. This analysis is in general supportive to the validity of the PPP hypothesis in the long run. A direct implication of this analysis is that the vast majority of the empirical studies, which has failed to confirm long run PPP equilibrium, may suffer from low power or it has ignored the presence of structural breaks and the possibility of nonlinear behaviour of the exchange rates, especially when developing countries are examined. Therefore, by employing advanced econometric techniques, Purchasing Power Parity can be more easily accepted as a valid long-run equilibrium phenomenon.

3. Exchange Rate Determination Models

International Macroeconomics is an extensively analyzed field of economics. However, there are a number of questions that are still unresolved. Obstfeld and Rogoff (2000) present some of those puzzles in International Macroeconomics. For instance, chapter 2 surveys the Purchasing Power Parity hypothesis, which states that exchange rate and price movements should be proportionate. Adler & Lehmann (1983), Corbae & Ouliaris (1988), Patel (1990) and others fail to accept the validity of this hypothesis. This is an embarrassing puzzle for International Macroeconomics. However, Taylor et. al. (2001), Sarno et. al. (2004) and Obstfeld & Taylor (1997), using more appropriate econometric techniques, show that PPP is a valid long run relationship.

Some of those puzzles have risen after the collapse of the Bretton-Woods system and the adoption of flexible exchange rate regimes. When exchange rates were fixed, fundamentals were more volatile. Moving to a floating regime, what changes is exchange rate volatility. Therefore, under fixed regimes exchange rate volatility is transferred to fundamentals. But, how this volatility can be explained? Is it dictated by economic fundamentals or it follows a random walk? The answer in this question is crucial in explaining exchange rates behaviour and in predicting future movements.

The monetary model of exchange rate determination, known as flexible-price model, states that the exchange rate is a function of fundamentals, such as relative money supply, relative real output and interest rate differential. Furthermore, taking into account the UIP condition, one more factor that affects the exchange rate is the expected inflation differential. The main characteristic of the monetary model is price flexibility and its focus on the money market. A modification to the flexible-price model is the Dornbusch's model, which is known as sticky-price model or overshooting model. It explains large fluctuations in exchange rates and shows that the initial value of the exchange rate overshoots its long run equilibrium value. The basic assumptions of the model are price stickiness and perfect asset substitutability.

An asset approach presented by Branson (1977) is the Portfolio Balance model. This model introduces a wide range of assets, such as domestic money, domestic and foreign bonds. The portfolio balance model does not assume that the UIP condition holds. In other words, domestic and foreign assets are not perfect substitutable. That means that agents choose this amount of domestic and foreign bonds, which maximizes their profits. Thus, agents choose a diversified portfolio of assets including domestic money, domestic and foreign bonds. According to this model, agents determine the short run exchange rate, which in turns determines the current account equilibrium. If the short run exchange rate implies a current account surplus, this can be eliminated by a proportionate capital account deficit. This means that agents accumulate foreign assets. But, this path can lead only to a temporary equilibrium. The long run equilibrium exchange rate is attained when the current account is in balance.

This chapter surveys the above exchange rate determination models. Although, theoretically these models seem to perform reasonably well, the empirical evidence of those models is an inquiry. The Dorbusch model performs relatively better than the other two models. This is because of the short run price stickiness assumption. Hence, under a monetary policy shock the exchange rate will overshoot its long run equilibrium because in the short run the shock affects only the foreign exchange market.

The following section outlines the monetary model and its application to the real world. Section 3.2 deals with the Sticky Price model while section 3.3 illustrates the concepts of the Portfolio Balance model. Each section includes evidence of the empirical application of each model and a criticism to the validity of those models. A final section concludes.

3.1. The Monetary Model

The monetary model is the earliest approach to the exchange rate determination and it has its origins in Frenkel (1976), Kouri (1976), and Mussa (1976, 1979). The main characteristic of the model is price flexibility. Moreover, it focuses on the money market. *"Basically, the monetary approach to the exchange rate may be viewed as a dual relationship to the monetary approach to the balance of payments. These approaches emphasize the role of money and other assets in determining the balance of payments when the exchange rate is pegged, and in determining the exchange rate when it is flexible"* [Frenkel (1976), page 200]. The assumptions of the model are as follows[30]:

1) Prices are flexible
2) Aggregate supply curve is vertical. This implies that the economy is at full employment level
3) Demand for money is a stable function of only a few domestic macroeconomic variables. Therefore, monetary equilibrium in the domestic market is given by:

[30] e= nominal exchange rate, m= domestic real money supply, m*=foreign real money supply, p= domestic price level, p*= foreign price level, y= domestic real income, y*= foreign real income, i= domestic interest rate, i*= foreign interest rate.

$$m_t - p_t = \varphi y_t - \mu i_t \quad (3.1)$$

The same holds for the foreign country:

$$m_t * - p_t * = \varphi * y_t * - \mu * i_t * \quad (3.2)$$

4) PPP hypothesis holds all the time:

$$e_t = p_t - p_t * \quad (3.3)$$

5) There is perfect asset substitutability and perfect capital mobility. Thus, UIP condition holds continuously:

$$i_t = i_t^* + E_t[\Delta e_{t+1}] \quad (3.4)$$

The foreign price level is exogenous to the domestic economy and the domestic money supply determines the domestic price level and hence the exchange rate. Combining equations (3.1) and (3.2), we get the following expression:

$$(m_t - m_t *) - (p_t - p_t *) = \varphi y_t - \varphi * y_t * - \mu i_t + \mu * i_t * \quad (3.5)$$

Assuming that the domestic and foreign coefficients are identical, the equation below gives the equation for relative money demands:

$$(m_t - m_t *) - (p_t - p_t *) = \varphi (y_t - y_t *) - \mu (i_t - i_t *) \quad (3.6)$$

Now, solving for the relative prices and using the PPP condition we get the exchange rate equation:

$$e_t = (m_t - m_t *) - \phi (y_t - y_t *) + \mu (i_t - i_t *) \quad (3.7)$$

Equation (3.7) shows that the nominal exchange rate depends on the relative money supply, the relative output, and the interest rate differential. Applying the UIP condition, the exchange rate equation becomes:

$$e_t = (m_t - m_t^*) - \phi(y_t - y_t^*) + \mu E_t[\Delta e_{t+1}] \tag{3.8}$$

But, as PPP holds all the time, $E_t[\Delta e_{t+1}] = E_t[\Delta p_{t+1}] - E_t[\Delta p^*_{t+1}]$, the exchange rate equation becomes:

$$e_t = (m_t - m_t^*) - \phi(y_t - y_t^*) + \mu(E_t[\Delta p_{t+1}] - E_t[\Delta p^*_{t+1}]) \tag{3.9}$$

A higher increase in the domestic money supply is expected to depreciate the domestic currency. The increased money stock increases the domestic price level. This makes domestic goods less competitive than the foreign ones. Thus, demand for domestic goods decreases and this of foreign goods increases. As a result, the domestic currency depreciates.

A relatively higher increase in the domestic output is going to appreciate the domestic currency. This will increase the demand for money and given the money supply constant there is excess demand for the domestic money stock. The money market equilibrium will be restored if people reduce their expenditure on consumption. Domestic prices fall and through PPP the exchange rate decreases.

The response of the exchange rate to an increase in the domestic interest rate has exactly the opposite effect with the increase in the domestic output. To be exact, a higher interest rate will decrease the demand for money and given the money supply unchanged, the domestic price level increases. As a consequence, foreign goods are preferable to domestic goods, as they are cheaper. The Trade Balance deteriorates and the exchange rate increases, i.e. the domestic currency depreciates.

Besides this effect, an increase in the domestic interest rate means increase in the expected domestic inflation, through the Fischer condition[31]. This will create expectations of depreciation of the domestic currency. Agents with perfect foresight will sell domestic currency for foreign currency. As a result, the domestic currency depreciates. Therefore, through this mechanism, it is obvious that a relatively higher expected inflation in the future is going to depreciate the domestic currency at the present.

3.1.1. Future Expected Changes

Current values of exchange rates include expectations for future values. If the foreign exchange market is efficient, current spot rates reflect all available information for future values.[32] In equation (3.8), we solve for the nominal exchange rate:

$$e_t = (m_t - m_t^*) - \phi(y_t - y_t^*) + \mu E_t[\Delta e_{t+1}] \tag{3.8}$$

$$e_t = (m_t - m_t^*) - \phi(y_t - y_t^*) + \mu(E_t[e_{t+1}] - e_t) \tag{3.10}$$

$$e_t = \frac{1}{1+\mu}[(m_t - m_t^*) - \phi(y_t - y_t^*)] + \frac{\mu}{1+\mu}E_t[e_{t+1}] \tag{3.11}$$

After n periods, equation (3.11) becomes:

$$e_t = \frac{1}{1+\mu}\sum_{i=0}^{n-1}\left(\frac{1}{1+\mu}\right)^i E_t[(m_{t+i} - m_{t+i}^*) - \phi(y_{t+i} - y_{t+i}^*)] + \left(\frac{\mu}{1+\mu}\right)^n E_t[e_{t+n}] \tag{3.12}$$

Assuming that $\lim_{n\to\infty}\left(\frac{\mu}{1+\mu}\right)^n E_t[e_{t+n}] = 0$, the above expression takes the form of:

[31] The Fischer condition says that the nominal interest rate is equal to the real interest rate plus the expected inflation rate. This is expressed by the following relationship: $i_t = r_t + E_t[\Delta p_{t+1}]$.

[32] Agents form rational expectations (i.e. they have perfect foresight).

$$e_t = \frac{1}{1+\mu}\sum_0^{\infty}\left(\frac{1}{1+\mu}\right)^i E_t[(m_{t+i} - m^*_{t+i}) - \phi(y_{t+i} - y^*_{t+i})] \tag{3.13}$$

Expression (3.13) implies that the exchange rate is forward looking and responds today to new information about future values of money stock and output. The effect on the exchange rate is discounted by the factor [1/(1+μ)]. This means that the higher the expected future change in money and output differentials, the smaller the current effect on the exchange rate.

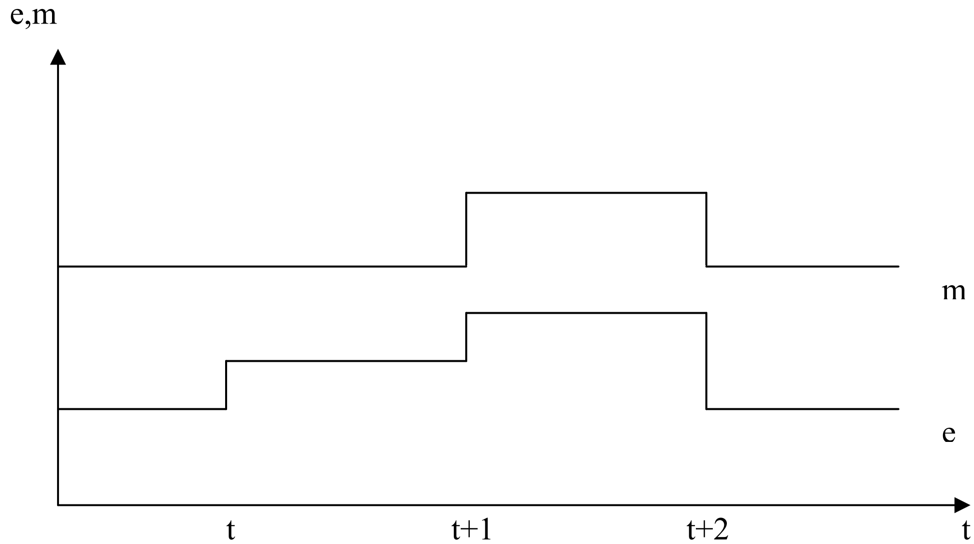
Given output differential and foreign money supply unchanged, suppose that at time t it is known that the domestic monetary authorities are willing to increase the money stock in period t+1. According to the monetary approach, this will depreciate the domestic currency. This movement may be temporary or can have a permanent effect. Taking into account the above assumption, let see the effect of a temporary increase in the domestic money supply:

$$e_t = \frac{1}{(1+\mu)^2} E_t[m_{t+1}] > 0 \tag{3.14}$$

$$E_t[e_{t+1}] = \frac{1}{1+\mu} E_t[m_{t+1}] < e_t \tag{3.15}$$

The announcement of a temporary increase in the money supply in period t+1 tends to the depreciation of the exchange rate in period t. In period t+1, when the money increase actually takes place, the exchange rate depreciates more. At the end of period t+1, money supply moves back to its previous level, then the exchange rate appreciates finding its prior long run equilibrium. This is shown in the following figure.

Figure 3.1: Temporary change



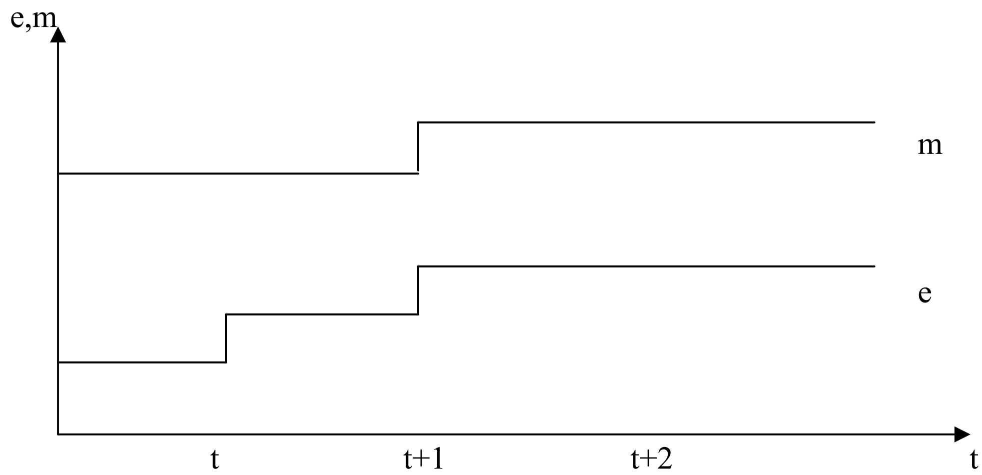
Now, suppose that the increase in the money stock will be permanent. This means that the increased money stock will be continued after period t+1. Thus, spot and expected exchange rates become:

$$e_t = \frac{1}{(1+\mu)^2} E_t[m_{t+1}] + \frac{1}{(1+\mu)^3} E_t[m_{t+2}] + ... = \frac{1}{1+\mu} E_t[m_{t+1}] \tag{3.16}$$

$$E_t[e_{t+1}] = E_t[m_{t+2}] > e_t \tag{3.17}$$

This announcement increases the exchange rate at time t. In other words the domestic currency depreciates. In period t+1, when the money stock increases, the exchange rate increases again. The main difference from the temporary change case is that now the money supply does not reach its previous level. It remains high, during periods following the t+1 period, until the next movement. Therefore, the exchange rate finds its new equilibrium and stays there until the next shock. This movement can be shown in figure 3.2.

Figure 3.2: Permanent change



3.1.2. Empirical Literature Review

A broad number of empirical studies deal with the question whether the monetary model is a reliable tool of explaining the behaviour of exchange rates. The empirical literature shows that using data until 1978 the monetary model performs well providing evidence of a valid empirical tool. Although this chapter concentrates on more recent studies, a brief review of those studies is presented below.

Frenkel (1976) tests the monetary model for the Deutsche mark/US dollar exchange rate and uses data from 1920 to 1923. His results, focusing on the German money and expected inflation, support the validity of the flexible-price model. Furthermore, Bilson (1978) tests the Deutsche mark/UK pound exchange rate over the period 1972-1976. Similarly, his results do not deviate from what the monetary model predicts. Hodrick (1978) examines the US dollar/Deutsche mark for the period 1972-1975 and finds that the effects of the fundamentals on the exchange rate coincide with the monetary model's analysis. In the same study and for the same sample, Hodrick states that the monetary model is also well applied in the case of the UK pound/US dollar exchange rate.

Dornbusch (1979), estimating the Deutsche mark/US dollar exchange rate for the period 1973-1978, provides supporting evidence for the monetary model. However, posterior studies do not offer a clear-cut statement on the validity of the monetary model. A selection of those is presented below.

MacDonald and Taylor (1994a) examine the long run and short run properties of the monetary model for the UK pound/US dollar exchange rate. The estimation period is from 1976 to 1990 and the monetary fundamentals consist of money supply (M1), income (industrial production) and long run interest rate. Applying the Dickey-Fuller (1979, 1981) and Phillips & Perron (1988) unit root tests, they find that all variables are of the same order of integration. The presence of I(1) variables dictates the use of non-conventional approaches. The long run relationship between the exchange rate and the monetary fundamentals is tested by two methods. First, the two-step cointegration approach of Engle and Granger (1987) fails to confirm the long run relationship. In contrast, the Johansen cointegration technique [Johansen, (1988, 1991) and Johansen & Juselius, (1990)] finds up to three cointegrating vectors. As a result, there is evidence of a valid long run relationship. The monetary model is more supported by the estimation of the cointegrating vectors. Indeed, the estimated coefficients - except US interest rate - are correctly signed in terms of the monetary model's predictions. Furthermore, the exclusion restrictions of the model are rejected for all variables.

An error correction model (ECM) tests the short run dynamics of the UK pound/US dollar exchange rate. As the goodness of fit of the model is established, the results imply that the monetary ECM performs satisfactorily in both in-sample and out-of-sample forecasting.[33] Therefore, the monetary model is a valid long run relationship that explains and predicts the fluctuation of the UK pound/US dollar exchange rate.

Using the same data set and sample period (1976-1990), MacDonald and Taylor (1994b) re-examine the monetary model in terms of the US dollar/French frank exchange rate. Under the same econometric technique, they find evidence of existence of four cointegrating vectors. As before, the monetary model is supported as a valid long run relationship. However, the monetary model cannot explain short run exchange rate movements and it is not accepted as a forward-looking process. The authors imply that this failure is a result of short run deviations from the equilibrium value, which in turns are due to irrational speculation.

McNown & Wallace (1994) test the validity of the monetary model in the case of three hyperinflation countries relative to the U.S. The panel of data consists of Argentina (1977-1986), Chile (1973-1985), Israel (1979-1988) and U.S. as the reference country. Data are filled with monthly observations on exchange rates and monetary fundamentals. High inflation rates are related with large changes in monetary variables. In example, high inflation may be a result of an unstable money supply. Testing statistical properties of the variables, the ADF test shows that for Argentina most variables are I(1), but KPSS test[34] implies that some may be I(2). For Chile and Israel, variables are I(2) (ADF) and

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[33] The out-of-sample forecasting performance is tested as follows: They estimate the model using data up to 1988:12. The estimated model is used to calculate five forecasting horizons over the period 1989:1-1990:12. Then, root mean square errors (RMSE) are estimated and compared with those of the random walk model. If monetary model's RMSE statistic is less than this of the random walk, the monetary model outperforms the random walk model. This is one more supporting point for the validity of the monetary model.

[34] This is developed by Kwiatkowski, Phillips, Schmidt and Shin (1991).

using 12 lags the KPSS test shows that these variables are I(1). US variables are undoubtedly I(1). However, all used variables are of the same order of integration [I(1)].

Cointegration results imply the existence of a unique cointegrating vector for Israel. For Argentina, two cointegrating vectors establish a long run relationship, while for Chile one cointegrating vector is found when US (M1) is applied and two when US money supply is expressed by M2. These results provide evidence of a long run relationship and support the monetary model as a long run phenomenon. But the coefficients, implied by the estimated cointegrated vectors, are not of the expected sign. Namely, the estimated coefficients are not correctly signed and inconsistent with the monetary model. However, McNown & Wallace (1994) state that it is difficult to reject the validity of the monetary model because the true structural model is unknown.[35]

Kouretas (1997) examines the Canadian – US Dollar exchange rate under the framework of the monetary model. The data set includes monthly end-of-period observations for the exchange rate, money supply, income and interest rates from June 1970 to May 1994.[36] A dummy variable is added in the model to include the change in US monetary policy in 1982. He tests the order of integration of the variables by the KPSS test and the existence of cointegration between the exchange rate and the monetary fundamentals by the Johansen multivariate cointegration technique. Moreover, he tests

[35] The estimated coefficients are derived from a reduced form model, which is a mixture of structural coefficients. Since the structural model is unknown, incorrect signs not necessarily mean rejection of the monetary model. This may be due to incorrect specification of the model.

[36] M1 is used as money supply, industrial production stands for income and the Treasury bill yield is used as interest rate.

the identification and the stability of the estimated model by the Johansen's FILM method and the DOLS approach[37].

The results imply that all variables are I(1). Cointegration estimation is applied by the likelihood ratio test and the trace statistic (Johansen's test). The former implies the existence of one cointegrating vector, while the latter accepts two significant cointegrating vectors. Kouretas (1997) accepts the existence of two cointegrating vectors. Furthermore, the test of identification of the model shows that both cointegrating vectors are overidentified as the linear restrictions are rejected. Thus, the monetary model cannot be accepted as a long run forward-looking relationship. However, Kouretas (1997) concludes that given the unrestricted model for the Canadian-US Dollar exchange rate, the monetary model is a valid long run relationship.

Cushman (2000) is critical to the Kouretas' results. To be specific, Cushman (2000) believes that Kouretas (1997) uses inappropriate critical values for the cointegration test. The inclusion of a dummy variable can affect critical values. The appropriate critical values are given by Johansen and Nielsen (1993) who have created a computer program (DisCo) to simulate the asymptotic distributions for testing cointegration with (and without) dummies. According to Kouretas' (1997) results, the monetary model's validity is confirmed under the unrestricted model because of the existence of two cointegrating vectors. But, using the correct critical values, no significant cointegrating vector can be accepted. As a result, the monetary model fails. Cushman (2000) re-estimates the Canadian-US Dollar exchange rate by adding 41/2 years

[37] This approach, developed by Stock and Watson (1993), adds leads and lags of first differences and first differences of unit root variables to an equation with the unit root and deterministic variables and then estimates by OLS.

data more. By applying the same technique he finds evidence of a unique cointegrating vector. But this is not equivalent to the support of the monetary model. All the estimated coefficients are statistically significant, but the majority of those are not correctly signed. In other words, these estimates are not consistent with the monetary model. An explanation, given by Cushman (2000), may be the low power of the Johansen test. As both Kouretas (1997) and Cushman (2000) point, this can be ruled out by using the DOLS approach (Stock and Watson, 1993). However, DOLS results are similar to the Johansen test's results.

Papadopoulos and Zis (2000) examine whether there is a long run equilibrium relationship between ECU/Drachma and monetary fundamentals of Greece and EU over the period 1980-1991 using quarterly observations. As the authors note, their model is based on the assumption that the Greek and EU demands for money are identical. Moreover, M2 is used for money because of its advantage of money demand stability.[38] The evidence of I(1) variables implies the application of cointegration techniques. As the constancy of the model and weak exogeneity[39] are established, the estimated VAR model implies the existence of a unique cointegrating vector. This is equivalent to the existence of a long run equilibrium relationship between the exchange rate and the monetary fundamentals. Moreover, given that the estimated coefficients are of the correct sign, the validity of the monetary model in the long run is strongly supported. However, the error correction model (ECM), which tests the short run dynamics of the exchange rate, does

[38] Papadopoulos and Zis (1997) find for the case of Greece that M1 produces an unstable demand function. In contrast, M2 is consistent with money demand stability.

[39] All variables except the exchange rate are weakly exogenous to the model. This means that if the exchange rate deviates from its long run equilibrium value, deviations can be damp out only by exchange rate adjustments.

not provide supporting results. All coefficients, except the exchange rate, are statistically insignificant. Furthermore, the impulse response analysis implies a highly complex process of adjustment consistent with the monetary model. For example, a higher Greek income will depreciate Greek Drachma in the short run, which in the long run will lead to the appreciation. Therefore, Papadopoulos and Zis (2000) conclude that the monetary model is a valid long run equilibrium condition with highly complex short run dynamics.

Groen (2000) applies time series, cross sectional and panel data analysis for 14 bilateral exchange rates[40] and monetary fundamentals over the period 1973-1994 using quarterly observations. Either US or Germany is used as a base country. Time series analysis provides some evidence of cointegration, but not satisfactory. In other words, there is no strong evidence that the monetary model is valid in the long run. On the other hand, cross-country analysis of the monetary model implies stronger evidence of validity. The estimated coefficients are statistically significant and correctly signed. As a result, a long run relationship exists.

Besides to the cross sectional analysis, a two-step panel data analysis is applied. In the first step, the model is estimated by an OLS regression. The second step examines the stationary nature of the residuals. In turn, the model is estimated by Feasible Generalized Least Squares (FGLS) to correct cross sectional dependence and cross sectional heteroskedasticity in residuals. The panel data analysis is separated in four sub-panels: (1) all 14 bilateral exchange rates, (2) the G7 bilateral exchange rates (Canada, France, Germany, Italy, Japan, UK and US), (3) the G10 bilateral exchange rates (adding the Netherlands, Sweden and Switzerland), (4) EMS bilateral exchange rates (Austria,

[40] The panel of the countries is: Australia, Austria, Canada, Finland, France, Germany, US, Italy, Japan, Netherlands, Norway, Spain, Sweden, Switzerland and UK.

France, Germany, Italy, the Netherlands and Spain). The results imply that for (1) and (3) panels, cointegration cannot be rejected regardless of the base country. For G7 panel, cointegration is not accepted and for EMS panel the null of no cointegration is rejected only when Germany is used as a base country.[41] Thus, in the majority of the panels, the monetary model is accepted as a long run relationship between the exchange rate and monetary fundamentals. On the contrary, time series analysis does not support the validity of the monetary model as a long run phenomenon.

Rapach and Wohar (2002) test the monetary model using long spans of data.[42] If the exchange rate is I(0) or I(1), then $\Delta e_{t+1} = 0$ in the steady-state. Thus, from UIP condition, domestic and foreign interest rates are equal. Given the above definition, the dataset includes annual observations of nominal exchange rates, money supply and real GDP for 14 industrialized countries[43] relative to US. The Unit Root test shows that for Australia, Belgium, France, Italy, Spain and UK all variables are I(1). For Portugal and Finland, only e and m are of the same order of integration [I(1)]. Hence, cointegration will be tested only between e and m. For Canada and Switzerland, results are not clear and for Denmark, Norway and Sweden there is evidence that the monetary model does not hold in the long run [e~I(0) & m~I(1)]. In contrast, for the case of the Netherlands, exchange

[41] Although in time series analysis the choice of the base country is not important, in panel data analysis this is crucial. The evidence shows that the monetary model is more supported when DEM bilateral exchange rates are examined.

[42] They assume that the rejection of the validity of the monetary model is a result of short data. However, the use of longer spans of data can cause structural instability. This can be managed if we assume that there is homogeneity across countries or a stable dynamic system.

[43] Australia, Belgium, France, Italy, Spain, UK, Finland, Portugal, Denmark, Norway, Sweden, Canada, Switzerland and the Netherlands.

rate deviations from any linear combination of money supply and real GDP are stationary.

In addition to the Unit Root test, Rapach and Wohar (2002) apply four cointegration tests[44]. The results imply that for France, Italy, Spain, and the Netherlands the monetary model is strongly supported since cointegration is accepted and the estimated coefficients are of the expected sign. For Belgium, only one of the four tests can reject the null of no cointegration. Despite the correct sign of the estimated coefficients, the monetary model is not supported for the case of Belgium. The same holds for Switzerland. Furthermore, the monetary model finds some support in the case of Finland and Portugal. The estimated coefficients are close to the expected values and three of the four tests accept the cointegration hypothesis. To sum up, the authors provide evidence that in most applications the monetary model is a valid long run relationship.

- Monetary model's predictability as a means of long-run exchange rate estimation

In a survey, Taylor (1995) presents an alternative way of examining the validity of the exchange rate determination models. Specifically, a number of studies are presented, which test the out-of-sample forecasting ability of the monetary and other models. A representative study is that of Meese and Rogoff (1983). They test the predictability of exchange rate determination models including the monetary model.[45] This is applied to the UK pound, Deutsche mark and Japanese yen against the US dollar, using monthly observations from 1973:3 to 1981:6. The monetary model produces forecasts at 1 to 12 month horizons, which are compared to the random walk's forecasts. The out-of-sample

[44] Phillips and Ouliaris (1990) test, Johansen (1988, 1991) trace test, Hansen (1992) Lc statistic and Shin (1994) Cμ statistic.

[45] The Dornbusch and portfolio balance modes are also examined.

forecasting is measured by three statistics: (i) ME (mean error), (ii) MAE (mean absolute error) and (iii) RMSE (root mean square error), which is the statistic that Meese and Rogoff (1983) apply. The other two statistics are useful in determining of whether the model undershoots or overshoots.

The results imply that the random walk model has the lowest RMSE over all horizons and over all exchange rates. Hence, the monetary model does not provide any better information on future exchange rate movements.[46] However, the ME and MAE statistics show that the monetary model neither underpredicts nor overpredicts. Finally, Meese and Rogoff (1983), providing some possible reasons for this forecasting inability, stress that there is structural instability due to oil shocks and unstable macroeconomic policies. Moreover, the model may be misspecified because of the unstable money demand function.

Under the same framework, Mark (1995) examines the predictability of the monetary model by testing the deviations of the spot exchange rate from its fundamental value. The latter is dictated by the monetary model, which is a linear combination of relative money stocks and relative real incomes. This study is applied to the Canadian dollar, Deutsche mark, Swiss frank and Japanese yen exchange rates relative to the US dollar, using quarterly data from 1973 to 1991. He estimates out-of-sample forecasts for a given horizon -h-, using $t<N$ observations (N = all available observations). Next, the first horizon -h- forecast is re-estimated by using $t+1$ observations to construct the second h-horizon forecast. This is continued until $N-h$ observations are used. These h-horizon forecasts are compared to the forecasts from the random walk model.

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[46] This statement does not change in the case of the other two exchange rate models. Neither structural model has better predictability performance than this of the random walk model.

Forecasting estimation includes the period 1981-1993 in order to cover the dollar appreciation and its peak point during 1985. The results show that for the first horizon, predictions for the Canadian dollar, Swiss Franc and Japanese Yen have RMSE (Root Mean Square Error) lower than those of the random walk model. In general, Mark (1995) shows that the monetary model in a long run base can predict the exchange rate.

Groen (1999) tests the long run predictability of the monetary model. His study is applied to Canada, France, Germany and the Netherlands relative to US, using monthly data over the period 1973 – 1994. He attempts to model the following expression:

$$\Delta_h e_{t+h} = \alpha_h + \beta_h (z_t - e_t) + u_{t+h} \tag{3.18}$$

where z is a vector of fundamentals (such as relative money supply and relative income). If the current exchange rate and the vector of fundamentals are cointegrated, the parameter β_h should be positive to confirm stability. If $\beta_h>0$, current exchange rate deviations from its equilibrium value will be offset in the future. Therefore, this is a good approximation for future exchange rate movements. Monte Carlo simulation gives the appropriate critical values for the cointegration test. The results imply that there is no evidence of long run relationship between the exchange rate and the fundamentals.

Next, he moves to the out-of-sample forecasting estimation, which is similar to the Mark's (1995) methodology. In explain, he compares the ratio of RMSE of the forecasting model with this of the random walk model. The estimated model will provide valuable forecasting information if the ratio of RMSE is less than 1 and statistical significant.[47] Forecasting evaluation is applied into two samples. The first one covers the period 1981:10 – 1991:12 and the second one includes the period 1981:10 – 1994:12.

[47] Significance is tested using the Diedold and Mariano (1995) DM statistic.

Forecasting performance of the model is weaker during the second period. As a general point, Groen (1999) finds no supporting evidence of the predictability of the monetary model. This failure may be due to the lack of cointegration.

Motivated by Mark's (1995) study, Kilian (1999) applies a long-horizon regression test using the same data set, but extending the sample size up to 1997 (1973-1997). Long run exchange rate predictability is examined through two criteria. The former is that the joint test statistic must be significant at the 10% significance level, and the latter claims that p-values should be decreasing as the forecast horizon increases.[48] For the period 1973-1991, most joint statistics are significant and p-values are decreasing, except this for Canada. For the extended sample, there is evidence of long-horizon predictability only for Switzerland. For the rest of the panel, p-values are either stable or increasing. Kilian (1999) in an effort to explain this contradiction states that Mark's technique may not be correct, as he does not include the appropriate drift. This can lead to misleading ADF test results. Moreover, OLS estimators may be biased. If this is the case, critical values and standard errors are invalid.

He concludes that there is some evidence of exchange rate predictability, but there is no evidence of long-horizon forecasting ability. According to the author, this failure may be due to the fact that the true process is described by nonlinear dynamics. If a linear model is used instead of the true nonlinear model, p-values are inconsistent. As a result, the implied results are misleading. The solution is to compute new p-values consistent with the true nonlinear specification.

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[48] P-values are constructed by 2,000 independent replications

Rapach and Wohar (2002), following Mark (1995), examine the predictability of the monetary model by comparing the monetary model's forecasts with those of the random walk model. The difference from Mark's (1995) technique is that they allow for a drift in the random walk model. They use five tests to compare the above forecasts. The null hypothesis is that forecasts from the random walk include monetary model's forecasts. If this is true, monetary model's forecasts are not informative for exchange rate fluctuations. The results show that for Belgium, Italy and Switzerland, monetary model's forecasts provide valuable information on exchange rate variability. In contrast, the monetary model does not provide additional information on exchange rate forecasting for France, Portugal, Spain and Finland. They conclude that any failure of the monetary model as a forecasting tool is a result of the weak exogeneity of the exchange rate.

3.1.3. A critical view on the validity of the Monetary model

The empirical evidence on the monetary model cannot be summarized by a clear statement. While interwar period data studies support the monetary model, subsequent studies differ in their implications. For example, a number of empirical works accept the monetary model as a long run phenomenon, while others reject the existence of any cointegrating relationship between the exchange rate and the monetary fundamentals. Besides these results, other studies - although accept the existence of a long run relationship - fail to accept that the monetary model can explain the short run dynamics of the exchange rate. In addition, researchers attempt to test the validity of the monetary model by estimating its in-sample and out-of-sample forecasting ability. Similarly, implications are mixed.

A review on the literature shows that researchers have moved to a more sophisticated econometric analysis. Hence, researchers seek to establish the validity of the monetary model by using non-conventional econometric techniques. They use longer spans of data, panel data analysis and more recently nonlinear models in explaining exchange rate behaviour. For example, Groen (2000), using time series analysis, fails to support the monetary model. In contrast, applying cross sectional analysis, he finds supporting evidence for the monetary model.

Rogoff (1999) answering the question "why is difficult to estimate exchange rates?" stresses some interesting points. Firstly, fundamentals are less volatile than exchange rates. This means that interest rates, money and income are not the only factors that affect exchange rates.[49] Secondly, money market cannot be easily modeled. For example, money demand is unstable and money supply is set exogenously by Central Banks. Moreover, when the inflation is close to zero, the effect of the monetary policy on the exchange rate is difficult to be detected. Finally, the exchange rate may not be correctly estimated due to the slow convergence to PPP.[50]

To sum up, the evidence is not clear about the validity of the monetary model. Recent studies use more powerful techniques in examining exchange rates. Any failure of the monetary model may be due to inappropriate econometric procedures. To avoid this misspecification, it is useful to test the properties of the model. Assuming that the model is characterized by nonlinear dynamics, an erroneous usage of a linear model instead of the true nonlinear model will produce invalid implications. Therefore, we need to turn on

[49] Rogoff (1999) implies that political factors have an active role in exchange rate determination.
[50] However, this is not a true reason for the failure of the Monetary model. As chapter 2 shows, recent studies manage to accept the validity of the Purchasing Power Parity hypothesis. For example, Sarno et. al. (2004), estimating a nonlinear model, find evidence that PPP hypothesis holds in the long run.

nonlinear models and new open economy macroeconomics.[51] Finally, the monetary exchange rate determination model was vital for the development of exchange rate economics and under conditions it is a useful empirical tool.

3.2. The Dornbusch model

This model is alternative to the monetary model, in which prices are flexible and the Purchasing Power Parity hypothesis holds all the time. Dornbusch (1976) develops a theory of exchange rate determination under perfect capital mobility, slow adjustment of goods markets relative to assets markets and consistent expectations. This model is also known as overshooting model because the current exchange rate tends to overshoot its long run equilibrium value following some exogenous shocks. The main characteristic of the model is that prices are sticky and the exchange rate is at equilibrium only in the long run. In the short run, the exchange rate is out of its equilibrium value because of the slow adjustment of the price level. The assumptions of the model are:

1) Prices are sticky in the short run.
2) The country is small in capital market, which means that interest rates are given.
3) The economy is at full employment, so the output level is given.
4) There is perfect asset substitutability, which means that the Uncovered Interest Parity (UIP) holds. If the domestic currency is expected to depreciate, interest rates on assets will exceed those abroad by the expected rate of depreciation. We rewrite equation (3.4), which illustrates the UIP condition. This is equivalent to the perfect capital mobility.

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[51] This is a suggestion of Rogoff (1999). Moreover, he introduces the estimation of political models to capture the role of political factors in exchange rate determination.

$$i_t = i_t^* + E_t[\Delta e_{t+1}] \quad (3.4)$$

The expected rate of depreciation is given by:

$$E_t[\Delta e_{t+1}] = \theta(\overline{e} - e_t) \quad (3.19)$$

where: e_t= logarithm of the current exchange rate

$\overline{e}$ = logarithm of the long run exchange rate

θ= coefficient of adjustment

5) The long run exchange rate is determined by monetary and real factors.
6) Import prices are given.
7) Prices of domestic goods depend on aggregate demand for domestic goods.

- **Money Market**

Equilibrium in money market requires the supply of money to be equal to the demand for money. We rewrite equation (3.1):[52]

$$m_t - p_t = \varphi y_t - \mu i_t \quad (3.1)$$

We substitute (3.4), (3.19) to (3.1):

$$m_t - p_t = \varphi y_t - \mu(i_t^* + E_t[\Delta e_{t+1}]) \quad (3.20)$$

$$m_t - p_t = \varphi y_t - \mu[i_t^* + \theta(\overline{e} - e_t)] \quad (3.21)$$

$$\mu\theta(\overline{e} - e_t) = -m_t + p_t - \varphi y_t - \mu i_t^* \quad (3.22)$$

$$e_t = \overline{e} + \frac{1}{\mu\theta}(m_t - p_t - \varphi y_t + \mu i_t^*) \quad (3.23)$$

Equation (3.23) shows the relationship between the exchange rate and the price level that guarantees money market equilibrium.

[52] All symbols stand for the same variables as in the monetary model, presented in the previous section.

- **Goods Market**

Equilibrium in goods market is restored when aggregate demand equals aggregate supply. The demand for domestic output is given by:

$$du_t = \alpha(e_t + p_t * - p_t) - \sigma i_t + \tau y_t \tag{3.24}$$

where α, σ, τ are positive coefficients.

Equation (3.24) shows that the demand for domestic output depends on the relative price of domestic goods, interest rates and real income. So, an increase in the relative price of domestic goods decreases demand. The same does an increase in interest rates, but the opposite happens in case of an increase in income[53]. The rate of increase in the domestic price level is given by:

$$\Delta p = \delta[\alpha(e_t + p_t * - p_t) - \sigma i_t + \tau y_t - \widehat{y}] \tag{3.25}$$

where δ is the coefficient of price adjustment. Assuming that the domestic price level does not change, writing (3.25) as follows we ensure that excess demand is zero.

$$\Delta p = 0 = \delta[\alpha(e_t + p_t * - p_t) - \sigma i_t + \tau y_t - \widehat{y}] \tag{3.26}$$

Now, using the UIP condition and the fact that the economy is at full employment (i.e $y = \widehat{y}$), equation (3.26) becomes:

$$\alpha(e_t + p_t * - p_t) - \sigma i_t + (\tau - 1) y_t = 0 \tag{3.27}$$

$$\alpha(e_t + p_t * - p_t) - \sigma[i_t * + \theta(\overline{e} - e_t)] + (\tau - 1) y_t = 0 \tag{3.28}$$

$$\alpha e_t + \alpha(p_t * - p_t) - \sigma i_t * - \sigma\theta\overline{e} + \sigma\theta e_t + (\tau - 1) y_t = 0 \tag{3.29}$$

$$(\alpha + \sigma\theta) e_t = \sigma(i_t * + \theta\overline{e}) - \alpha(p_t * - p_t) - (\tau - 1) y_t \tag{3.30}$$

$$e_t = \frac{1}{\alpha + \sigma\theta}\left[\sigma(i_t * + \theta\overline{e}) - \alpha(p_t * - p_t) - (\tau - 1) y_t\right] \tag{3.31}$$

[53] Dornbusch (1976) sets the foreign price level equal to one, so that its logarithm is equal to zero (p*=0).

Equation (3.31) indicates the relationship between the current exchange rate and the domestic price level that ensures equilibrium in the goods market.

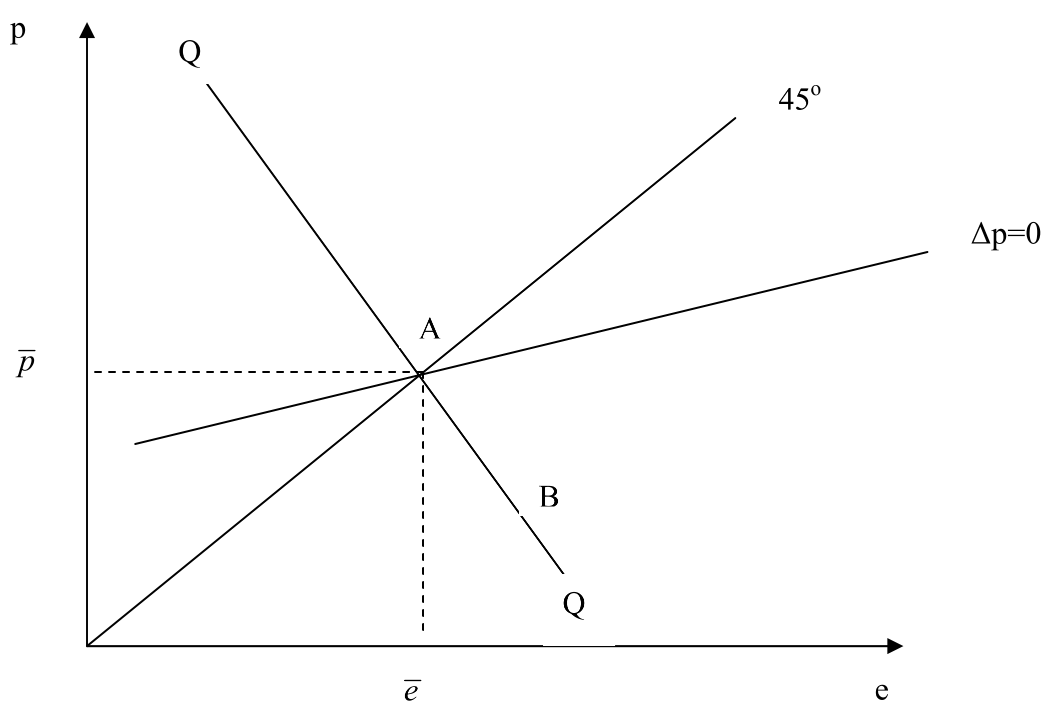
- **Equilibrium**

When both markets are in equilibrium the exchange rate and the price level find their long run equilibrium levels. This is shown in figure 3.3 (point A). At this point, aggregate demand is equal to aggregate supply, which means that there is no pressure on the domestic price level. Moreover, domestic interest rate is equal to the foreign interest rate. Thus, there is no expectation of either appreciation or depreciation of the exchange rate.

The curve QQ gives the combination of exchange rates and price levels at which the money market is at equilibrium. As we can see from equation (3.23) exchange rate and price level are negatively correlated. Thus, its slope is negative. To explain the negative slope of the QQ curve, suppose that price level is below its long run level. As a result, the real money supply increases and the domestic interest rate decrease. From the UIP condition we can see that the term $E_t[\Delta e_{t+1}]$ falls, which is equivalent to expectations of appreciation of the domestic currency. Equation (3.19) implies that if the current exchange rate is above its long run level, the exchange rate is expected to appreciate. Thus, a low price level requires a high exchange rate.

The curve $\Delta p = 0$ includes the combinations of exchange rate and price level at which the excess demand in goods market is equal to zero. Its slope is positive but as figure 3.3 shows it is lower than this of the 45^{o} line. An increase in the price level above its equilibrium value has two effects on the aggregate demand. Firstly, as prices raise the real money supply decreases, this leads to the increase of the domestic interest rate. As a consequence, investment and aggregate demand decrease. Secondly, any increase in the domestic price level reduces competitiveness because foreign goods are relatively cheaper. Thus, export rates decline and aggregate demand for domestic goods declines as well. For that reasons, aggregate demand falls more than the aggregate supply, which causes disequilibria in the goods market. The excess supply can be reduced by increasing the exchange rate in a rate higher than that of the domestic price. Therefore, the slope of the curve is lower.

Figure 3.3: Dornbusch model



The excess supply case corresponds to points above the curve. On the other hand, points below the curve indicate excess demand. Such a point is B. There is excess demand for domestic goods because the price level is lower than the equilibrium level and the exchange rate is higher than its long run equilibrium value (i.e. it is undervalued). Equilibrium will tend from B to point A because the excess demand will cause a higher domestic price level. We saw that in the case of excess supply due to high prices, equilibrium is restored through the depreciation of the exchange rate. In a similar way, excess demand requires the appreciation of the exchange rate in order the market to be in equilibrium.

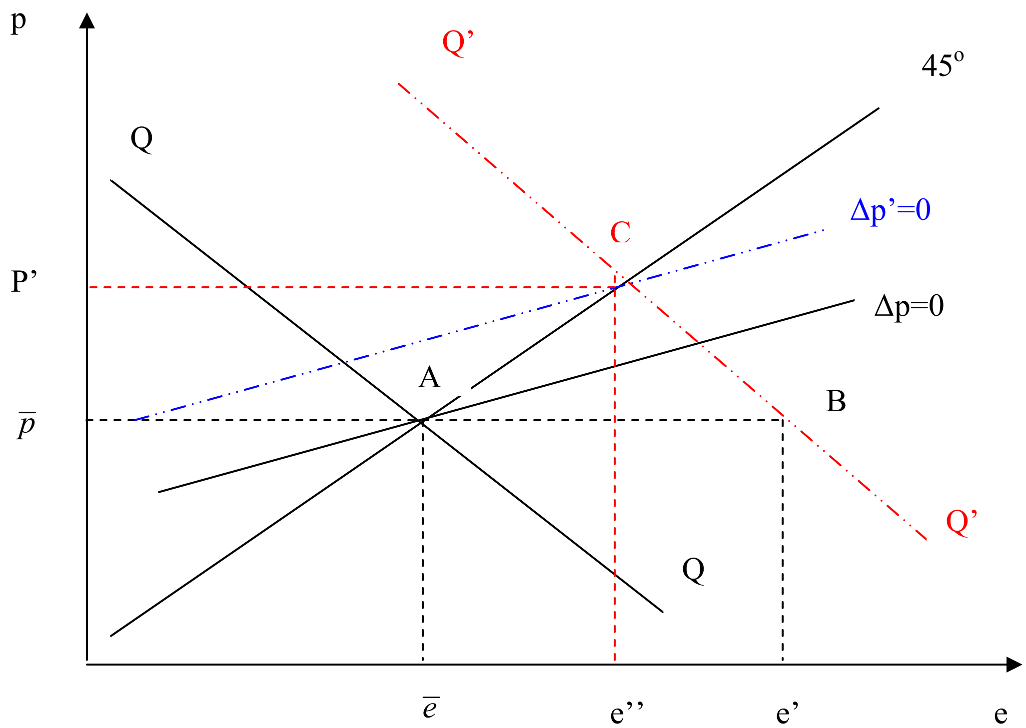
3.2.1. Effects of an Expansionary Monetary Policy

An increase in the nominal supply of money will cause disequilibria in goods and assets markets. In order to have equilibrium in assets market, prices will increase and the exchange rate will depreciate. Figure 3.4 presents the effect of a monetary expansion on the exchange rate. At point A, goods and money markets are in equilibrium. Suppose that the monetary authorities increase the nominal quantity of money in the economy. Then, the curve QQ shifts out to QQ' (this shift is proportional to the increase in the quantity of nominal money supply). In the short run, when prices are sticky, increase in nominal money supply means increase in real money supply. Then, the domestic currency depreciates as a result of the decreased interest rate. In the figure, that means shift from A to B, which is the short run equilibrium. The effect on the exchange rate is given by:

$$\frac{de}{dm} = 1 + \frac{1}{\mu\theta} \quad > 1 \tag{3.32}$$

From (3.32) we can see that in short run the exchange rate will overshoot. For example, 1% increase in the money supply will increase the exchange rate by more than 1%. This is because in short run, prices do not change and the monetary expansion affects only the foreign exchange market. At point B, there is excess demand for domestic goods because of the decrease in the domestic interest rate and the depreciation of the home currency. This will cause the domestic price level to increase in the long run. Real money supply decreases and domestic interest rates increase. As a result, the exchange rate appreciates. In the figure, that means shift from B to C. In the long run equilibrium (point C) both markets are in equilibrium.

Figure 3.4.: Monetary Expansion



- Flexible Output

Finally, Dornbusch (1976) relaxes the assumption of fixed output at the full employment level. Here, output can change in the short run due to aggregate demand movements. Thus, inflation rate depends on the difference between actual output and full employment level. The effect of a higher money stock on output is described as follows: the increased money supply will increase output and in turns will increase the domestic price level since domestic income increases as well. Real balances move to equilibrium until the increased money supply be offset by increased prices. This will lead output back to full employment level.

However, the effect of the same policy on the exchange rate and the interest rate is not identical to the fixed output analysis. Recall that since domestic money supply increases, interest rate declines and the exchange rate overshoots its long run equilibrium value. In contrast, the increased output (due to the increased money supply) will raise domestic income and as a result interest rate goes up. Moreover, the exchange rate undershoots rather than overshoots. Given the increased interest rate, domestic and foreign assets returns will be equal if the exchange rate increases (i.e. domestic currency depreciates). But, it depreciates less than the long run equilibrium level. Specifically, the rate of increase of the exchange rate is lower than this of money supply. Actually, the behaviour of the exchange rate and this of the interest rate depends on income and price elasticity.

3.2.2. Empirical Literature Review

Driskill (1981) estimates a reduced form exchange rate equation based on the Swiss franc/US dollar exchange rate. The Dornbusch model is estimated through the period 1973 – 1977 using quarterly data.[54] The estimated reduced form equation is as follows:

$$e_t = a_0 + a_1 e_{t-1} + a_2 m_t + a_3 m_{t-1} + a_4 p_{t-1} + a_5 y_t + a_6 y_{t-1} + a_7 \varsigma_t \qquad (3.33)$$

where ζ_t is a first order serially correlated random variable. If the restriction $\sum_{i=1}^{4} a_i = 1$ is accepted, the Purchasing Power Parity holds. Moreover, the exchange rate will overshoot

[54] Quarterly data are computed by three monthly end-of-period averages. CPI index is used for price variable and M3 stands for the money variable.

if $a_2 > 0$. The results imply that the above sum of coefficients is insignificantly different from one. Therefore, PPP holds in the long run. The estimated coefficients of the lagged exchange rate and the lagged price level are not correctly signed in terms of the Dornbusch model. However, there is evidence of exchange rate overshooting. The exchange rate depreciates in the first quarter, then appreciates for three quarters and then depreciates again. Thus, the exchange rate path to the long run equilibrium is not monotonic. Recall that the Dornbusch model implies that after overshooting, the path to the equilibrium exchange rate will have only one direction. Finally, the author points out that any inconsistency of the estimated exchange rate equation to the Dornbusch model may be due to the reduced-form model estimation rather than the true structural model estimation.

Hacche and Townend (1981) examine the UK pound effective exchange rate using a number of alternative exchange rate determination models. The effective exchange rate is calculated as the weighted average of the UK pound against US dollar, French franc, Deutsche mark, Japanese Yen and Italian lireta. Although, weakly, monthly, quarterly and annually observations are applied, the estimation of the model is based on monthly observations over the period 1972:5 – 1980:2. The results imply that the exchange rate does not follow a random walk. Moreover, money supply is the only significant and correctly signed coefficient. This estimated coefficient provides evidence that an increase in money supply causes a more than proportionate depreciation of the exchange rate. This evidence is consistent with the Dornbusch model. Furthermore, the authors find that an oil price shock has an impact on the exchange rate in the short run but not in the long run. Finally, they fail to find a strong long run relationship between the exchange rate and fundamentals. They conclude that the exchange rate overshoots its long run value (providing some support to the Dornbusch model), but many coefficients are statistically insignificant and wrongly signed. It is worth notable that the evidence from other exchange rate determination models is even unsatisfactory.

Papell (1988) provides supporting evidence for the sticky price model applying constraint maximum likelihood methods. He claims that single equation methods are inappropriate and unsuccessful. The Dornbusch model is tested for US, UK, Japan and Germany effective exchange rates over the period 1973-1984 (quarterly observations). The reduced form model is an ARMA with nonlinear constraints on the parameters. His estimation contains two steps. Firstly, a vector ARMA model is estimated for the exogenous variables.[55] Then, the constraint model is estimated by a maximum likelihood approach. The results imply that most of the structural coefficients are statistically significant and of the correct sign. In addition, Papell (1988) compares the results from the constrained model with those of a semi-constrained model. The estimated coefficients do not deviate significantly except of the case of Germany. To give a review of his results, the estimated coefficients indicate that the German effective exchange rate overshoots while the Japan effective exchange rate undershoots. The results for the UK and US exchange rates are not clear-cut.

Faust and Rogers (2000) model the effects of an expansionary monetary policy on the exchange rate. Taking into account the Dornbusch's overshooting model, they attempt to find if the exchange rate overshoots in response to the monetary policy shock. Moreover, they test if that shock is responsible for the high exchange rate volatility. Their results,

[55] Domestic money supply, foreign price level, foreign real output and foreign interest rate are exogenous.

based on the estimation of four models[56], indicate no strong evidence of delayed overshooting. They find that the speed of the exchange rate adjustment is sensitive to dubious assumptions. Furthermore, they find significant UIP deviations and evidence of forward premium anomaly. Recall that one of the building blocks of the sticky price model is that UIP holds all the time. In addition, the model states that spot rates are proportional to forward rates. Therefore, the above finding is contradictory to the Dornbush model. However, they do not find that this forward premium anomaly is due to UIP deviations.

Rogoff (2002) in a charming paper, expressing his experience of being in Rudiger Dornbusch's course at MIT, tests the empirical application of the overshooting model. Prior to this, he stresses the contribution of Dornbusch's model to the development of New Open Economy Macroeconomics. Actually, it is a further development of the Mundell (1962)-Fleming (1962) model. Dornbusch's model is the first, which introduces both expectations and price stickiness. Based on Frankel's (1979) observation that, under the framework of the Dornbusch model exchange rates and interest rate differentials are positively correlated, he examines the US dollar/Deutsche mark, Japanese Yen/US dollar and UK pound/US dollar exchange rates in terms of the above relationship. In the first two cases, there is some evidence of relationship. Many turning points can be explained by interest rate fluctuations. On the other hand, the identification of this relationship is very difficult in the case of the pound/dollar exchange rate. In most turning points, an increase in the exchange rate is associated with a decrease in interest rate differential. Moreover, accepting Flood's (1981) position that, in Dornbusch model spot rates movements are proportionate to forward rate movements, he tests the Yen/dollar and

[56] 7-variable and 14-variable models for US/UK and US/Germany.

pound/dollar exchange rates. He implies that this attempt is not very supportive for the Dornbusch model.[57]

3.2.3. A critical view on the validity of the Dornbusch model

The empirical literature on the sticky price model neither supports nor rejects the model. In the majority of the studies, there is some support. For example, Driskill (1981) finds that there is exchange rate overshooting but some of the estimated coefficients are statistically insignificant and incorrectly signed. More satisfactory are the results of Papell (1988). Furthermore, Smith and Wickens (1988), estimating an alternative version of the sticky price model developed by Buiter and Miller (1981), find that the UK pound exchange rate overshoots its long run value. A 5% change in the money supply causes 21% change in the exchange rate. However, there are studies, such as Faust and Rogers (2000), which fail to accept the validity of the Dornbusch model. In general, evidence on this model is relatively satisfactory. In our sense the Dornbusch model has a better empirical application than the monetary model. One of the reasons must be its realistic assumption. In particular, the Dornbusch model avoids assuming that the price level changes in the short run (as the Monetary model does). Such an assumption would accept that PPP holds continuously. Hence, the Dornbusch model is a useful empirical tool and a brilliant theoretical note for new open economy macroeconomics. Rogoff (2002) points out the contribution of the Dornbusch model in explaining the appreciation of the domestic currency in response to an increase in money supply. As it is well known, an

[57] However, he remarks that he did not test the statistical significance of his results. Moreover, the exchange rate – interest rate differential relationship is tested by a figure analysis and not by a regression analysis.

expansionary monetary policy causes the depreciation of the domestic currency. However, how is the above appreciation possible? Dornbusch gives the answer. The depreciation is higher than it should be. Namely, the exchange rate overshoots its long run value. As a consequence, in the long run the exchange rate decreases (i.e. the domestic currency appreciates) to find its equilibrium value.

3.3. The Portfolio Balance Model

As shown before, the monetary models of exchange rate determination show that the exchange rate is a function of money supply, interest rates, inflation rates and output levels. The portfolio balance model introduces a wide range of assets, such as domestic money, domestic and foreign bonds. This is not the only difference from monetary models. The portfolio balance model does not assume that the UIP condition holds. In other words, domestic and foreign assets are not perfect substitutable. This means that agents choose this amount of domestic and foreign bonds, which maximizes their profits. Thus, agents choose a diversified portfolio of assets including domestic money, domestic and foreign bonds.

Exchange rates depend on agents who invest between domestic and foreign bonds. Agents form expectations about future domestic and foreign bond prices. In that way, expectations have an important impact on the exchange rate determination. But, some researchers (for example, Allen & Kenen 1976, MacDonald 1988) assume that expectations are static. On the other hand, Dornbusch & Fischer (1980), Allen & Kenen

(1980), Branson and Henderson (1985) allow expectations to have an active role in determining the exchange rate.

Another important point of the portfolio balance model is the distinction between short run and long run exchange rate determination. Agents determine the short run exchange rate, which in turn determines the current account equilibrium. If the short run exchange rate implies a current account surplus, this can be eliminated by a proportionate capital account deficit. This means that agents accumulate foreign assets. But, this path can lead only to a temporary equilibrium. The long run equilibrium exchange rate is achieved when the current account is in balance.

Allen & Kenen (1980) compare the effect of an open market operation under fixed and flexible exchange rate regimes. The purchase of domestic bonds (from government spending) increases the demand for domestic bonds and the money supply at home. Under a fixed regime, the new asset equilibrium implies loss of reserves and the monetary policy cannot have any permanent effect on prices, output and employment. Under a flexible regime, this purchase causes the depreciation of the home currency and in contrast to the fixed regime the monetary policy can have a permanent effect on income. However, the model presented below will be tested only under the flexible exchange rate regime.

3.3.1. Static Expectations

The model presented here is that of Branson (1977). Its assumptions are as follows:

1) Domestic country is a small country and as a result the interest rate is fixed to the world level, i.e. interest rate is exogenous.

2) Foreign agents do not hold domestic assets

3) Supply of assets is fixed

4) Domestic and foreign agents have identical portfolio preferences

5) Agents prefer domestic than foreign assets

The wealth constraint of the home country is given by equation (3.34):

$$W = M + B + eF \tag{3.34}$$

where
$$M_t = M(i_t, i_t^* + E_t[\Delta e_{t+1}])W \tag{3.35}$$

is the domestic money supply and $\frac{\partial M_t}{\partial i_t} < 0$, $\frac{\partial M_t}{\partial (i_t^* + E_t[\Delta e_{t+1}])} < 0$

$$B_t = B(i_t, i_t^* + E_t[\Delta e_{t+1}])W \tag{3.36}$$

is the net holding of domestic bonds which represents the private sector holding of the government debt, and $\frac{\partial B_t}{\partial i_t} > 0$, $\frac{\partial B_t}{\partial (i_t^* + E_t[\Delta e_{t+1}])} < 0$

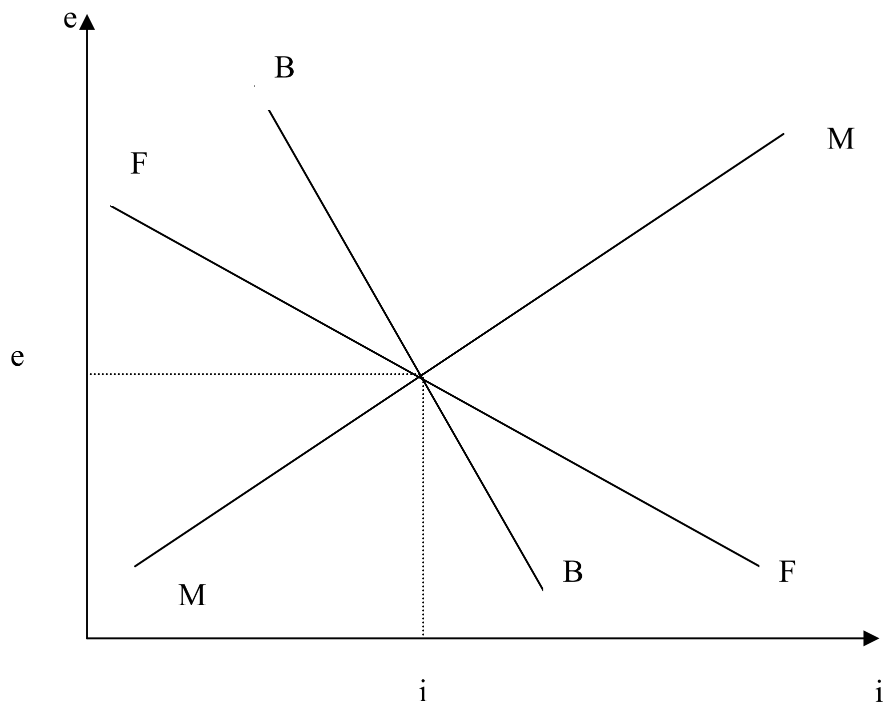
$$e_t F_t = F(i_t, i_t^* + E_t[\Delta e_{t+1}])W \tag{3.37}$$

is the net holding of foreign bonds expressed in the domestic currency, and

$$\frac{\partial F_t}{\partial i_t} < 0, \ \frac{\partial F_t}{\partial (i_t^* + E_t[\Delta e_{t+1}])} > 0.$$

The rate of return on domestic and foreign bonds is expressed as i and i^*, respectively. The expected rate of return on foreign bonds is shown as $i_t^* + E_t[\Delta e_{t+1}]$. Assuming that expectations are static, the term $E_t[\Delta e_{t+1}]$ is equal to zero. The equation set (3.34) – (3.37) represents the portfolio balance model, which diagrammatically is shown in the following figure:

Figure 3.5: Equilibrium



The curve MM represents the money market equilibrium. It contains all possible combinations of interest rates and exchange rates, which ensure the money market equilibrium. Its slope is positive, as an increase in the exchange rate requires a higher interest rate to restore equilibrium. Suppose that the domestic currency depreciates (e increases). Then, given other things constant, domestic income increases because eF increases (through equation 3.34). The increased income increases the demand for money, so a higher interest rate is required to restore money market equilibrium.

The curve BB represents the combinations of interest rates and exchange rates, which guarantee domestic bonds market equilibrium. This curve is negatively sloped because any disequilibrium caused by a higher exchange rate can be offset by a lower interest rate. Assuming again that domestic income increases due to the higher holding of foreign bonds (eF increases), the demand for domestic bonds increases. As a result, their prices rise and the interest rate declines.

Finally, the curve FF shows equilibrium combinations of exchange rates and interest rates for the foreign bonds market. Like curve BB, it is negatively sloped. The increased domestic income increases the demand for foreign bonds and the supply of those (as eF increases). The supply of foreign bonds increases more than the demand because agents invest between domestic and foreign bonds (i.e. the increased income is allocated between domestic and foreign bonds). Therefore, the net impact is excess supply of foreign bonds. This can be offset by a lower interest rate. This is because by decreasing the interest rate, domestic bonds are less attractive, thus agents are forced to purchase foreign bonds eliminating the excess supply.

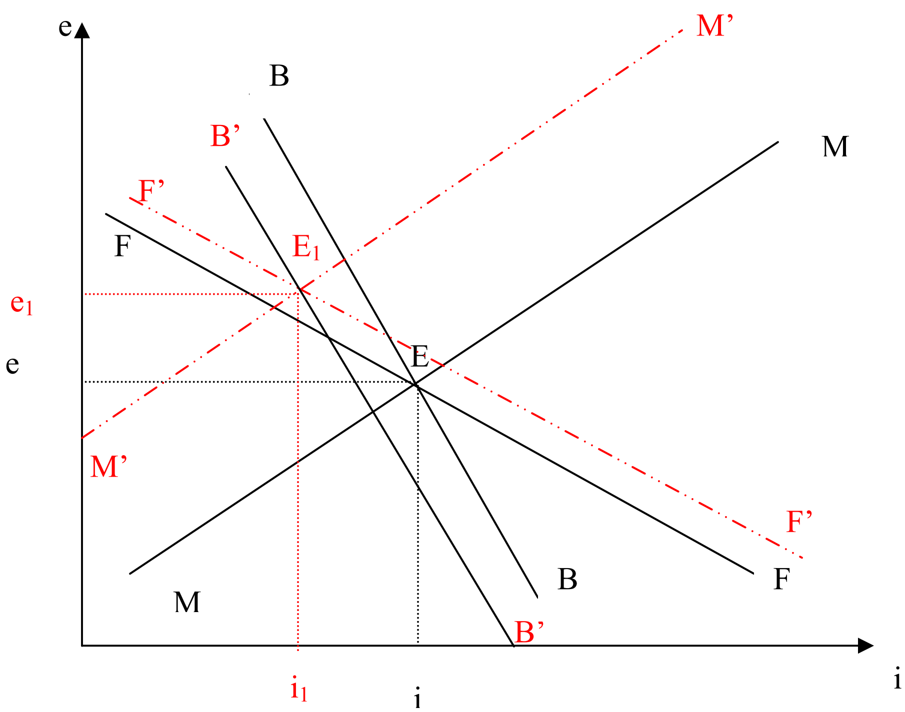
As shown in figure 3.5, curve BB is steeper than FF curve. This means that the former has bigger slope than the latter. A given change of the domestic interest rate has a stronger effect on domestic bonds than on foreign bonds. Similarly, a movement of the foreign interest rate affects more the foreign bonds market. As the domestic interest rate increases, the demand for domestic bonds increases more than the decrease of demand for foreign bonds. As a result, equilibrium requires the exchange rate to fall more in domestic bonds market than in foreign bonds market.

- <u>Short Run Equilibrium</u>

Equilibrium in the model is attained when all markets are in balance. In figure 3.5, the equilibrium point (E) is the tangent point of the three curves. It is worth notable to remind that, because of the wealth constraint, if two of the markets are in balance then, and the third market will be in balance. Next, we will examine the static analysis of the short run equilibrium.

Governments can affect the equilibrium conditions by changes in government spending (fiscal policy) and open market operations (monetary policy). Government can increase its spending by increasing the money supply or by increasing its debt. In other words, governments can increase the supply of the domestic bonds. Under the first scenario, the increased money supply will increase the demand for domestic and foreign bonds. This will cause excess money supply and excess demand for domestic and foreign bonds. In figure 3.6, the curve MM will move upward and to the left at M'M'.

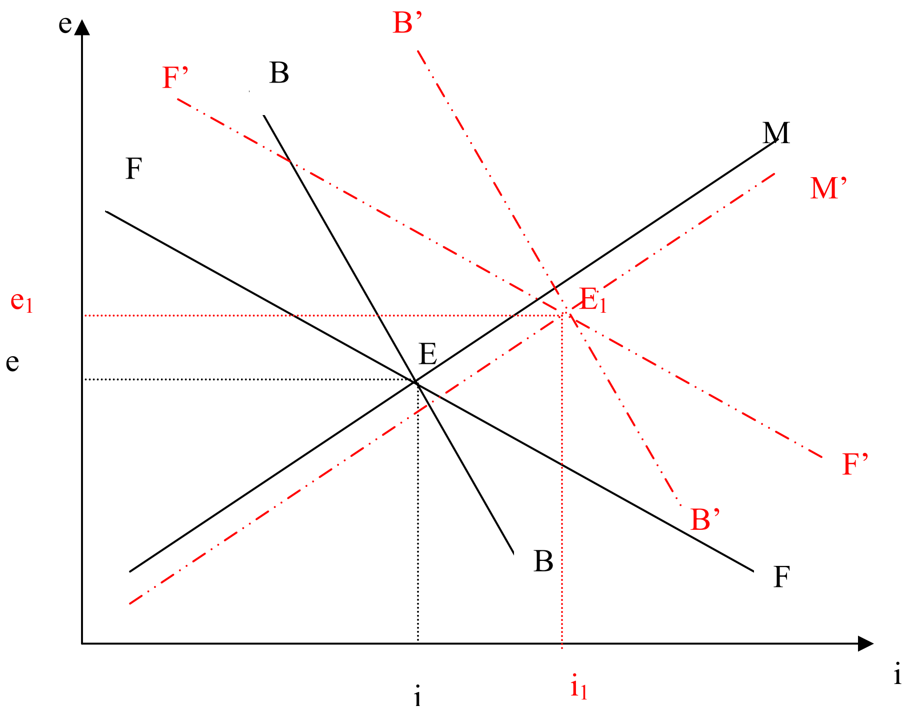
Figure 3.6: Increased Government Spending (new issued money)



At each exchange rate level, the money market equilibrium will be restored with a lower interest rate. As a consequence of the excess demand for domestic bonds, their prices rise and the interest rate falls. Then, the curve BB will move downward and to the left at B'B'. Satisfying the wealth constraint, the foreign bonds market meets its new equilibrium and the curve FF moves upward and to the right at F'F'. The new tangent point implies a short run equilibrium in which the interest rate decreases and the exchange rate increases (i.e. the domestic currency depreciates).

Let now see the effect of an increase in government spending by increasing the supply of domestic bonds. At each exchange rate, the domestic bonds market equilibrium requires a higher interest rate. In figure 3.7, this is equivalent to a movement of curve BB to a new curve B'B'. This movement causes disequilibria in markets. There is excess supply of domestic bonds and excess demand for money and foreign bonds. If we assume that domestic and foreign bonds are close substitutes, the domestic currency will appreciate. This is because the increased interest rate (substitution effect) will be higher than the increase in income (wealth effect). Thus, domestic agents will reduce the demand for foreign bonds. But, here we assume that domestic bonds and money are better substitutes than domestic and foreign bonds are. Consequently, the substitution effect (lower increase in interest rate) will be less than the wealth effect. Diagrammatically, the excess demand for money causes the movement of curve MM downward and to the right at the new curve M'M'. Then, the curve FF moves upward at F'F' (at each exchange rate, a higher interest rate is required). The new equilibrium is a short run equilibrium with a higher interest rate and a depreciated domestic currency.

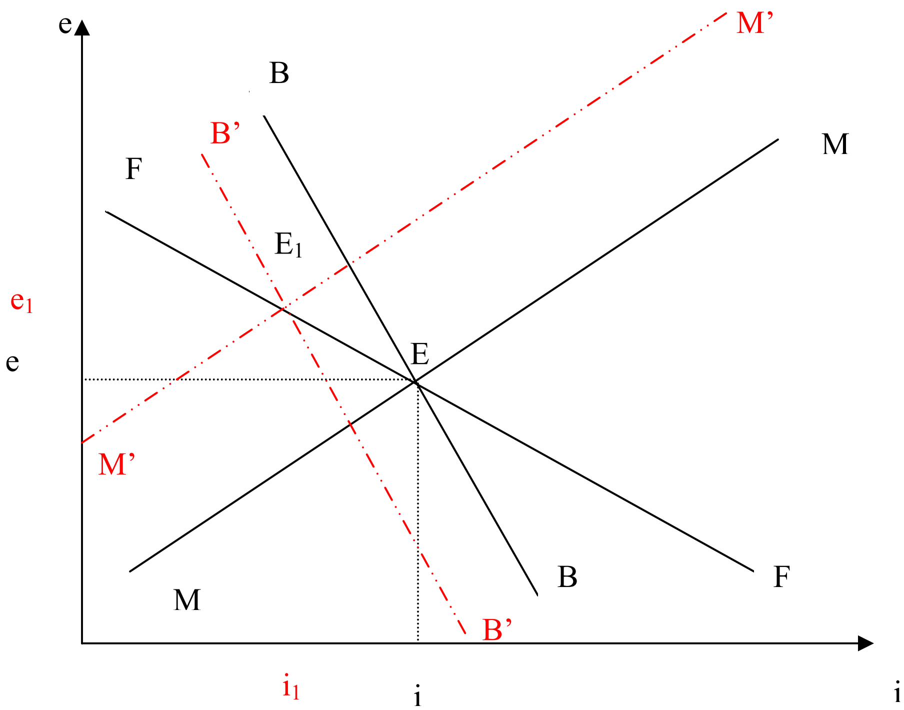
Figure 3.7: Increased Government Spending (bond-financed debt)



Besides the change in government spending, governments can influence equilibrium by open market operations. By this procedure, governments intervene into the markets adjusting the money stock. The main difference from fiscal policies is that now there is no income effect because wealth is unchanged. The total effect is caused only by the substitution effect.

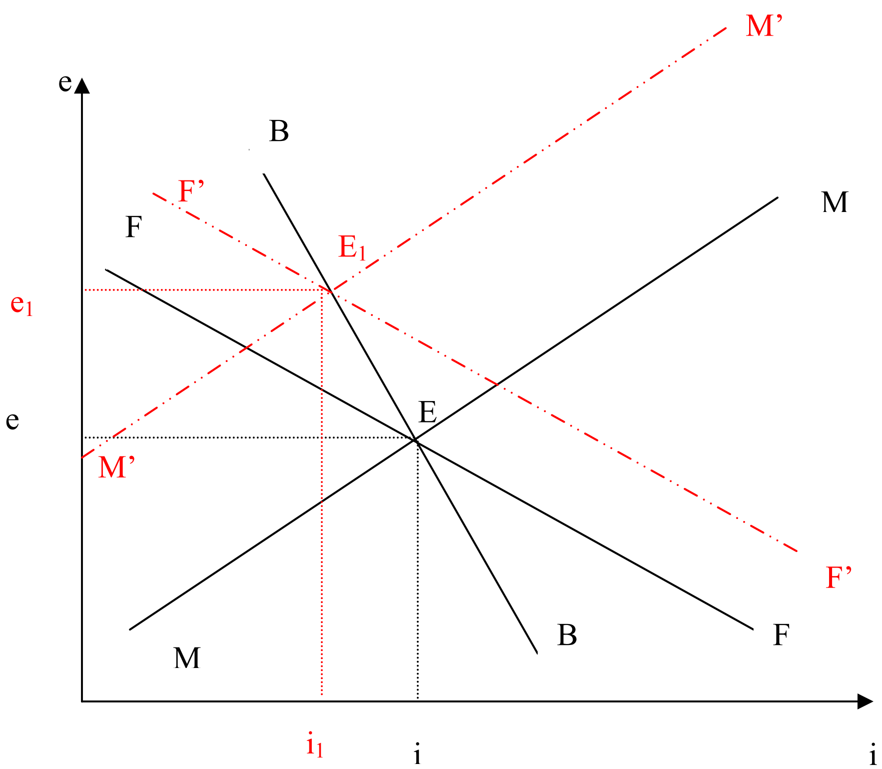
Suppose that the domestic government increases the money supply by exchanging money for bonds (i.e. government purchases domestic bonds from households). As a consequence, there is excess supply of money and excess demand for domestic bonds. Figure 3.8 illustrates this situation. MM curve is moving upward (M'M') since at a given exchange rate, a lower interest rate is required to restore money market equilibrium. Similarly, BB curve moves downward to B'B', to express the lower interest rate that is necessary for domestic bonds market equilibrium. At this interest rate, foreign bonds market is characterized by excess demand. This will be offset by a higher exchange rate (i.e. depreciation of the domestic currency). The new equilibrium is on FF curve (point E_1). This policy leads to a short run equilibrium accompanied with a lower interest rate and a depreciated domestic currency.

Figure 3.8: Open Market Operation (ΔB = - ΔM)



Alternatively, governments can exchange money for foreign bonds. This will create excess money supply and excess demand for foreign bonds. As before the MM curve moves to curve M'M' and the interest rate declines. The excess demand for foreign bonds will be offset by a higher exchange rate. Therefore, the FF curve moves upward to the new curve F'F'. The new equilibrium point (E_1) is the tangent point of M'M', F'F' and the original BB. This short run equilibrium is shown in figure 3.9. The specific policy depreciates the domestic currency while the interest rate falls. Observing figures 3.8 & 3.9, we can see that in figure 3.8 the domestic currency is depreciated less than in figure 3.9. Moreover, domestic interest rate decreases more in figure 3.8 than in figure 3.9. Therefore, the first policy has a bigger effect on interest rates and a smaller effect on the exchange rate than the second policy has. As a result, given the assumptions of the model, the open market purchase of domestic bonds is more appropriate.

Figure 3.9: Open Market Operation ($\Delta eF = -\Delta M$)



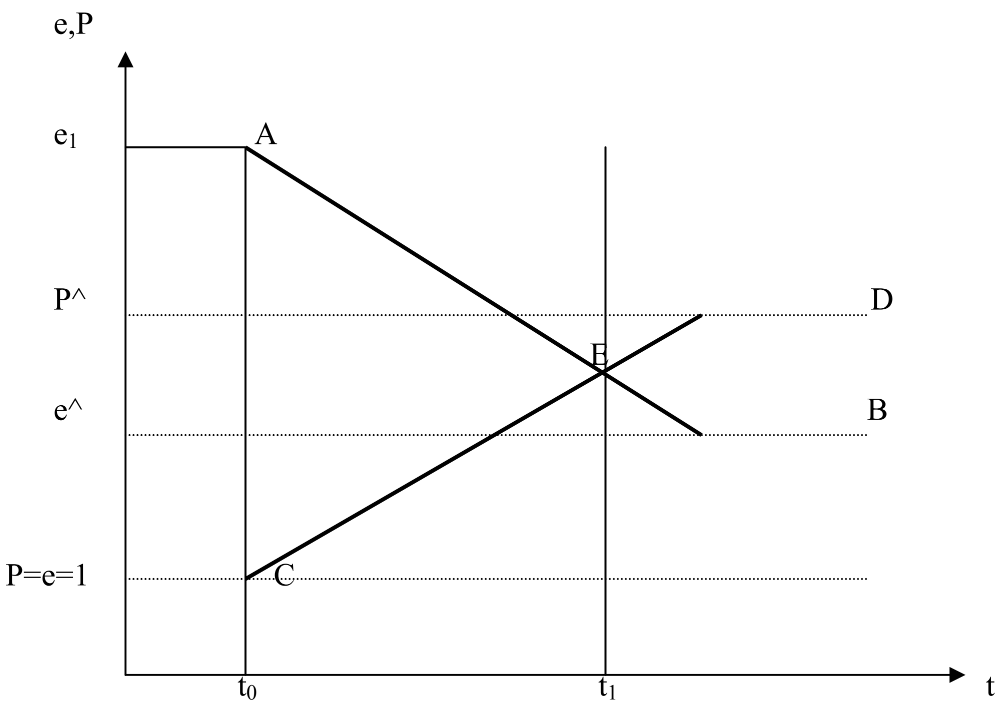
- Long Run Equilibrium

The above analysis shows that open market operations cause the depreciation of the domestic currency and a decline in the interest rate. In the long run, the exchange rate depends on the current account and capital account situation. For example, a current account surplus must be offset by a capital account deficit. Domestic agents will increase the net holding of foreign bonds. On the other hand, a current account deficit must be accompanied by a decrease in holding of foreign bonds. But, these changes in F can affect the exchange rate. Therefore, an unbalanced current account leads only to a temporary equilibrium. The long run equilibrium requires a current account balance, at which there is no reason for accumulation or decumulation of foreign bonds. The current account is equal to the sum of net exports and net income on foreign bonds:

$$CA = (EX - IM) \cdot (eP^* / P) + i^* eF \tag{3.38}$$

A crucial assumption for long run equilibrium is that the system is stable. Suppose that the exchange rate (e) is linked with a current account surplus (CA>0). This causes two contradictable effects. Firstly, domestic agents accumulate foreign assets and secondly the current account surplus appreciates the domestic currency. The first effect increases wealth and the current account surplus is increasing more and the second effect reduces domestic goods competitiveness, which in turns decreases the current account surplus. The system will be stable only if the second effect overshoots the first effect.

Figure 3.10: Long Run Equilibrium



Let now see the effect of an exchange of money for domestic bonds on the long run equilibrium. In figure 3.10, equilibrium before the shock (time t_0) is illustrated by P=e=1. The open market operation increases the money stock at home and as a result the exchange rate increases in order the asset market equilibrium to be restored (e_1). Given that the price level changes very slowly, the real exchange rate is increasing. Hence, the domestic currency depreciates and domestic net exports rise, creating a current account surplus.

The current account surplus tends agents to accumulate foreign assets, reducing the exchange rate (domestic currency appreciates). Then, the exchange rate follows the downward path AB (figure 3.10). On the other hand, since the price level is more flexible in the long run, the price level rises as the money supply increases. In figure 3.10, the price level follows the upward path CD. At point E the price level is equal to the exchange rate, however this is not the long run equilibrium. This is because the current account is not in balance due to the increased income on foreign bonds. As F is rising, e will continue to fall and P will keep on increasing until the current account is zero [(EX - IM)(eP*/P) = -i*eF]. This happens at P^ and e^ which ensure the long run equilibrium.

Like the Sticky Price Monetary model, short run exchange rate overshoots its long run equilibrium. This is because a change in domestic interest rate affects more the demand for foreign bonds than the money demand. In contrast, when the money demand is affected more, the short run equilibrium is below its long run value (i.e. the exchange rate undershoots).

3.3.2. Rational Expectations

So far, the portfolio balance model has been presented under the assumption of static expectations. In other words, agents have no information about future changes or they cannot apply any information to predict future exchange rate movements. Alternatively, they believe that the current exchange rate will be unchanged. But, this is not a realistic assumption. Agents form expectations about future bond prices and given that exchange rates are mainly determined in assets markets, their expectations are crucial for the exchange rate determination. Moreover, they choose between bonds denominated in two currencies, and their choices must reflect their expectations about the future value of the exchange rate. In this section we assume that agents form rational expectations. Hence, domestic and foreign agents have perfect foresight, which means that they are able to predict correctly future movements.[58]

Under the framework of Branson's model, Branson and Henderson (1985) develop a portfolio balance model assuming that agents form rational expectations. Other assumptions of the model are:

- Domestic agents hold only domestic money
- Domestic demand for money does not depend on foreign bond returns
- Changes in domestic demand for money are associated with changes in demand for domestic bonds
- Domestic demand for money does not depend on nominal wealth
- The elasticity of domestic demand for money with respect to nominal income is unity.

<u>Fixed Goods Prices</u>

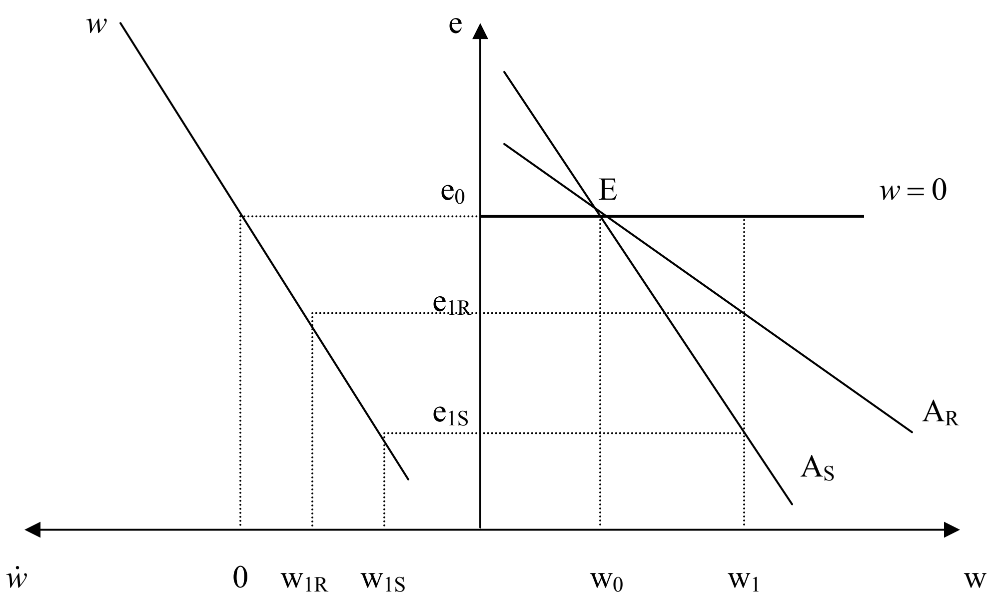
The following figure (3.11) contains the equilibrium conditions under static and rational expectations when goods prices are fixed. The curve *w* presents the

[58] Besides to static and rational expectations, Masson (1981) presents the case of regressive expectations. This is an inverse procedure. Agents look ahead to the long run effect of exogenous variables on the exchange rate, and assume that in the short run the exchange rate tends to this value.

combinations of exchange rates and home assets accumulation, which ensure balance of payments equilibrium. Its slope is positive because a depreciation of the domestic currency increases domestic trade surplus and domestic asset accumulation. The curve $w = 0$ corresponds to the equilibrium real exchange rate, where asset accumulation is zero.

Curves A_S and A_R represent asset market equilibrium under static and rational expectations, respectively. Following Branson (1977), it is assumed that domestic agents prefer more domestic assets.[59] When there is local asset preference, a transfer of wealth from foreign to home agents increases the demand for domestic assets and decreases the demand for foreign assets. As wealth increases, the domestic currency appreciates to restore asset equilibrium. Then, the slope of those curves is negative and the higher the local asset preference, the steeper is A_S.

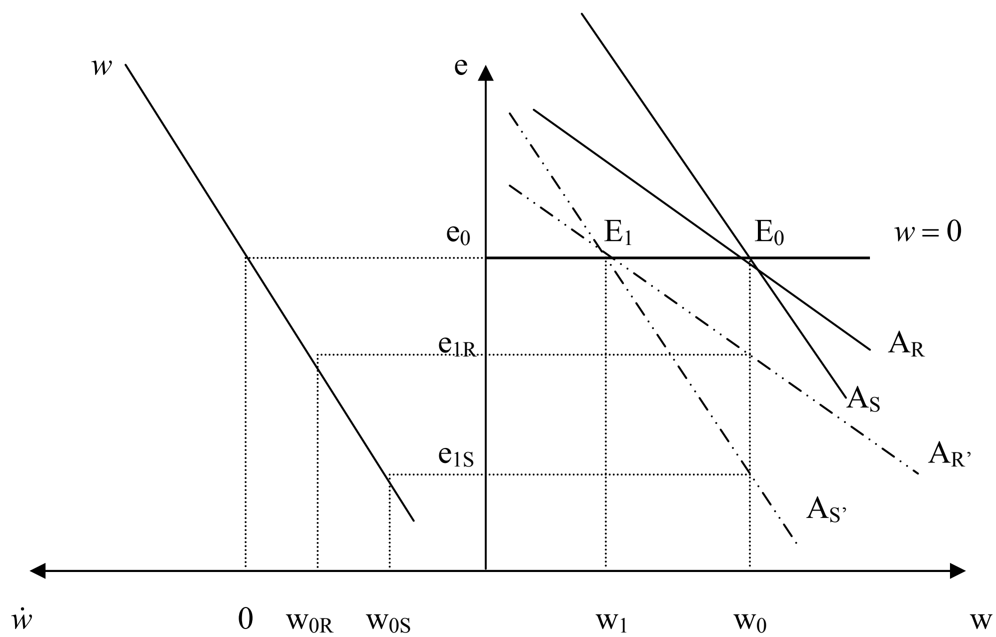
Figure 3.11: Unanticipated Transfer of Wealth to Domestic Agents



[59] This assumption is not adopted by Branson & Henderson (1985). Alternatively, they test each case separately. However, only the case of local asset preference is examined here.

Figure 3.11 illustrates the exchange rate adjustment, caused by an unanticipated transfer of wealth from foreign to domestic agents, when goods prices are fixed. Under static expectations the domestic currency appreciates (e_{1s}), because demand for domestic bonds increases. At this point, the domestic country runs a trade deficit. Therefore, as wealth decreases the domestic currency depreciates until its previous equilibrium (e_0). The effects under rational expectations are the same but relatively smaller. Indeed, the domestic currency appreciates less and the trade deficit is lower. In both cases, the exchange rate meets its previous equilibrium. Hence, the exchange rate is unchanged.

Figure 3.12: Unanticipated Contractionary Open Market Operation



Assuming again that goods prices are fixed, an unanticipated contractionary open market operation moves A_S and A_R downward, as shown in figure 3.12. Given wealth constant, the domestic currency appreciates under both expectation types. As before, the exchange rate decreases less under rational expectations. Due to the domestic currency appreciation, domestic country faces a trade deficit and asset decumulation. As a result, the domestic currency begins to depreciate. Under both expectations, the exchange rate meets its previous value, but at the new equilibrium (E_1) wealth is lower.[60]

Flexible Goods Prices

In the case of flexible goods prices and local asset preference, equilibrium conditions are shown in figure 3.13. The obvious difference from the fixed prices case is the slope of curve $w = 0$. Here, the curve that ensures zero asset accumulation is positively sloped. An increase in wealth causes lower home asset accumulation, so the domestic currency must depreciate in order to increase it. As before, asset equilibrium under static and rational expectations is expressed by negatively sloped curves.

Figure 3.13: Transfer of Wealth to Domestic Residents

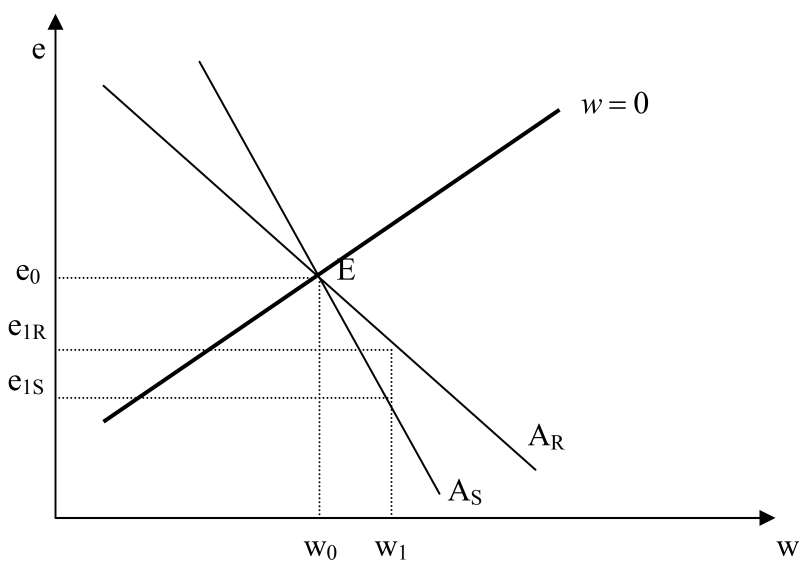


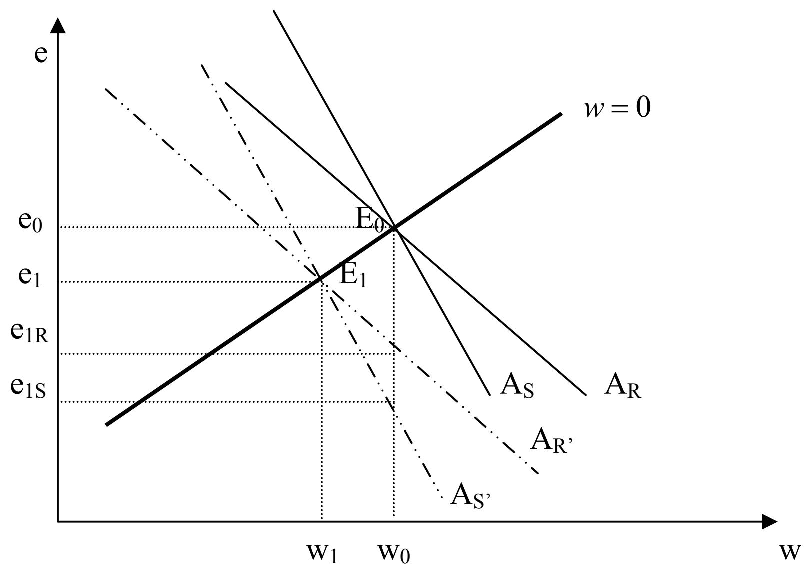
Figure 3.13 entails the effect of a transfer of wealth to domestic agents. As wealth increases, the demand for domestic bonds increases and the demand for foreign bonds decreases. This will lead to the appreciation of the domestic currency. The analysis is

[60] The reason for lower wealth may be that the domestic interest rate has been increased excessively to restore asset market equilibrium.

exactly the same with the fixed price case. Indeed, the appreciation is less under rational expectations and the new equilibrium leaves unchanged wealth and exchange rate.

A contractionary open market operation, under flexible prices, produces different results from those derived under fixed prices. To be specific, due to this policy A_S and A_R curves are moving downward. This is shown in figure 3.14.

Figure 3.14: Contractionary Open Market Operation



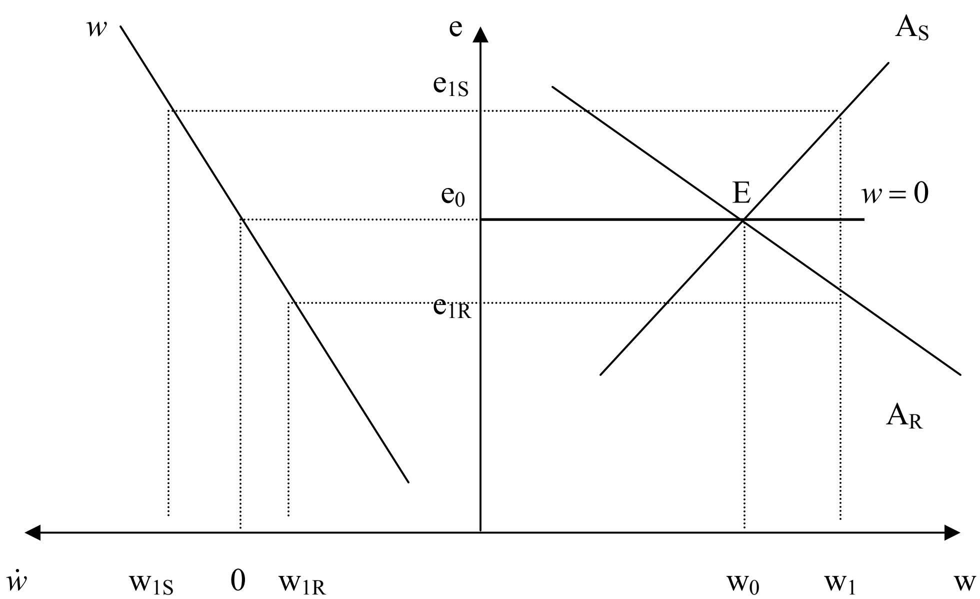
When w is unchanged the exchange rate is decreasing. Again, under rational expectations domestic currency appreciates less. At this point, trade deficit causes home asset decumulation. Therefore, as w decreases the domestic currency depreciates in order to restore zero home asset accumulation. The interesting point here is that the exchange rate does not reach its previous level. The net effect of this policy is the appreciation of the domestic currency since the rate of appreciation exceeds this of depreciation. Moreover, the new equilibrium point (E_1) is accompanied with lower wealth.[61]

[61] In the new long run equilibrium, real exchange rate is unchanged. Assuming that there is local good preference, as w increases domestic goods prices rise and foreign goods prices fall. When the nominal exchange rate appreciates, the real exchange rate appreciates too. Finally, if there is neither local asset

3.3.3. Net Foreign Asset Position, Expectations and Stability

The above subsection shows that the long run equilibrium is stable under both expectation systems. This statement is not valid if the country has a negative net foreign asset position. Here, we present the effect of an unanticipated transfer of wealth to home agents under static and rational expectations assuming that the domestic country is a net debtor (i.e. F<0). The analysis will be focused on the stability of the system. Taking first the case of fixed goods prices (figure 3.15) curves $\dot{w}$ and $\dot{w}=0$ are unchanged as the foreign asset position is not included in the balance of payment equation.

Figure 3.15: Unanticipated Transfer of Wealth to Domestic Agents (F<0)



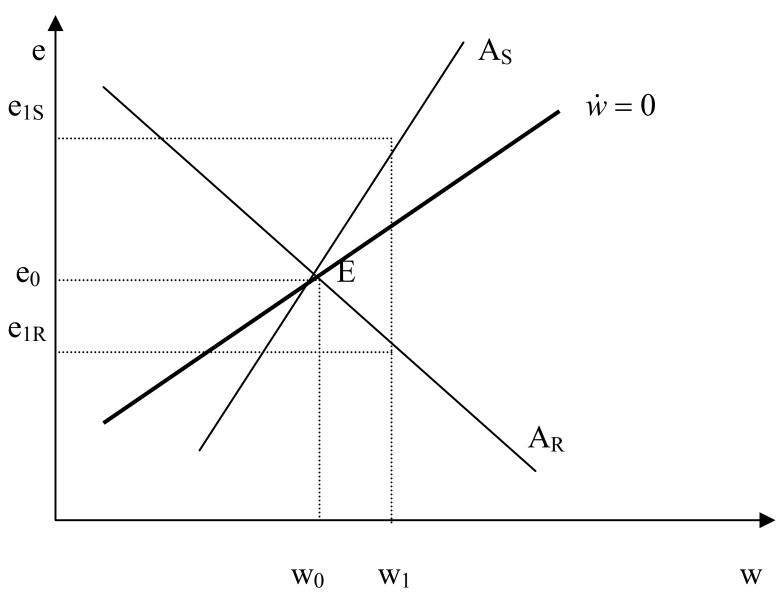
On the contrary, the slope of curve A_S is positive expressing that an increase in wealth is associated with a depreciation of the home currency to restore asset market equilibrium. When F is positive, a depreciation of the domestic currency increases

preference nor local good preference, changes in nominal exchange rate do not affect the real exchange rate.

domestic wealth and demand for domestic bonds. Alternatively, if F is negative, a depreciation of the home currency decreases wealth and demand for domestic bonds.

As wealth increases to w_1, demand for domestic bonds rises and the asset market equilibrium is restored by a higher exchange rate. Domestic country runs a trade surplus and since asset accumulation takes place the exchange rate is increasing more. In other words, long run equilibrium is unstable under static expectations. Under rational expectations long run equilibrium remains stable. As w increases, the appreciation of the domestic currency restores asset market equilibrium. Thus, the imminent trade deficit is linked with asset decumulation. As a result, the exchange rate increases finding its previous value. Identical results are derived in the case of flexible goods prices. Long run equilibrium is unstable under static expectations and stable under rational expectations. This is shown in figure 3.16.

Figure 3.16: Unanticipated Transfer of Wealth to Domestic Residents (F<0)



To sum up, Branson and Henderson (1985) show that the portfolio balance model under static expectations produces an unstable equilibrium when the case of a net debtor country is examined. On the contrary, the rational expectation version of the model is consistent with stability even if the country has a negative net foreign asset position. However, the portfolio balance model under rational expectations may be unstable if speculation is destabilizing. Masson (1981) provides a different point of view about stability. He points out that the unstable equilibrium of the portfolio balance model is not due to expectations. Further, it is a property of the portfolio balance model that a negative net foreign asset position causes instability.[62]

Finally, two contradictory rational expectation models are those of Calvo & Rodriguez (1977) and Dornbusch & Fischer (1980). The first one, assuming that domestic goods are separated into traded and nontraded goods and that domestic agents invest between domestic and foreign money, shows that an anticipated expansionary monetary policy leaves unchanged the exchange rate, but increases the stock of foreign currency.[63] Dornbusch and Fischer (1980), assuming that agents invest between domestic money and foreign assets, show that an anticipated increase of the domestic money stock depreciates the domestic currency leaving unchanged the stock of foreign assets.

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[62] Masson (1981) accepts the stability of the portfolio balance model if and only if strong expectational assumptions are applied.

[63] It is worth notable that in most models (i.e. Mundell - Fleming model) an increase in the domestic money supply causes loss of foreign exchange. This model, instead, shows that there is foreign exchange accumulation.

3.3.4. Empirical Literature Review

Like monetary models the portfolio balance model predicts that a higher domestic money stock depreciates the domestic currency. Furthermore, an increase in the supply of domestic bonds depreciates the domestic currency as well. To test if model's statements are true we have to search in the empirical literature. However, empirical studies on the portfolio balance model are relatively limited. This is due to the complexity of collecting disaggregated data on domestic and foreign holding of assets. Empirical literature contains two different types of research techniques in examining the portfolio balance model. The first technique tests the model directly, examining short run dynamics in a reduced form. A representative study is this of Branson, Halttunen & Masson (1977, 1979). The alternative technique tests the portfolio balance model in terms of the existence of a risk premium. The assumption of imperfect substitutability of domestic and foreign bonds implies that domestic and foreign bonds are separated by a risk premium. Thus, this technique examines the significance of the risk premium. A relative study is this of Dooley & Isard (1982).

Branson, Halttunen & Masson (1977) examine the US Dollar/ Deutche Mark exchange rate under the framework of the portfolio balance model. The data set includes monthly data from August 1971 to December 1976. They include only the variables of domestic money and foreign bonds because of their clear effects on the exchange rate. The effect of domestic assets depends on the relative substitutability in the portfolio balance model. Therefore, the exchange rate is described by the following function:

$$e = h(M_u, M_g, F_u, F_g) \qquad (3.39)$$

Theoretically, they expect that a higher US money stock (M_u) will depreciate the US dollar. On the other hand, higher German money supply (M_g) will appreciate the US dollar. When it comes to the holding of foreign assets variable, an increase in the foreign asset stock of US in dollars (F_u) is going to appreciate US dollar. In contrast, a rise in the German holding of US assets (F_g) is expected to depreciate US dollar.[64]

They regress an OLS in (3.39) introducing private sector's asset stocks. The foreign asset stock variable in (3.39) actually is the private foreign asset stock (FP), resulting from the difference between total national claims on foreigners (NF) and government net claims (FG). Hence, the regression equation takes the form of:

$$e = \alpha_0 + \alpha_1 M_g + \alpha_2 M_u + \alpha_3 FP_g + \alpha FP_u + u \qquad (3.40)$$

The results imply that coefficients are statistically significant and correctly signed. But the results are not reliable because the residuals in (3.40) are autocorrelated. Since autocorrelation is present, OLS estimators are not valid because they produce invalid standard errors. Next, they introduce the case of Central Banks' Intervention. They provide consistent estimates of reaction function estimated by Two Stage Least Squares (2SLS). For the case of Germany, the regression shows that German base money is weakly and insignificantly related to the exchange rate. The money stock in Germany is also not significantly related to the exchange rate. But the foreign exchange reverse stock is significantly and positively related to the exchange rate. These results imply that German monetary policy is exogenous to the exchange rate. As a consequence, this leads

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[64] MacDonald (1988) criticizes the dataset of Branson et al (1977) as unsatisfactory because of the way they estimate net foreign assets. These are estimated by taking cumulative current accounts, but this is not the right way because cumulative current account surpluses may include foreign assets held by US or German agents in third countries, which are irrelevant to the determination of the US dollar/German mark exchange rate.

to a two-equation system for exchange rate and central bank intervention policy estimated by 2SLS. The estimated coefficients are correctly signed and more significant than these of (3.29). Finally, examining exchange rate elasticities, they show that US variables cause stronger effects than German variables on the exchange rate.

Branson, Halttunen & Masson (1979), extending the data set with more data (until March 1978), re-estimate the original model.[65] The results from OLS estimation do not change significantly. Moreover, 2SLS estimation implies that exchange rate elasticities have not changed very much, US variables are now more significant and forecasts are not far away from actual values. In that paper, Branson et al. (1979) test the empirical effects of a negative net foreign asset position. The sample period is divided into two subperiods: (i) when FPg>0, and (ii) when FPg<0. While in the whole period FPg is statistically insignificant, in both subperiods FPg is not only significant but also its coefficient changes sign. The rest of the coefficients do not change sign.

As Copeland (2000) points out, if the portfolio balance model is valid, a current account surplus will be associated with appreciation of the exchange rate. Similarly, a current account deficit will be associated with a depreciating exchange rate. This is tested in the case of six industrialized countries: UK, US, Germany, Japan, France and Switzerland. The data set includes annual effective exchange rates and current account balances for the period 1972-1998. This relationship is violated in the cases of UK and US. For the rest of the sample, this statement is not so clear. In any case the relationship between current account balance and exchange rate is very weak.

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[65] See Branson, Halttunen & Masson (1977).

3.3.5. A critical view on the validity of the Portfolio Balance model

Although Branson et al. (1977, 1979) provide supporting results for the validity of the model; these results are misleading as their model suffers from serious econometric problems (i.e. autocorrelation). Moreover, Backus (1984) estimates the US dollar/Canadian dollar and fails to derive consistent results with the portfolio balance model. Their coefficients are wrongly signed and statistically insignificant. An exception is the study of Bisignano & Hoover (1982) who, by testing the same exchange rate, obtain supportive results for the portfolio balance model. They criticize the Branson et. al. (1977, 1979) model, because it is based on the small country assumption but it is never tested.

In general the evidence on portfolio balance model is unsatisfactory. One of the possible explanations for this failure is inadequate data. As mentioned above, it is difficult to collect disaggregated data on domestic and foreign holding of bonds. Some researchers estimate this values by approximation. For example, some researchers take an initial estimate and by adding each period’s current account surplus approximately estimate domestic holding of foreign assets. Copeland (2000) argues that this is an invalid procedure because capital gains or losses are ignored and it is assumed that only domestic agents hold domestic assets. This is a fundamental assumption of the model, but in the real economic world this is not the case.

Another reason is that in many cases short run dynamics are due to oil price shocks and international financial crises. Such shocks are difficult to be introduced in the econometric regression. Moreover, empirical models suffer from econometric misspecification. In Branson et al. (1977, 1979) model, serial correlation invalidates its results. Besides to autocorrelated residuals, the statistical properties of the variables have not been tested. Namely, they did not test the presence of unit roots in variables. In the presence of unit root, OLS estimators are inappropriate.

Finally, one more explanation of the empirical failure of the portfolio balance model may be its restrictive assumptions. It is not a realistic assumption that foreigners do not hold domestic assets. Furthermore, it is a two-country model, which ignores the interrelationships with third countries. It is obvious that in the real economic world the current account of country A is affected not only by transactions with country B, but also by economic relationships with country C.

Bearing in mind the very poor application of the portfolio balance model, our point of view is that it is not a useful empirical tool and not appropriate for forecasting purposes. However, in a theoretical basis, the contribution of the model is crucial due to the introduction of dynamics of assets demand and supply in the exchange rate determination.

3.4. Concluding Remarks

The above analysis is not supportive for the examined exchange rate determination models. The empirical evidence on monetary models (flexible-price and sticky-price) is not clear. While interwar period data studies support the monetary model, subsequent studies differ in their implications. For example, a number of empirical works accept the monetary model as long run phenomenon, while others reject the existence of any cointegrating relationship between the exchange rate and the monetary fundamentals. Besides to these results, other studies although accept the existence of a long run relationship fail to accept that the monetary model can explain the short run dynamics of the exchange rate. However, the empirical application of the Sticky-Price model is more satisfactory than this of the Flexible-price model.

The evidence for the Portfolio Balance model is clearly unpleasant. Although Branson et al. (1977, 1979) provide supporting results for the validity of the model, these results are misleading as their model suffers from serious econometric problems. Some of the explanations for this failure that can be reported are inadequate data, econometric misspecification and its restrictive assumptions.

In general, MacDonald (1995) argues that the poor performance of the monetary and portfolio balance models can be charged in two reasons. Firstly, reduced form estimates are estimated with very limited data dynamics. If static regressions are estimated, it is very difficult to distinguish between short run and long run relationships. Secondly, in many cases estimators are not estimated by the true reduced form equations. Often, researches ignore some significant relationships in their specifications. This can lead to misleading implications. Furthermore, Rogoff (1999) points out that economic fundamental are not the only factors that affect the exchange rate. Perhaps, other factors, such as social and political, affect the exchange rate. In addition, money market cannot be easily modeled. For example, money demand is unstable and money supply is set exogenously by Central Banks. Moreover, when the inflation rate is close to zero, the effect of the monetary policy on the exchange rate is difficult to be detected. All these facts are an obstacle in the effort of explaining exchange rate behaviour. Rogoff (1999) states that these problems can be managed if researchers apply more appropriate econometric techniques.

4. Equilibrium Exchange Rate Models

A successful macroeconomic policy requires the combination of the appropriate monetary, fiscal and exchange rate policies. Economic authorities have to decide about the way they will apply each policy in order to manage internal and external equilibrium. Of course, these policies are closely related with each other since macroeconomic fundamentals can influence the exchange rate and vice-versa. The Exchange rate is the link of the economy with the rest of the world. It reflects all transactions between domestic agents and foreigners. Imports, exports and investment in domestic and foreign financial assets do not only affect the exchange rate but also are influenced by its current and expected values. Thus, economic activity is sensitive to the exchange rate and more properly to the equilibrium value of the exchange rate.

Economists attempt to explain and predict the behaviour of exchange rates. However, this is not a simple task since agents, besides to usual transactions, purchase foreign currency for speculative reasons. Unfortunately, speculation cannot be easily predicted. In most cases, the examined exchange rate is away from the optimal level. In other words, the observed exchange rate is misaligned in respect to its equilibrium value. This implies significant consequences for any economy. For instance, when the domestic currency is undervalued (below its equilibrium rate) the economy faces inflationary pressures. On the other hand, if the domestic currency is overvalued (above its equilibrium rate) a competitiveness problem arises for the domestic economy. Foreign goods are relatively cheaper and preferable. Thus, domestic production is weakened and unemployment is increasing. This is a serious obstacle especially for developing countries.

Convectional studies based on Purchasing Power Parity (PPP) hypothesis fail to explain the exchange rate fluctuation.[66] Furthermore, the empirical literature on monetary models (flexible-price and sticky-price) is not clear for the validity of those models. As chapter 3 shows, another traditional exchange rate determination model with poor empirical application is the Portfolio Balance model. The evidence is unsatisfactory and this may be due to inadequate data or (and) very restrictive assumptions. As a result, this model is not the best tool of explaining and forecasting exchange rate behaviour.

Given that any country should know the equilibrium level of its exchange rate, there is an explicit necessity of employing a well-performed tool to explain exchange rate fluctuations. Under this desire, Williamson (1985) proposes an alternative exchange rate determination model suitable for medium-run analysis, which is called as “Fundamental Equilibrium Exchange Rate” (FEER). This approach indicates that the exchange rate is at its equilibrium value when satisfies the condition of simultaneous internal and external balance. The Internal Balance condition is satisfied when the employment and price levels meet their target levels. An alternative expression of the Internal Balance consists of higher employment combined with controlled inflation. Williamson interprets the external balance condition in terms of current account balance and states that the current account must be sustainable. Combining these two macroeconomic conditions, the FEER is the rate that equates the current account at full employment with sustainable net capital

[66] However, by estimating TAR, STAR, and ESTAR nonlinear models, some studies succeed to find supportive evidence of PPP in the long run. For an analytical review on PPP hypothesis, the reader should refer to chapter 2.

flows. A very similar approach to FEER is the Desired Equilibrium Exchange Rate (DEER) presented by Bayoumi et al (1994).

An alternative approach is the Behavioural Equilibrium Exchange Rate (BEER) presented by Clark & MacDonald (1998). BEER is a short run concept, which involves the direct econometric analysis of the behaviour of the real exchange rate. It does not actually rely on any theoretical model and the equilibrium rate is designated by the long run behaviour of the macroeconomic variables. It is based on the estimation of a reduced-form equation that explains the behaviour of the real effective exchange rate. Although a theoretical model is not necessary to be specified, most researchers have in mind the condition of simultaneous internal and external balance. In a similar way, the Permanent Equilibrium Exchange Rate (PEER) is the direct econometric analysis of the exchange rate. The PEER approach differs from BEER in the way that the exchange rate is a function of variables that have only persistent effect on it. This fact makes PEER a medium-run concept.

One more approach presented in this chapter is the Natural Real Exchange Rate (NATREX) which is referred in both medium-run and long-run periods. The Natural Real Exchange Rate (NATREX) is *"…the rate that would prevail if speculative and cyclical factors could be removed while unemployment is at its natural rate"* (Stein 1994, page 135). This rate is consistent with simultaneous internal and external balance. NATREX equates the sustainable current account with saving and investment. Obviously, there is an implicit similarity with Williamson's FEER model. But, NATREX is not only medium run equilibrium but also long run equilibrium because it is consistent with portfolio balance as well.

The aim of this chapter is to survey the above approaches and to evaluate their empirical performance.[67] The following section describes the theoretical background of the FEER approach, while a small subsection deals with DEER methodology. Section 4.2 illustrates the BEER and PEER approaches and section 4.3 gives an outline of the NATREX approach. In each section, a review on the relevant empirical literature is provided. A final section concludes this survey by comparing and evaluating these approaches.

4.1. The Fundamental Equilibrium Exchange Rate (FEER) Approach

In the presence of global macroeconomic instability in 1980s, the aim for macroeconomic and exchange rate stability was obvious. In doing so, exchange rates should be targeted to equilibrium levels. Under this desire, Williamson (1985) proposes a new exchange rate determination model, which is called as "Fundamental Equilibrium Exchange Rate" (FEER). The term "fundamental" is relevant to the "fundamental disequilibrium" term, which was a parity criterion in the Bretton-Woods system. Fundamental disequilibrium refers to an exchange rate inconsistent with macroeconomic stability. In contrast, the Fundamental Equilibrium Exchange Rate (FEER) proposed by

[67] These are the most known approaches of estimating equilibrium exchange rates. Others, which are not presented here but they are very similar to the above are: APEER (Atheoretical Permanent Equilibrium Exchange Rate), CHEER (Capital Enhanced Equilibrium Exchange Rate), and ITMEER (Intermediate-Term Model Based Equilibrium Exchange Rate). APPER is a medium and long run concept but the absence of any theoretical assumption differentiates it from PEER. The CHEER is based on PPP and UIP assumptions. While PPP holds any deviation from equilibrium may exists if UIP condition does not hold. Finally, ITMEER is a short-run equilibrium concept and the basic theoretical assumption is nominal UIP. The distinctive point is that estimation does not rely on cointegration techniques. To find more about these models, see Driver & Westaway (2004).

Williamson, is the rate consistent with macroeconomic balance. For this reason, this approach is also called as “macroeconomic balance approach” because it estimates the real exchange rate consistent with macroeconomic balance.

This approach indicates that the exchange rate is at its equilibrium value when it satisfies the condition of simultaneous internal and external balance. In other words, the Fundamental Equilibrium Exchange Rate is the equilibrium rate that would be consistent with ideal macroeconomic performance. The Internal Balance condition is satisfied when employment and price levels meet their target levels. An alternative expression of the Internal Balance consists of higher employment combined with controlled inflation. Furthermore, we can say that full employment is the employment level consistent with NAIRU.

The meaning of External Balance, in Williamson’s model, differs from the meaning of overall balance. According to the traditional interpretation, external balance exists when the current account imbalance is financed by a capital flow leaving the reserves unchanged. In contrast, Williamson interprets the external balance condition in terms of current account balance and states that the current account must be sustainable. Thus, Williamson sets a current account target rather than an overall balance target. In selecting the appropriate current account target, countries may choose to have capital inflows or outflows. So, countries can have sustainable current accounts consistent with macroeconomic balance even if no all imbalances are eliminated. It is not sensible to assume that countries have balanced current accounts. This is because in any period countries can increase their imports or exports relative to the conditions in international trade.

As a consequence we need to know the capital flow consistent with current account sustainability. As Williamson (1994, p: 183) points out "*the aim should be to achieve that current account balance that transfers capital at a rate that is sustainable and desirable, and therefore consistent with macroeconomic equilibrium, rather than to eliminate all imbalances"*.

Combining these two macroeconomic conditions, we can say that the FEER is the rate that equates the current account at full employment with sustainable net capital flows. Following Clark & MacDonald (1998), this is expressed by equation (4.1), which shows that the current account is equal to the negative capital account:

$$\text{CA} = -\text{KA} \tag{4.1}$$

Equation (4.2) includes the determinants of the current account, which are domestic and foreign output and real effective exchange rate:

$$CA = \alpha + \beta_1 s + \beta_2 y + \beta_3 y^* = -KA \tag{4.2}$$

where $\alpha<0$, $\beta_2<0$ & $\beta_3>0$.

The above equation shows that the Fundamental Equilibrium Exchange Rate is the real effective exchange rate (s), which equates the current account with the sustainable capital account while the determinants of the current account are at full employment levels. Solving (4.2) for s we get FEER:

$$FEER = \frac{-(KA + \alpha + \beta_2 y + \beta_3 y^*)}{\beta_1} \tag{4.3}$$

The FEER calculation provides only an estimate of the current value of the exchange rate. FEER does not focus on the dynamic adjustments of the real exchange rate. Therefore, in that form, it is not appropriate for forecasting purposes. It is appropriate for comparing the actual rate with the equilibrium rate. For example, if the actual rate is below the estimated FEER, the exchange rate is undervalued. In contrast, if the actual rate exceeds FEER, the exchange rate is overvalued.

In equation (4.3), the capital account is exogenously determined. In reality, it reflects the sustainable capital flow, which equates the capital account with the current account. Williamson (1994) attempts to include the factors that affect the capital account and in some sense he examines the dynamics that force the capital flow to a sustainable level. Williamson begins with the following identity

$$\text{EX} - \text{IM} = (\text{SA} - \text{IN}) - (\text{G} - \text{TR}) \tag{4.4}$$

which says that net investment in the rest of the world is equal to net saving of the private sector minus the public sector deficit. This means that we have to find the optimal level of public sector deficit, so that to estimate the sustainable capital flow. But, this is not a simple task. Alternatively, he states that the sustainable capital account is the difference between the desired aggregate saving and investment at full employment:

$$-\text{KA} = (\text{SA} - \text{IN}) \tag{4.5}$$

Substituting (4.5) to (4.2) we get:

$$CA = \alpha + \beta_1 s + \beta_2 y + \beta_3 y^* = SA - IN \tag{4.6}$$

$$FEER = \frac{(SA - IN) - \alpha - \beta_2 y - \beta_3 y^*}{\beta_1} \tag{4.7}$$

Equations (4.6) & (4.7) imply that the FEER is the exchange rate which equates the current account with (SA - IN) while the determinants of the current account are at full employment levels. In other words, Williamson proposes the examination of saving-investment balance. The main point here is to identify the determinants of saving and investment. Some of the factors that affect the full employment levels of saving and investment are output gap and fiscal position (i.e. fiscal deficit).[68]

The methodology of selecting the current account target can be summarized in the following steps:

1. We observe all the present and past imbalances and examine whether they are relevant to economic theory. To be specific, we test their relationship with saving and investment conditions.
2. We test whether these imbalances form a sustainable current account. Sustainability is a constraint only for deficit countries. A current account surplus does not need to be examined as sustainable, since surpluses may be seen as sustainable current accounts. Therefore, when a current account deficit is the case we have to decrease the deficit in a level consistent with sustainability.
3. Current account sustainability may not be a sufficient condition for the FEER. What is needed is international consistency among the current account targets. If this is not satisfied we have to alter all targets until international consistency is achieved. For instance, international cooperation may be unsuccessful if the sum of the surpluses exceeds the sum of the targeted deficits.

Finally, Williamson (1994) makes the distinction between ex post and ex ante analysis. Under the framework of an ex post analysis, the aim is to estimate the real exchange rate that is consistent with internal and external balance during a past period.

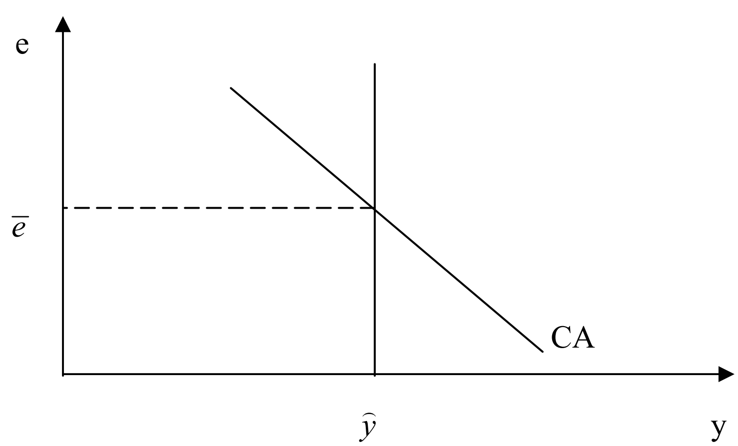
[68] Investment and saving behaviour can be analyzed by the debt cycle theory of the balance of payments and the life cycle hypothesis, respectively. To find more, see Williamson (1994).

On the other hand, the ex ante analysis indicates the aim to estimate the real exchange rate consistent with internal and external balance in the present and future periods.

4.1.1. DEER as an extension of the FEER

The DEER approach, presented by Bayoumi et. al. (1994), is very similar to the FEER methodology. It is the real effective exchange rate consistent with simultaneous internal and external balance. Once again the internal balance refers to the full-employment output (with controlled inflation) and for external balance the current account should be sustainable. Like FEER, the DEER is the rate consistent with ideal macroeconomic performance. In other words, fundamentals must be driven to the "desired" levels. When this is satisfied the exchange rate finds its Desired Equilibrium Exchange Rate. This rate is illustrated in the following figure where $\hat{y}$ is the full employment output (shown by a vertical line), e is the actual effective exchange rate, $\overline{e}$ is the implied DEER and CA stands for the current account. This schedule is downward sloping because a higher domestic income increases imports and the current account deteriorates. As a result, the exchange rate needs to be depreciated to maintain current account stability.

Figure 4.1: Desired Equilibrium Exchange Rate



The main difference from the FEER approach is the way that defines the sustainable current account. As shown before, Williamson proposes the analysis of the saving-investment balance. In the DEER framework, the desired current account is a function of the desired levels of domestic output, foreign output and the DEER:

$$\overline{CA} = CA\,(\hat{y},\hat{y}^*,\overline{e}) \tag{4.8}$$

Thus, we observe the actual values of y, y*, CA and e and we compute the required change in e to move to the desired values (y to $\hat{y}$, y* to $\hat{y}^*$ and CA to $\overline{CA}$). The exchange rate, that drives the above variables to the desired values, is the DEER.

The Desired Equilibrium Exchange Rate, like the Fundamental Equilibrium Exchange Rate, is sensitive to the "hysteresis effect". To give an example, suppose that at time t the exchange rate is equal to the DEER and the next period appreciates. Then, the current account deteriorates and the net foreign indebtedness increases. As a consequence, the current account target must change to repay the increased debt. Hence, the exchange rate depreciates and the previous DEER is not any more the desired exchange rate.

4.1.2. Empirical Literature Review

The FEER approach was revolutionary in the Equilibrium Exchange Rate literature. According to Williamson (1985), US Dollar was overvalued, rather than undervalued as PPP-based forecasts were indicating. Similarly, contrary to the PPP claims, Japanese Yen was undervalued. There are an adequate number of empirical studies that attempt to estimate equilibrium exchange rates using Williamson's approach. First of all, Williamson (1994) estimates the Fundamental Equilibrium Exchange Rate for the US dollar, UK pound, Japanese Yen, French franc, Canadian dollar, Deutsche mark and

Italian lira. Estimates of FEER's are taken by six macroeconometric models: EAG, GEM, Interlink, Intermod, Mimosa and MSG.[69] These models provide different estimates of FEER's for a single currency and as a consequence the range of these estimates is too large. So, the question that arises is which model provides the most appropriate FEER. Williamson proposes two ways of getting a unique FEER. The first one is the calculation of the average of the alternative estimates. A more appropriate method is to select one of the models and accept this as the correct FEER.[70] He finds that the most appropriate model is the GEM and the proper FEER estimates refer to this model. Comparing the FEER estimate of the first quarter of 1990 with the actual rate of the fourth quarter of 1989, he finds that all currencies - except Japanese yen and Deutsche mark - were overvalued.

Finally, Williamson points out that FEER estimates are volatile over time. By comparing the FEER of the fourth quarter of 1984 with the FEER of the first quarter of 1990, he finds that the equilibrium rates of US dollar and French frank depreciated by 15%, the Japanese Yen appreciated by 32%, the Deutsche mark by 16% and the UK pound by 4%. Some of the factors, which can cause the fluctuation of the FEER are: (i) different income elasticities, (ii) productivity bias, (iii) asset accumulation, (iv) oil price changes, and (v) changes in the current account target. However, these factors can explain only the 2% of the US dollar volatility. Similarly, these factors indicate that the

[69] To find more about the origins of those models and the way that can be used, see Williamson (1994). Almost all models estimate the fundamental equilibrium exchange rate in consistency with current account targets. For example, the EAG model includes the values of growth and real exchange rate and provides estimates of the current account. Then, this outcome is compared to the targeted value. If there is a significant misalignment, the exchange rate is adjusted until the current account finds its targeted level. Thus, the FEER is the exchange rate path that drives the current account to the desired value.

[70] The selection of the model is done by the satisfaction of three criteria, shown in Williamson (1994).

UK pound should be depreciated by 13% and not to appreciate by 4%. More satisfactory is the case of the French franc, in which only 2% of the volatility cannot be explained.

Smidkova (1998) estimates the Equilibrium Real Effective Exchange Rate of the Czech crown applying the FEER methodology. In other words, the equilibrium value of the crown is estimated through the condition of simultaneous internal and external balance. In the first part of her paper, provides an overview of the macroeconomic facts of the Czech Economy and tests the sustainability of the current account. The ratio of Government Foreign Debt to GDP and that of Central Bank's Reserves to GDP, used as indicators of Debt Sustainability, show that the external position of the Czech economy is stable. But, these that actually affect negatively the external stability are financial indicators, i.e. foreign reserves. Smidkova estimates a model introducing four equations: (1) export of goods, (2) export of services, (3) import of goods, and (4) import of services. Internal balance consists of that situation consistent with NAIRU. External Balance exists when trade balance plus structural flows are consistent with asset market equilibrium. As shown before, the main issue in FEER methodology is the selection of the appropriate current account target. Here, the author provides a relevant formula:

$$C\bar{A} = \frac{CA + FDI}{Y \cdot P} \tag{4.9}$$

where CA= current account, FDI= foreign direct investment, Y= real GDP, P= domestic CPI. Estimation is based on the National Institute Global Econometric Model (NIGEM) and covers the period 1992-1996. The FEER is calculated for 12 alternative cases.[71] The

[71] The current account target can get three values: (i) 0%, (ii) -4%, and (iii) -2.04%. Similarly, capital inflow may be low or higher. Finally, real financial wealth can increase in a restrictive way or in an expansive way.

results imply that the Czech crown was overvalued relative to the estimated FEER and Smidkova concludes that this misalignment may be a warning sign for a future external crisis.

Hallet & Richter (2004) estimate the equilibrium exchange rate of US dollar, euro, Canadian dollar and other currencies. The theoretical background requires simultaneous internal and external balance. In other words, the equilibrium exchange rate is a FEER estimate, which is consistent with a sustainable current account. This is achieved in that value of current account, in which the ratio of foreign debt to GDP is stable.

For their estimation, the MULTIMOD macro econometric model is applied. They solve the model until 2200 and the output they get is actually the equilibrium level for all the estimated variables. Thus, this output becomes a long run equilibrium path. The results imply that for the next 5 years (2002-2007), the variables (current account, GDP, real exchange rate) will not deviate significantly from their actual trend. The following step in the estimation procedure involves the FEER calculation. This comes by adjusting the conditions of the equilibrium solution in order to get an alternative solution, which will be the new solution path. This new solution indicates the depreciation of the US Dollar against the other major currencies. A fact responsible for this is the fall in the US growth rate. Finally, they test the implications on FEER estimates of US Dollar if the other countries do not act in a consistent way. For example, suppose that euro appreciation is restricted and that Japan's current account remains high. These assumptions do not differentiate significantly the results derived from the "new solution". Therefore, euro area and Japan do not play a crucial role in the development of the US economy. In contrast, relevant assumptions for Canada can change the above outcome. Hence, Canada's policy is a significant determinative factor of the US economy.

Motivated by the recent appreciation of the real exchange rates of the Central and Eastern European Countries, Coudert & Couharde (2002) estimate those countries' Fundamental Equilibrium Exchange Rates. Under the FEER methodology, the exchange rate should be consistent with internal and external stability. External balance is satisfied when the current account is sustainable. Current Account sustainability indicates smaller current account deficits in order to generate in the future sufficient surpluses to repay these debts. This path leads to the depreciation of the currency. However, the authors here apply a different approach to interpret external balance. They estimate an econometric model with respect to saving-investment balance.

Their model is estimated by the NIGEM macroeconometric model, in which trade elasticities are compared to the exogenous variables, such as output gaps and deviations from current account targets. In the first step, the elasticities of deviation from FEER with respect to deviations from current account targets are estimated. A negative value implies that the exchange rate is undervalued. This is because the actual current account is higher than the targeted value and real appreciation is needed. The final step includes the comparison of the above estimates with the exogenous variables. The results imply that real exchange rates do not deviate from their equilibrium values. Thus, their appreciation trend in the last years cannot be accepted as overvaluation. Finally, the authors confirm the robustness of their model by changing the current account target and by taking lower trade elasticities.

Feyzioglu (1997) estimates the equilibrium real effective exchange rate of the Finnish markka for the period 1975-1995. The author uses a similar to FEER approach, as the long run equilibrium exchange rate is defined as the level consistent with simultaneous internal and external balance. He estimates a reduced form model using the Johansen cointegration technique. According to his theoretical model, a positive terms of trade shock is expected to appreciate the real effective exchange rate. An increase in the world interest rate will increase the domestic interest rate and the exchange rate is going to appreciate (as demand for money declines, saving increases, and the external position of the economy is improved). Similarly, a positive productivity differential is expected to appreciate the Finnish markka. The econometric model is estimated by the Full Maximum Likelihood approach and the results imply that all coefficients have the expected signs. The short run movements, modelled by an Error Correction Model, show that a relatively higher domestic price level and a higher foreign interest rate appreciate the real effective exchange rate. He concludes that the actual exchange rate deviates from its long run equilibrium value. These deviations can be explained by price and interest rate differentials.

Paiva (2001) estimates the equilibrium real exchange rate for Costa Rica using the CGER and FEER approaches.[72] The sample period is from 1990 to 2000. He estimates the real exchange rate by an error correction model in accordance with the sustainable values of the explanatory variables. These variables consist of terms of trade, degree of economic openness, fiscal position and net capital flows. The FEER approach implies

[72] The CGER approach is developed by the IMF's Coordinating Group on Exchange Rate Issues and is used to estimate equilibrium exchange rates for industrialized countries. The condition for equilibrium is simultaneous internal and external balance.

that higher government consumption and greater capital inflows lead to the appreciation of the real exchange rate. On the other hand, deterioration in the terms of trade depreciates the exchange rate. As the CGER methodology is not appropriate for estimating exchange rate misalignments, he applies the FEER methodology. The latter estimates that the Costa Rica's actual real exchange rate was overvalued the period 1999-2000.

Combining the FEER and BEER approaches, Egert (2002) estimates the equilibrium exchange rate in five European transition economies[73]. Internal balance is defined in terms of relative prices and external balance as the sustainable value of the current account. An increase in relative prices and an improvement in current account are expected to appreciate the real exchange rate. He estimates a VAR model with three equations, which implies that all coefficients are correctly signed except the terms of trade, which indicates that an improvement leads to the depreciation of the exchange rate. Measuring the misalignments, he finds that the exchange rates of Czech Republic, Poland, and Slovakia were overvalued. Hungary's currency, before its convergence to its equilibrium value, was undervalued by 10% in the first half of 1990s. Finally, Slovenia's currency was very close to its equilibrium rate.

[73] These economies are: Czech Republic, Hungary, Poland, Slovakia, and Slovenia. The estimation sample is from 1992 to 2001 for Hungary, Poland, and Czech Republic and from 1993 to 2001 for Slovakia and Slovenia. The exchange rate for all countries responds to the effective exchange rate and in any case is based on the German mark and the US dollar.

4.2. The Behavioural Equilibrium Exchange Rate (BEER) Approach

The Behavioural Equilibrium Exchange Rate (BEER) involves the direct econometric analysis of the behaviour of the real exchange rate. This approach estimates the misalignment of exchange rates in accordance with the deviations of the actual exchange rate from the estimated value, derived from the relationship between the real exchange rate and the macroeconomic fundamentals. This approach does not actually rely on any theoretical model and the equilibrium rate is designated by the long run behaviour of the macroeconomic variables. It is based on the estimation of a reduced-form equation, which explains the behaviour of the real exchange rate. Clark & MacDonald (1998) apply the following equation to answer the question why exchange rates deviate from their equilibrium rates.

$$s_t = \beta_1 Z_{1t} + \beta_2 Z_{2t} + \tau T_t + u_t \qquad (4.10)$$

where s_t = real effective exchange rate

Z_1= vector of macroeconomic fundamentals that affect the exchange rate in the long run,

Z_2= vector of macroeconomic fundamentals that affect the exchange rate in the medium run,

β_1, β_2 ,τ = reduced form coefficients

T= vector of macroeconomic fundamentals that affect the exchange rate in the short run,

u = error term

The current values of the medium-run and long-run fundamentals give the current equilibrium exchange rate (equation 4.11) and by subtracting (4.11) from (4.10) we find the current misalignment (equation 4.12):

$$\overline{s}_t = \beta_1 Z_{1t} + \beta_2 Z_{2t} \tag{4.11}$$

$$s_t - \overline{s}_t = \tau T_t + u_t \tag{4.12}$$

But, what actually matters is total misalignment, which is the deviation of the actual exchange rate from the total equilibrium exchange rate. The latter comes by putting in (4.10) the long run (or equilibrium) values of the fundamentals ($Z_1 = \tilde{Z}_1 \,\&\, Z_2 = \tilde{Z}_2$). So, equation (4.13) illustrates the total misalignment rate and by adding and subtracting $\overline{s}$ from the right-hand side of that equation we can decompose the sources of exchange rate misalignment (ξ).

$$\xi_t = s_t - \beta_1 \tilde{Z}_{1t} - \beta_2 \tilde{Z}_{2t} \tag{4.13}$$

$$\xi_t = (s_t - \overline{s}_t\ ) - \beta_1 \tilde{Z}_{1t} - \beta_2 \tilde{Z}_{2t} + \overline{s}_t \tag{4.14}$$

$$\xi_t = (s_t - \overline{s}_t\ ) - \beta_1 \tilde{Z}_{1t} - \beta_{2t} \tilde{Z}_{2t} + \beta_1 Z_{1t} + \beta_2 Z_{2t} \tag{4.15}$$

$$\xi_t = (s_t - \overline{s}_t\ ) + \beta_1 (Z_{1t} - \tilde{Z}_{1t}) + \beta_2 (Z_{2t} - \tilde{Z}_{2t}) \tag{4.16}$$

$$\xi_t = (\tau T_t + u_t) + \beta_1 (Z_{1t} - \tilde{Z}_{1t}) + \beta_2 (Z_{2t} - \tilde{Z}_{2t}) \tag{4.17}$$

Equation (4.17) illustrates the sources of exchange rate deviation from its equilibrium value. These are (i) transitory factors that have a short run effect on the exchange rate, (ii) a disturbance term and finally and more importantly (iii) deviations of the macroeconomic fundamentals from their long run (or equilibrium) values.

We have already pointed out that the BEER approach does not need any theoretical model. However, this does not mean that any theoretical concept is not required. Stein (2001) presents an evaluation of studies based on the BEER approach, in which the authors have in mind a theoretical model but there is no need to be specified. For example, most authors - like in FEER - have in mind the condition of simultaneous internal and external balance. Internal Balance corresponds to low inflation and full employment. External Balance is described by the situation where agents are indifferent between investing on domestic or foreign assets. This can be expressed by the Uncovered Interest Parity (UIP) condition. Therefore, more properly we can say that the building idea of the BEER approach is the UIP condition. Following Clark & MacDonald (1998) and MacDonald (2000), the theoretical framework of the BEER approach starts with the UIP condition:

$$E_t(e_{t+1}) - e_t = i_t - i_t^* + rp_t \tag{4.18}$$

where e and i stand for nominal exchange rate and interest rate respectively, while rp is the risk premium. Equation (4.19) shows the expected inflation differential.

$$E_t(\Delta p_{t+1}) - E_t(\Delta p_{t+1}^*) = [E_t(p_{t+1}) - p_t] - [E_t(p_{t+1}^*) - p_t^*] \tag{4.19}$$

By subtracting (4.19) from (4.18), we get the real interest parity (equation 4.20) and by solving for the real exchange rate we find that this is a function of the expected real exchange rate, the real interest rate differential and the risk premium.

$$E_t(s_{t+1}) - s_t = r_t - r_t^* + rp_t \tag{4.20}$$

$$s_t = E_t(s_{t+1}) - (r_t - r_t^*) - rp_t \tag{4.21}$$

The expected real exchange rate, which can be shown as the long run component of the real exchange rate, depends on the expected values of the macroeconomic fundamentals. Thus, besides to the real interest rate differential, the equilibrium real exchange rate depends on the long run values of the macroeconomic fundamentals. According to Clark & MacDonald (1998) and MacDonald (2000) these variables are: (i) net foreign asset, (ii) terms of trade and (iii) relative price of traded to non-traded goods. The latter captures the Balassa-Samuelson effect. So, the vector of the macroeconomic fundamentals is of the form $\{s_t = f(nfa_t, tot_t, tnt_t)\}$. It is obvious that the BEER estimate is sensitive to the selected fundamentals. For instance, BEER may differ if we include productivity, government debt, and oil price as fundamentals instead of those used above. The risk premium has a time-varying component, which is a function of the relative supply of domestic to foreign government debt. So, BEER is given by the following expression:

$$BEER = (r - r^*, gdebt / gdebt^*, tot, tnt, nfa) \tag{4.22}$$

4.2.1. PEER as a special case of BEER

The Permanent Equilibrium Exchange Rate (PEER) can be seen as a special approach of the BEER. As we have seen, according to BEER approach, the exchange rate is a function of transitory and permanent factors. The PEER approach differs in the way that the exchange rate is a function of variables that have only persistent effect on it. Thus, transitory factors are excluded from equations (4.10) & (4.17).

The question here is how to decompose the exchange rate to permanent and transitory factors. Most studies use the Multivariate Beveridge-Nelson Decomposition. Some of these are Huizinga (1987) and Cumby & Huizinga (1990). A different way is that proposed by Clarida & Gali (1994). They decompose the real exchange rate into supply, demand and nominal components and they test the importance of these variables to the exchange rate. In other words, they create three shocks (supply, demand and nominal) and examine the effects of each shock to the variability of the exchange rate. They expect that supply and demand shocks are going to affect significantly the real exchange rate in the long run. However, by examining the exchange rate of US dollar against the Canadian dollar, Deutsche mark, Japanese yen and UK pound, they find that supply-side shocks explain only small movements of the real exchange rates. A more comprehensive presentation of the PEER approach is shown in MacDonald (2000).

4.2.2. Empirical Literature Review

Most of the empirical studies, having the UIP condition as a benchmark, calculate the equilibrium real effective exchange rate of developing countries. Others attempt to approach the equilibrium exchange rate of euro. This is an interesting task as from the birth of the euro this has been very volatile. For example, the period 1999 – 2000 euro depreciated against USA dollar by 17.5% but afterwards an appreciating period raised for euro. Today, there is an appreciating trend for euro. This means that the euro/US dollar exchange rate has not yet reached its long-run equilibrium.

A leading study is that of Clark and MacDonald (1998), which estimates the equilibrium exchange rate of the effective rates of US dollar, Deutsche mark and Japanese yen under the framework of the BEER methodology. They use annual data from 1960 to 1996 for the following variables: real effective exchange rate, terms of trade, relative price of non-traded to traded goods, stock of net foreign assets and relative stock of government debt. The latter is a determinative factor of the risk-premium (UIP condition). Estimation is based on the Johansen cointegration technique. So, by estimating a VAR model, they find that all the macroeconomic fundamentals are statistically significant and correctly signed. An increase in any variable is expected to appreciate the real effective exchange rate. But, the relative stock of government debt is not correctly signed and statistically insignificant. The estimated BEERs imply that the actual real effective exchange rates were away from their equilibrium values during the estimated period.

MacDonald (2002) uses the BEER approach to estimate the equilibrium exchange rate for the New Zealand dollar real effective exchange rate within the period 1985-2000. His theoretical model is motivated by the UIP condition and shows that the current equilibrium exchange rate is given by a systematic component plus the interest rate differential. The systematic component is a function of the ratio of net foreign assets to GDP, relative labor productivity, relative output gap and the New Zealand's terms of trade. He estimates his model by VAR and VEC models. The net foreign assets and relative productivity variables can be excluded from the long run relationship. His results indicate that all remaining coefficients are statistically significant and positively correlated with the real effective exchange rate. The estimated BEER is more volatile than the actual exchange rate and this reflects the volatility of the real interest rate differential and the terms of trade. He concludes that the New Zealand Dollar was undervalued in the period after 1999.

A study that focuses on the euro before its actual existence is that of Clostermann and Schnatz (2000). The authors examine the euro-dollar exchange rate over the period 1975-

1998 by applying the BEER approach. The exchange rate corresponds to a "synthetic" real euro exchange rate that is calculated as a weighted average of the Dollar exchange rates of individual EMU countries. A Vector Error Correction model estimates the euro-dollar exchange rate and for forecasting purposes they progress a reduction of the VECM to a single equation approach. Their results imply that a higher price level in euro area appreciates the euro. In contrast, higher real oil price depreciates it, as EMU members are more oil dependent than US. Moreover, a decrease in relative government expenditure appreciates the real exchange rate.

Using the BEER and PEER approaches, Fernandez et al (2001) evaluate the factors that determine the euro real effective exchange rate. They examine a "synthetic" effective exchange rate, using time series that have been calculated as a geometric weighted average of the individual euro area countries series. Estimating five alternative models, find that euro can be affected by productivity differentials (a relative increase in the productivity leads to the appreciation of the currency), real interest rate differentials (a higher domestic interest rate tends to the appreciation of the domestic currency) and external shocks (an increase in the oil price can be a negative external shock which will depreciate the euro). The results imply that the BEER is more volatile than the PEER. Both approaches show that in seventies and in the first half of nineties, euro was not significantly away from its equilibrium value. But, during 2000, euro real effective exchange rate was undervalued.

Osbat et al (2003) study the long run determinants of the euro-yen exchange rate and through cointegration techniques estimate the Behavioural Equilibrium Exchange Rate.[74] An increase in euro area productivity and an improvement in euro area's net foreign asset position appreciate the euro against the yen. Moreover, an increase in real oil price is estimated to appreciate the euro, as Japan is more oil dependent than EMU countries. From 1975 to 2001, yen appreciated by 65% against euro. Oil price and government expenditure movements cannot explain this outcome. In contrast, relative productivity and relative net foreign asset position variables explain the 90% of this progress. Finally, the estimated BEER implies that euro appreciation against Yen in 2001 was a result of equilibrium correction of its previous depreciation.

Zhang (2001) estimates the Behavioural Equilibrium Exchange Rate for China and the exchange rate misalignments in accordance with China's exchange rate policy reforms. Using annual data from 1952 to 1997, he estimates that a higher investment rate in China depreciates the exchange rate. The same effect corresponds to the index of openness of the China's economy. This indicates that trade restrictions may appreciate China's currency. Higher government consumption and growth rate of China's exports appreciate the exchange rate. The actual exchange rate was overvalued much of the estimated period but, economic reforms in China have made the actual real exchange rate to fit better with its equilibrium rate.

In a similar way Zhang (2002) employs the BEER approach to estimate the equilibrium rate of the Chinese renminbi yuan (RMB) for the period 1984:1-1999:4. In the lines of Clark & MacDonald (1998) the vector of the fundamentals includes the terms

[74] The estimation sample is from 1975 to 2001. For the period before the introduction of euro, a 'synthetic' euro is estimated, which is calculated as a trade-weighted average of the EMU members' currencies.

of trade, productivity, money supply (M2) and net foreign assets. All these variables are statistically significant and correctly signed. Next, he estimates the long run values of the fundamentals (H-P filter) in order to calculate the long run equilibrium exchange rate. The BEER illustrates that the Chinese RMB was either undervalued or overvalued over the estimated period. Finally, he checks the robustness of his results by comparing the BEER with another model, motivated by the models of Edwards (1994) and Eldabawi (1994), which includes a different set of fundamentals. Robustness is confirmed since the two misalignment curves seem to be quite similar.

Melecky & Komarek (2005) estimate the Behavioural Equilibrium Exchange Rate of the Czech crown against the German mark.[75] The data sample covers quarterly observations from 1994 to 2004, including real exchange rate, productivity differential, foreign direct investment, terms of trade, real interest rate differential, trade openness, net foreign assets and government consumption. Their theoretical concept, inspired by Clark & MacDonald (1998), states that the fundamentals that affect the exchange rate should be enhanced by factors, which affect the exchange rate only in transition periods. Since Czech Republic is a developing and transition economy, they test the importance of the above variables to the exchange rate by regressing three alternative models.[76] According to the ARDL approach, only productivity, foreign direct investment, terms of trade and real interest rates seem to affect significantly the relevant exchange rate. The estimated BEER implies that the Czech crown was in general undervalued over the referred period.

[75] After 1999 German mark is replaced by euro.

[76] These are the DOLS approach by Stock & Watson (1993), the ARDL approach by Pesaran & Shin (1995) and finally the Johansen's (1988) methodology. By comparing the implied speed of adjustment of those approaches, they find that the more appropriate is the ARDL approach.

Furthermore, using the Hodrick – Prescott filter, they simulate the long run values of the fundamentals and find that total misalignment does not differ significantly from the current one.

4.3. The Natural Real Exchange Rate (NATREX) Approach

The Natural Real Exchange Rate (NATREX) is *"…the rate that would prevail if speculative and cyclical factors could be removed while unemployment is at its natural rate"* (Stein 1994, page 135). This rate is consistent with simultaneous internal and external balance. NATREX equates the sustainable current account with saving and investment. As in FEER, saving and investment depend on a number of fundamentals. This is a medium run equilibrium concept. Obviously, there is an implicit similarity with Williamson's FEER. But, NATREX is not only medium run equilibrium but also long run equilibrium because it is consistent with portfolio balance as well.

In the medium run NATREX capital stock and foreign debt are exogenous to the system, while in the long run they are endogenous. Medium run NATREX requires only internal and external balance. In contrast, long run NATREX - besides to internal and external balance - requires that (i) net foreign assets are constant, (ii) capital stock is constant, (iii) domestic and foreign interest rates are equal, (iv) there are no changes in reserves, namely there is absence of any speculative action.

The inclusion of stocks makes NATREX a stock-flow equilibrium concept, which is determined by the above conditions and a vector of fundamentals. But, which are these fundamentals? In reality, they vary from country to country but in general the vector Z includes (i) the productivity variable, presented by the growth rate of GDP and (ii) the time preference or discount rate, presented by the ratio of social consumption (consumption plus government expenditure) to GDP. So, the medium run NATREX is expressed by **s[k, F, Z]**, where k stands for the capital stock, F stands for the foreign debt and Z is the vector of the fundamentals. The real exchange rate (s) is described by the following equation:

$$s = \{s - s[k, F, Z]\} + \{s[k, F, Z] - \overline{s}[Z]\} + \overline{s}[Z] \tag{4.23}$$

Equation (4.23) shows that the exchange rate is the sum of three components: (i) exchange rate deviations from the medium-run NATREX, (ii) the difference between medium run NATREX and steady state equilibrium ($\overline{s}[Z]$) and (iii) the steady-state equilibrium itself, which exists when capital stock and foreign debt satisfy the portfolio balance. When cyclical and speculative factors are removed the actual exchange rate is equal to the medium run NATREX. So, the first term of equation (4.23) becomes zero. Next, when portfolio balance is satisfied, medium run NATREX equalizes the steady-state equilibrium. Therefore, the second term is equal to zero. As a consequence, in the case of simultaneous internal, external and portfolio balance, the actual real exchange rate coincides with the steady-state equilibrium.

4.3.1. Stein's NATREX Model

NATREX was originally presented by Stein (1994), who examined the US dollar exchange rate against the other G-10 currencies. The main characteristic of the model is that the equilibrium debt is endogenous to the system and countries may change their position from debtors to creditors and vice-versa. The only requirement is that trade balance must be large enough to repay the existing debts. Furthermore, in that model there is no perfect foresight. The model is presented by a number of equations, regarding goods market equilibrium, investment, capital stock and portfolio balance. This is expressed by the following equations[77]:

$$y(k,cp) = C(k,F,r,Z) + (dk/dt + \eta k) + TB(s,k,F,k^*,Z) \quad (4.24)$$

$$y(k^*,cp^*) = C(k^*,F,r,Z) + (dk^*/dt + \eta k^*) + TB(s,k,F,k^*,Z) \quad (4.25)$$

$$dk/dt = IN(k,r,Z) \quad (4.26)$$

$$IN = dk/dt + \eta k \quad (4.27)$$

$$dF/dt = IN - SA - \eta F = -(CA + \eta F) \quad (4.28)$$

$$SA = y(k,z) - rF - C(k,F,r,Z) \quad (4.29)$$

$$d(r - r^*)/dt = -a(r - r^*) \quad (4.30)$$

Equations (4.24) and (4.25) present goods market equilibrium, while equations (4.26) and (4.27) stand for investment equations. The last three equations express the portfolio balance condition.

Medium Run Solution

In the medium run capital stock and foreign debt are given, while goods market equilibrium at home and abroad are expressed by equations (4.31) and (4.32) respectively:

$$s = h[r,k,F,Z] \quad (4.31)$$

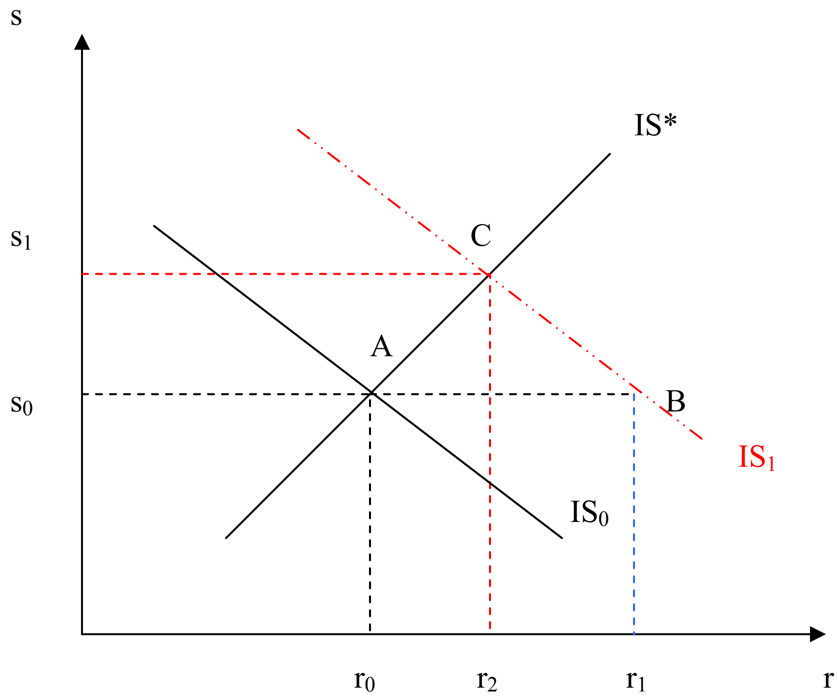
---

[77] y=GDP per effective worker, k=capital intensity, F=net foreign asset position, r=real interest rate, TB=trade balance per effective worker, CA=current account per effective worker, C=consumption per effective worker, rF=real interest payment per effective worker, SA= savings per effective worker, IN=investment per effective worker, cp=parameter of the capital productivity, η=growth of effective labor. Finally, stars in variables imply a foreign variable.

$$s = f[r^*, k^*, F^*, Z^*] \tag{4.32}$$

Here we remind that k is the capital stock, F is the foreign debt, Z is the vector of fundamentals and r is the real interest rate. The above equations represent home and foreign IS curves in figure 4.2.

Figure 4.2: Medium Run NATREX



The domestic IS curve is negatively sloped because an increase in the home interest rate decreases domestic goods demand creating disequilibria in the goods market. Equilibrium will be restored if relative prices decline as well. This leads to the decline of the real exchange rate. Thus, the real exchange rate depreciates.[78] In contrast, the slope of the foreign IS curve is positive since depreciation of the domestic currency means appreciation of the foreign one.

[78] Stein defines the real exchange rate as the amount of goods that a unit of currency can buy abroad relative to the amount can buy at home. So, an increase in the real exchange rate implies appreciation of the domestic currency.

The system is at full equilibrium at point A, in which the exchange rate and the interest rate are expressed by equations (4.33) & (4.34).

$$s = s[k, F, k^{*}, Z] \quad - \qquad \text{exchange rate} \qquad (4.33)$$

$$r = r[k, k^{*}, Z] \quad - \qquad \text{interest rate} \qquad (4.34)$$

Now, suppose that there is an increase in investment or a decrease in saving at home. This leads to the movement of IS curve from IS_0 to IS_1. In response, domestic interest rates increase to restore equilibrium. So, equilibrium moves from point A to point B, associated with unchanged exchange rate and a higher domestic interest rate. The increased interest rate causes higher capital inflow and as a consequence the domestic currency is going to appreciate since the balance of payments is improved. The new equilibrium point C represents the medium run NATREX.

<u>Long Run Solution</u>

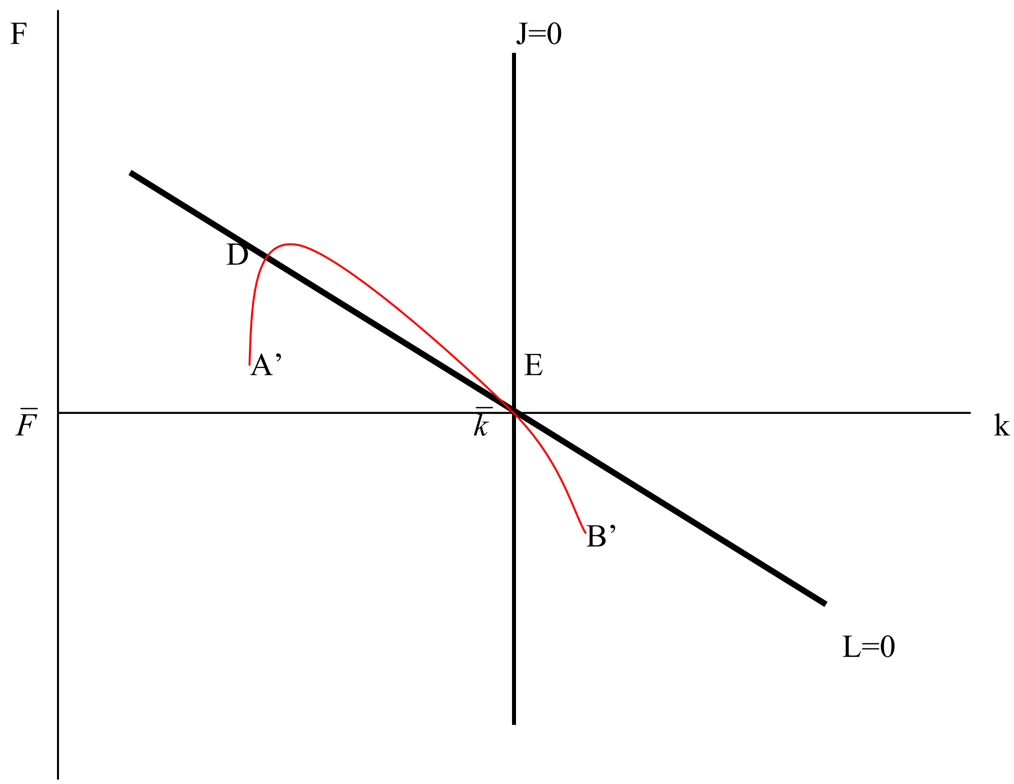
In the long run solution the fact that actually matters is that capital stock and foreign debt are not any more exogenous to the system. Indeed, they have an active role in determining the real exchange rate as they move towards their steady-state levels. We substitute equation (4.34) into equation (4.26) and then the modified equation (4.26) is substituted into equation (4.27) to solve for investment. Next, equation (4.34) is substituted into equation (4.29) and we solve for saving. Finally, the modified investment and saving equations are introduced into equation (4.28) to derive equations (4.35) & (4.36).

$$dk / dt = J(k, \bar{k}, Z) \qquad (4.35)$$

$$dF / dt = J - S = L(k, F, \bar{k}, Z) \qquad (4.36)$$

Equation (4.35) gives the change in capital intensity, while equation (4.36) stands for the rate of change of the foreign debt. These two equations are presented in figure 4.3. Equation (4.35) is expressed by the J=0 curve and equation (4.36) is expressed by the L=0 curve.

Figure 4.3: Long Run NATREX



In J=0 curve the change in capital stock is equal to zero (dk/dt=0). This holds if the marginal product of capital is equal to the world interest rate ($k = \bar{k}$), where the $\bar{k}$ term is the steady-state value of capital stock. To the left of the curve, the capital stock is lower than the steady state level and the capital stock increases. On the other hand, to the right of the curve, k exceeds $\bar{k}$ and capital intensity decreases.

In L=0 curve the rate of change of the foreign debt is equal to zero (dF/dt=0). This is the case when there is no capital flow. Namely, saving must equalize investment. As the current account is equal to saving minus investment, this implies that along the L=0 curve the current account is completely balanced. To the left and below of the curve there is current account deficit because saving is less than investment. Thus, foreign debt increases. In contrast, above the curve saving exceeds investment and the existing current account surplus decreases foreign debt. The slope of that curve is negative because a higher capital stock produces a current account deficit and a reduction in foreign debt.

Let assume that there is a time preference increase (i.e. a rise in social consumption) at home. The medium run effect of this is captured by the medium run solution. Namely, equilibrium moves from A to B and then to point C with a higher interest rate and an appreciated domestic currency. The path B΄E in figure 4.3 illustrates the long run effect. At point B΄ current account runs a deficit and capital intensity is positive (dk/dt>0). The current account deficit increases foreign debt and the steady-state debt increases too. Furthermore, capital stock decreases because of the increased interest rate. This trajectory will stop at point E, which is the long run equilibrium.

Now suppose that domestic productivity increases. Likewise the medium run solution of figure 4.2 applies in this case, while the A΄DE arc describes the long run solution. At point A΄ domestic country faces a current account deficit and a higher foreign debt. Then, both capital stock and foreign debt rise until point D. Along the DE path, as capital stock increases, there is current account surplus, which reduces debt. Hence, the system meets its long run equilibrium (point E) by increasing capital intensity and decreasing foreign debt.

All these show that despite the appreciation in the medium run the exchange rate turns back to its equilibrium level. Capital stock and foreign debt movements force the exchange rate to depreciation, up to the point of its initial value. This fact implies that the NATREX approach comes in contradiction with the Mundell-Fleming model. According to the latter, an expansionary fiscal policy is expected to appreciate the domestic currency in both medium run and long run periods. In contrast, the NATREX model indicates that the real exchange rate is going to appreciate in the medium-run and to depreciate in the long run.

4.3.2 Empirical Literature Review

The methodology of estimating NATREX is based on cointegration techniques. Some studies use the Engle-Granger two-stage least square estimation, while others employ the Johansen's cointegration technique and the estimation of Vector Error Correction models. In addition, cointegration analysis may be undertaken by the ARDL methodology. To give an example, Frait & Komarek (2001) use an ARDL model and the H-P filter to calculate exchange rate misalignments.[79] A selection of NATREX empirical studies is presented below.

Stein (1994) estimates the equilibrium rate of US dollar against the G-10 currencies covering the period from the third quarter of 1973 to the first quarter of 1989. His empirical estimation is based on the above theoretical model and the variables used as fundamentals are US growth rate, foreign growth rate, foreign debt, capital intensity and social consumption. In order to move out cyclical factors, growth is measured as a 12-

[79] The Hodrick-Prescott (H-P) filter simulates the long run (i.e. sustainable) values of the fundamentals. This way of estimation makes NATREX similar to BEER methodology.

quarter moving average of GNP growth. Similarly, foreign debt is measured as a 12-quarter moving average of the ratio of current account to GNP.

The first step of the estimation involves the medium run solution as in the theoretical model of NATREX. In the long run solution, the set of endogenous variables includes real exchange rate, foreign debt and capital stock, while US and foreign growth, and US time preference (social consumption) are exogenous to the system. Foreign time preference is omitted due to lack of data availability. The author's aim is to find if, under the motivation of NATREX, fundamentals can explain exchange rate movements. The estimation procedure entails three steps. First, the Johansen cointegration test is applied to confirm the long run relationship among endogenous and exogenous variables. This is confirmed by 2 cointegrating vectors. Next, OLS and Nonlinear OLS estimate the implied equations and the results derived from OLS are compared to those derived from NOLS to check robustness. Indeed, the two models provide similar results, which imply that, an increase in foreign growth rate and in social consumption depreciate US dollar, and a positive real long-run interest rate differential appreciates US dollar. US growth rate is expected to appreciate dollar, but the estimated coefficient is not statistically significant. Stein concludes by pointing out that in general actual real exchange rates seem to be very similar to NATREX, but there are significant deviations in the short run, which may be due to non-fundamental factors (i.e. cyclical and speculative factors).

Gandolfo & Felettigh (1998) estimate the multilateral equilibrium exchange rate of Italian lira from 1976:2 to 1995:4 using quarterly observations. Instead of cointegration techniques and the estimation of a single-equation error correction model, they propose an alternative approach to estimate NATREX. This is the estimation of a simultaneous equations model, which is a nonlinear system of four equations: (i) net social investment, (ii) social consumption, (iii) trade balance, (iv) real interest rate. The system of simultaneous equations is a nonlinear model estimated by the FILM econometric methodology and the results imply that all coefficients are correctly signed and statistically significant. Testing for system's robustness they find that the hypothesis of non-normality cannot be rejected, however this cannot affect the validity of the results.[80] Since the reliability of the NATREX is confirmed they go on in measuring the deviations of the actual rate from the estimated NATREX. Lira was undervalued from 1976 to 1982 and overvalued during 1982-1993. In 1992 Italian lira faced a rapid depreciation, which is not consistent with its equilibrium rate. As a result, lira was below its equilibrium rate from the mid of 1993 until the end of the estimated period.

A study focusing on the case of Czech crown is that of Frait & Komarek (2001). Especially, they estimate the equilibrium exchange rate of the CZK/DEM for the period 1993:1 to 2000:3 (quarterly data). The set of fundamentals includes (i) terms of trade, (ii) productivity (real GDP), (iii) world real interest rate, and (iv) foreign direct investment (fdi/GDP).[81] Cointegration analysis is based on the ARDL methodology. The results show that all estimated coefficients are statistically significant and consistent with theory. As a result, they observe that the fundamentals can explain the exchange rate behaviour under the framework of the NATREX approach. Next, they estimate the current and the

[80] In a nonlinear model when the residuals are not normal, FILM estimators are not valid but in contrast 3-stage least square approach provides valid estimators. In this specific case, the system is nonlinear because of the inclusion of the ECM terms, while for the endogenous variables the system is linear. Then, FILM and 3-stage least square estimators do not significantly deviate, so we can accept FILM's validity.

[81] Following the theoretical underpinnings of NATREX, they also included the rate of saving as a fundamental, but it was the only I(0) among I(1) variables. For this reason, they decided to eliminate this variable.

actual misalignments through the H-P filter (as in BEER). Both estimates show that the actual value of the crown was initially undervalued and afterwards overvalued. However, those two estimates of exchange rate misalignment are not similar enough. One possible explanation is that the applied macroeconomic policy might not be sustainable. Finally, they stress that the Czech crown has an overvaluation trend, which entails a danger for the Czech economy.

Detken et al (2002) employ four different models[82] to estimate the synthetic real effective exchange rate of euro.[83] Their theoretical specification to NATREX includes three behavioural equations (investment, consumption, and trade balance), the national account identity, real uncovered interest parity and the Fischer equation, stock accumulation and the steady-state values of the stock variables. The empirical section deals with the estimation of separate VEC models for the three behavioural equations. A significant error correction term and the fact that all coefficients are statistically significant and correctly signed imply that NATREX is a reliable medium-run measure. In addition, they estimate the long run NATREX as well. The latter is estimated by obtaining the long run values of the fundamentals.[84] Both measures of NATREX look quite similar. For instance, at the end of 1998 the actual effective euro was undervalued by 0.7% according to medium run NATREX and by 2.3% according to the long run

[82] Besides NATREX model, they apply a cointegration analysis consistent with PPP, a structural VAR analysis and a macroeconometric model developed by ECB.

[83] The effective exchange rate is calculated in respect to UK, US, Japan and Switzerland, while the data set covers the period 1970:1 – 2000:4 (quarterly observations).

[84] Recall that the difference between medium run and long run NATREX is that capital stock and foreign debt are given in medium run NATREX, but as they tend to their steady-state values we move to long run NATREX. In other words, NATREX illustrates the exchange rate's trajectory from the medium run to the long run equilibrium.

NATREX. During the period 1997-2000, euro was undervalued. So, the following appreciation trend of euro can be accepted as a correction movement.

Rajan & Siregar (2003) examine the real effective exchange rate of the Singapore dollar with respect to NATREX. Applying the Johansen's Cointegration technique they estimate a single-equation model from 1980 to 2000. This equation includes the terms of trade variable, productivity, world interest rate and government spending. Moreover, they include a dummy variable capturing the East Asian currency crisis in 1997. All the estimated coefficients are consistent with theory and statistically significant, except government expenditure and the dummy variable. For this reason, the dummy variable is excluded. The most significant variable is productivity, implying that it has the most explanatory power. This estimation output enforces the view that NATREX is an appropriate measure of the Singapore dollar equilibrium exchange rate. The following step is to measure the rate of exchange rate misalignment. In order to make valid implications, they test if misalignment is stable. In other words, they apply ADF and Phillips-Perron tests on exchange rate misalignment. As stationarity is confirmed they state that there are both overvalued and undervalued periods but on average Singapore dollar was undervalued. An interesting finding is that after Asian crisis (after 1997) the actual exchange rate was undervalued at a rate, similar to the pre-crisis period.

4.4. Concluding Remarks

The concept of equilibrium exchange rates is very important for developing as well as for developed countries. As mentioned before, an abnormal exchange rate can cause serious problems to countries. For example, an undervalued currency imports high inflation, while an overvalued currency makes the domestic economy less competitive. Especially, when a developing country is the case, overvaluation is an alarm of future currency crises. Since traditional exchange rate determination models seem not to be so reliable in many empirical applications, researchers have turned to alternative approaches. In this chapter, the most important models have been analyzed: FEER, BEER and NATREX.

The Fundamental Equilibrium Exchange Rate is that rate consistent with internal and external balance. Williamson's main contribution to this approach is the alternative meaning of external balance, which is current account's sustainability. Under this framework, there are a number of alternative methods in the literature for measuring external balance. Most studies (Williamson 1994, Smidkova 1998) set a target value for the current account while others (Feyzioglu 1997, Paiva 2001, Egert 2002) use cointegration techniques and by taking the average of the actual current account balances estimate equilibrium exchange rates. An alternative approach is the cointegration analysis of the saving-investment balance. This is shown in Coudert & Couharde (2002). Finally, current account balance exists if the ratio of foreign debt to GDP is stable (Hallet & Richter 2004).

The main advantage of the FEER approach is that it is not based on the direct econometric analysis. Exchange rates are very volatile and in many cases it is difficult to establish a valid relationship between exchange rates and economic fundamentals. Thus, because of the difficulties we face in the direct econometric analysis, Williamson's approach seems to be an appropriate empirical tool. But, there are many drawbacks as well. Firstly, some factors included in the FEER do not affect directly the exchange rate.

For example, saving and investment are not mentioned as determinants in any exchange rate determination model. Moreover, as Clark & MacDonald (1998) state, FEER is not a dynamic solution. It provides only a calculation of current values and it is not suitable for forecasting purposes. Another problem with FEER estimation is that it is a medium-run equilibrium rather than a long-run equilibrium. Some argue that the FEER is not a real equilibrium because it is not stock-flow equilibrium. Driver & Westaway (2004) do not actually accept this statement arguing that this is because the concept of FEER is misunderstood. However, it is true that FEER estimates are sensitive to the "hysteresis effect". This is because a medium-run current account can be affected by temporary movements and, as a consequence, FEER is also affected.

The Behavioural Equilibrium Exchange Rate approach involves the direct econometric analysis of the behaviour of the real exchange rate. It is based on the estimation of a reduced-form equation that explains the behaviour of the real effective exchange rate, dictated by economic fundamentals. The long run real equilibrium exchange rate is then estimated by filtering fundamentals from speculative and cyclical factors. What makes BEER reliable is that the exchange rate is a function of variables that have a direct effect on the exchange rate. In other words, the equilibrium exchange rate is driven by the sustainable values of variables that affect the actual exchange rate and not by overall macroeconomic balance. As we have seen in FEER, equilibrium is subject to conditions, which are difficult to hold in reality or they are difficult to be measured. Therefore, the equilibrium exchange rate is a rate that is difficult to be matched. In contrast, BEER is the rate consistent with the sustainable values of variables, which constitute the core of exchange rate fluctuation. Furthermore, important policy implications arise from this methodology. Economic authorities have to apply the appropriate macroeconomic policy to drive macroeconomic fundamentals to the desired levels in order to achieve the equilibrium exchange rate.

However, econometric analysis may include some inconsistencies, which will affect model's robustness. For example, absence of any cointegrating vector rejects the long run relationship between fundamentals and the exchange rate. So, in this case, no variable can explain exchange rate behaviour. These problems may be due to inappropriate econometric procedures.[85]

Finally, the Natural Real Exchange Rate seems to be the most appropriate approach. NATREX is the rate consistent with natural unemployment and absence of speculative and cyclical factors. Similarly, the main condition is simultaneous internal and external balance. The fact, which differentiates NATREX from FEER, is the condition of portfolio balance. An advantage of this approach compared to FEER is that it is suitable for medium-run as well as for long-run analysis. In the medium run, capital stock and foreign debt are exogenous to the system while in the long run they are endogenous. The inclusion of stocks makes NATREX a dynamic stock-flow equilibrium concept. Therefore, NATREX seems to be more appropriate than FEER. Furthermore, NATREX has an advantage compared to BEER in terms of econometric inconsistencies. However, weaknesses are not eliminated. The correspondence between theoretical and empirical variables is an embarrassing issue. Some variables, such as foreign debt and capital stock cannot be easily measured. As a result, approximations of those variables are usually

[85] The main disadvantage of the BEER approach is that because of the volatility of the exchange rate, the applied econometric techniques may not be appropriate. These econometric inconsistencies weaken BEER compared to FEER and NATREX approaches.

employed. Another serious problem is that, like in FEER, some variables may have no direct effects on the exchange rate. Finally, NATREX is based on “quite strong” assumptions, which are hardly satisfied. For instance, capital stock constancy and net foreign assets stability are not simple tasks for any economy. However, NATREX is suitable for developing countries, in which direct econometric analyses may provide ambiguous results.

5. Foreign Exchange Market Efficiency

In a micro-foundation framework, the term “efficiency” corresponds to the efficient resource allocation within an economy. In financial economics, an efficient investment requires agents to remove their capital from markets with lower return to markets with higher return. However, the *Efficient Market Hypothesis* (EMH) relies on the efficient exploitation of information by economic actors. EMH is also referred as Informational Efficiency (Hallwood & MacDonald, 1994). For example, an asset market is efficient if the asset price fully reflects all available information. EMH requires that market agents have rational expectations and there are no transaction costs that avert them from buying and selling assets.

According to Fama (1970), if it is not possible for a trader to make abnormal profits using only the past history of prices, the market is *weakly efficient*. If by increasing public information set (about money supply, interest rates, e.t.c.) it is not possible for a trader to make abnormal profits, the market is *semi-strong form efficient*. Finally, if it is not possible for a trader to make abnormal profits using public or private information, the market is *strong form efficient.*

The efficient market hypothesis can be applied to asset markets as well as to foreign exchange markets. Fama (1984) states that foreign exchange markets are efficient if fully reflect all available information. This is a strong version of the efficiency hypothesis. A weak form is presented by Jensen (1978). An efficient market reflects information up to the point where the marginal benefit of information does not exceed the marginal cost of collecting it. Foreign Exchange Efficiency Hypothesis is also called as Forward Rate Unbiasedness Hypothesis (FRUH), because in an efficient market the forward rate should be unbiased (or good) predictor of the future spot rate. Fama (1984) shows that the forward rate includes a risk premium, which is equal to the interest rate differential. An alternative expression of this hypothesis illustrates that a market is efficient if the expected value of excess return is zero. In other words, efficiency means that the available information cannot lead to unusual profits. Non-zero expected excess return may exist because of UIP deviations, or due to the existence of a risk premium in the forward rate, or because of exchange rate speculation. Bilson (1981) argues that if a profit from speculation can exist, the market cannot be efficient.

All these statements, which summarize the efficiency hypothesis, imply different test procedures to test for the robustness of this hypothesis. Earlier studies, based on the statistical properties of the spot and forward rates are Cornell (1977), Geweke & Feige (1979), Rose & Selody (1984) and Ligeralde (1994). Posterior studies can be decomposed into two major categories. Those which test the efficiency hypothesis through conventional econometric techniques, i.e. OLS – Fama (1984), Naka & Whitney (1995) e.t.c. - and those which apply cointegration techniques between spot and forward rates, i.e. Dutt (1994), Corbae et. al. (1992), Liu & Maddala (1992), Zivot (2000) e.t.c.

The following section presents the theoretical framework of the Forward Rate Unbiasedness Hypothesis, while section 5.2 deals with the empirical findings of relevant studies. Section 5.3 concludes by criticizing the theoretical and empirical literature.

5.1. Theoretical Framework

In a two-country model, let e_t and f_t be the spot and forward rates of currency α per currency β, respectively. Moreover, let i_t and i_t^* be nominal interest rates on bonds in country α and country β, respectively. We assume that both interest rates and the forward rate are of the same maturity and the bonds in the two countries are under the same risk and taxation.

Suppose that an agent from country α invests in a domestic bond, which yields $1+i_t$. Alternatively, this agent can invest in a foreign bond with return $(1+i_t^*)/e_t$. Because the future spot rate is now uncertain, the return of the investment in foreign bonds is doubtful. The agent can cover this uncertainty by selling a forward contract of $(1+i_t^*)/e_t$. Thus, the new value of the future return becomes $[(1+i_t^*)f_t]/e_t$. The Covered Interest Arbitrage makes the two returns equal:

$$(1+i_t) = \frac{f_t}{e_t}(1+i_t^*) \tag{5.1}$$

Now, solving for the interest rate differential (assuming that the term [1+i*] is close to 1) we find the Covered Interest Parity condition:

$$f_t = e_t \cdot \frac{(1+i_t)}{(1+i_t^*)} \tag{5.2}$$

$$\frac{f_t}{e_t} - 1 = \frac{(1+i_t)}{(1+i_t^*)} - 1 \tag{5.3}$$

$$\frac{f_t - e_t}{e_t} + \frac{(i_t - i_t^*)}{(1+i_t^*)} \tag{5.4}$$

$$i_t - i_t^* = \frac{f_t - e_t}{e_t} \tag{5.5}$$

Equation (5.5) illustrates the Covered Interest Parity condition, which states that the forward premium (as a percentage) is equal to the interest rate differential. Now, introducing the Uncovered Interest Parity condition (under risk neutrality)

$$E_t\left[\Delta e_{t+1}\right] = i_t - i_t^* \tag{5.6}$$

which states that the interest rate differential is equal to the expected change of the future spot rate (or equivalently, the expected depreciation) and combining the covered and the uncovered interest parity conditions, we get:

$$\frac{f_t - e_t}{e_t} = E_t\left[\Delta e_{t+1}\right] \tag{5.7}$$

$$f_t - e_t = E_t\left[e_{t+1}\right] - e_t \tag{5.8}$$

$$f_t = E_t\left[e_{t+1}\right] \tag{5.9}$$

Equation (5.9) is the benchmark equation of the foreign exchange market efficiency hypothesis. It says that the forward rate is a good predictor of the expected future spot rate. Assuming that expectations are rationally formed, we have:

$$e_{t+1} = E_t\left[e_{t+1} \middle| \Omega_t\right] + u_{t+1} \tag{5.10}$$

where Ω_t is the informational set available at the time of forming expectations and u_{t+1} is a random forecast error. Substituting (5.10) to (5.9), we get:

$$f_t = e_{t+1} - u_{t+1} \tag{5.11}$$

$$e_{t+1} - f_t = u_{t+1} \tag{5.12}$$

Equation (5.12) shows that the forward rate deviates from the future spot rate only by a random error.

5.1.1. Relaxing the Assumption of Risk Neutrality

So far we have assumed that both domestic and foreign bonds include the same risk and are under the same taxation. These facts make agents risk neutral. Now, let suppose that investment in country β is more risky than investment in country α, which makes agents risk averse.[86] Thus, the Uncovered Interest Parity becomes:

$$i_t - i_t^* = E_t[\Delta e_{t+1}] + rp_t \tag{5.13}$$

where rp is the risk premium. Then, from (5.5) and (5.13) we have:

$$f_t - e_t = E_t[e_{t+1}] - e_t + rp_t \tag{5.14}$$

$$f_t = E_t[e_{t+1}] + rp_t \tag{5.15}$$

Equation (5.15) is the condition of foreign exchange market efficiency under risk aversion. The difference of the forward rate from the expected future spot rate is equal to the risk premium. However, the foreign exchange market efficiency hypothesis requires that the forward rate should not include any time-varying risk premium.

Following Fama (1984) and rearranging equation (5.1) in the following way:

$$\frac{f_t}{e_t} = \frac{(1+i_t)}{(1+i_t^*)} \tag{5.16}$$

we can easily observe than any deviation of the forward rate from the corresponding spot rate is because of interest rate differentials. This is intensively sensible if we recall that different riskiness in the two bonds yields to different returns (i.e. different interest rates). As a result, the premium should be analyzed in terms of interest rate differentials. Taking natural logarithms in (5.16) we get:

$$\ln f_t - \ln e_t = (1+i_t) - (1+i_t^*) \tag{5.17}$$

$$\ln f_t - \ln e_t = i_t - i_t^* \tag{5.18}$$

[86] This may be due to a higher taxation or due to an unstable financial system in country β.

Now we introduce, in equation (5.18), the Fischer equation, which is described by the following expression,

$$i_t = r_t + E_t[\Delta p_{t+1}] \tag{5.19}$$

where i_t is the nominal interest rate

r_t is the real interest rate

$E_t[\Delta p_{t+1}]$ is the expected future inflation rate, at time t.

$$f_t - e_t = [r_t + E_t(\Delta p_{t+1})] - [r_t^* + E_t(\Delta p_{t+1}^*)] \tag{5.20}$$

$$f_t - e_t = (r_t - r_t^*) + [E_t(p_{t+1}) - E_t(p_{t+1}^*)] - (p_t - p_t^*) \tag{5.21}$$

Assuming that PPP holds all the time, equation (5.21) becomes:

$$f_t - e_t = (r_t - r_t^*) + E_t[e_{t+1}] - e_t \tag{5.22}$$

$$f_t = (r_t - r_t^*) + E_t[e_{t+1}] \tag{5.23}$$

$$f_t - E_t[e_{t+1}] = r_t - r_t^* \tag{5.24}$$

From the above equations we can easily observe that the forward rate deviates from the expected future spot rate when the real returns on the bonds of the two countries are not equal. Thus, this difference can explain the existence of a risk premium in the forward rate. In other words, when the Fischer equation and the PPP condition hold, the variables which determine the real returns on different bonds can also settle on the premium in the forward rate.

5.2. Empirical Literature Review

As mentioned above the foreign exchange market efficiency hypothesis holds if the forward rate is an unbiased predictor of the future spot rate. An alternative expression of the foreign exchange market efficiency hypothesis states that a market is efficient if fully reflects all available information. Moreover, in an efficient market, the available information cannot lead to an unusual profit.

All these statements, which summarize the efficiency hypothesis, imply different test procedures in testing the robustness of this hypothesis. Earlier studies, based on the statistical properties of the spot and forward rates were able to accept the efficiency hypothesis. Suggestively, Cornell (1977) examines 7 major currencies against US dollar (1973:4 – 1977:1). The efficiency hypothesis requires the absence of a risk premium and the spot rate to deviate from its expected value only by a white noise error. He finds no evidence of a risk premium, as the mean of the forward forecast error is close to zero. Moreover, in an efficient market, the standard deviation of the forecast error should be less than (or equal to) the standard deviation of the forecast error derived from an alternative model. The results show that the forecast errors do not deviate significantly, which is supportive for the existence of market efficiency. As a general statement, Cornell confirms foreign exchange market efficiency hypothesis. Other studies, based on statistical properties analysis are Geweke & Feige (1979), Rose & Selody (1984) and Ligeralde (1994).

Posterior studies can be decomposed into two major categories. Those which test the efficiency hypothesis through conventional econometric techniques, i.e. OLS and those which apply cointegration techniques between spot and forward rates. Below we discuss the properties and the pitfalls of each econometric methodology and we present the empirical evidence from relevant studies. The majority of the empirical studies examine the efficiency hypothesis in terms of the relationship between the spot and forward rates.

However, we can add one more set, which includes studies approaching the foreign exchange market efficiency hypothesis through a somewhat different theoretical and empirical concept. For example, Bilson (1981) performs the efficiency test in terms of speculative efficiency, while Franker & Froot (1987) test the hypothesis of rational and static expectations. Furthermore, Hai et. al. (1997) decompose the exchange rate into permanent and transitory components and estimate this model by Maximum Likelihood Estimation.

5.2.1. Conventional Studies based on OLS Estimation

The first category includes studies, which estimate the following equation by Ordinary Least Squares:

$$e_{t+1} = \alpha + \beta \cdot f_t + u_{t+1} \tag{5.25}$$

where the null hypothesis states: $\alpha=0$ & $\beta=1$, and that the error term has a conditional mean of zero, $E_t[u_{t+1}]=0$. Namely, under the null, the forward rate is a good (unbiased) predictor of the future spot rate. The second part of the null requires the forecast error to be orthogonal or uncorrelated to information available to agents at the time they form their expectations. However, this methodology incorporates an important econometric inconsistency. Both spot and forward rates are expected to be non-stationary, which means that OLS estimators will be inconsistent since they provide invalid standard errors and confidence intervals.

Given that these variables are difference stationary [i.e. I(1)], the above inconsistency can be ruled out by regressing the above equation in differences. Hence, some studies test market efficiency by estimating the above equation:

$$e_{t+1}-e_t=\alpha+\beta\cdot(f_t-e_t)+u_{t+1} \qquad (5.26)$$

where $f\text{-}e=fp$ is the forward premium and $e_{t+1}-e_t=\Delta e_{t+1}$ is the change in future spot rate. Similarly, the null states: $\alpha=0$ & $\beta=1$ and $E[u_{t+1}]=0$. At first glance, the above inconsistency seems not to hold any more. However, following Liu & Maddala (1992), we can be sure about the stationary nature of Δe_{t+1} but we cannot assume the same for the forward premium. The forward premium is written as follows:

$$f_t-e_t=(f_t-f_{t-1})+(f_{t-1}-e_t) \qquad (5.27)$$

The first term of the right hand-side of equation (5.27) is stationary. If the second term is stationary, the forward premium will be stationary as well. But, it is not clear-cut that this is I(0). Therefore, the stationary nature of the forward premium is not certain.[87] Moreover, Liu & Maddala (1992) show that the estimation of (5.26) by OLS provides inconsistent estimates. The forward rate, under risk aversion, is given by:

$$f_t=E_t[e_{t+1}]+rp_t \qquad (5.28)$$

and the future spot rate is given by the following expression:

$$e_{t+1}=E[e_{t+1}]+u_{t+1} \qquad (5.29)$$

Equation (5.28) shows that the forward rate is equal to the expected future spot rate plus a risk premium, while equation (5.29) implies that the future spot rate deviates from its expected value only by a random forecast error. Combining these two equations we get:

$$e_{t+1}=f_t+u_{t+1}-rp_t \qquad (5.30)$$

$$e_{t+1}-e_t=(f_t-e_t)+(u_{t+1}-rp_t) \qquad (5.31)$$

but in (5.31), the forward rate is correlated with the risk premium. This can lead to biased

[87] This is important because if the forward premium is still non-stationary, OLS estimators will be biased.

OLS estimators. As a consequence, this methodology can lead to rejection of the efficiency hypothesis even if it is true. Therefore, under this analysis we observe that conventional econometric procedures are not valid for testing the foreign exchange market efficiency hypothesis.

Empirical Evidence

A seminal study is that of Fama (1984), which examines efficiency in nine exchange rates (nine currencies against US dollar), using monthly data from 1973:8 to 1982:12. Fama regresses equation (5.26) by Ordinary Least Squares and tests the corresponding null hypothesis. The results show that the estimators of β are not equal to 1 and negative. Moreover, he finds positive autocorrelations of the forward rate, which indicate that the forward premium or the expected future change of the spot rate is highly unstable. He states that the negative values of β can be attributed to the negative correlation between the forward premium and the expected future change of the spot rate. Hence, Fama concludes that the market efficiency hypothesis is not accepted because of a time-varying risk premium.

Similarly, Naka & Whitney (1995) test the efficiency hypothesis of seven exchange rates (against US dollar) from 1974:1 to 1991:4 (monthly observations). They regress both equations by OLS, i.e. equations (5.25) & (5.26). The results from regressing equation (5.25) show that the estimates of β are positive and close to 1, with small standard errors. However, the non-stationary nature of the exchange rates invalidates these estimates. For this reason, they regress equation (5.26) by OLS and set again the same null hypothesis. Their output implies negative estimates of β, with large standard errors. So, the null is rejected. They argue that efficiency is rejected because of the existence of a time-varying risk premium. Finally, they manage to accept the efficiency hypothesis through Non-Linear Least Squares estimation. The estimates of β are close to 1 and the null is accepted, which means that the forward rate is an unbiased predictor of the future spot rate.

Other studies in that field, which apply similar econometric techniques, are those of Hakkio (1981), Taylor (1989), Backus et. al. (1993), McCallum (1994), e.t.c.[88]. All studies fail to accept the efficiency hypothesis. For example, Hakio (1981) examines five exchange rates against US dollar from 1973:4 to 1977:5. In all cases, the unbiasedness hypothesis cannot be accepted. Taylor (1989) examines the US dollar/UK pound exchange rate from January 1981 to July 1985. He finds a statistically significant risk premium, so there is evidence of risk-averse behaviour. He also tests the rationality of expectations but, he cannot accept the hypothesis that expectations are not rational. Therefore, risk aversion rather than non-normality causes the rejection of the efficiency hypothesis. Similarly, McCallum (1994) examines the efficiency hypothesis in the case of Japanese yen, Deutsche mark and UK pound against US dollar from 1978:1 to 1990:7 (monthly observations) and he finds negative estimates of β, significantly away from 1. Finally, Backus et. al. (1993) examines the same currencies plus Canadian dollar and French frank, against US dollar, from 1974:7 to 1990:4 (monthly observations). His estimates are once again significantly away from 1 and negative.

5.2.2. <u>Cointegration-based Studies</u>

On the other hand, empirical studies based on cointegration techniques provide mixed results. Cointegration techniques, such as the two-step Engle-Granger (1987)

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[88] A more comprehensive review on these empirical studies can be found in Hodrick (1987) and Engel (1996).

methodology and the Johansen's (1988) multivariate cointegration technique are applied to equation (5.25), as well as to equation (5.26). Namely, applying this technique to equation (5.25) we test the hypothesis of cointegration between spot and forward rates in levels, while equation (5.26) examines cointegration between the forward premium and the change of the future spot rate. Under the framework of cointegration analysis, two non-stationary variables are cointegrated if they form a valid long run relationship. In other words, spot and forward rates will be cointegrated if the forecast error term [in equation (5.25)] is stationary (Engle-Granger 2-step methodology) or there is at least one cointegrating vector (Johansen's technique). Dutt (1994) calls the efficiency hypothesis test, performed by the Engle-Granger 2-step procedure as a strong-form test and this of the multivariate cointegration technique as a weak-form test.

Therefore, the acceptance of the foreign exchange market efficiency hypothesis requires the existence of cointegration (necessary condition) and the absence of unit roots in any autocorrelation pattern in the residuals, i.e. the error term to be white noise (sufficient condition). However, inconsistencies are not absent. Hai et. al. (1997) show that when cointegration analysis is applied to equation (5.25), there is evidence of cointegration with estimates of β equal to 1. Similarly, when equation (5.26) is the case, cointegration is not rejected but the estimators of β are found to be negative. This is a puzzling issue because when the levels is the case, the forward rate is an unbiased predictor of the future rate and when differences is the case, the forward premium predicts the future change of the spot rate with the wrong sign. Fama (1984) charges this inconsistency to the presence of a time-varying risk premium, which is negatively related to the change of the spot rate.

Another type of cointegration test is testing the efficiency market hypothesis in an international framework. In an efficient market, a spot rate cannot be cointegrated with any other spot rate. The main motivation here is that if two variables are cointegrated, at least one can be predicted from the other.[89] This is not consistent with market efficiency, especially with the weak-form efficiency hypothesis, because if a spot rate includes all available information, its future change cannot be predictable.

A lot of criticism has been applied to this type of test. For instance, Hodrick (1987) describes as false the above statement about the predictability of the future spot rate. Similarly, Baffes (1994) argues that efficiency does not require unpredictable exchange rates. Actually, efficiency is weakened only if arbitrage opportunities can arise from predictability. Moreover, Engel (1996) does not accept that two spot rates, in a pair of efficient markets, should not be cointegrated and argues that foreign exchange market efficiency does not require unpredictable spot rates. Furthermore, Dwyer & Wallace (1992) show that there is no evidence of market inefficiency if two exchange rates are cointegrated. Crowder (1994) explains that even if two spot rates are cointegrated, this will not violate efficiency if there is a risk premium. His argument is that if the forward premium is I(1), then efficiency requires the risk premium to be I(1) as well. However, this argument has not escaped from Engel's critique.[90]

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[89] This is found in Granger (1986). Namely, two asset prices from two efficient markets cannot be cointegrated.

[90] To find more about the arguments against this methodology, see Engel (1996).

Empirical Evidence

The empirical evidence generally rejects the efficiency hypothesis. Liu & Maddala (1992) test this hypothesis in two steps. First, the Rational Expectations Hypothesis (REH) is tested, which states that agents use all available information in forming their expectations. The REH test is based on:

$$e_t = \beta_0 + \beta_1 \cdot E_t[e_{t+1}] + u_t \tag{5.32}$$

where e is the current spot rate and $E_t[e_{t+1}]$ is its expected value. This hypothesis will be accepted if $\beta_0=0$, $\beta_1=1$, the forecast error is uncorrelated with the variables in the information set and the error term is not autocorrelated. Because of the evidence of I(1) variables, cointegration techniques are applied. Using weekly data, the REH is not rejected. However, using monthly data, REH is rejected. The second step of the test is the Market Efficiency Hypothesis (MEH). Once again, when weekly and monthly data are used, MEH is rejected. Thus, the forward rate is not an unbiased predictor of the future spot rate. It is not clear what is responsible for this failure. When weekly data are applied, this may be due to a risk premium. On the other hand, when monthly data are used, the reason differs from currency to currency. For example, for the British pound, the Deutsche mark and the Swiss franc both a risk premium and the rejection of REH are responsible for the rejection of MEH. In the case of Japanese Yen, only the rejection of REH causes the rejection of MEH.

Zivot (2000) tests the foreign exchange market efficiency hypothesis for the British pound, Japanese Yen, Canadian dollar against US dollar from 1976:1 to 1996:6 (monthly observations). He compares cointegration models between the forward rate with the current spot rate and the forward rate with the future spot rate. He finds that cointegration analysis in the first case, estimating a VECM, strongly rejects the efficiency hypothesis in all exchange rates. Thus, the forward rate is not an unbiased predictor of the corresponding spot rate. This failure may be attributed to the existence of a risk premium. When it comes to the second pair of cointegration analysis, he states that this cointegration model has not a finite lag VAR representation. Hence, standard VAR models can lead to misleading statements about foreign exchange market efficiency.

Hakkio & Rush (1989) examine the efficiency hypothesis for the UK pound and the Deutsche mark from 1975:1 to 1986:10 (monthly observations). They find that all variables are I(1), which dictates the application of cointegration techniques. This is performed in three steps. In an international framework, there is no evidence of cointegration between the two spot rates or the two forward rates. So, this is a first sign consistent with efficiency.[91] At a second stage, spot and forward rates, within a country, are cointegrated, which is consistent with efficiency too. But, the estimation of the error correction model rejects the hypotheses of no risk premium and efficient use of the available information by the agents. These findings reject the foreign exchange market efficiency hypothesis. However, they cannot be sure about the factors which cause this failure.

Baillie & Bollerslev (1989) examine the exchange rates of seven currencies against US dollar. Their dataset includes daily spot rates and one-month forward rates from 1980 to 1985. Since, unit roots tests imply that all variables are non-stationary, the appropriate methodology is this of cointegration analysis. They find that all pairs (e_t & f_t) are cointegrated, implying a stationary error term. This finding is consistent with market

[91] Recall that Hodrick (1987), Engel (1996) and others do not accept this kind of test.

efficiency. On the other hand, a multivariate cointegration analysis in an international framework shows that spot rates are cointegrated. The same holds for the forward rates as well. The authors interpret this finding as a violation of the efficiency hypothesis because the disequilibrium error can predict the future change in the spot rate.[92] In an attempt to find the reason of this failure they state that this may be due to a risk premium.

Similarly, Aroskar et al (2004) apply cointegration techniques in an international framework. The interesting point here is that they examine the efficiency hypothesis between crisis and non-crisis periods. This study is applied to British pound, Italian lira, German mark, French franc, all against US dollar. Data are daily spot rates and 1-month forward rates from 1990:1 to 1999:12.[93] Both cointegration tests, i.e. Engle-Granger and Johansen, show that the examined spot rates are cointegrated in all periods. This is not consistent with market efficiency. Moreover, they test the hypothesis of exclusion of a currency from the long-run relationship, i.e. the exogeneity assumption. However, the results indicate that no one currency can be excluded. Thus, all currencies help to maintain the long run relationship, as they are endogenous to the cointegrating equation. Finally, they examine efficiency in terms of lack of forecasting ability. This is performed by comparing the predictability of the implied Error Correction Model (ECM) with the Random Walk Model (RWM).[94] If the criteria have lower values in the ECM rather than RWM, foreign exchange efficiency cannot be supported. However, the results for the

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[92] See footnote 90.

[93] They decompose the examined period in three sub-periods: (1) pre-crisis period (1990:1 – 1991:12), (2) crisis period (1992:9-1993:3) and (3) post-crisis period (1994:1-1999:12). The crisis period is referred to the ERM crisis. There is no evidence of structural breaks during the crisis period. However, breaks are found during pre-crisis and post-crisis periods.

[94] The applied criteria are: Mean Absolute Error (MAE), Mean Square Error (MSE) and Root Mean Square Error (RMSE).

French franc and the Italian lira are mixed, while for the UK pound and the German mark, the ECM has higher predictability than the RWM. As a general statement, this study shows that foreign exchange market efficiency hypothesis cannot be accepted. Furthermore, this failure may be due to the existence of a risk premium during the crisis period.

An empirical study, which tests the efficiency hypothesis in a developing foreign exchange market, is that of Wickremasinghe (2004). He examines efficiency of the Sri Lankan foreign exchange market through six spot rates.[95] Two unit root tests (ADF & PP) show that all spot rates are not stationary. By performing two cointegration tests (Engle-Granger & Johansen), they find evidence against semi-strong efficiency. In other words, they find evidence of cointegration among the spot rates. As a conclusion, the author states that the efficiency hypothesis cannot be accepted for the Sri Lankan foreign exchange market.

Cointegration techniques do not always provide clear-cut inferences on foreign exchange market efficiency hypothesis. Sephton & Larsen (1991) using both the Engle-Granger and the Johansen methodologies for the Canadian dollar, the Japanese yen and the Deutsche mark against US dollar (1975:7-1988:12, monthly observations), point out the weaknesses of cointegration techniques. Specifically, they estimate a 2-currency and a 4-currency model by cointegration techniques. Their results are mixed, which implies that the efficiency hypothesis is sensitive to the model specification and to the estimated period.

[95] These are: Us dollar, UK pound, German mark, French franc, Japanese yen, Indian rupee against Sri Lanka's currency. The data include only monthly spot rates (1986:1-2000:11) because, the Sri Lankan forward market is not well developed.

Corbae et. al. (1992) provide mixed results as well. They consider six currencies against US dollar from 1976:1 to 1985:1 (weekly observations). They find that when the forward rate unbiasedness hypothesis is not accepted, the risk premium includes an I(1) component and a transitory component [I(0)], which means that in overall it is non-stationary. On the other hand, if the above hypothesis is accepted, the risk premium is stationary and negative. Moreover, they estimate a multi-country test, which implies that other currency forward rates, especially those of Deutsche mark and Japanese yen, affect significantly most of the future spot rates. Nonetheless, these effects are not stronger than these of the currency's own forward rate.

Dutt (1994) performs a strong-form test (Engle-Granger 2-step) and a weak-form test (Johansen multivariate). He examines the exchange rates of five currencies against US dollar. The dataset includes spot rates and forward rates from 1981 to 1988. Under the framework of the strong-form test, the spot and the forward rates are I(1) but the stationarity of the error term cannot be accepted. Thus, strong-form efficiency hypothesis is not accepted. On the other hand, weak-form test requires the existence of at least one cointegration vector. The trace and the max-eigenvalue test statistics indicate that there is at least one cointegrating vector. Thus, as cointegration is confirmed the weak version of the foreign exchange market efficiency hypothesis is accepted.

A study, which extends the horizons of cointegration-based tests, is this of Aron (1997), which examines the validity of the foreign exchange market efficiency hypothesis for South Africa. He performs a weak-form efficiency test through cointegration analysis between spot and forward rates. Likewise, the necessary condition requires evidence of cointegration and the sufficient condition requires the error term to be white-noise.

Although the necessary condition is accepted he finds evidence of autocorrelation in the error term, which means that lagged residuals can predict the future spot rate. Thus, this kind of test rejects the efficiency hypothesis. However, Aron (1997) introduces another type of cointegration-based test, which is more appropriate for the case of South Africa. This is a semi-strong form test based on the long run equilibrium of the spot rate with a vector of macroeconomic fundamentals.[96] Actually, he uses an error correction model to examine the predictability of future excess returns via the lagged disequilibrium error term. This test entails a two-step procedure. Firstly, evidence of cointegrating vectors between the spot rate and the vector of fundamentals implies that exchange rate movements can be explained by the relevant fundamentals. But, the estimation of the error correction model shows that exchange rate returns are predictable by fundamentals. Therefore, the efficiency hypothesis is rejected.

5.2.3. Other Studies

Bilson (1981) examines the foreign exchange efficiency hypothesis in terms of speculative efficiency. In other words, he introduces a direct test of nonzero speculative profit. If a profit from speculation can exist, the market cannot be efficient. He estimates the following equation:

$$\Delta e_t = \alpha + \beta \cdot f_{t-1} + u_t \tag{5.33}$$

and the null states: $\alpha=0$, $\beta=1$ & $E_t[u_t, u_{t-i}]=0$. The dataset includes weekly spot rates and 1-month forward rates of nine currencies against US dollar. OLS estimation of (5.33) does not support efficiency. He states that conventional tests of speculative efficiency in

[96] The vector of fundamentals includes: tariff, government expenditure, government revenues, gold price and interest rate differential. Observations are monthly from 1979:2 to 1995:1.

the foreign exchange market are low in power. This test can be improved by using higher frequency data (weekly) and by estimating the above equation by Generalized Least Squares. However, he concludes that the null of no speculation profits cannot be accepted.

Under a similar framework, Frankel & Froot (1987) approach the efficiency market hypothesis through exchange rate expectations. They test whether investors' expectations are unbiased predictors of the future spot rate. They regress the following equation:

$$E_t[e_{t+1}] = \beta \cdot f_t + (1-\beta) \cdot e_t \tag{5.34}$$

The null hypothesis requires β=0. This implies that expectations are static, i.e. agents believe that the exchange rate follows a random walk. This test is applied to UK pound, German mark, Swiss franc, Japanese Yen and French franc against US dollar from 1976 to 1985. The results show that there is no evidence of static expectations. This is equivalent to the rejection of foreign exchange market efficiency hypothesis.

Hai et. al. (1997) apply a simple parametric Permanent-Transitory (P-T) components model for spot and forward rates.[97] The fundamental component is modelled by a stochastic trend, which includes a common random walk for both e_t and f_t. The transitory component is modelled by a vector ARMA. This study deals with the exchange rates of UK pound, French franc and Japanese Yen against US dollar from 1976:1 to 1992:8 (monthly observations). The P-T components model is estimated by Maximum Likelihood using the Kalman filter. The results show that the slope coefficients are negative in all exchange rates. Moreover, expected excess return, which is estimated by subtracting the expected future spot rate (estimated by the Kalman filter) from the

[97] Their model is inspired from Mussa's (1982) sticky-price model, in which the exchange rate is a function of fundamentals and a transient disequilibrium term.

forward rate is more volatile than the expected change of the spot rate and negatively correlated with this. As a consequence, they fail to confirm the validity of the forward rate unbiasedness hypothesis. However, they cannot charge this failure to the existence of a risk premium.

Finally, Barkulas et al (2003) employ a univariate unit root test as well as a more powerful multivariate panel unit root test to six major currencies against US dollar. The multivariate test is applied, through a Johansen Likelihood-Ratio test, by utilizing the cross sectional information available in the term structure of forward exchange premiums. The data set includes daily spot rates and 1, 3, 6 and 12-month forward rates of six exchange rates.[98] As a preliminary test, they apply a univariate test by ADF-GLS, which is more powerful than conventional DF and ADF tests. The results, regarding the stationary nature of the forward premium, are mixed. For example, stationarity is accepted only at 1 & 3-month forward rates for the Canadian dollar. In the case of Japanese yen, this is accepted only at 1-month maturity horizon. Moreover, Deutsche mark forward premiums are stationary except this of 1-month maturity horizon. Finally, all the remaining forward premiums are stationary at all maturity horizons. However, the results from the multivariate panel unit root test are not inconclusive. The forward premiums, at all maturities, follow a stationary process. This finding is consistent with foreign exchange market efficiency.

[98] These are Canadian dollar, Deutsche mark, UK pound, French franc, Italian lira and Japanese Yen against US dollar.

5.3. Concluding Remarks

The majority of the empirical studies do not support the validity of the foreign exchange market efficiency hypothesis. Some of those studies attribute this failure to the existence of a risk premium in the forward rate. For example, Fama (1984), Baillie & Bollerslev (1989), Naka & Whitney (1995) find evidence of a time-varying premium. Similarly, Taylor (1989) does not find any evidence of irrational expectations. Thus, the rejection of the hypothesis is charged to the risk premium. On the other hand, other studies such as Frankel & Froot (1987) and Hai et al (1997) do not find sufficient evidence to attribute this failure to a risk premium. Moreover, reviewing the empirical literature, Engel (1996) argues that it is not the risk premium, which is responsible for the efficiency hypothesis rejection. Mixed implications are found from Liu & Maddala (1992), which states that the reason of rejection is sensitive to the frequency of the data and differs from currency to currency.

Boothe & Longworth (1986) present some possible reasons for the efficiency failure: (i) investors may not be rational, (ii) the full model of exchange rate determination may not be known to the investors at time they form their expectations, and (iii) a risk premium may exist in the forward rate.

Dealing with the same issue, MacDonald (1988) collects some reasons that explain this failure: (i) validity of test statistics used in the tests. In many cases, test statistics are only asymptotically valid, (ii) uncertainty about government's policy. If intervention rules change from period to period, agents are not able to have rational expectations.[99]

[99] This is consistent with Boothe & Longworth (1986). They show that policy intervention does not affect efficiency only if it is applied in a systematic way. Government intervention can affect efficiency by affecting the risk premium.

Besides, incomplete information can lead to inefficient estimates and biased variance estimates, and finally (iii) transaction costs.

However, a rejection of the hypothesis does not always mean that the foreign exchange market is inefficient. Some studies may have failed to accept the efficiency hypothesis because of misspecification problems.[100] Recall that conventional OLS approaches suffer from important econometric pitfalls. Moreover, the recent development in econometrics and specifically in cointegration analysis shows that earlier cointegration studies may provide misleading implications because of insufficient test procedures. For example, a valid cointegration analysis is based on a VAR model, which is correctly specified, the error term is not serially correlated, not homoskedastic and normally distributed. Very few studies have tested all these assumptions. This implies that some studies may have failed to accept the efficiency hypothesis because of misspecification problems. One more issue, which is currently under examination but it is absent in earlier studies, is the weak exogeneity assumption. If this assumption does not hold, the estimates of the implied cointegrating vector will be invalid.[101]

Another theoretical and empirical pitfall is that there is a gap in the literature regarding tests of efficiency in developing countries. These countries do not have well developed and independent from the government financial systems. Therefore, forward rates may be highly regulated and as a consequence inappropriate for deriving any inferences about foreign exchange efficiency. In some cases, forward markets are totally absent and the forward rates unavailable. Aron (1997) proposes a test of foreign exchange

[100] This is relevant with what Fama (1991) called as "bad model problem". To be specific, Fama was referred to the problematic structure of a theoretical model.

[101] To find more about the statistical properties of this assumption, see Johansen (1995).

market efficiency by regressing the long run relationship of the spot rate with a vector of fundamentals. Although, Wickremasinghe (2004) applies a cointegration test in the case of a developing country, we cannot adopt this methodology. Hodrick (1987), Baffes (1994), Engel (1996) and others emphasize the invalid properties of this test. Efficiency does not require that two spot rates cannot be cointegrated. Moreover, there is no need for a spot rate to be unpredictable. As a consequence, the empirical tool for testing this hypothesis in developing markets is still missing.

6. Purchasing Power Parity in Central & Eastern European Countries

In line with the theoretical and empirical literature - shown in chapter 2 - the present chapter concentrates on the validity of long run PPP hypothesis in the case of four Central & Eastern European Countries (Czech Republic, Hungary, Poland and Slovak Republic), which recently became the new country-members of EU. The purpose of this study is twofold. Firstly, we seek whether PPP is a valid long run relationship in the case of these developing countries. Secondly, we attempt to define those countries' trade linkages between euro area, US and the rest of the world. For this reason we examine 3 types of exchange rates. For each country, we estimate 2 bilateral exchange rates (against euro and US dollar) and the effective exchange rate. In other words, this study contributes on understanding whether PPP holds as groundwork of equilibrium exchange rate. Namely, in line with their entry into EU, we expect strong trade linkages with former EU country-members. By establishing PPP hypothesis we can argue that these trade relations exist, indicating no trade frictions and other barriers. Therefore, a normal entry into EMU requires PPP to be valid in the long run between these countries and former EU members.

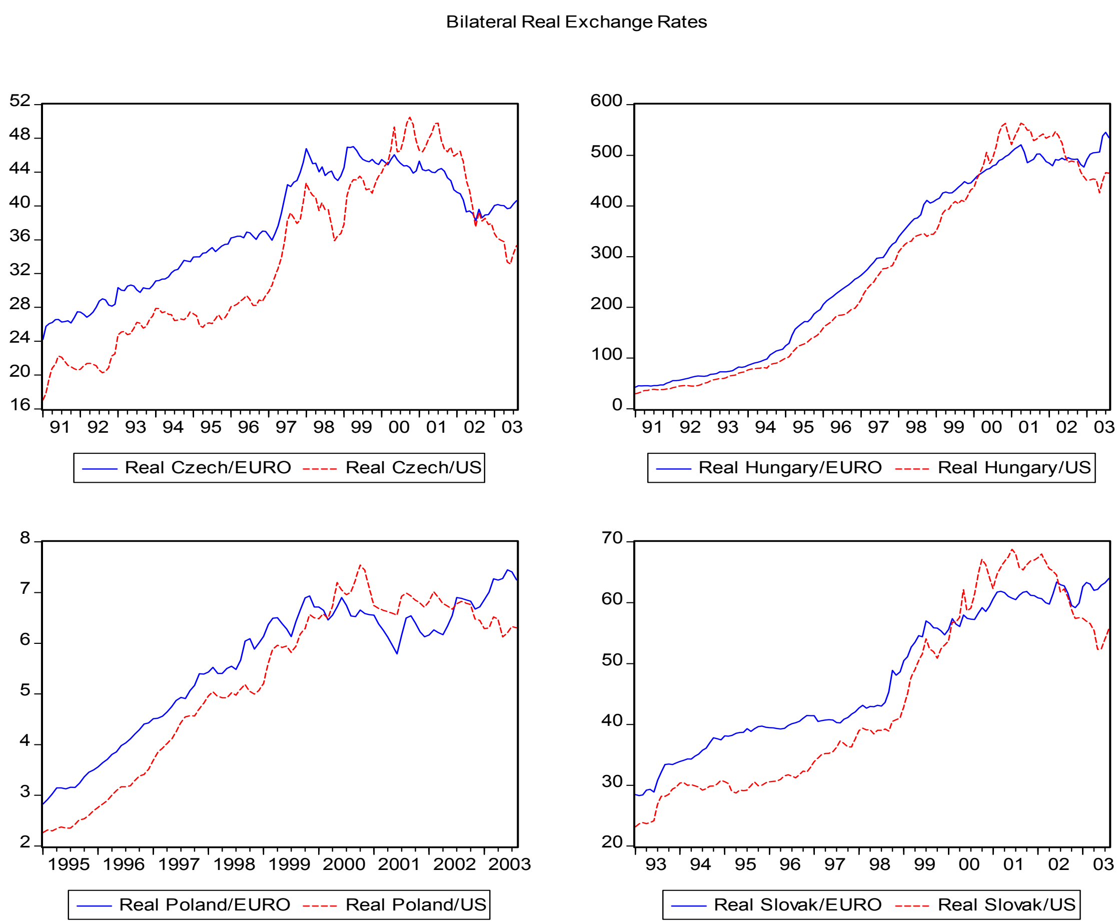
The following section describes the data used in this study, while sections 6.2, 6.3 and 6.4 illustrate evidence of PPP from univariate unit root and multivariate cointegration-based tests, respectively. A final section concludes by evaluating the estimation output.

6.1 Data Description

The dataset consists of four bilateral (nominal and real) exchange rates against euro and four bilateral (nominal and real) exchange rates against US dollar. Real Exchange

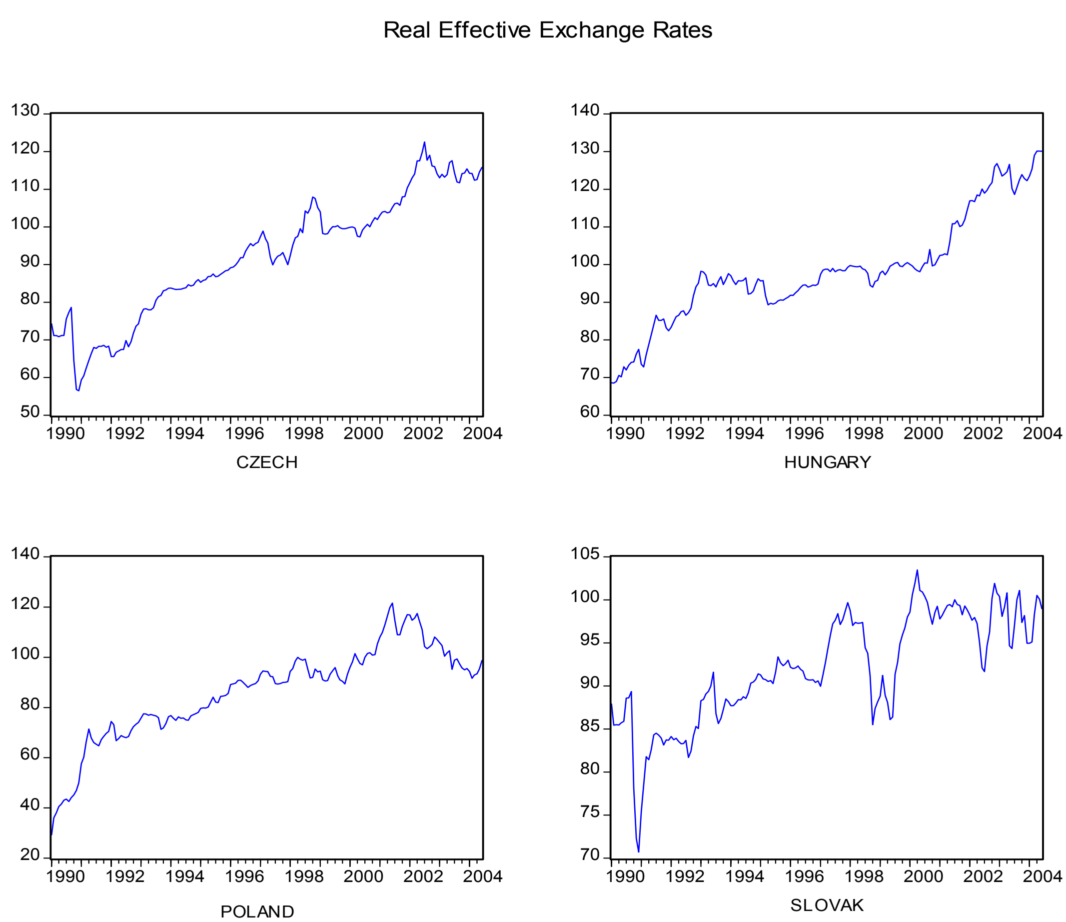
Rates are computed based on Consumer Price Indices of Czech Republic, Hungary, Poland, Slovak Republic, euro area and US. The above rates are taken from OECD statistical database. Exchange rates per euro stand for cross exchange rates (assuming perfect triangular arbitrage), while the euro/US dollar exchange rate is estimated by the OECD methodology, in which prior to 1999 rates stand for ECU rates. The data sample includes monthly observations for all variables from 1991:1 to 2003:8 for Czech Republic and Hungary, 1995:1-2003:8 for Poland, and 1993:1 to 2003:8 for Slovak Republic.

Figure 6.1: Bilateral Real Exchange Rates



Finally, the dataset includes four real (CPI-based) effective exchange rates provided by IFS statistical database (1990:1 to 2004:6). The effective exchange rate is an indicator of the domestic economy's international competitiveness in terms of its foreign exchange rate. It is a measure of the value of the domestic currency against a basket of other currencies. It is calculated as a weighted average of exchange rates and it is expressed as an index (base year 2000 = 100). As a consequence, the effective exchange rate is applied to capture the domestic country's trade linkages with the rest of the world. All variables are presented in natural logarithms.

Figure 6.2: Real Effective Exchange Rates



6.2. Conventional Unit Root Tests

Here we apply two alternative univariate unit root tests (ADF & PP) on bilateral real exchange rates as well as on real effective exchange rates. Consistent with the evidence shown in sub-section 2.1.1, PPP can be accepted only by rejecting the unit root hypothesis. This is because even if the Law of One Price (LOP) does not hold, PPP will be valid if the real exchange rate follows a mean reverting process. In other words, deviations from PPP equilibrium must be only transitory. This is confirmed by establishing the stationary nature of the real exchange rate.

Suppose that the real exchange rate s_t follows an AR(1) process:

$$s_t = \rho s_{t-1} + u_t, \quad u \sim NID(0, \sigma^2) \tag{6.1}$$

- if $|\rho| < 1$, the real exchange rate is covariance stationary or integrated of order zero, i.e. I(0).
- if $\rho = 1$, the real exchange rate contains a unit root.

The above definition can be tested by applying the Dickey-Fuller (1979, 1981) test. The following relations present this test in any form. Equation (6.4) is the less restricted case where both a constant and a linear trend are included. In contrast, equation (6.2) includes no exogenous terms. Finally, in equation (6.3) only a constant term is included.

$$\Delta s_t = (\rho - 1)s_{t-1} + u_t \tag{6.2}$$

$$\Delta s_t = \mu + (\rho - 1)s_{t-1} + u_t \tag{6.3}$$

$$\Delta s_t = \mu + \delta \cdot \tau + (\rho - 1)s_{t-1} + u_t \tag{6.4}$$

Dickey – Fuller (DF) test suffers from low power as in practice we often find strong evidence of autocorrelation in first differences. A treatment to this problem is given by the Augmented Dickey Fuller (ADF) test, which includes the term "$\sum_{j=1}^{l}\psi_j \Delta s_{t-j}$" in order to "soak up" autocorrelation. Thus, the above three processes become:

$$\Delta s_t = (\rho - 1)s_{t-1} + \sum_{j=1}^{l}\psi_j \Delta s_{t-j} + u_t \tag{6.5}$$

$$\Delta s_t = \mu + (\rho - 1)s_{t-1} + \sum_{j=1}^{l}\psi_j \Delta s_{t-j} + u_t \tag{6.6}$$

$$\Delta s_t = \mu + \delta \cdot \tau + (\rho - 1)s_{t-1} + \sum_{j=1}^{l}\psi_j \Delta s_{t-j} + u_t \tag{6.7}$$

The problem here is the selection of the appropriate lag length. If "l" is too small, the test will not be asymptotically valid and if "l" is too large, the test will suffer from low power. The Akaike Information Criterion (AIC) provides a useful test to manage this problem. The AIC statistic is given by: $AIC = N\log|\Sigma| + 2\Xi$, where N = number of observations, Ξ = total number of parameters, and $|\Sigma|$ stands for the determinant of the variance/covariance matrix of the residuals. We choose this lag length, which is associated with the lowest value of the above statistic.

In order to check the robustness of the ADF test we apply one more test, the Phillips-Perron (1988) test. This test has its origins in Phillips (1987) who proposes an alternative to DF test for testing the presence of unit root in time series. Phillips suggests accounting for autocorrelation through a non-parametric analysis. This procedure aims to capture the effect of autocorrelated errors on results. In the ADF test errors are iid ~ (0, σ^2), but Phillips' test relaxes this assumption. The disturbance term can be weakly dependent and heterogeneously distributed. The Phillips' proposal was extended by Phillips & Perron (1988) to two special cases. As in the ADF test, the PP test covers three alternative processes:

$$s_t = \rho s_{t-1} + u_t \tag{6.8}$$

$$s_t = \mu + \rho s_{t-1} + u_t \tag{6.9}$$

$$s_t = \mu + \delta(t - N/2) + \rho s_{t-1} + u_t \tag{6.10}$$

PP test computes test statistics suitable for testing the null hypothesis (ρ =1). For the most restricted case (no exogenous term) these statistics have the following form:

$$K(\rho) = N(\rho - 1) - \frac{1}{2}(R_{Nl}^2 - R_u^2)(N^{-2}\sum_{t=2}^{N} s_{t-1}^2)^{-1} \tag{6.11}$$

$$K[t(\rho)] = (R_u / R_{Nl})t(\rho) - \frac{1}{2}(R_{Nl}^2 - R_u^2)[R_{Nl}(N^{-2}\sum_{t=2}^{N} s_{t-1}^2)^{1/2}]^{-1} \tag{6.12}$$

where $R_u^2 = N^{-1}\sum_{t=1}^{N} \hat{u}_t^2$ and $R_{Nl}^2 = N^{-1}\sum_{t=1}^{N} \hat{u}_t^2 + 2N^{-1}\sum_{j=1}^{l}\sum_{t=j+1}^{N} \hat{u}_t \hat{u}_{t-j}$.

In both ADF and PP tests, the null hypothesis states that the real exchange rate contains a unit root (i.e. ρ =1). Rejection of the null states that the real exchange rate is mean reverting, indicating that PPP holds in the long run. Table 6.1 shows the statistics and the probabilities of accepting the unit root hypothesis. The two alternative tests provide quite similar results. This confirms robustness of our tests. The results show that in the case of Czech Republic both bilateral real exchange rates are non-stationary. Only the real effective exchange rate seems to be stationary (at 5% and 10% significance level according to ADF and PP tests, respectively). Even worse is the evidence for Hungary. There is strong evidence against stationarity in all types of real exchange rates.

Table 6.1: ADF and P-P Unit Root Tests

Real Exchange Rate	Augmented Dickey-Fuller		Phillips-Perron	
	Exogenous Term (lags)	Statistic (probability)	Exogenous Term (bandwidth)	Statistic (probability)
Czech/euro	none (1)	1.75 (0.98)	none (2)	2.13 (0.99)
Czech/US	none (1)	1.09 (0.92)	none (4)	1.35 (0.95)
Czech Effective	μ & τ (2)	-3.70 (0.02)	μ & τ (6)	-3.30 (0.06)
Hungary/euro	none (8)	1.06 (0.92)	none (8)	4.57 (1.000)
Hungary/US	none (5)	2.08 (0.99)	none (8)	4.01 (1.000)
Hungary Effective	μ & τ (1)	2.62 (0.99)	none (10)	3.02 (0.99)
Poland/euro	constant (2)	-2.94 (0.04)	constant (23)	-3.79 (0.04)
Poland/US	constant (5)	-3.33 (0.01)	constant (6)	-3.33 (0.01)
Poland Effective	constant (4)	-4.003 (0.001)	μ & τ (0)	-6.12 (0.000)
Slovak/euro	none (1)	3.25 (0.99)	none (2)	3.83 (1.000)
Slovak/US	none (1)	2.09 (0.99)	none (5)	2.32 (0.99)
Slovak Effective	μ & τ (1)	-4.90 (0.000)	μ & τ (10)	-3.76 (0.002)

*MacKinnon (1996) one-sided p-values.

On the other hand, there is strong evidence that real Polish zloty/US dollar and real zloty effective exchange rates are stationary. Weaker evidence, but sufficient, exists for the real Polish zloty/euro exchange rate (stationary at 5% and 10%). Similarly, non-stationarity is strongly rejected for the Slovak crown real effective exchange rate. In contrast, both bilateral Slovak real exchange rates are found to be non-stationary.

To sum up our findings, when it comes to bilateral exchange rates we found supporting evidence of PPP only in the case of Poland. In line with this, we found that the Polish zloty real effective exchange rate is stationary as well. Thus, the implied consistency with PPP - found in bilateral exchange rates – is incorporated in the real effective exchange rate, which illustrates the external relations of Polish economy with the rest of the world. However, this does not hold in the rest of our estimated exchange rates. While by examining the Slovak and the Czech real effective exchange rates we are able to confirm PPP as valid long run relationship, the bilateral real exchange rates are not mean reverting. Namely, it seems that those countries have more developed trade relations with other countries rather than US and EU. Finally, when Hungary is the case, PPP cannot be accepted in any exchange rate form.

6.3. Unit Root Test with Structural Breaks

However, conventional unit root tests may be inappropriate when structural breaks are present in real exchange rates. As chapter 2 reviews, the presence of structural breaks in real exchange rates is something not surprising, especially in the case of developing countries. For example, Kocenda (2001) finds that structural breaks in exchange rates are present in less stable economies. Under the presence of structural breaks conventional unit root tests are biased against rejecting non-stationarity. For this reason we apply Perron's (1997) unit root test, which allows the presence of structural breaks in real exchange rates. When it comes to the PPP hypothesis, we explicitly test the validity of the quasi PPP hypothesis, as it has been explained in chapter 2.

Hence, we test for quasi PPP in those exchange rates, which were found to be non-stationary. The methodology is based upon Perron (1997).[102] Perron (1989) presents three alternative break specification models. The first model, named "Innovational Outlier

[102] This test has its origins in Perron (1989). The present test differs from the Perron (1989) in the way the break point is determined. In Perron (1989), the break point was set exogenously. On the contrary, Perron (1997) test determines the break point endogenously.

Model 1", allows only a change in the intercept under both the null and the alternative hypotheses. It has the following form:

$$s_t = \mu + \alpha DU_t + \beta\tau + \delta D(T_b)_t + \rho s_{t-1} + \sum_{i=1}^{l} \psi_i \Delta s_{t-i} + u_t \qquad (6.13)$$

where μ is a constant, DU is a dummy variable which captures the effect on the real exchange rate when the break occurs, τ is a time trend and $D(T_b)$ is a dummy variable which captures the effect on the ρ-coefficient when the break occurs. The term $\sum_{i=1}^{l} \psi_i \Delta s_{t-i}$ is included in order to "soak up" autocorrelation. The second model, "Innovational Outlier Model 2", allows for both a change in the intercept and the slope at time T_b and has the following form:

$$s_t = \mu + \alpha DU_t + \beta\tau + \gamma DT_t + \delta D(T_b)_t + \rho s_{t-1} + \sum_{i=1}^{l} \psi_i \Delta s_{t-i} + u_t \qquad (6.14)$$

where the dummy DT captures the change in the slope. The third model, "Additive Outlier Model", allows a change in the slope but both segments of the trend function are joined at the time of break. Firstly, the series are de-trended by the regression (6.15), and finally the test is performed in regression (6.16):

$$s_t = \mu + \beta\tau + \gamma DT^* + \hat{s}_t \qquad (6.15)$$

$$\hat{s}_t = \rho \hat{s}_{t-1} + \sum_{i=1}^{l} \psi_i \Delta \hat{s}_{t-i} + u_t \qquad (6.16)$$

The main advantage of the Perron (1997) unit root test is that both the time of the break and the l-lag length are treated as unknown. These are identified endogenously to the system. The l-lag length is selected by the "general to specific" procedure instead of any information criteria, such as Akaike and Schwarz. When it comes to the selection of the break date, there are two alternative methods. First, T_b is selected as the value that minimizes the t-statistic for testing $\rho = 1$. Secondly, T_b is this value that minimizes either the t-statistic on the parameter associated with the change in the intercept (IO1 model), or the t-statistic on the change in the slope (IO2 & AO models). In the present study we perform this test by the Colletaz & Serranito (1998) procedure for RATS. While the l-lag length is selected by the general to specific approach, the break date is selected by minimizing the t_ρ - statistic. The following table resumes this test's output.

Table 6.2: Unit Root Test with Breaks

Real Exchange Rate	Model	Sample	Break Time	l	μ	α	β	γ	δ	ρ	t_ρ
Czech/euro	AO	1993:1-2003:8	1999:07	8	3.21	------	0.006	-0.009	---	0.70	-4.92**
					(564.92)		(70.32)	(-37.01)		(11.82)	
Czech/US	IO2	1993:1-2003:8	2000:05	1	0.36	0.30	9.40	-0.002	-0.09	0.87	-4.05
					(4.10)	(3.70)	(3.94)	(-3.87)	(3.67)	(29.16)	
Hungary/euro	IO2	1993:1-2003:8	1994:11	3	0.16	0.82	0.001	-0.001	-0.03	0.45	-4.005
					(4.28)	(5.65)	(3.92)	(-4.37)	(-2.18)	(91.46)	
Hungary/US	IO2	1993:1-2003:8	2000:05	1	0.24	0.28	0.001	-0.002	-0.07	0.93	-2.84
					(3.09)	(2.99)	(2.77)	(-3.15)	(-3.35)	(39.55)	
Hungary Effective	AO	1990:1-2004:6	2002:04	11	4.36	------	0.002	0.004	------	0.92	-2.72
					(483.39)		(23.21)	(4.48)		(35.17)	
Slovak/euro	IO1	1993:1-2003:8	1998:06	1	0.43	0.02	3.76	------	-0.03	0.87	-4.43
					(4.57)	(4.52)	(2.40)		(-2.17)	(31.83)	
Slovak/US	AO	1993:1-2003:8	2003:07	1	3.17	-------	0.008	-0.25	------	-0.92	-2.67
					(163.44)		(32.67)	(-2.33)		(33.23)	

** means rejection of the null at 5% significance level

The results show a significant change only in the constant for the Slovak/euro (1998:06), while a significant change in both the slope and the constant is found in Czech/US (2000:05), Hungary/euro (1994:11) and Hungary/US (2000:02) exchange rates. Finally, a significant change only in the slope is found for the Czech/euro (1999:07), Slovak/US (2003:07) and the Hungarian forint effective exchange rate (2003:04). The break points in Czech exchange rates are not linked with the exchange rate regime switch (1997:05). Furthermore, the break dates in the Hungarian exchange rates do not match with 1991:09, when the exchange rate was fixed to a central parity against euro. Finally, the exchange rate regime switch, for the case of Slovakia, does not affect the observed breaks because it happens after the end of the estimated period (2004).

When it comes to the unit root hypothesis test, non-stationarity can be rejected in a unique case. Thus, by allowing the presence of structural breaks we failed to confirm that the failure of rejecting the unit root hypothesis can be attributed to structural breaks. Quasi-PPP is accepted only between Czech Republic and EU. This implies that although the Czech/euro real exchange rate was stationary, a break (happened in 1999:07) caused a significant change in the slope, which was responsible for deriving misleading results.

In overall, we have found strong evidence that PPP holds for the case of Poland. Besides, PPP hypothesis is accepted among Czech Republic, EU and the rest of its trade partners apart from US. While real Slovak effective exchange rate is stationary, which implies that PPP holds, both bilateral real exchange rates are non-stationary. Finally, there is no sign that PPP is established between Hungary and any of its trade partners. But, can we make valid implications based only on unit root tests? As shown in chapter 2, many researchers argue that univariate unit root tests suffer from low power. They can increase power either by using longer span of data or by employing panel unit root tests. Therefore, it is necessary to re-test the PPP hypothesis before we state that this does not hold when non-stationary real exchange rates are found. Below, we apply a more powerful multivariate cointegration test, based on Johansen's (1988) technique.

6.4. Multivariate Cointegration Analysis

6.4.1. Methodology

At a first stage we need to establish a valid long run relationship among the nominal exchange rate, the domestic and the foreign price levels. This is confirmed by finding at least one cointegrating vector. This is the necessary condition for PPP to hold in the long run. If this is confirmed, the sufficient condition states that the domestic and the foreign CPI's should be proportional. Namely, the proportionality condition requires that if p=1, then p* = -1. If only the necessary condition holds, PPP is accepted in its weak form. Furthermore, if both the necessary and the sufficient conditions hold, strong form PPP is accepted.

For illustrational purposes, consider the following VAR model:

$$Z_t = \Pi_1 Z_{t-1} + \Pi_2 Z_{t-2} + ... + \Pi_l Z_{t-l} + u_t \tag{6.17}$$

where Z_t is the endogenous vector and the disturbance term (u_t) is iid~N(0, σ^2). Assuming that the vector of the endogenous variables contains nonstationary variables, we have to reform the VAR model to an error correction form:

$$\Delta Z_t = \Pi Z_{t-1} + \sum_{i=1}^{l-1} \Gamma_i \Delta Z_{t-i} + u_t \tag{6.18}$$

where $\Pi = \sum_{i=1}^{l} \Pi_i - I$ is a $v \times v$ matrix which determines the rank of cointegrating relationships and $\Gamma_i = -\sum_{j=i+1}^{l} \Pi_j$ is a $v \times v$ coefficient matrix. The VEC model implies that any stationary variable ΔZ_t is equal to a nonstationary variable, $Z_{t-i,}$ plus some lagged stationary variables, $\Gamma_i \Delta Z_{t-1,}$ and a stationary error term.

The rank of the matrix Π determines how many linear combinations of variables are I(0). In the case of cointegration, this matrix has those numbers of rank equal to the number of linear combinations of variables that are covariance stationary. If $rc = v$, then all variables included in Z_t are I(0) and if $rc = 0$ then, there is no cointegration and the dynamic system does not depend on the value of any variable. If $rc < v$, Π matrix can be written as the product of two $v \times rc$ matrices (Π = αβ′). α is the matrix of error correction coefficients and β is the matrix of cointegrating vectors such that $\beta' Z_t \sim I(0)$. Thus, under the I(1) hypothesis, the cointegrated VAR model is of the form:

$$\Delta Z_t = \alpha\beta' Z_{t-1} + \Gamma_1 \Delta Z_{t-1} + \ldots\ldots\ldots\ldots + \Gamma_{l-1} \Delta Z_{t-l+1} + u_t \tag{6.19}$$

where $\beta' Z_{t-1}$ is a $rc \times 1$ vector of stationary cointegrating relationships. The main advantage of the error correction model is that both differences and levels are included, which makes researchers able to estimate the short run as well as the long run adjustments. But, the determination of the cointegration rank is not a simple task. First of all, we have to select the appropriate model dictated by the data. To be specific, in reality we do not know a priori whether there are linear or quadratic trends in the model. Consider the general case:

$$\Delta Z_t = \alpha\beta' Z_{t-1} + \mu_0 + \mu_1 \tau + u_t \quad (6.20)$$

where $\mu_0 = \alpha\beta_0 + \gamma_0$ and $\mu_1 = \alpha\beta_1 + \gamma_1$.

According to Johansen (1995) there are five sub-models, which can be seen as special cases of the above. These models assume:

Case 1: $\mu_0 = 0, \mu_1 = 0$. In this case there is no deterministic component in the data.

Case 2: $\mu_1 = 0, \gamma_0 = 0, \beta_0 \neq 0$. In this case, there are no linear trends in the data. Instead, a constant term is included in the model.

Case 3: $\mu_1 = 0$. In this case, there are linear trends in the data, but there is no linear trend in the model.

Case 4: $\gamma_1 = 0, (\gamma_0, \beta_0, \beta_1) \neq 0$. In this case, there are linear but no quadratic trends in the data.

Case 5: trend and constant are unrestricted. In this case, we allow for linear and quadratic trends.

The choice of the cointegration rank is crucial as it can affect significantly the results derived from the reduced form equation. This decision is based on the well-known Johansen Cointegration test, which is a likelihood ratio test. Johansen (1995, theorem 6.1, p.93) shows that under the hypothesis that $H(rc) : \Pi = \alpha\beta'$, the maximum likelihood estimator of β can be found by solving the equation $\left|\lambda S_{11} - S_{10} S_{00}^{-1} S_{01}\right| = 0$, for the eigenvalues $1 > \hat{\lambda}_1 > ...... > \hat{\lambda}_v$ and the eigenvector $\hat{V} = (\hat{u}_1, ... \hat{u}_v)$. The likelihood ratio test statistic for testing the null [rank(Π)<rc] against the alternative [rank(Π)=v] is:

$Trace = -2\log Q[H(rc)\,|\,H(v)] = -N\sum_{i=rc+1}^{v}\log(1-\hat{\lambda}_i)$. The likelihood ratio test statistic for testing the null [rank(Π)=rc] against the alternative [rank(Π)=rc+1] is given by: $\lambda_{\max} = -2\log Q[H(rc)\,|\,H(rc+1)] = -N\log(1-\hat{\lambda}_{t+1})$. For both tests, we accept this number of cointegrating vectors when the null is accepted for the first time.

6.4.2. Results

We start with estimating 8 VAR models in levels, in which the endogenous vector includes 3 variables (nominal exchange rate, domestic CPI, foreign CPI). The appropriate lag length, which "soaks up" autocorrelation, is selected by the Akaike Information Criterion.[103]. Furthermore, we test the specification of each of the VAR models in order to confirm robustness. Specifically, we apply the Lagrange Multiplier test for autocorrelation, the White's heteroskedasticity test and the Jargue-Bera test for normality.

Table 6.3: Diagnostics

Model	Lags	LM test statistic (probability)	White test statistic (probability)	Jargue-Bera test statistic (probability)
Czech/euro	2	15.73 (0.07)	104.86 (0.06)	7862.3 (0.0000)
Czech/US	3	4.39 (0.88)	131.46 (0.22)	3900.2 (0.0000)
Hungary/euro	2	8.11 (0.52)	92.56 (0.24)	1187.1 (0.0000)
Hungary/US	3	6.73 (0.66)	153.8 (0.02)	504.36 (0.0000)
Poland/euro	7	8.88 (0.44)	257.2 (0.60)	14.19 (0.027)
Poland/US	9	3.14 (0.95)	325.3 (0.65)	50.31 (0.001)
Slovak/euro	1	7.44 (0.59)	68.7 (0.02)	952.25 (0.0000)
Slovak/US	2	3.26 (0.95)	107.4 (0.04)	746.91 (0.0000)

[103] This statistic is illustrated in section 6.2.

The residuals are not serially correlated as the no autocorrelation hypothesis is strongly accepted. When it comes to homoskedasticity, there is strong evidence in 5 out of the 8 models. In 3 models the homoskedasticity hypothesis is rejected at 10% and 5% significance levels, but it is accepted at 1%. Table 3 provides strong evidence against normality. In all cases, except Poland/euro model, there is strong evidence that errors are not normally distributed. However, this is not really a problem. Since our sample size is quite large, estimators are approximately Normal (Central Limit Theorem). Thus, the presence of Non-normality does not affect the validity of our estimation output.

As we have verified that our VAR models are not misspecified, we can estimate those models in first differences (VECM) to test for cointegration. As shown above, this is performed by the well-known Johansen Likelihood Ratio test. This test determines the rank of matrix Π (Π=αβ´) by computing two test statistics: the Trace and the max-eigenvalue test statistics. Based on the trace statistic we find evidence of cointegration in all the cases. These are shown in table 6.4[104]. The last two columns in table 3 represent the test of the proportionality condition. When the cointegrating vector is normalized, we assume that the domestic price is equal to one and the foreign price is equal to minus one. This can be tested by restricting the coefficients in the following way: (s, p, p*) = (1, 1, -1). This hypothesis cannot be accepted in two cases.

[104] The column cointegration sub-model corresponds to the cointegration specification. Sub-model 1 does not include any deterministic component in the data. In sub-model 2 there are no linear trends in the data but, a constant term is included to the model.

Table 6.4: Cointegration Test

Model	Cointegration Sub-model	Cointegrating Vectors	Likelihood Ratio Statistic	Probability
Czech/euro	2	1	0.72	0.69
Czech/US	2	1	0.72	0.69
Hungary/euro	1	1	32.67	0.00
Hungary/US	2	2	7.13	0.03
Poland/euro	2	2	7.88	0.02
Poland/US	1	2	2.46	0.29
Slovak/euro	1	1	16.10	0.00
Slovak/US	1	1	5.51	0.06

MacKinnon-Haug-Michelis (1999) p-values

In general, we have found evidence of cointegration in all models. However, the proportionality restriction holds in 6 out of the 8 models. This implies that for these 6 models strong-form PPP is confirmed, while for the rest two models, PPP holds only in its weak version. This happens in the Hungary/euro and Slovak/euro models. In contrast, the corresponding evidence (when US is the reference country) shows that strong-form PPP is accepted. This fact illustrates that, during the estimated period, there are stronger trade linkages between these two countries and US than between those and EU.

This points out the significant influence of the US economy on these countries, which are new EU members and potential members of EMU. Does this imply that, at this moment, these countries are more oriented towards US rather than EU? In addition, can we imply that, despite their entry into EU, these countries have currently better trade relations with US? In our point of view, the answer in both questions is negative. We cannot safely state that these countries have now more developed trade linkages with US. The above contradictory finding is because our data sample describes a past situation instead of the current one. Thus, we need more data (observations) in order to be able to capture the increase of trade linkages with EU and their consequences.

6.5. Concluding Remarks

In this chapter we test the validity of the Purchasing Power Parity hypothesis for four Central & Eastern European Countries – members of the European Union (Czech Republic, Hungary, Poland and Slovak Republic). Through the examination of this hypothesis we seek to define how well developed the trade relations between those countries and their trade partners are. In doing so, we employ three types of exchange rates: two bilateral national rates per US dollar and euro and a national effective exchange rate. While euro (US dollar) bilateral rates capture the trade linkages between the domestic county and EU (US), the effective exchange rate captures trade relations with the rest of their trade partners.

By applying two univariate unit root tests (ADF, PP) we found evidence of PPP for the cases of Czech Republic, Poland and Slovak Republic (between those and the rest of the world). When it comes to bipartite relations, we found evidence of PPP between Poland & US and Poland & euro area. Next, we performed Perron's (1997) unit root test, which allows the presence of a structural break (endogenously determined) in real exchange rates. Although we failed to find evidence of PPP between Czech & EU by conventional unit root tests, this test manages to accept quasi-PPP. However, in the rest of the real exchange rates, non-stationarity cannot be rejected although we have found significant break points. This implies that any failure to accept PPP cannot be attributed to structural breaks, apart from only one case. Furthermore, we failed to find evidence of

PPP between Slovakia & EU and Slovakia & US, even though we found that PPP holds between Slovakia and the rest of the world. This may mean that Slovakia has more developed trade relations with other trade partners rather than EU and US.

However, this contradictory finding may be due to the low power of univariate unit root tests. To confirm our estimation, we employ a more powerful cointegration test. We found evidence of strong-form PPP in 6 out of the 8 cases. Weak-form PPP is accepted between Hungary and EU and Slovakia and EU. The lack of strong-form PPP in these two cases could mean that Hungary and Slovakia are more oriented towards US rather than EU. But, carefully analyzing this output we state that we need more observations in order to see if this is really true.

To sum up, by comparing the results from unit root and multivariate cointegration tests, the latter provides stronger evidence of PPP. Moreover, any rejection of the PPP hypothesis cannot be charged to structural breaks. This happens in only one case. So, focused more on cointegration analysis we confirm PPP as a long run equilibrium baseline for these exchange rates per euro. This entails positive implications for the introduction of those countries into EMU. Furthermore, the fact that PPP holds between these countries and euro area implies that well-developed trade linkages exist between CEEC and EU. As a consequence, this study provides supportive evidence that the entry of those countries into EMU is going to be normal.

7. **Nonlinear Exchange Rate Adjustment in the Enlarged Euro Zone**

There are an adequate number of studies, which focus on the aftermaths of the EU enlargement as well as on the integration process of the candidate countries towards EMU. Hochreiter & Tavlas (2004) derive implications for the accession countries by examining the exchange rate policies undertaken by the Austrian and Greek monetary authorities. They argue that the exchange rate regime does matter if viewed as a transitional phase on the road to a monetary union. Thus, the participation into ERM II offers an essential framework for a continuation of policy adjustments as well as a test for the sustainability of the central rate vis-à-vis euro. Most of the empirical studies focus on the examination of the Maastricht convergence criteria and on the possibility of real convergence within the enlarged Europe. For example, Breuss et al (2004) find more arguments in favor of EMU enlargement than against it. The only problem they refer is the high level of debts in Poland and Malta. Frenkel & Nickel (2005) focus on CEECs and examine the speed of adjustment to demand and supply disturbances in these economies compared to France, Germany and Italy. In general, CEECs exhibit different adjustment process compared to EMU countries. But, some of the more advanced economies exhibit similar response to shocks with former EMU members. Similarly, Furceri & Karras (2006) perform a cost-benefit analysis of adopting euro by examining (a) the business cycle correlation between the candidate's economy and that of the euro zone and (b) the candidates' inflationary bias. Their results imply that most countries' business cycle is well synchronized with that of euro zone. In addition, price stability in candidate countries is stronger compared to some EMU members, such as Portugal and Greece.

However, there is little empirical work based on direct exchange rate analysis.[105] Beyond the exchange rate stability criterion, the exchange rate should not be significantly misaligned compared to its equilibrium rate. Purchasing Power Parity (PPP) can be seen as a preliminary measure of exchange rate equilibrium. Moreover, the validity of PPP hypothesis implies prices co-movement and evidence of well-developed trade relations between two countries. Although PPP hypothesis has been thoroughly examined for developed as well as for developing countries, the literature is not rich for the prospective EMU countries. Koedijk et al (2004), applying a Seemingly Unrelated Regression (SUR) methodology, examine PPP hypothesis within the euro area, in which candidate members are not included. By taking Deutche mark as a numeraire currency, they find evidence of PPP among EMU members. Recall that a more relevant study is this presented in chapter 6, in which we have found sufficient evidence of PPP for the case of four candidate countries (CEECs).

In the present chapter, by applying both a linear ADF test and a nonlinear SETAR model, we test the validity of PPP hypothesis for 10 prospective EMU members[106] for the period 1990 – 2006 as well as for the former EMU members for the period 1980 –

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[105] The majority of the existing studies focus on CEECs. For more information see Egert (2002), Egert & Lahreche-Revil (2003), Coudert-Couharde (2002) and Bulir & Smidkova (2005). These studies estimate equilibrium exchange rates through FEER, BEER and NATREX methodologies. To find more about these alternative methodologies, see chapter 5.

[106] Since January 2007, Slovenia is not any more a candidate EMU country. On January 1, 2007, Slovenia adopted the euro. However, in our analysis, Slovenia belongs to the cluster of candidate countries.

1998.[107] For both clusters of countries, euro is taken as the numeraire currency. Our study contributes on EMU enlargement literature by shedding light on the importance of PPP hypothesis for the accessing process of the candidate countries towards EMU. A number of important implications can be derived from this analysis, such as exchange rate misalignment and the degree of trade openness within the enlarged euro area. Furthermore, the estimation of the nonlinear SETAR model gives us the opportunity to estimate the true reverting process towards equilibrium. Finally, by comparing the evidence of the candidate countries with this of the current EMU members we generate implications for the progress of economic integration in Europe and expectations for the candidates' assessing process towards EMU.

The structure of the remainder of the chapter is as follows. Section 7.1 presents theoretical notes on nonlinearities in real exchange rates. Section 7.2 illustrates the econometric methodology, including the properties of the nonlinear SETAR model and the Hansen's Linearity test. The data set is described in section 7.3 while section 7.4 presents our empirical findings. Section 7.5 discusses the implications derived from our analysis and section 7.6 summarizes and concludes.

7.1. Theoretical Notes on Nonlinear Adjustment in Real Exchange Rates

Real exchange rates may exhibit a nonlinear behaviour because of heterogeneity of opinion in forex markets (Kilian & Taylor, 2003), heterogeneous Central Banks' objectives (Taylor, 2004) and differences in technology and preferences (O'Connell & Wei, 2002). Heckscher (1916) first introduced the idea that real exchange rate

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[107] The estimation period ranges form country to country due to data availability. In addition, the data set for Greece is extended for two years (1980-2000) because of its delayed entry into EMU.

adjustments may be nonlinear because of transaction costs. These developments have direct effects on goods arbitrage and on the validity of the PPP hypothesis. The Law of One Price (LOP) states that homogeneous goods across countries should have the same price once they are converted to a common currency. The intuition behind the LOP is that goods arbitrage can equalize prices across countries. However, in the presence of transaction costs, goods arbitrage becomes unprofitable. As a consequence, PPP may not hold in the long run because of transaction costs, which include transportation cost, tariff and non-tariff barriers. Though, tariff barriers decline over time, other trade frictions (non-tariff barriers) cause significant nonlinearities in the adjustment process of real exchange rates.[108]

Theoretical models (O'Connell, 1998a, Obstfeld & Taylor, 1997), studying nonlinear real exchange rate adjustment, show that transaction costs create a band for the real exchange rate within which goods arbitrage is unprofitable (i.e. the marginal cost of arbitrage exceeds the marginal benefit). This is called as proportional or "iceberg" transaction cost. O'Connell (1998a) shows that if a good is shipped from one country to another, a fraction ϕ melts on the way, so only the $(1-\phi)$ of the good arrives. If P is the good's price, the profit from shipping the good from one country to another is $(1-\phi)-P$, which is positive for $P<1-\phi$. The profit from shipping the good in the opposite direction is $(1-\phi)P-1$, which is positive for $P>1/(1-\phi)$. Thus, the "band of no arbitrage" is $(1-\phi)<P<1/(1-\phi)$.

[108] Knetter (1994) shows that non-tariff barriers can successfully explain the deviations of the Deutche mark/Japanese yen real exchange rate from PPP equilibrium.

Empirically, researchers model nonlinearities in real exchange rates through the estimation of models that allow the autoregressive parameter to vary. These models are known as Threshold Autoregressive (TAR) models. In line with theoretical studies, TAR models allow for a transaction costs band within which no adjustment takes place. As a consequence, real exchange rate adjustment is non-stationary. Outside the band, arbitrage becomes profitable and the process becomes stationary autoregressive. That means that PPP deviations will be persistent if they are small and mean reverting if they are large.[109]

7.2. Econometric Methodology

7.2.1. Linear Unit Root Test

In a linear framework the real exchange rate is modeled by $s_t = e_t - p_t + p_t^*$, where e_t is the nominal exchange rate, p_t is the domestic price level and p_t^* stands for the foreign price level (all expressed in natural logarithms). Purchasing Power Parity hypothesis is valid if the real exchange rate follows a mean reverting process. Namely, once the real exchange rate describes deviations from the Law of One Price (LOP), the stationary nature of the real exchange rate means that deviations from LOP are transitory. If linearity is the case, a simple unit root test, based on ADF test, is described by equation (6.7):

$$\Delta s_t = \mu + \delta \cdot \tau + (\rho - 1)s_{t-1} + \sum_{j=1}^{l} \psi_j \Delta s_{t-j} + u_t \qquad (6.7)$$

The null hypothesis of non-stationarity ($H_0 : \rho = 1$) is tested against the alternative that the real exchange rate is stationary ($H_1 : \rho < 1$). Following the specification of the ADF test, half-life is estimated by $\ln(0.5)/\ln(\hat{\rho}+1)$. However, Taylor et al (2001) show that if

[109] An analytical review on these models and their empirical findings is presented in chapter 2, subsection 2.1.4.

real exchange rates exhibit a nonlinear behaviour, conventional linear unit root tests are biased against rejecting non-stationarity. This means that even if non-stationarity is rejected, the estimated half-life implies slower mean reversion than the actual one.

7.2.2. Self-Exciting Threshold Autoregressive (SETAR) model

Consider a two-regime Threshold Autoregressive (TAR) model, originally presented by Tong (1983), of the following form:

$$s_t = \begin{cases} \sum_{i=1}^{l} \alpha_i \cdot s_{t-i} + u_t, & if \quad s_{t-d} \leq \vartheta \\ \vartheta \cdot (1-\beta_1) + \beta_1 \cdot s_{t-1} + \sum_{i=2}^{l} \beta_i \cdot s_{t-i} + u_t, & if \quad s_{t-d} > \vartheta \end{cases} \tag{7.1}$$

where ϑ is the threshold parameter, s_{t-d} is the threshold variable and d is the delay parameter. Furthermore, the error is assumed to be normally and identically distributed with zero mean [$u_t \sim NID(0,\sigma^2)$]. The above TAR (l, q, d) model,[110] in which the threshold variable is the lagged dependent variable, is named as Self-Exciting TAR model.

Assuming symmetry in the bottom and upper regimes, the SETAR (l, 1, d) model can be written as a symmetric three-regime SETAR (l, 2, d) of the form:

[110] The specification of this model is as follows: l is the lag length of the autoregressive process, q is the number of thresholds and d is the delay parameter.

$$\Delta s_t = \begin{cases} (\beta_1 - 1)\cdot(s_{t-1} - \vartheta) + \sum_{i=2}^{l} \beta_i \cdot (s_{t-i} - \vartheta)\cdot \ell(s_{t-d} > \vartheta) \\ + \left[\sum_{i=1}^{l} \alpha_i \cdot \Delta s_{t-i} \right] \cdot \ell(|s_{t-d}| \le \vartheta) \\ +(\beta_1 - 1)\cdot(s_{t-1} + \vartheta) + \sum_{i=2}^{l} \beta_i \cdot (s_{t-i} + \vartheta)\cdot \ell(s_{t-d} < -\vartheta) + u_t \end{cases} \quad (7.2)$$

Based on theoretical assumptions, the process is non-stationary inside the band $[-\vartheta, \vartheta]$. Namely, the real exchange rate is not mean reverting if $|s_{t-d}| \le \vartheta$. Once $s_{t-d} > \vartheta$ or $s_{t-d} < -\vartheta$, the process becomes mean reverting. The above SETAR (p, 2, d) model is written as follows:

$$\Delta s_t = A_t(\vartheta, d)' \cdot B + u_t \quad (7.3)$$

where $A_t(\vartheta, d)'$ is a 1x3 vector that illustrates the behaviour of the real exchange rate in the three regimes, and B is a 3x1 vector which involves the autoregressive parameters to be estimated.[111] Hansen (1996, 1997), assuming that the error term is $NID(0, \sigma^2)$, shows that the Ordinary Least Square (OLS) is an appropriate estimation procedure.[112] Applying sequential conditional least squares, for any combination of ϑ and d, the OLS estimator of B is given by:

[111] Following the theoretical assumptions, we would restrict the process to be non-stationary inside the band. However, we estimate the autoregressive parameters of the outer regime as well as these of the inner regime to test robustness of the theoretical model.

[112] Under this condition, OLS is equivalent to Maximum Likelihood Estimation.

$$\hat{B}(\vartheta,d)=\left(\sum_{t=1}^{n}A_t(\vartheta,d)\cdot A_t(\vartheta,d)'\right)^{-1}\cdot\left(\sum_{t=1}^{n}A_t(\vartheta,d)\cdot\Delta s_t\right) \tag{7.4}$$

with residuals:

$$\hat{u}_t(\vartheta,d)=\Delta s_t-A_t(\vartheta,d)'\cdot\hat{B}(\vartheta,d) \tag{7.5}$$

and residual variance:

$$\hat{\sigma}^2(\vartheta,d)=\frac{1}{n}\cdot\sum_{t=1}^{n}\hat{u}_t(\vartheta,d)^2 \tag{7.6}$$

The OLS estimators of ϑ and d are those that minimize the residual variance:

$$(\hat{\vartheta},\hat{d})=\underset{\vartheta\in\Theta,d\in D}{\arg\min}\ \hat{\sigma}^2(\vartheta,d) \tag{7.7}$$

where $\Theta=[\varphi,(1-\varphi)]$ and $D=[1,\overline{d}]$. Hansen (1999) shows that by writing the residual variance as $\hat{\sigma}^2(\vartheta,d)=\hat{\sigma}^2-f^2(\vartheta,d)$, the minimization problem of (7.7) is equivalent to a maximization problem of $f^2(\vartheta,d)$. In this problem the search of values of the threshold variable lies between the φ-th and $(1-\varphi)$-th fractiles of the data. However, if l and n are large, this process is too long. So, we restrict the search to N-values of ϑ lying on a grid between φ-th and $(1-\varphi)$-th fractiles of S_{t-d}. If $\overline{d}=l$, the procedure runs a search over $l\cdot N$ pairs of (ϑ,d). Once the optimal combination of the threshold variable and the delay parameter has been selected,[113] the OLS estimator of B is given by $\hat{B}(\hat{\vartheta},\hat{d})$ with residual variance $\hat{\sigma}^2(\hat{\vartheta},\hat{d})$.

[113] Hansen (1997) argues that as D is discrete, the estimator of the delay parameter is superconsistent.

7.2.3. Hansen's Linearity Test

Here we investigate whether real exchange rates exhibit a nonlinear behaviour. In other words, we test the null hypothesis of a true linear AR(l) model against a nonlinear SETAR (l, q, d). Conventional tests of the null of a linear AR model against the TAR alternative have nonstandard distributions because of the presence of nuisance parameters under the null (Davies, 1977). Hansen (1996) shows that the nuisance parameters in a SETAR model are the threshold parameter (ϑ) and the delay parameter (d). Davies (1977) suggests an alternative LM test statistic, which has an unknown distribution under the null. Furthermore, Luukkonen et al (1988) propose the replacement of the transition function with its third-order Taylor approximation when testing linearity against a STAR model.

Hansen (1996, 1997) proposes a bootstrap test procedure, which replicates the asymptotic distribution of the F statistic. The null of the linear AR(l) model against the SETAR(l, q, d) is tested by:

$$F_n(\vartheta, d) = n \cdot \left(\frac{\widetilde{\sigma}^2 - \hat{\sigma}^2(\vartheta, d)}{\hat{\sigma}^2(\vartheta, d)} \right) \tag{7.8}$$

where $\widetilde{\sigma}^2$ is the residual variance of the linear AR(l) model (i.e. restricted), and $\hat{\sigma}^2(\vartheta, d)$ is the residual variance of the SETAR(l, q, d) model (i.e. unrestricted). Hansen (1999) shows that the F-statistic in (7.8) can be written as:

$$F_n(\vartheta, d) = n \cdot \left(\frac{f^2(\vartheta, d)}{\widetilde{\sigma}^2 - f^2(\vartheta, d)} \right) \tag{7.9}$$

which is an increasing function of $f^2(\vartheta, d)$. He shows that the appropriate F-statistic is described by:

$$F_n = \max_{\vartheta \in \Theta, d \in D} F_n(\vartheta, d) \tag{7.10}$$

Since ϑ and d are not identified under the null, the F_n statistic does not have an asymptotic X^2 distribution.[114] Hansen (1997) shows that the asymptotic distribution of the F_n statistic can be approximated by the following bootstrap procedure.[115] Let ω_t^*, $t = 1,.....n$ be NID(0, 1) random draws and set $s_t^* = \omega_t^*$. Then, using the observations s_{t-i}, $t = 1,.....n$, & $i = 1,....l$, we get the residual variances of the null and the alternative to estimate the following F statistic:

$$F_n^*(\vartheta, d) = n \cdot \left(\frac{\hat{\sigma}^{*2} - \hat{\sigma}^{*2}(\vartheta, d)}{\hat{\sigma}^{*2}(\vartheta, d)} \right) \tag{7.11}$$

The bootstrap approximation to the asymptotic p-value of the test is performed by counting the percentage of bootstrap samples for which $F_n^*(\vartheta, d)$ exceeds the observed $F_n(\vartheta, d)$.

The above analysis assumes that the error term is homoskedastic. Nonetheless, in the presence of conditional heteroskedasticity, the derived distributions provide misleading p-values. Hansen (1999) has presented appropriate algorithms to calculate heteroskedastic asymptotic and bootstrap distributions. If it is not clear whether the error term is homoskedastic or not, Hansen (1999) suggests the use of bootstrap distribution

[114] F-statistic has an asymptotic X^2 distribution for any fixed (ϑ, d). However, once we allow for $N \cdot l$ pairs of (ϑ, d), we get $N \cdot l$ asymptotic X^2 random variables.

[115] Hansen (1999) presents two similar replication procedures to derive robust p-values. The first one yields the asymptotic distribution of the test statistic, while the other one yields the bootstrap distribution. The empirical findings in Hansen (1999) show that there is no significant difference between the asymptotic and the bootstrap p-values.

which allows for conditional heteroskedasticity. Moreover, if homoskedasticity is clearly rejected, the most appropriate p-values are those of the heteroskedastic bootstrap distribution. On the other hand, if the evidence of homoskedasticity is strong, homoskedastic bootstrap p-values are more credible. Though, to confirm robustness in our study, we present all types of p-values (i.e. A-Hm, B-Hm, A-Ht, B-Ht).

7.3. Data

The dataset involves monthly observations on nominal exchange rates per euro, euro area's Consumer Price Index (CPI) and domestic CPI for two clusters of countries. National exchange rates per euro are taken from Eurostat (ECU rates before 1999), while Consumer Price Indices are taken from IFS statistical database (base year 1995 = 100). Once all variables are expressed in natural logarithms, real exchange rates per euro are computed as the difference of the price differential (domestic CPI minus euro area's CPI) from the nominal exchange rate.

The first group of countries corresponds to 10 new members of the EU and candidates for EMU membership (so after called candidate countries), while the second group covers the current EMU members (henceforth, called EMU countries), except Germany and Ireland. This is because of data unavailability on German and Irish CPI's. The examined period for the candidate countries is similarly subject to data availability. So, the estimation for Cyprus, Hungary, Poland and Malta covers the period 1990:1-2006:7, for Latvia and Slovenia the estimated period is 1992:1-2006:7, for Czech Republic, Slovak Republic and Estonia is 1993:1-2006:7 and for Lithuania is 1993:6-2006:7. Accordingly, the under-examination period for the EMU countries is this before adopting the single currency. Hence, Austria, Belgium, Finland, France, Italy, Luxembourg, The Netherlands, Portugal and Spain are examined for the period 1980:1-1998:12, while for Greece the estimated period is extended for 2 years, i.e. 1980:1-2000:12.

7.4 Empirical Analysis

7.4.1. Linear Unit Root Test

Real exchange rates measure the degree of deviations from the Law of One Price (LOP). Given that testing for PPP makes sense only in its relative form, PPP hypothesis will be valid if the stationary nature of the real exchange rate is confirmed. As a preliminary test, we apply a linear unit root test (ADF) on real exchange rates per euro. The results, shown in Table 7.1, are quite satisfactory for the candidate countries.

Table 7.1: Augmented Dickey-Fuller test (Candidate countries)

	Exogenous Term	Lags	Statistic	Probability
Cyprus	Constant	0	-6.14	0.0000
Czech Republic	Constant	1	-6.31	0.0000
Estonia	Constant	9	-5.53	0.0000
Hungary	Constant	1	-3.73	0.0042
Latvia	None	1	-3.95	0.0001
Lithuania	Constant	1	-4.66	0.0002
Malta	None	0	-11.78	0.0000
Poland	Constant	1	-2.71	0.0734
Slovak Republic	Constant	1	-6.29	0.0000
Slovenia	Constant	1	-4.15	0.0010

MacKinnon (1996) one-sided p-values

The real Polish zloty/euro is stationary at 10% significance level, while the evidence of stationarity is stronger for the remaining real exchange rates. The evidence of a mean reverting process makes us look for the speed of the adjustment process. In other words, we need to know how fast are deviations from LOP diminishing. The estimated autoregressive parameters imply the half-life estimates, shown in Table 7.5.

Half-life periods are measured in months. For example, PPP deviations of the Cyprus pound/euro exchange rate will damp out by 50% in about 69 months (i.e. 6 years approximately). The highest half-life is found, as expected, in the Polish zloty/euro exchange rate. On the other hand, the lowest half-life is found in Lithuania and Slovak Republic (about 43 months or 3.5 years). However, these values are high and imply a slow mean reverting process.

Table 7.2: Augmented Dickey-Fuller test (EMU countries)

	Exogenous Term	Lags	Statistic	Probability
Austria	Constant	3	1.40	0.9990
Belgium	None	6	-0.78	0.3746
Finland	None	10	-1.50	0.1237
France	None	3	-1.91	0.0541
Italy	None	3	2.98	0.9993
Luxembourg	None	6	-0.78	0.3778
Netherlands	None	3	-2.35	0.0185
Portugal	None	6	0.60	0.8439
Spain	None	6	0.40	0.7971
Greece	None	12	0.21	0.7462

MacKinnon (1996) one-sided p-values

When it comes to the EMU countries, table 7.2 shows that all real exchange rates are found to be nonstationary, except the French franc/euro and the Dutch guilder/euro rates, which are covariance stationary at 5% and 1% significance levels, respectively. This means that the calculation of the half-life is impossible unless meaningless. Suggestively, half-life estimates for the French franc/euro and Dutch guilder/euro rates imply mean reversion in about 36 years, which is tremendously high.

7.4.2. Testing Linear AR against SETAR

The implied slow mean reversion may be misleading due to the presence of nonlinearities in the adjustment process. This is because conventional linear unit root tests are biased against rejecting non-stationarity (i.e. the autoregressive coefficient is biased upward) when the process in nonlinear. So, we test whether a linear AR model or instead a nonlinear TAR model characterizes the adjustment process. In other words, we test the significance of the threshold effect on the process. Since ϑ and d are not identified under the null, the F-statistic (expression 7.10) does not have an asymptotic X^2 distribution. To overcome this problem, we perform asymptotic and bootstrap procedures as described in Hansen (1997, 1999). In fact, the F-statistic can have an asymptotic X^2 distribution for any fixed combination of ϑ and d. But, the maximization problem of (7.10) requires a search over $l \cdot N$ pairs of (ϑ,d). For our model, we set p = 6 and we restrict N = 100. This yields to $6 \cdot 100 = 600$ pairs of (ϑ,d).

The asymptotic as well as the bootstrap distributions are calculated using 1,000 random draws (replications) which yield the F*-statistics of (7.11). Then, p-values are computed as the percentage of bootstrap values for which the F*-statistic (7.11) exceeds the observed F-statistic (7.10). However, the above p-values are consistent only if the error term is homoskedastic. Hence, we perform an F-type Heteroskedasticity test, which has a standard X^2 distribution [$X^2(6)_{,5\%} = 12.6$, $X^2(6)_{,1\%} = 16.8$]. The Heteroskedasticity test is carried out through an OLS regression of the squared OLS residual on the squares of the lagged real exchange rate, and on dummy variables indicating the regime. Once homoskedasticity is rejected, asymptotically robust to heteroskedasticity distributions are calculated and robust p-values are considered.

The results imply that errors are homoskedastic in the cases of Cyprus, Lithuania, Poland and Slovenia, while for the remaining 6 countries this hypothesis is rejected. The computed p-values, shown in Table 7.3, show that linearity can be accepted only in the cases of Estonia and Hungary.[116] For the rest of the countries, the evidence that real exchange rates exhibit nonlinear behaviour is stronger when asymptotic p-values are considered. An exception is the case of Malta and Slovenia, for which bootstrap p-values provide stronger evidence of nonlinear adjustment. When it comes to the group of EMU countries (Table 7.4), homoskedasticity is rejected only for the case of Italy. In addition, the Italian lira/euro exchange rate is the only one, which follows a linear adjustment process. For the remaining EMU countries, linearity has been rejected.

7.4.3. SETAR Estimation

The evidence from the linearity test implies the estimation of a nonlinear TAR model for all real exchange rates, apart from the Hungarian forint/euro, Estonian kroon/euro and Italian lira/euro, which were found to follow a linear autoregressive process. For the

[116] Homoskedastic p-values imply that both real exchange rates are characterized by nonlinearities. However, the evidence of heteroskedasticity makes homoskedastic p-values inappropriate.

remaining real exchange rates a symmetric 3-regime SETAR (6, 2, d) model is estimated. In all cases, the lag length l is set equal to 6, [117] while the number of thresholds is equal to 2. The symmetric 3-regime SETAR model is equivalent to a 2-regime SETAR if we assume that the process is symmetric in the outer regimes. Thus, if ϑ is the single threshold (2-regime), the double threshold (3-regime) is described by $(-\vartheta, \vartheta)$. The delay parameter (d) illustrates the possibility that market participants react with a delay on PPP deviations. The minimum delay order is equal to 1 and the maximum delay order is set equal to 6, i.e. $\bar{d} = l = 6$ and $d \in D(1,6)$.

Table 7.3: SETAR estimation: Candidate Countries

	d	ϑ	α	β	**A-Hm**	**B-Hm**	**A-Ht**	**B-Ht**	**F-Het**	**RRV**
Cyprus	1	-3.980	0.983	0.942	0.00	0.12	0.04	0.03	15.126	0.751
Czech Republic	4	2.940	0.985	0.978	0.00	0.00	0.03	0.09	23.45	0.715
Estonia	1	2.120	--------	--------	0.00	0.05	0.12	0.10	42.51	0.740
Hungary	1	2.150	--------	--------	0.00	0.17	0.12	0.19	21.93	0.759
Latvia	4	-2.460	1.008	0.919	0.00	0.00	0.04	0.02	27.28	0.535
Lithuania	5	1.300	0.979	0.940	0.04	0.47	0.18	0.58	3.18	0.865
Malta	4	-4.450	0.978	0.946	0.00	0.06	0.14	0.01	24.50	0.655
Poland	5	-1.790	0.985	0.889	0.00	0.18	0.16	0.17	15.20	0.789
Slovak Republic	1	3.150	0.962	0.904	0.00	0.02	0.05	0.01	23.26	0.711
Slovenia	1	2.630	1.242	0.988	0.09	0.66	0.13	0.58	12.59	0.897

[117] In selecting the lag length of the autoregressive process, we faced two important restrictions. Firstly, we had to ensure that errors are not serially correlated and secondly we should achieve high power of the linearity test. A high lag length can soak up autocorrelation. However, Sarno et al (2004) find that the power of the test is higher the lower the lag length of the SETAR model.

Notes: 1. d is the delay parameter.
2. ϑ is the threshold parameter.
3. α stands for the inner root, calculated as the sum of the estimated autoregressive parameters of the inner regime: $\alpha = \sum_{i=1}^{l} \alpha_i$.
4. β stands for the outer root, calculated as the sum of the estimated autoregressive parameters of the outer regime: $\beta = \sum_{i=1}^{l} \beta_i$.
5. A-Hm and B-Hm are homoskedastic asymptotic and bootstrap p-values, respectively. A-Ht and B-Ht stand for heteroskedastic p-values.
6. F-Het is the F-type heteroskedasticity test that follows a standard X^2 distribution.
7. RRV is the ratio of the residual variance of the nonlinear SETAR(6, 2, d) model to the residual variance of the linear AR(6) model.

Moreover, the search of values of the threshold parameter lies between the 10% and 90% fractiles of the data and since $l = 6$ and N is restricted to 100, the search of the combination of (ϑ, d) entails $6 \cdot 100 = 600$ pairs of (ϑ, d). A final restriction on the estimation of the SETAR model requires 10% minimum percentage of observations per regime.

Tables 7.3 & 7.4 present the results of the SETAR estimation. For the cluster of candidate countries, the most frequently observed delay order is 1, which indicates that market participants react to deviations with a delay of one month. The highest delay parameter (d=5) is observed in the cases of Lithuania and Poland. On average, reaction is delayed by about 3 months when candidate countries are examined. Likewise, the most frequent delay order is 1 month for the cluster of EMU countries. The longest delay, 5 months, is observed in Finland and Portugal. On average, delay is slightly lower in EMU countries. Market agents react with a delay of about 2 months.

Once the delay and the threshold parameters have been determined, we can estimate the autoregressive parameters inside and outside the band. In other words, we do not restrict the process to follow a random walk inside the band $(-\vartheta < s_{t-d} < \vartheta)$. So, we allow the true process to show if theoretical assumptions are valid. For all candidate countries, apart form Latvia and Slovenia, the inner root implies a reverting process. However, the process is faster outside the band. This means that the theoretical assumptions are partly satisfied. Namely, the random walk hypothesis has been established in only two cases but the hypothesis of faster mean reversion when deviations are large has been confirmed in each case. Hence, we focus on the outer root of the SETAR model, which indicates the degree of nonlinear reversion towards the thresholds.

Table 7.4: SETAR estimation: EMU Countries

	d	ϑ	α	β	A-Hm	B-Hm	A-Ht	B-Ht	F-Het	RRV
Austria	1	-0.920	1.045	1.011	0.00	0.06	0.28	0.11	6.23	0.796
Belgium	1	0.140	1.010	1.047	0.00	0.05	0.29	0.08	9.46	0.796
Finland	5	-1.920	1.004	0.955	0.00	0.05	0.22	0.04	8.67	0.804
France	1	-1.690	1.648	1.011	0.00	0.09	0.32	0.20	5.30	0.813
Greece	1	1.970	1.014	1.002	0.00	0.10	0.27	0.09	7.60	0.858
Italy	2	3.700	-------	-------	0.00	0.07	0.26	0.22	20.03	0.822
Luxembourg	1	0.140	1.010	1.049	0.00	0.05	0.28	0.07	10.36	0.789
Netherlands	1	-2.720	1.050	1.010	0.00	0.07	0.27	0.13	4.35	0.797
Portugal	5	1.550	0.999	0.955	0.00	0.09	0.27	0.06	3.04	0.819
Spain	1	1.240	1.009	1.020	0.00	0.04	0.22	0.26	12.11	0.783

Notes: 1. d is the delay parameter.

2. ϑ is the threshold parameter.

3. α stands for the inner root, calculated as the sum of the estimated autoregressive parameters of the inner regime: $\alpha = \sum_{i=1}^{l} \alpha_i$.

4. β stands for the outer root, calculated as the sum of the estimated autoregressive parameters of the outer regime: $\beta = \sum_{i=1}^{l} \beta_i$.

5.A-Hm and B-Hm are homoskedastic asymptotic and bootstrap p-values, respectively. A-Ht and B-Ht stand for heteroskedastic p-values.

6.F-Het is the F-type heteroskedasticity test that follows a standard X^2 distribution.

7.RRV is the ratio of the residual variance of the nonlinear SETAR(6, 2, d) model to the residual variance of the linear AR(6) model.

Compared to the linear model, the implied adjustment process is much faster when a nonlinear model is estimated. This is clearly shown by the estimated half-life (Table 7.5). On average, the linear model implies reduction of deviations by 50% in about 62 months (5 years), while the corresponding period, implied by the nonlinear process, is about 18 months (1.5 years). Specifically, the linear half-life estimate for the Cyprus pound/euro rate is about 69 months and the nonlinear half-life is just 12 months.

Table 7.5: Half-life estimates

	$\hat{\rho}$	**Linear Half-Life**	$\hat{\beta}$	**Nonlinear Half-life**
Cyprus	-0.010	68.968	0.942	11.577
Czech Republic	-0.015	45.862	0.978	31.212
Estonia	-0.013	52.971	-------	--------
Hungary	-0.008	86.296	-------	--------
Latvia	-0.012	57.415	0.919	8.171
Lithuania	-0.016	42.974	0.940	11.286
Malta	-0.012	57.415	0.946	12.433
Poland	-0.006	115.178	0.889	5.918
Slovak Republic	-0.016	42.974	0.904	6.897
Slovenia	-0.011	62.666	0.988	55.828

Notes: 1. Linear Half-life = $\ln(0.5)/\ln(\hat{\rho}+1)$.

2. Nonlinear Half-life = $\ln(0.5)/\ln(\hat{\beta})$.

3. $\hat{\rho}$ is the estimated autoregressive parameter of the linear ADF test.

4. $\hat{\beta}$ is the estimated outer root of the nonlinear SETAR model.

The fastest process is this observed in Polish zloty/euro rate, in which the nonlinear half-life estimate is 6 months. The fact that, under the linear model, this process was the slowest mean reverting process (half-life = 115 months) makes this finding even more impressive. On the other hand, the slowest nonlinear reverting process is observed in the case of Slovenia, half-life = 56 months (4.5 years). But, it is faster than the implied from the linear model (half-life = 63 months or 5.5 years).

For the EMU countries the process is found to be non-reverting in both regimes, except two real exchange rates, even by allowing for nonlinearities. Specifically, a reverting process in the outer regime is observed in the Finnish markka/euro and Portuguese escudo/euro rates. Suggestively, half-life estimates imply convergence to equilibrium by one half in about 15 months, while in the linear ADF test we failed to confirm stationarity. Therefore, there is evidence of a band of inaction and adjustment outside the band - when goods arbitrage becomes profitable - in only two cases. For the rest of the real exchange rates, although the hypothesis of random walk in the inner regime has been confirmed, we failed to find evidence of reversion when deviations are large. As a matter of fact, theoretical assumptions are in part satisfied.

Finally, as a robustness check we estimated the ratio of the residual variance of the nonlinear SETAR(6, 2, d) model to the residual variance of the linear AR(6) model. For all real exchange rates the ratio (RRV) is less than 1, which means that the variance of the error term of the estimated SETAR model is smaller that this of the alternative AR model. This evidence supports the estimation of the nonlinear SETAR model contrary to the linear AR. Furthermore, the evidence of heteroskedastic errors in some SETAR models does not affect our estimation since robust to heteroskedasticity p-values have been applied.

7.5. Implications

A number of important implications can be derived from the above analysis. First of all, it is obvious that the adjustment process of real exchange rates in Europe is nonlinear. For both clusters of countries, specifically in 17 out of the 20 real exchange rates, linearity has been rejected. This is the critical point for our analysis. The estimation of nonlinear SETAR models provides interesting implications regarding PPP hypothesis, trade relationships and economic integration for both clusters of countries.

Candidate Countries

A linear unit root test (ADF) implies stationary real exchange rates but the half-life estimates show that the adjustment process is slow. On the other hand, nonlinear (SETAR) half-life estimates imply much faster reverting processes. This discordance is due to the presence of nonlinearities in the adjustment process. Recall that linear autoregressive parameters are biased upwards in case of nonlinearities. The outer root of the SETAR model implies average half-life of 1.5 years. Rogoff (1996) describes the PPP puzzle as the evidence of slow convergence to PPP equilibrium (3 to 5 years). That means that our estimation resolves this puzzle at least for the examined exchange rates. As a consequence, the validity of PPP hypothesis in the long run assigns evidence of exchange rate equilibrium. Given that a stable and not highly misaligned currency is important for the EMU membership, our findings provide supporting evidence for their assessing process to the euro zone. On the other hand, the evidence of nonlinearities –

because of transaction costs – might be warning signs of future problems for the integration process with former EMU members. In our point of view, once tariff and non-tariff barriers decline over time, these problems seem not to be significant and prohibitive for the entry of those countries into EMU.

<u>EMU Countries</u>

Non-stationarity for real exchange rates, even by allowing for nonlinearities, cannot be rejected for EMU countries apart from Finland and Portugal, whose real rates per euro were found to follow a reverting process towards the threshold band. This finding looks quite strange for the integrated Europe. However, we can avoid misleading implications if we carefully analyze these findings. First, we have to take into account that the estimated period does not cover the most recent period. In contrast, it covers the period between the post Bretton-Woods era and the pre euro zone era (1980-1998). During this period Europe has been experienced a number of important economic developments. An important step, which was preparing the economic environment for the monetary union, was the creation of the European Monetary System (EMS) in March 1979. Besides to the EMS, the European Community (EC) decided the creation of the Exchange Rate Mechanism (ERM) and the European Currency Unit (ECU), which both were parts of the EMS. Nonetheless, it is not clear whether the EMS succeed in achieving monetary and exchange rate stability. It is indicant that, during the period 1979 – 1993, EMS central rates were realigned seventeen times. The ERM crisis of 1992 broadened the exchange rate fluctuation band from 2.25% to 15%.[118] This development marked the collapse of the Exchange Rate Mechanism.

So, our findings do not imply that Europe is not currently integrated as much as required. In addition, we do not argue that at the moment price differentials in EMU members are persistent and higher compared to the candidate countries. What we can argue is that Europe is now more integrated than two decades before. This means that trade relationships are well developed and tariff barriers have been eliminated for the EU members. However, current trade relationships as well as price differentials in the euro zone are out of the scope of this study. The reason we examined PPP hypothesis among EMU members was to compare the adjustment process of the euro real exchange rate in candidate countries with the corresponding process of EMU countries for the time-period they were candidates for entering the euro zone.

7.6. Concluding Remarks

In this study we examined the adjustment process of real exchange rates per euro in the enlarged European Union concerning the validity of PPP hypothesis and the degree of trade rigidities in Europe. We focused on the candidate EMU countries, while an analogous analysis on current EMU countries is undertaken to justify that integration in Europe is currently more mature than two decades ago. The evidence of nonlinearities in real exchange rates dictates the estimation of a nonlinear SETAR model. The results imply that nonlinearities bias linear half-life estimates (5 years on average), implying slower reversion than the actual one. So, SETAR half-life estimates (1.5 years on

[118] Only Germany and the Netherlands retained the 2.25% fluctuation band. To find more about theoretical explanations of the ERM crisis, see Ozkan & Sutherland (1995).

average) imply a faster reverting process towards PPP equilibrium. As a matter of fact, PPP puzzle seems to be resolved for the examined countries.

To sum up, this study implies that candidate countries follow a normal integration process towards the European Union. Furthermore, the evidence in favor of PPP hypothesis and the fast reverting process of the real exchange rate imply an equilibrium process for their currencies, which is a crucial requirement for adopting the single European currency. It is worth notable that Slovenia, which recently adopted euro, has the slowest reverting process towards PPP equilibrium among the candidate countries. The slow convergence may be attributed to the applied exchange rate policy vis-à-vis euro before and after its membership into ERM II. Prior to the participation in ERM II, Slovenia adopted an exchange rate policy against euro, which was gradually depreciating the tolar vis-à-vis euro. Since joining ERM II, the tolar/euro exchange rate was very close to the central rate indicating very low volatility. As a consequence, the implied intervention in the foreign exchange market prevents the nominal exchange rate to reflect movements in relative prices.[119] This is in line with Sideris (2007), who states that omission of interventions bias negatively the evidence in favor of PPP equilibrium. Finally, the evidence of nonlinear adjustment – mainly due to transaction costs – is not really a problem. We just need to consider that these countries, as full members of the EU, face no more any tariff barriers while non-tariff barriers decline over time.

[119] Given the calculation of the real exchange rate, as described in 7.3, this is equivalent to slow mean reversion of the real exchange rate.

8. Estimating the Equilibrium Effective Exchange Rate for Potential EMU Members

In this chapter, we attempt to examine the likelihood of emergence of significant exchange rate fluctuations in the future for the candidate EMU countries. In doing so, we estimate the equilibrium rate of the nominal effective exchange rate for Poland, Hungary, Slovakia and Malta. If significant misalignments persist, the behaviour of nominal exchange rate is expected to be unstable in its attempt to find its equilibrium rate. If the actual rate is undervalued, the domestic economy is expected to face inflationary pressures. On the other hand, if the actual rate is overvalued, the domestic economy is expected to loose competitiveness. Each of the above scenarios will cause significant problems to the process of joining EMU. In contrast, an observed exchange rate close to its equilibrium implies that we do not expect large fluctuations in the future, excluding unanticipated shocks.

This study's contribution to the EMU enlargement empirical literature is the way of examining exchange rate stability. In other words, our approach accepts the exchange rate convergence criterion as a necessary but not sufficient condition for successful entry into EMU.[120] The intuition is that if the exchange rate is currently stable but significantly away from its equilibrium rate, the exchange rate is likely to be unstable in the future. Moreover, a high misalignment rate can cause macroeconomic instability as well,

[120] In this study we examine nominal effective exchange rates. However, the Maastricht exchange rate criterion does not deal with effective exchange rates. A successful entry into EMU requires stability in the bilateral rate against euro. We argue that an unstable effective exchange rate may entail instability in bilateral exchange rates, such as this against euro.

because the unstable exchange rate will affect negatively the macroeconomic indicators. Therefore, the stability of euro will not be weakened if the examined exchange rates are not significantly misaligned. The estimation of the equilibrium effective exchange rate is undertaken by the Behavioural Equilibrium Exchange Rate (BEER) and the Permanent Equilibrium Exchange Rate (PEER) approaches, presented by Clark & MacDonald (1998) and MacDonald (2000). The next section presents an overview of the economies considered. The model that is going to be estimated is presented in section 8.2, while section 8.3 outlines the applied econometric methodology. Section 8.4 describes the data and section 8.5 provides the empirical findings. A concluding section summarizes and evaluates the derived output.

8.1 Economies' Overview

8.1.1. Poland

Poland can be characterized as a transition country, which since 1989 performed significant economic and political reforms. The social economic system has been replaced by the free market system and the centralized economy is now operating by the law of the free market. In comparison with other Central European Countries this transition was smooth for the Polish economy, which has the lowest decrease in GDP growth and the shortest period of economic recession during this transformation. Since 1/5/2004 Poland is a member of the European Union. This is a consequence of the aim of the Polish authorities to integrate with EU. An indicator of this movement is the rapid growth of trade between Poland and the other EU members.

The Polish economy is a dynamic economy with promising macroeconomic indicators. The inflation rate is stable, the public deficit is low but above 3% (about 5% of GDP in 2003), the public debt is lower than 60% of GDP and the GDP growth is increasing over time. But, the path of the GDP growth is not monotonic. From 2000 to 2001, GDP growth decreased by 3%, while economic growth is increasing after 2001. GDP increased by 1.4% in 2002 compared to the previous year and by 5.3% in 2004 compared to 2003. This growth is not because of labour productivity. Actually, it is thanks to production means productivity. Moreover, this is a result of the rapid growth in the industry sector and the stable growth in the services sector.

Despite the satisfactory GDP growth, other macroeconomic variables are performing poor. The per capita GDP corresponds only to 42.7% of the average of the EU (15 members). The most important problem of the Polish economy is the high unemployment rate. The conditions in the labour market became even worse the last years. The employment rate decreases and the unemployment rate increases significantly. At the end of 2003, the unemployment rate was 19.3%. Some of the reasons of this phenomenon are: the high labour cost, mismatched supply and demand in the labour market, dramatic increase of persons in productive age, and other rigidities in the labour market. It is remarkable that although domestic GDP is rapidly growing, this economic growth does not produce a proportional decrease in unemployment. In contrast, unemployment rate follows an upward trend. This fact amplifies the view of low competitiveness of the Polish economy.

The main object of the National Bank of Poland (NBP)[121] is the reduction of inflation and its maintenance in low levels, i.e. price stability. The overall target for the period 1999-2003 was the reduction of the inflation at a rate below to 4% by the end of 2003. In 2000, the inflation target was set to 5.4%-6.8%, however due to supply shocks the inflation target was not fulfilled. The aim for 2001 was set to 6%-8%, while a more tight monetary policy was required. This policy had to be applied under the environment of high economic deficit (current account deficit) and insufficient fiscal policy, which was not consistent with the monetary policy strategy. In 2002, monetary policy aims to drive inflation to 5% within a band +/- 1%. In 2004, the target was set to 2.5% +/- 1%. This year Polish economy faced large price shocks, especially in food and oil prices. The increased inflation rate was not a result of a rise in domestic demand. Hence, the reaction of the monetary authorities was not a simple task. They had to apply this policy, which would not affect economic activity and domestic demand. But, the main obstacle in applying the monetary policy was public finance imbalances (public debt, e.t.c.). This fact reveals the necessity of the public finance reform. Therefore, the goal of low and stable inflation rate requires a fiscal policy consistent with the applied monetary policy. As a consequence, the monetary council sets again the target of 2.5% in 2005 and remarks that it has to be matched as soon as possible. However, inflation rate was 3% in April (2005), indicating that the inflation target is not yet matched (Inflation Report May 2005). Similarly, the long-term interest rate was higher than the implied by the relevant

[121] The National Bank of Poland, which is responsible for the formulation of the applied monetary policy in Poland, is the Central Bank of Poland. The operation of the NBP is not compatible with the requirements on central bank independence. The co-operation of the NBP with the state authorities and especially the obligation of the Bank to ensure the approval of the Council of Ministers, on its annual accounts, imply that the NBP is highly dependent on the government.

convergence criterion. From 2001, interest rates follow a downward path. This was in line with the concurrent decreasing trend of the inflation rate. Despite this declining trend, the long term interest rate was 2.9% in August 2004, slightly above the reference rate (2.4%).

As mentioned above, the public finance situation of Poland is relatively stable. In 2003, the government deficit as a ratio of GDP was 3.9% (above 3%) and the public debt ratio was 45.4% of the GDP (below 60%). Both ratios have increased compared to 2002, by 0.3% the deficit ratio and by 4.3% the public debt ratio. The former is expected to fall to 1.5% by 2007, while the latter is expected to jump to 52.3% at the same time. Despite this upward trend, both fiscal criteria are expected to be fulfilled by the end of 2007. A final task for the Polish authorities is the introduction of the Polish zloty into ERM II at least two years before joining EMU. The main requirement is the stability of the bilateral exchange rate of zloty against euro, which means that the exchange rate should deviate no more than 15%. This is a crucial restriction for the Polish zloty, as during 2002-2004 the Polish zloty deviated by about 19% against euro.

8.1.2. Hungary

Hungary has moved from the transition period of 1990s to the present period of EU challenges. Since May 2004, Hungary is one of the ten new member-states of the European Union. This is a result of a successful reform program, including privatization, markets' liberalization e.t.c. Nowadays, Hungarian economy differs significantly from its previous status. It has become a growing economy and one of the most open economies in Europe. In the first quarter of 2005 the GDP growth rate was increased by 2.9%

relative to 2004. However, Hungary's growth rate is one of the lowest in the Central & Eastern Europe. It is worth notable that the sector, which enforces more the growth rate, is the services sector. When it comes to its unemployment rate, this was declined from 1998 until 2001. From then, unemployment was relatively stable, following a slightly upward trend. This trend became more rapid in 2004, exceeding the 7%.

As a full member of EU, the next task is the membership into EMU and the adoption of the single European currency. This requires the introduction of the Hungarian forint into ERM II at least two years before adopting euro. The Hungarian exchange rate regime was a crawling peg one, which in September 2001 was replaced by a fixed central parity against euro. The central parity is 282.36 forints per euro and the fluctuation band is +/- 15%.

Despite the successful change of the Hungarian economy, the performance in main economic indicators shows that convergence is not a simple task. The convergence program of the government (November 2004) sets 2010 as the target date for adopting euro, but the criteria are not yet matched. The inflation criterion must be met during 2007-2008, the fiscal criteria by 2008 and the introduction into ERM II by the end of 2007.

The main objective of the monetary policy, applied by the Magyar Nemzeti Bank[122] (MNB), is price stability. In the last five years inflation follows a downward path, but it cannot be argued that price stability is achieved. In the middle of 1990s the inflation rate

[122] The Magyar Namzeti Bank (MNB), member of the European System of Central Banks, is the central bank of Hungary. MNB is characterized as independent, but according to the ECB, its independence requires a number of changes in the way that is operating. For example, the provision of the right to the Ministry of Justice to review its draft legal acts is not consistent with the Treaty and Statute requirements on central bank independence.

was 30% and at the end of the same decade this rate became less than 10%. In 2002 the monetary authorities set the inflation target for 2004 to 3.5% +/- 1%. This target was updated twice until 2005. The inflation target was set to 4% for 2005 and 3.5% +/- 1% for 2006. At the end of 2004 the inflation rate was 5.5%, which was higher than the targeted rate[123].

Hungary has had the highest long-term interest rate since 2003 among the new EU states. From 2001 to 2003, the Hungarian interest rate followed a declining path, but from 2003 the long-term interest rate increased rapidly. This declined again during 2004-2005 but it is still above the level required by the convergence criterion.

When it comes to the fiscal position of Hungary, this has the highest government deficit of all the new EU members and the highest public debt in the CEEC of EU. The government deficit criterion was met in 2000, but from then the deficit as ratio of the GDP increased until 2002. The period 2002-2004 was a decreasing period for the deficit ratio, but from 2004 it is rising again, being higher than 3%. Public debt ratio was from 2000 lower than 60% of the GDP, but in 2004 was slightly above the targeted ratio.

8.1.3. Slovak Republic

After the creation of the Slovak Republic (1993), the Slovak Economy has been significantly improved. From its previous status of a political instability and an inefficient industrial sector, now Slovakia's economy has become an attractive foreign investment one. Gross Domestic Product growth rate has increased by 4.3% after just a year of the independence of Slovakia. This growth was stable and continuous all over the time. Especially, the growth rate increased by 4.5% in 2003 and by 5.5% in 2004. This implies

[123] The Magyar Namzeti Bank argues that the high inflation rate was a result of the increased indirect tax.

that Slovak economy has been transformed to a fast growing one. During the period 1993-1994, Slovak inflation rate was decreased from 20% to 12%. In December 2004, the inflation rate was 5.9%, which was lower by 3.4% compared to the previous year. The unemployment rate in 2004 was 14.3%, which was by 0.9% lower compared to 2003. This rate could be much lower if the supply of labour force had not increased so much. So, the small percentage change in the unemployment rate does not mean inability of creating new jobs.

The exchange rate of the Slovak crown is determined under a floating exchange rate regime since 2004. The National Bank of Slovakia (NBS)[124], which is responsible for monetary and exchange rate issues, may intervene in the foreign exchange market to manage the fluctuations in the exchange rate. Since the main mission of the Slovak Republic is the adoption of the single European currency, the Slovak crown must participate ERM II at least two years before adopting euro with no large fluctuations against euro (no more than +/- 15%). Although NBS convergence program set the first half of 2006 as the possible period of introduction into ERM II, Slovak Republic has been a member of ERM II since May 2005 (1 euro = 35.4424 SKK).

However, the inflation criterion is not yet matched. The average of the Harmonized Index of Consumer Price (HICP) for 2004 was 8.7%, which is higher than the reference rate. It is estimated that at the end of 2007 the domestic inflation rate will be 2.5%, while

[124] The National Bank of Slovakia, member of the European System of Central Banks, is from 1993 the Central Bank of Slovakia. The NBS is responsible for the formulation of the applied monetary policy and the exchange rate developments. When it comes to the independent status of the NBS, the right of the Slovak parliament to obligate the NBS to modify its annual report is not compatible with the Treaty and Statute requirements on central bank independence.

the reference rate will be 2.8%.[125] On the other hand, the long-term interest rate criterion is fulfilled, as for 2004 this rate was 5.13% and the reference rate was 6.46%. This was a result of the action of the NBS to decrease its key interest rate, from 2001 to 2004, by 3.5%.

Similarly, the public debt criterion is fulfilled. Actually, the public debt as a ratio of GDP had not ever exceeded the reference rate (i.e. 60%). This is a result of the dynamic growth of the GDP and the applied stabilization program in public finances. It is expected that the public debt ratio will not exceed the 46% of GDP. On the contrary, the other public finance criterion is not yet fulfilled. The government deficit as ratio of GDP is higher than 3%. In 2002 this rate was 5.7%, while in 2003 declined to 3.5%. This criterion will be matched only by completing the necessary structural reforms in the Slovak economy.

8.1.4. Malta

Malta has a small open economy, which is basically dependent on international trade and tourism. Malta produces only the 20% of its consumption on food and the main activity of the Maltese economy is motivated by its tourism industry and the industrial sectors of electronics and pharmaceutical products. The contribution of tourism in GDP was about 35% in 2000. Although, the Maltese economic authorities have introduced a reform policy, which incorporates a gradual economic liberalization, the Maltese economy is still highly regulated by the public sector.

In 2000 the economy has grown by 4.3% compared to 1999. Because of this increased growth rate, the unemployment rate decreased by 4.4% to a rate, which was the

[125] This is a National Bank of Slovakia's prediction.

lowest in the last three years. However, this high growth rate did not last the next years. Indeed, the Maltese economy grows only by 1.5% in 2004, while an updated estimation implies an even lower growth rate (i.e. 1%). It is worth notable that in 2001 and 2003 the GDP did not rise, but instead decreased by 1.7% and 1.8%, respectively. So, the positive growth rate in 2004, as well as in the first quarter of 2005, is synonymous to economic recovery. What caused this insufficient development was the increase of imports, which offset the rise of exports. Furthermore, in the first quarter of 2005, exports declined by 14%, compared to the same period of the previous year. This was caused by the decrease in the manufacturing sector's exports, especially in the electronics sector. The recent economic recovery had positive effects on the labour market and the unemployment rate. In the first quarter of 2005, the labour force increased by 0.2% compared to 2004 (first quarter) and the unemployment rate fell from 7.2% in 2004 to 6.7% in 2005.

Moving to the analysis of the convergence criteria, the average of the Harmonized Index of Consumer Price (HICP), between 1997 and 2003, was 3%. From 2003 to 2004, the same index fell to 2.6%, which is slightly above the reference ratio (2.4%). In the first quarter of 2005, the HICP was 2.7%, while in the second quarter this rate became 2.5%. Hence, in terms of the inflation rate criterion, price stability is not yet matched but the Maltese inflation rate is very close to the reference rate. However, the ECB's view is that this criterion will be achieved if the Maltese monetary authorities apply a monetary policy consistent with capital flows liberalization. On the other hand, the interest rate criterion seems to be already satisfied. During 2003-2004 the long-term interest rate was 4.7%, which is stably below the reference ratio (6.4%). This was the consequence of the

Central Bank of Malta's[126] policy to decrease, from 2001, its key interest rate. Moreover, a development, which helped this policy, was the relatively low inflation rate.

Despite the satisfactory performance in the monetary-based criteria, both the government deficit and the public debt criteria are not yet matched. In 2003, the government deficit ratio was 9.7% and the public debt ratio was 71.1%. Comparing these rates with those of 2002, we observe that the former increased by 3.8% and the latter by 8.4%. By enlarging the reference period (1996-2003), we find the impressive fact that the public debt as a ratio of GDP increased by 31.1%. The government deficit ratio fell to 5.2% in 2004, while the CBM expects this to fall more (3.7%) during 2005. This rate must be 1.4% by the end of 2007. Instead, the public debt ratio increased in 2004 (73.2%), while the CBM's expectations imply a rate of 70.4% by the end of 2007.

Finally, since May 2005 Malta is a member of ERM II. This is a pre-entry to EMU step, in which the Maltese lira should be relatively stable against euro for at least two years before adopting euro (i.e. the Maltese lira/euro exchange rate should not deviate by more than +/- 15%). Now, the Maltese lira is pegged to euro (with a central parity 0.4293 against it), instead of the previous regime in which the Maltese lira was pegged to a basket of three currencies (i.e. euro, US dollar and UK pound).

[126] The Central Bank of Malta (CBM) is responsible for the formulation of the monetary policy in Malta. The main objective of monetary policy is the achievement and the maintenance of price stability and in general the formulation of that policy consistent with a sustainable development and the introduction of Malta into EMU. The operation of the CBM is fully compatible with the Treaty and Statute requirements on central bank independence.

8.2. Theoretical Framework

The equilibrium exchange rate is estimated through the Behavioural Equilibrium Exchange Rate and the Permanent Equilibrium Exchange Rate approaches, presented by Clark & MacDonald (1998) and MacDonald (2000). As chapter 4 illustrates, the BEER approach involves the direct econometric analysis of the behaviour of the exchange rate. It estimates exchange rate misalignments in accordance with the deviations of the actual exchange rate from the estimated value, derived from the relationship between the exchange rate and the macroeconomic fundamentals. The BEER is estimated when the actual values of the fundamentals are replaced by their sustainable (or smoothed) values.

On the other hand, the Permanent Equilibrium Exchange Rate (PEER) can be seen as a special approach of the BEER. According to BEER approach, the exchange rate is a function of transitory and permanent factors. The PEER approach differs in the way that the equilibrium exchange rate is a function of variables that have only persistent effect on it. So, we decompose the fundamentals into permanent and transitory components. These permanent series are allowed to determine the equilibrium exchange rate.

8.2.1. The Model

These approaches do not actually rely on any theoretical model and the equilibrium rate is designated by the long run behaviour of the macroeconomic variables. It is based on the estimation of a reduced-form equation that explains the behaviour of the effective exchange rate. However, this does not mean that any theoretical concept is not required.

Following Clark & MacDonald (1998) and MacDonald (2000), the theoretical framework is based on the UIP condition[127]:

$$i_t = i_t{}^* + \Delta E_t[neer_{t+1}] \tag{8.1}$$

where i and i* are domestic and world nominal interest rates, respectively

neer is nominal effective exchange rate

E is conditional expectations

Solving for neer, equation (8.1) becomes:

$$neer_t = E_t[neer_{t+1}] - (i_t - i_t{}^*) \tag{8.2}$$

Now, focusing on the forward-looking dynamics of the exchange rate we get:

$$neer_t = E_t[neer_{t+1}] + E_t E_{t+1}[neer_{t+2}] - (i_t - i_t{}^*) \tag{8.3}$$

Using the Law of Iterated Expectations ($E_t[.] = E_t E_{t+1}[.]$), we have:

$$neer_t = E_t[neer_{t+1}] + E_t[neer_{t+2}] - (i_t - i_t{}^*) \tag{8.4}$$

$$neer_t = E_t[neer_{t+1}] + E_t[neer_{t+2}] + ... + E_t[neer_{t+n}] - (i_t - i_t{}^*) \tag{8.5}$$

$$neer_t = \sum_{n=0}^{\infty} E_t[neer_{t+n}] - (i_t - i_t^*) \tag{8.6}$$

Equation (8.6) shows that the current value of the nominal effective exchange rate depends on the nominal interest rate differential plus expectations on future values of the exchange rate. The expected exchange rate, which can be shown as the long run component of the nominal exchange rate, depends on the expected values of the macroeconomic fundamentals. Thus, besides to the interest rate differential, the long run

[127] Clark & MacDonald (1998) and MacDonald (2000) assume that in the UIP condition a risk premium is included. This has a time-varying component, which reflects the relative supply of domestic to foreign debt. Here, due to lack of data availability we assume that the risk premium is equal to zero.

effective exchange rate depends on the macroeconomic fundamentals. The vector of the macroeconomic fundamentals includes the domestic terms of trade, the domestic foreign asset holding, and the world oil price. So, the vector is of the form: {tot, fa, op). Hence, Long run Effective Exchange Rate is given by the following expression:

$$LEER = f(i - i^*, tot, fa, op) \tag{8.7}$$

8.2.2. Expected Signs of the Variables

Interest Rate Differential: Based on the monetary model of exchange rate determination (as it is shown in chapter 3) a positive interest rate differential is going to depreciate the domestic currency (i.e. the effective exchange rate decreases). This can be seen by the UIP condition (equation 8.1) and the nominal effective exchange rate equation (8.6). On the other hand, accepting the Portfolio Balance model of exchange rate determination (Branson, 1977), presented in chapter 3 as well, a higher domestic interest rate relative to the world level is going to appreciate the effective exchange rate. This is because the increased interest rate will cause capital inflows and the capital account will be improved. Therefore, the expected sign of the interest rate differential is ambiguous.

Terms of Trade: A higher increase in the value of exports relative to the value of imports (i.e. an increase in the terms of trade) is expected to affect the effective exchange rate in two different ways. The first effect, called as substitution effect, improves the current account and as a consequence the exchange rate appreciates. On the other hand, the income effect means that the improved current account will increase domestic income. So, domestic consumption of imported goods increases and as a result the domestic currency has to depreciate to restore equilibrium. The final effect depends on the relative price elasticity of demand for imports and exports. However the first effect comes before the latter. Therefore, we expect that the direct effect of a positive terms of trade shock on the exchange rate will be the appreciation of the effective exchange rate.

Domestic Holding of Foreign Assets: This variable reflects the external position of the domestic country. It is actually the amount of assets that domestic agents hold abroad and affects the domestic monetary base. Following the portfolio balance model of exchange rate determination (Branson, 1977), an increase in foreign assets can decrease the effective exchange rate. In other words, if domestic agents prefer foreign than domestic assets, there is a capital outflow responsible for the capital account deficit. This is going to depreciate the domestic currency. Therefore, the expected sign of foreign asset holding is negative.

Oil Price: This variable is included in the model to capture a kind of external shock. Usually an increasing trend in the world level of oil price produces negative consequences in any economy. However, the magnitude of the effect depends on the type of the economy. More oil dependent economies face serious problems and the terms of trade deteriorate. As a result, the exchange rate depreciates. On the other hand, less oil dependent economies are able to handle this shock and to avoid the depreciation trend. For example, an increase in oil price will affect less the US. In contrast, this shock will affect heavily developing countries. To sum up, the sign of this variable for the domestic country is expected negative (i.e. effective exchange rate depreciation).

8.2.3. Equilibrium Exchange Rates

The Behavioural Equilibrium Exchange Rate is estimated by getting the smoothed values of the fundamentals. If the long run exchange rate is estimated by the following reduced form equation:

$$LEER_t = a_1(i_t - i_t*) + a_2 tot_t + a_3 fa_t + a_4 op_t \tag{8.8}$$

Then, the BEER estimate is shown below (the symbol "~"denotes a smoothed series):

$$BEER = a_1(\tilde{i}_t - \tilde{i}_t*) + a_2 t\tilde{o}t_t + a_3 f\tilde{a}_t + a_4 o\tilde{p}_t \tag{8.9}$$

The Permanent Equilibrium Exchange Rate is estimated by using, in the regression equation, only the permanent series of the fundamentals. This is shown below (p denotes to a permanent series):

$$PEER = a_1(i_t - i_t*)^p + a_2 tot_t{}^p + a_3 fa_t{}^p + a_4 op_t{}^p \tag{8.10}$$

Comparing these rates with the actual exchange rate we find how the latter deviates from the former. In other words, this yields to the total misalignment rate, which shows whether the exchange rate is overvalued or undervalued. If e > beer or peer, the domestic currency is said to be overvalued and if e < beer or peer, the domestic currency is undervalued.

8.3. Econometric Methodology

Estimation is undertaken by the well-known Johansen's (1988, 1991) cointegration technique.[128] Under this framework, the acceptance of at least one cointegrating vector

[128] This methodology has been thoroughly illustrated in chapter 6. Hence, to avoid any repetitive descriptions, the Johansen cointegration technique is not presented here. The reader should refer to section 6.4.1

means that the effective exchange rate and the vector of fundamentals form a valid long run relationship. If this is the case, the fundamentals can explain the exchange rate fluctuation. Then, by normalising the cointegrating vector, we can derive the reduced form equation, which explains the relationship between the exchange rate and the fundamentals. This equation will be valid if the weak exogeneity assumption is accepted. This means that all the variables included in the exchange rate equation are weakly exogenous to the exchange rate. In other words, any misalignment from the equilibrium rate must be absorbed only by exchange rate movements. The derived reduced-form equation computes the Long run Effective Exchange Rate. This rate is the anchor for estimating the Behavioural Equilibrium Exchange Rate (BEER) and the Permanent Equilibrium Exchange Rate (PEER).

8.3.1. Behavioural Equilibrium Exchange Rate

According to the BEER methodology, the reduced-form equation, implied by the cointegrating vector, is called as current equilibrium exchange rate. The total equilibrium is derived by estimating the long run (sustainable) values of the fundamentals. These values are estimated by the Hodrick-Prescott (1997) filter. This is a smoothing method, which estimates the long run components of the variables. Suppose that we want to estimate the smoothed series q of the variable y. Then, the H-P filter chooses q subject to λ to minimize the following expression:

$$\sum_{t=1}^{N}(y_t - q_t)^2 + \lambda \sum_{t=2}^{N-1}[(q_{t+1} - q_t) - (q_t - q_{t-1})]^2 \tag{8.11}$$

However, a lot of criticism has been applied to the statistical properties of the H-P filter. One of the discussed issues is its poor performance near the end of the sample. Mise et.

al. (2005), Kaiser & Maravall (1999) and Baxter and King (1999) provide evidence of suboptimal H-P filtering at the endpoints. To avoid this inconsistency, following Kaiser and Maravall (1999), we estimate optimal ARIMA forecasts and we apply the H-P filter to the extended series.[129] As noted by Mise et. al. (2005), this approach minimizes revision standard deviation.

So, we substitute these smoothed series to the reduced form equation to get the Behavioural Equilibrium Exchange Rate. Finally, by subtracting the BEER from the actual nominal effective exchange rate we estimate the total misalignment rate.

8.3.2. Permanent Equilibrium Exchange Rate

According to the PEER methodology, the equilibrium exchange rate is a function of the permanent elements of the fundamentals. The decomposition into permanent and transitory components is undertaken by Gonzalo & Granger (1995) methodology[130]. Based on the information derived from the cointegration analysis, the elements of the vector x_t can be decomposed into permanent-transitory components by the following expression:

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[129] The forecasts are estimated by an ARIMA, using the TRAMO-SEATS program of Gomez and Maravall provided by Eviews 5.

[130] As it is already shown in chapter 4, other studies use the Univariate and Multivariate Beveridge-Nelson (1995) Decomposition. This methodology entails the direct decomposition of the exchange rate into permanent and transitory components. A different way of measuring PEERs is that proposed by Clarida & Gali (1994). They decompose the real exchange rate into supply, demand and nominal components and test the importance of these variables to the exchange rate. In other words, they create three shocks (supply, demand and nominal) and examine the effects of each shock to the variability of the exchange rate. Moreover, two of the studies, which have applied the Gonlzalo & Granger approach to estimate PEERs are Clark & MacDonald (2000) and Hoffmann & MacDonald (2000).

$$x_t = A_1 a_{\perp}^{'} x_t + A_2 \beta' x_t \tag{8.12}$$

where $A_1 = \beta_{\perp}(a_{\perp}^{'}\beta_{\perp})^{-1}$ and $A_2 = a(\beta' a)^{-1}$. The first term of equation (8.12) gives the permanent component of x_t, while the second term stands for the transitory component. Granger & Gonzalo show that if the vector x_t is of reduced rank rc, x_t can be explained by (v-rc) I(1) variables, where v is the number of the parameters included in the vector x_t and rc is the cointegration rank. In other words, we expect (v-rc) common trends.

Johansen (1995) shows that the Beta and Alpha orthogonal components are given by (8.13) and (8.14), respectively:

$$\beta_{\perp} = S_{11}(b_{rc+1},.....b_v) \tag{8.13}$$

$$a_{\perp} = S_{00}^{-1} S_{01}(b_{rc+1},...,b_v) \tag{8.14}$$

where $S_{ij} = N^{-1} R_i R_j', \qquad i, j = 0,\ 1.$

The Alpha orthogonal matrix shows which of the variables affect more the common trends. The A_1 and A_2 matrices show how the variables are affected by the common trends. The product of the transposed Alpha orthogonal matrix with the A_1 matrix yields to a new matrix. The diagonal of this matrix displays the permanent rate of each variable.

Similarly, the product of the transposed beta matrix by the A_2 matrix yields to the transitory components matrix. The diagonal shows the transitory rate of each variable. The permanent series of the fundamentals are derived by multiplying the rates in the diagonal by the actual series of the fundamentals. Then, the permanent series of the fundamentals substitute their actual values, in the reduced-form equation, to derive the Permanent Equilibrium Exchange Rate (PEER).

8.4. Data Description

The data set includes quarterly observations for four new EU-members. These countries are Poland (1993:1-2004:1), Hungary (1990:1-2004:1), Slovak Republic (1993:1-2003:4) and Malta (1990:1-2003:3), which stand for the domestic country. All variables, including the nominal effective exchange rate of the domestic country, the world and the domestic nominal interest rates, the domestic terms of trade, the domestic holding of foreign assets and the world price level of petroleum (hereafter called oil price), are taken from IFS CD-ROM statistical database. The nominal effective exchange rate *(neer)* is an indicator of the domestic economy's international competitiveness in terms of its foreign exchange rate. It is a measure of the value of the domestic currency against a basket of other currencies. It is calculated as a weighted average of exchange rates and it is expressed as an index (base year 2000 = 100). An increase in this index is equivalent to the appreciation of the domestic currency. Obviously, a reduction corresponds to the depreciation of the nominal effective exchange rate.

The nominal interest rates correspond to lending rates. For the world interest rate the US prime loan rate is applied, while for the rest of the panel standard lending rates are applied. Subtracting the US lending rate from the domestic one we get the nominal interest rate differential *(i-i*)*. An increase in this variable implies a relatively higher increase in the domestic interest rate. Next, domestic holding of foreign assets *(fa)* shows all foreign assets held by domestic agents abroad, expressed in millions (domestic currency). The terms of trade *(tot)* variable is calculated as a ratio of the value of exports to the value of imports, both expressed in millions (domestic currency). A higher increase in the price of exports relative to the price of imports is linked with the rise of the terms of trade. This means that the terms of trade are improved and the trade position of the domestic economy is enforced. Finally, oil price *(op)* is the world price level of petroleum per barrel, expressed in US dollars. All variables, except interest rates, are expressed in natural logarithms.

8.5. Estimation

8.5.1. Cointegration Analysis

The estimation analysis entails three steps. Firstly, we check if the exchange rate and the fundamentals form a valid long run relationship, credible for the calculation of the equilibrium exchange rate. In other words, we have to find whether the exchange rate and the fundamentals are cointegrated in the long run. This is performed by the well-known Johansen's cointegration technique (1988, 1991), presented in a previous chapter. The second step includes the estimation of a reduced-form equation, derived form the above technique. This reflects the long run effective exchange rate. The final step incorporates the estimation of the equilibrium exchange rate, getting two alternative estimates, the Behavioural Equilibrium Exchange Rate (BEER) and the Permanent Equilibrium Exchange Rate (PEER).

The Johansen's methodology is based on the estimation of a VAR model. Accepting that a VAR model is valid only when stationary variables are included, we regress VAR models in an error correction form by using the first differences of the variables. We pre-regress the VAR models in levels just to select the appropriate lag length by the Akaike Information Criterion (AIC). This statistic is given by:

$$AIC = N \log\left|\Sigma\right| + 2\Xi \tag{8.15}$$

where N = number of observations, Ξ = total number of parameters, and $|\Sigma|$ stands for the determinant of the variance/covariance matrix of the residuals. The appropriate lag length is this which "soaks up" autocorrelation. So, we select this number of lag which fits with the lowest value of the AIC statistic. The following table indicates the appropriate length of lags in each specific case:

Table 8.1: Lag Length Selection

Model	Poland	Hungary	Slovak Republic	Malta
Number of Lags	2	4	3	2

Including 2 lags for the Poland's and Malta's cases, 3 lags for the Slovak Republic and 4 lags for Hungary, we estimate the corresponding VAR models in first differences and we check their robustness by testing their parameters constancy. To be specific we test the hypotheses of non-autocorrelated, homoskedastic and normally distributed residuals. The serial correlation hypothesis is tested through the Lagrange-Multiplier test (up to the maximum lag), in which the null hypothesis states that the errors are not serially correlated. Next, White's heteroskedasticity test includes the null hypothesis of homoskedastic errors and the hypothesis of normal errors is tested through the Jargue-Bera test. The following table summarises the performance of the above tests. Test statistics are presented first, while the values in brackets denote the probability of accepting the null. The first test statistic is a Lagrange Multiplier statistic, while the next two test's statistics follow the Chi-square distribution. As a matter of fact, this table confirms VAR models' stability. Errors are non-autocorrelated, homoskedastic and normally distributed in each of the estimated models. This information persuades us to believe that the estimated VEC models are stable and robust for the foregoing analysis.

Table 8.2: Diagnostics

	No Serial Correlation	Homoskedastic Errors	Multivariate Normal Errors
Poland	**30.77 *(0.1908)***	**322.67 *(0.6028)***	91.26 (*0.8281*)
	21.08 *(0.6881)*		
Hungary	**27.83 *(0.0331)***	**328.94 *(0.6566)***	56.94 *(0.4028)*
	20.80 *(0.1864)*		
	28.05 *(0.0312)*		
	16.92 *(0.3905)*		
Slovak Republic	**13.38 *(0.6444)***	**262.78 *(0.4401)***	49.75 *(0.6749)*
	14.19 *(0.5843)*		
	29.26 *(0.0222)*		
Malta	**27.74 *(0.3198)***	**334.14 *(0.4260)***	71.72 (*0.9946*)
	18.34 *(0.8277)*		

The next step of analysis entails the test of cointegration. This test is crucial for the estimation of the Equilibrium Exchange Rate. What we actually test is whether the exchange rate and the fundamentals form a valid long run relationship. If this is not accepted (i.e. series are not cointegrated), no fundamental can explain any exchange rate movement. Therefore, the desired output will be the acceptance of at least one cointegrating relationship. This test is performed through the Johansen's likelihood ratio test. This test determines the rank of matrix Π ($\Pi=\alpha\beta'$) by computing two test statistics: the Trace and the max-eigenvalue test statistics.

An important decision is the selection of the appropriate sub-model. An erroneous selection may drive us to misleading implications. In doing so, we follow Koukouritakis & Michelis (2005) who select their model through a test proposed by Johansen (1995, chapter 11, Corollary 11.2 & Theorem 11.3, p. 161-162). We test the restricted against the less restricted model using their computed trace statistics. These tests follow the X^2 distribution and the degrees of freedom are as shown below:

1~2 (**rc** d.f.), 2~3 (**v-rc** d.f.), 3~4 (**rc** d.f.) , 4~5 (**v-rc** d.f.)

where rc is the number of cointegrated vectors and v is the number of parameters. For example, in the case of Poland, testing the first against the second sub-model, we accept the most restricted model. Thus, the cointegration test is applied when no constant and trend are included either to data or to the model.[131] The same holds for Hungary and Slovak Republic, while for Malta the second sub-model is accepted. In this case, a constant term is included in the model.

In a first step, the vector of fundamentals includes all the variables defined in the theoretical section and we test whether they are cointegrated in the long run with the effective exchange rate. However, the acceptance of the cointegration hypothesis is not sufficient for deriving this relationship. What is needed is to test the hypothesis of weak exogeneity. We assume that the only endogenous variable in the exchange rate equation is the exchange rate itself. Macroeconomic fundamentals are assumed to be weakly exogenous. This means that if the exchange rate deviates from its long run equilibrium value, deviations can be damp out only by exchange rate adjustments. In practice, weak

[131] These sub-models are tested in pairs. We subtract the calculated trace of the first sub-model from the calculated trace of the second sub-model. The derived statistic is (52.11-33.9=18.21), which denotes the rejection of the movement from the first to the second sub-model. So, the first sub-model is selected.

exogeneity assumption is required because the asymptotic distribution theory for the estimate of beta becomes very difficult without exogeneity. The exogeneity assumption is tested by imposing the following restriction on alpha matrix: (α_{11}, 0, 0, 0, 0), while beta is identified.

Table 8.3 shows the results from these tests. At first glance, in all models, the fundamentals and the effective exchange rate are cointegrated. However, only in Poland and Malta models weak exogeneity is not rejected. This means that for these specific models, the fundamentals are all exogenous to the exchange rate equation. On the other hand, in the other two models, some of the fundamentals may be endogenous to the exchange rate. When this assumption is rejected the implied long run relationships are meaningless. As a result, under the absence of weak exogeneity the estimation of the equilibrium exchange rate is meaningless as well.

Table 8.3: Cointegration – Weak Exogeneity Test

Model	Cointegrating Vectors	Cointegration Sub-model	LR Statistic	Probability
Poland	1	1^{st}	6.40	**0.17**
Hungary	3	1^{st}	31.13	0.00
Slovak Republic	4	1^{st}	*	*
Malta	1	2^{nd}	8.46	**0.075**

MacKinnon-Haug-Michelis (1999) p-values
* means that convergence is not achieved

In order to find these endogenous variables we exclude the foreign asset variable and the terms of trade variable from the Hungary and Slovak Republic models, respectively. We re-estimate those models, applying again the cointegration and weak exogeneity tests. The updated results are shown in the following table:

Table 8.4: Updated Cointegration – Weak Exogeneity Test

Model	Cointegrating Vectors	Cointegration Sub-model	LR Statistic	Probability
Poland	1	1st	6.40	**0.17**
Hungary	2	1st	5.006	**0.28**
Slovak Republic	1	1st	8.94	**0.03**
Malta	1	2nd	8.46	**0.075**

MacKinnon-Haug-Michelis (1999) p-values

The revised estimation satisfies both the cointegration and weak exogeneity hypotheses. As before, in all models, there is at least one cointegrating vector. The new information here is that for the Hungary and Slovak Republic models, weak exogeneity is not rejected. Thus, the included fundamentals are all weakly exogenous to the exchange rate equation. This finding implies that the foreign asset variable is endogenous to the exchange rate for the Hungary model. Similarly, the Slovak Republic terms of trade variable seems to be endogenous to the relevant exchange rate equation.

Having established the validity of the implied long run relationships, we estimate the non-restricted component of the alpha matrix, known as adjustment coefficient. The adjustment coefficient is statistically significant in all models. This value denotes the speed of adjustment of the exchange rate towards equilibrium. Specifically, it is estimated that deviations are expected to decrease in a quarter (3-months) by about 30%, 43% and 4% for the Poland, Malta and Hungary models, respectively. The positive value of the adjustment coefficient in the Slovak Republic model implies that the actual exchange rate is expected to move away from its long run rate, in a quarter, by about 3%.

Next, we can derive the estimated coefficients, implied by the reduced form equations. Before we form these equations, it is necessary to test whether these coefficients are statistically significant and correctly signed. The following table briefly presents these estimates:

Table 8.5: Estimated Coefficients

Coefficients (standard errors)	Poland	Hungary	Slovak Republic	Malta
constant (s.e.)	---------------	-------------------	-------------------	**5.24** (0.13)
i-i* (s.e.)	**0.05** (0.02)	**0.024** (0.01)	**0.01** (0.03)	**0.008** (0.001)
tot (s.e.)	**0.3** (0.17)	**3.99** (1.13)	-------------------	**0.05** (0.04)
fa (s.e.)	**0.27** (0.02)	-------------------	**0.8** (0.21)	**-0.117** (0.017)
op (s.e.)	**0.35** (0.08)	**1.58** (0.06)	**-1.63** (0.77)	**0.03** (0.01)

All estimated coefficients are statistically significant apart from the interest rate differential in the Slovak Republic model and the Malta's terms of trade. When it comes to the sign of the estimated coefficients, the interest rate differential and the terms of trade are positively signed, as expected, in each estimated model. Based on the Portfolio Balance model (Branson 1977), a higher domestic interest rate is going to appreciate the nominal effective exchange rate because of the increased capital inflows. The terms of trade sign shows that the substitution effect will overshoot the income effect. In other words, the improvement in the current account will be higher than the increase in domestic income. Thus, the nominal effective exchange rate rises.

The domestic holding of foreign assets sign is as expected only in the Malta's model. For the rest it is estimated that an increase in the domestic holding of foreign assets is going to appreciate the exchange rate, which is not consistent with our theoretical model. A possible explanation can be given by examining the monetary base of domestic country. As the foreign asset position of the domestic country affects its monetary base, a rise in foreign bonds decreases the monetary base. Then, domestic money supply decreases.[132] Now, following the monetary model of exchange rate determination we can easily explain the appreciation of the effective exchange rate. We just need to assume that this action decreases domestic money supply, which in turn appreciates the domestic currency. An alternative explanation states that the increased foreign asset holding creates positive expectations of high capital inflow in the future. This is due to the expected capital gains caused by this investment.

Finally, the effect of the oil price shock is surprisingly unusual for all cases except this of Slovak Republic. The estimated coefficients imply that an increase in the world price level of oil is going to appreciate the nominal effective exchange rates of Poland, Hungary and Malta. This movement may be sensible for less oil dependent countries. This interesting finding is an inspiration for further research. However, a possible reason for this is that while the nominal effective exchange rate is a weighted average of a basket of currencies, these countries may have been relatively less affected from oil shock.

[132] Based on the money multiplier theory, the amount of money (coins & notes) held by domestic residents, decreases. Since the monetary base (MB) is equal to the sum of bank reserves (BR) plus coins & notes held by domestic residents (CN) [MB = BR+CN], monetary base declines. Thus, domestic money supply declines as well because money supply is equal to monetary base multiplied by the money multiplier. However, this holds only if coins and notes finance the purchase of foreign bonds. In case of an exchange between domestic and foreign bonds, monetary base remains unaffected.

8.5.2. Equilibrium Exchange Rate

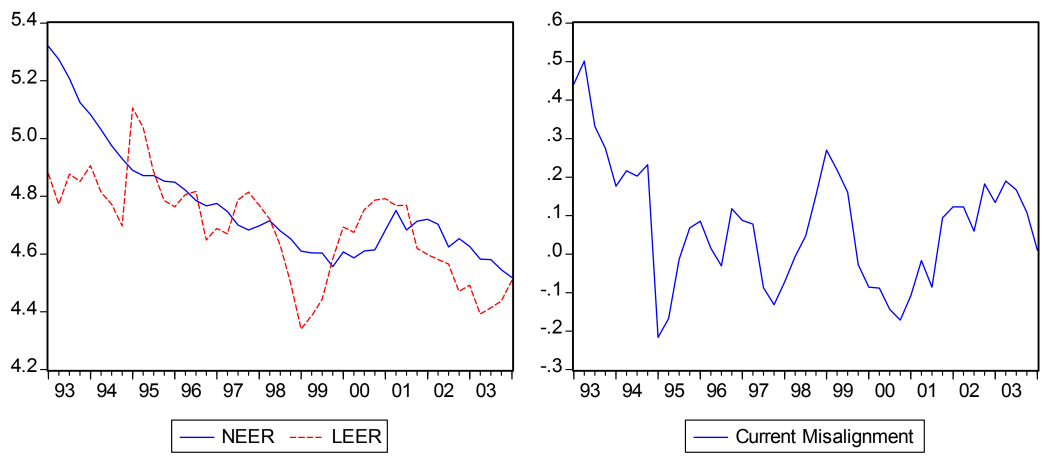
Polish Zloty

Having tested the significance of the estimated coefficients, we can now derive the Long run Effective Exchange Rate (LEER) for the Polish zloty, implied by the estimated cointegrating vector. This is estimated from equation (8.16).

$$leer_t = \underset{(0.002)}{0.05} \cdot (i - i^*)_t + \underset{(0.17)}{0.3} \cdot tot_t + \underset{(0.02)}{0.27} \cdot fa_t + \underset{(0.08)}{0.35} \cdot op_t \qquad (8.16)$$

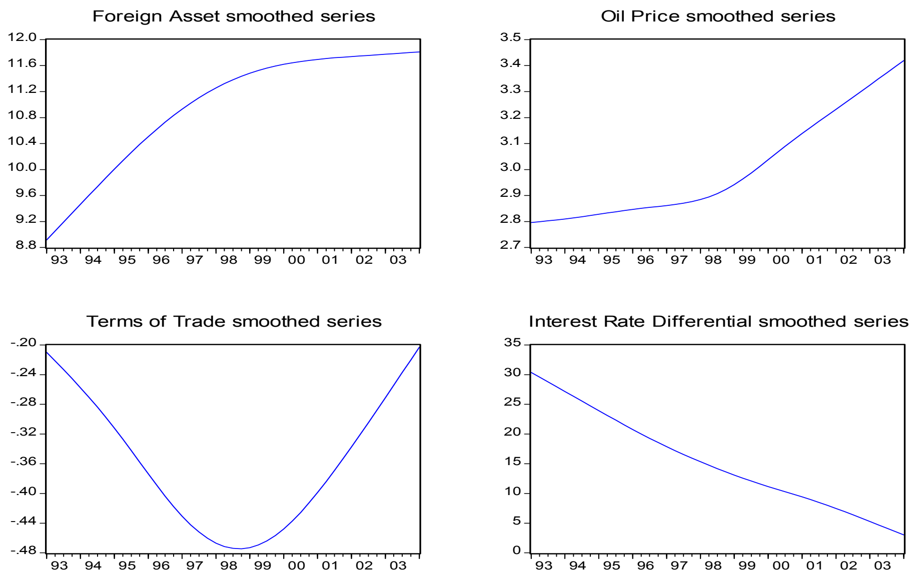
Below, this rate is plotted against the observed Nominal Effective Exchange Rate (NEER), while the right hand-side of the graph illustrates the current misalignment.

Figure 8.1: Long Run Effective Exchange Rate, Current Misalignment



Positive values indicate that the observed effective exchange rate is above the estimated (i.e. overvalued) and negative values show that the observed exchange rate is undervalued. This graph implies that there are both overvaluation and undervaluation periods, with the former to be a more usual case. However, this that actually matters is total misalignment, which is the deviation of the actual effective exchange rate from the BEER and PEER estimates. So, we evaluate the long run values of the fundamentals, by the Hodrick-Prescott (H-P) filter (λ=1600). This is shown in figure 8.2.

Figure 8.2: Macroeconomic Fundamentals Smoothed Series



The smoothed series of the above variables replace their actual series in the estimated exchange rate equation (8.16). This yields to the estimation of the long run equilibrium effective exchange rate. The derived BEER is plotted against the actual nominal effective exchange rate in figure 8.3.

The Permanent Equilibrium Exchange Rate (PEER) can be seen as a special approach of the BEER. The PEER approach differs in the way that the exchange rate is a function of variables that have a persistent effect on it. Thus, we have to decompose the fundamentals into permanent and transitory components. The permanent-transitory decomposition is undertaken by the Gonzalo & Granger (1995) methodology. So, we decompose the fundamentals into permanent and transitory series and then, we substitute the permanent series into equation (8.16) to derive the Permanent Equilibrium Exchange Rate.

The cointegration analysis confirms the acceptance of a single cointegrating vector. This implies that we expect four common trends.[133] Johansen (1995) shows that the Beta and Alpha orthogonal components are given by (8.13) and (8.14), respectively:

$$\beta_{\perp} = S_{11}(b_{rc+1},.....b_{v}) \tag{8.13}$$

$$a_{\perp} = S_{00}^{-1}S_{01}(b_{rc+1},...,b_{v}) \tag{8.14}$$

where $S_{ij} = N^{-1}R_i R'_j, \qquad i, j = 0,\ 1.$

Solving equations (8.13) and (8.14), we calculate $a_{\perp}$ & $\beta_{\perp}$. Next, we estimate the A_1 and A_2 matrices. All these estimates are shown in the following tables:

Table 8.6: Alpha Orthogonal Components

	$a_{\perp}^{1}$	$a_{\perp}^{2}$	$a_{\perp}^{3}$	$a_{\perp}^{4}$
neer	-1.965	-0.02	0.83	-1.052
i-i*	-0.288	0.051	-0.042	-0.027
tot	-0.269	-0.306	-0.8	-0.583
fa	1.168	-0.201	8.84	-0.263
op	3.694	0.956	0.01	0.438

Table 8.7: Beta Orthogonal Components

	$\beta_{\perp}^{1}$	$\beta_{\perp}^{2}$	$\beta_{\perp}^{3}$	$\beta_{\perp}^{4}$
neer	0.567	-1.33	2.548	-0.128
i-i*	0.277	-6.27	3.886	-1.94
tot	1.67	-2.77	6.684	-0.323
fa	-0.04	0.08	-0.253	0.106
op	0.32	-0.81	1.788	0.07

[133] Gonzalo & Granger (1995) show that if the vector x_t is of reduced rank rc, x_t can be explained by (v-rc) I(1) variables, where v is the number of the parameters included in the vector x_t and rc is the cointegration rank.

Table 8.8: A_1 Matrix

	A_1^1	A_1^2	A_1^3	A_1^4
neer	-0.27	0.026	0.006	-0.488
i-i*	-1.458	0.865	-0.235	-4.731
tot	0.01	-0.139	-0.01	-0.134
fa	-0.003	-0.01	0.11	0.01
op	0.144	0.07	-0.05	-0.64

Table 8.9: A_2 Matrix

	A_2
neer	-0.03
i-i*	0.581
tot	0.008
fa	0.006
op	0.026

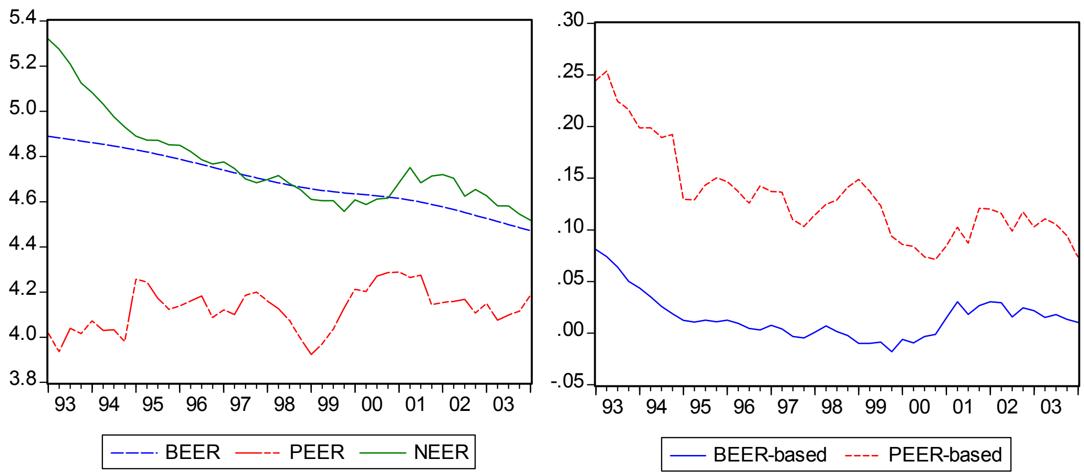
The product of matrices A_1 and $a_{\perp}'$ yields to a new matrix, which entails the permanent components of the fundamentals. Similarly, the product of A_2 and β′ corresponds to the transitory components of the fundamentals. These values are summarized in the following table:

Table 8.10: Permanent – Transitory Decomposition

	i-i*	tot	fa	op
Permanent (P)	0.604	0.97	0.97	0.886
Transitory (T)	0.396	0.03	0.03	0.114
P + T	1	1	1	1

The above analysis implies that about the 60% of the interest rate differential is permanent and the 88.6% of the oil price movements have a permanent effect. Moreover, about the 97% of the terms of trade and the domestic holding of foreign assets is permanent. The robustness of this decomposition is confirmed by the last row of table 8.10. Summing the permanent and the transitory components yields to unity. By multiplying the permanent values with the actual series of the fundamentals we get their permanent components. Then, we substitute in equation (8.15), the actual series of the fundamentals by their permanent series. This estimate is the Permanent Equilibrium Exchange Rate. Both Equilibrium Exchange Rates are plotted against the actual exchange rate in the following figure:

Figure 8.3: BEER, PEER, Total Misalignment



It is obvious that the actual effective exchange rate was mainly overvalued. The BEER line implies that the long run values of the macroeconomic fundamentals indicate a lower effective exchange rate than the observed. A single undervaluation period is from 1998 to 2001. Comparing this graph with the current misalignment figure (8.1), we can see that there is a significant difference between current and total misalignments. This is due to the inclusion of the filtered values of the fundamentals in the BEER estimation. From 2002, the actual nominal effective zloty declines following the BEER's trend. This is an indicator of a movement approaching the equilibrium rate.

It is clear-cut that the PEER implies a lower effective exchange rate. Moreover, the difference between thee BEER and the PEER estimates is obvious. Although, both rates show that the Polish Zloty was mainly overvalued, the PEER shows that the overvaluation rate is much higher. Recall that the BEER estimate allows for a single undervaluation period, which does not hold in the PEER implication. This is clearly shown in the misalignment's figure. Taking as ground that both rates provide evidence of an overvalued Polish zloty, we now analyze the difference in the magnitude of misalignments. The BEER estimate is very close to the actual effective exchange rate, implying highest overvaluation at a rate of 8%, while on average the exchange rate deviates by 2%. In contrast, the PEER estimate deviates significantly from the actual exchange rate. The corresponding misalignment rate is about 25%, while on average deviates by 13%. These high rates are observed at the beginning of the estimated period. It is worth notable that both misalignment rates follow a downward path, implying that the actual exchange rate moves towards equilibrium. In the first quarter of 2004, the BEER-based misalignment rate was 1%, while the PEER-based deviation has declined to 7%. The divergence between the BEER and the PEER implies that the BEER estimate incorporates some transitory elements.

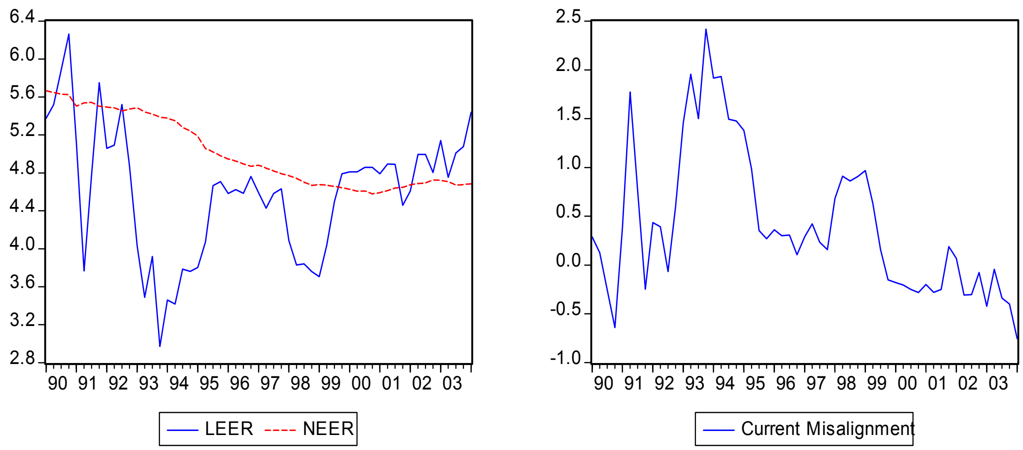
Hungarian forint

Given that the domestic holding of foreign assets variable is statistically insignificant for the Hungary's model, we exclude this variable from the regression equation. Thus, the long run effective exchange rate (LEER) is estimated by equation (8.17):

$$leer_t = \underset{(0.01)}{0.024} \cdot (i - i^*)_t + \underset{(1.13)}{3.99} \cdot tot_t + \underset{(0.06)}{1.58} \cdot op_t \tag{8.17}$$

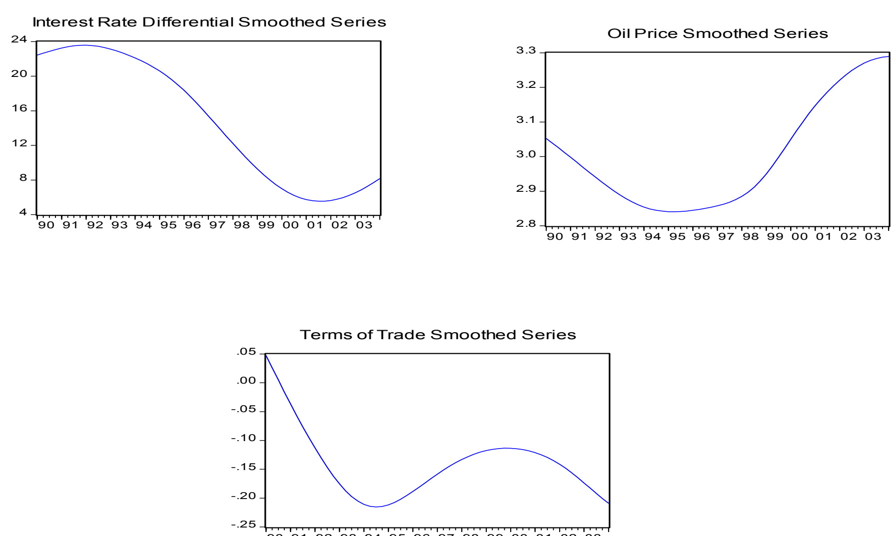
This rate is plotted against the actual effective exchange rate, while the second part of the following figure shows the deviation of the former from the latter. As it has already been mentioned in the case of Poland, this estimated rate is not the equilibrium exchange rate and the implied misalignment rate is referred as current misalignment. The figure 8.4 shows that the Hungarian Forint is mainly overvalued, while there are two undervaluation periods. This is clearly shown in the second part of the following figure. Recall that positive values indicate overvaluation and negative values imply undervaluation.

Figure 8.4: Long Run Effective Exchange Rate, Current Misalignment



The Behavioural Equilibrium Exchange Rate will be estimated by the sustainable values of the fundamentals. As in the case of Poland, we measure the long run values of the fundamentals through the Hodrick-Prescott filter. These estimates are shown below:

Figure 8.5: Smoothed Series



Now, we substitute the fundamentals by their smoothed values, in equation (8.17), to derive the Behavioural Equilibrium Exchange Rate. This rate is plotted against the actual exchange rate, in figure 8.6.

Likewise, the Permanent Equilibrium Exchange Rate is estimated by decomposing the vector of fundamentals into permanent and transitory components. Hence, performing the Gonzalo & Granger decomposition, we can derive the permanent components of the fundamentals. This requires the estimation of the alpha and beta orthogonal matrices and the A_1 and A_2 matrices, defined in the econometrics section. Since the cointegration analysis finds that there are two valid cointegrating relationships, we expect two common trends. These matrices, shown below, have rank 4x2.

Table 8.11: Alpha Orthogonal Components

	$a_{\perp}^{1}$	$a_{\perp}^{2}$
neer	-2.238	-0.055
i-i*	-0.06	0.001
tot	3.282	-0.047
op	-3.593	-0.0207

Table 8.12: Beta Orthogonal Components

	$\beta_{\perp}^{1}$	$\beta_{\perp}^{2}$
neer	-0.703	3.194
i-i*	1.567	6.627
tot	-0.0003	-0.07
op	-0.471	2.09

Table 8.13: A_1

	A_1^{1}	A_1^{2}
neer	-0.13	-5.705
i-i*	-6.144	417.002
tot	0.033	-2.115
op	-0.033	-5.35

Table 18.4: A_2

	A_2^{1}	A_2^{2}
neer	-0.064	-0.065
i-i*	0.076	-3.165
tot	0.043	-0.028
op	0.078	0.067

Transposing the alpha orthogonal matrix and multiplying the transposed matrix by the A_1 matrix, we get a new matrix, which entails the rate of permanent components of the fundamentals. Similarly, transposing the beta matrix and multiplying the transposed matrix by the A_2 matrix, we derive the rate of the transitory components of the fundamentals. These coefficients (rates) are presented in the following table:

Table 8.15 : Permanent – Transitory Decomposition

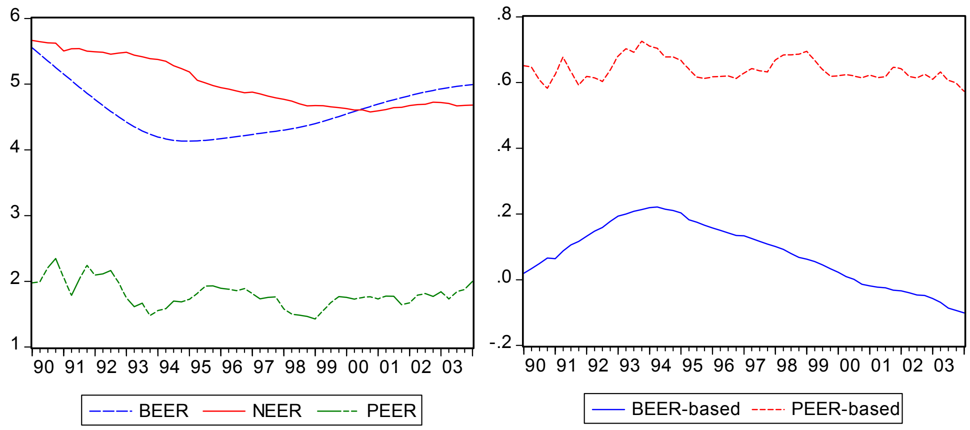
	i-i*	tot	op
Permanent (P)	0.842	0.21	0.338
Transitory (T)	0.158	0.79	0.662
P + T	1	1	1

In this case, the rate of permanent elements is high for the interest rate differential but most of the fluctuation of the terms of trade and the oil price variables are transitory. About the 84% of the interest rate differential movements are permanent, while only the 21% and 34% of the terms of trade and the oil price fluctuation, respectively, are permanent.[134]

We use the above rates to measure the permanent elements of the fundamentals, which substitute their actual series in equation (8.17). This yields to the Permanent Equilibrium Exchange Rate, shown with the Behavioural Equilibrium Exchange Rate in the following figure.

[134] The robustness of the decomposition is established since by summing the permanent rate and the transitory one, we find always unity.

Figure 8.6: BEER, PEER, Total Misalignment



In this case the two alternative procedures provide considerably different equilibrium exchange rates. The BEER-based approach shows that the actual forint does not deviate significantly from its equilibrium rate. The highest overvaluation rate is about 20%, while on average the Hungarian forint deviates by 10%. The interesting point here is that from 1994 the BEER follows an upward path, implying that the domestic currency should appreciate. In contrast, the actual exchange rate continues the depreciation until 2001. Hereafter the actual exchange rate is very close to its equilibrium rate. At the end of the estimated period, the Hungarian forint is overvalued by less than 10%.

The PEER estimate is clearly lower than the actual exchange rate and the estimated BEER. This seems sensible since a significant percentage of the terms of trade and the oil price variables can be characterised as transitory. As a consequence, the deviation of the PEER from the BEER is due to the transitory components of the BEER estimate. This deviation becomes more impressive if we calculate the misalignment rates and compare the BEER-based misalignment with the PEER one. The BEER-based misalignment rate does not exceed the 30%. In contrast, the PEER-based misalignment rate shows that the overvaluation rate is high and sustainable. On average, the Hungarian forint is overvalued by about 60%.

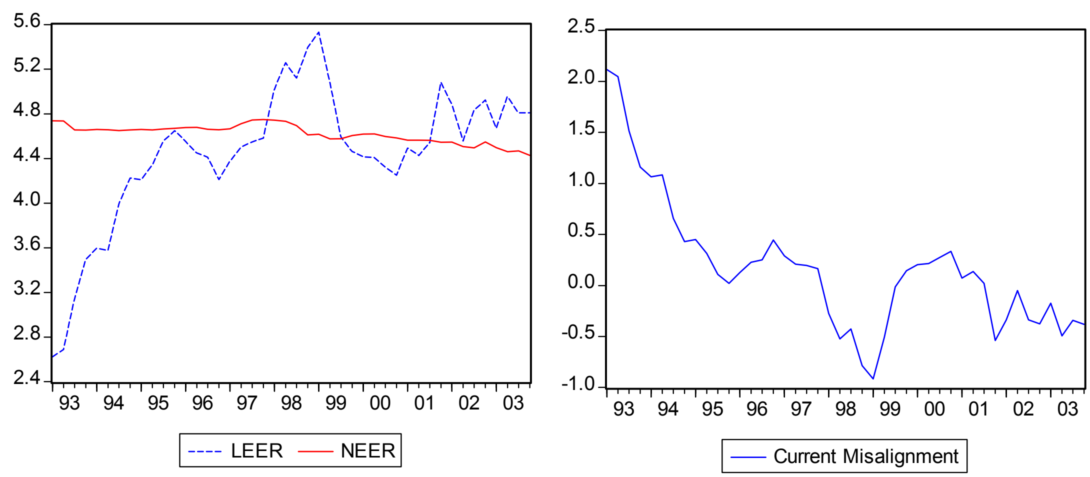
Slovak crown

The Slovak terms of trade variable is endogenous to the exchange rate, so it is not included in the regression equation. Similarly, the interest rate differential is excluded from the reduced form equation because of its statistically insignificant sign. Thus, the estimation is based on the following equation:

$$leer_t = \underset{(0.21)}{0.8} \cdot fa_t - \underset{(0.77)}{1.63} \cdot op_t \tag{8.18}$$

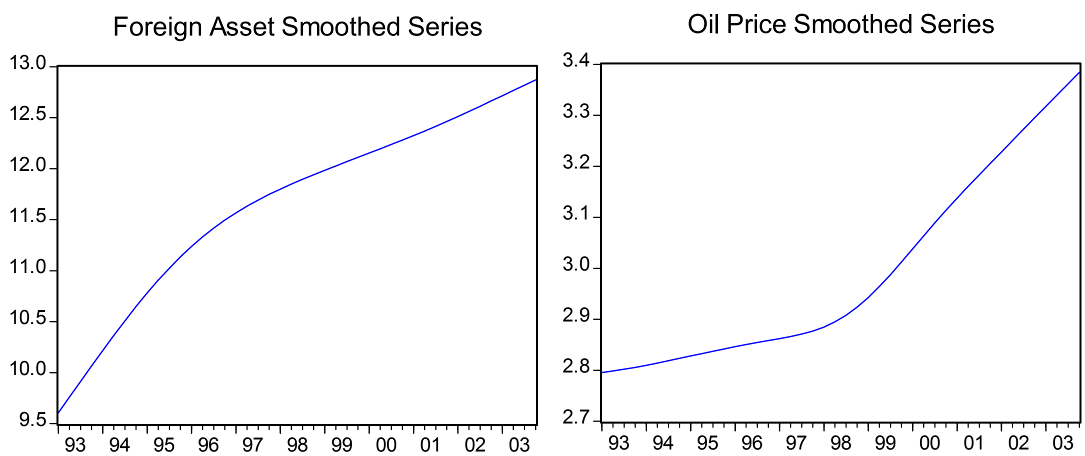
The analysis is analogous to the other two models' estimation. This equation yields to the long run effective exchange rate and by subtracting this rate from the actual effective exchange rate we get the current misalignment. These rates are shown in the following figure:

Figure 8.7: Long Run Effective Exchange Rate, Current Misalignment



While the exchange rate was initially overvalued, it was undervalued - but relatively close to its long run value - at the end of the estimated period. As in the previous models, this rate cannot be considered as the equilibrium exchange rate and the above misalignment rate stands for the current misalignment rate. The BEER and the total misalignment rate will be estimated by filtering the fundamentals by the Hodrick-Prescott filter. The smoothed series of the foreign asset and the oil price are shown below:

Figure 8.8: Smoothed Series



The actual values of the fundamentals are substituted by the above series (equation 8.18). The derived rate corresponds to the Behavioural Equilibrium Exchange Rate, while the total misalignment rate arises by subtracting this rate from the actual exchange rate.

Following the Gonzalo & Granger methodology, the existence of one cointegrating vector implies that there are three common trends. Thus, the alpha and beta orthogonal matrices as well as the A_1 matrix are of the rank 4x3. The A_2 matrix is of the rank 4x1. Solving the same problem as in the other two models, we get the above matrices:

Table 8.16: Alpha Orthogonal Components

	$a_{\perp}^{1}$	$a_{\perp}^{2}$	$a_{\perp}^{3}$
neer	8.27	16.132	8.687
fa	-2.082	-0.685	1.833
op	-1.36	0.115	1.831
i-i*	7.915	-4.34	0.964

Table 8.17: Beta Orthogonal Components

	$\beta_{\perp}^{1}$	$\beta_{\perp}^{2}$	$\beta_{\perp}^{3}$
neer	-2.912	-1.38	-0.108
fa	-7.511	3.8	-0.817
op	-1.912	-0.91	-0.29
i-i*	0.075	0.08	-0.0003

Table 8.18: A_1 Matrix

	A_1^1	A_1^2	A_1^3
neer	0.012	0.042	0.025
fa	-0.157	-0.009	0.189
op	0.063	-0.153	0.196
i-i*	0.07	0.074	0.07

Table 8.19: A_2 Matrix

	A_2
neer	0.006
fa	0.102
op	-0.135
i-i*	0.004

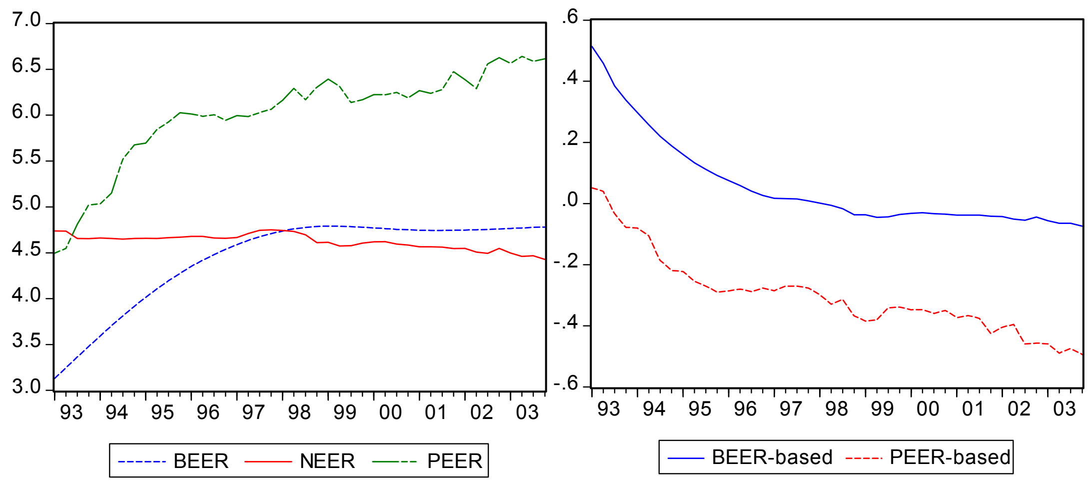
The transposed matrix of the alpha orthogonal components is multiplied by the A_1 matrix and the transposed matrix of the cointegrating vector (beta) is multiplied by the A_2 matrix. The former product yields to the permanent matrix and the latter gives the transitory matrix. The diagonals provide the permanent and transitory rates, respectively. These rates are summarized in the following table:

Table 8.20: Permanent – Transitory Decomposition

	fa	op	i-i*
Permanent (P)	0.777	0.256	0.955
Transitory (T)	0.223	0.744	0.045
P + T	1	1	1

As the robustness of the decomposition is established (P+T=1 in each variable), we can derive the permanent series of the above variables. About the 78% of the foreign asset movements are permanent and only the 26% of the oil price fluctuation is permanent. Although, we have decomposed the interest rate differential, we do not measure its permanent series because it was statistically insignificant in the reduced-form equation. So, we measure the foreign asset and the oil price permanent series and estimate the Permanent Equilibrium Exchange Rate (figure 8.9).

Figure 8.9: BEER, NEER, Total Misalignment



The BEER estimate follows the same path as the long run effective exchange rate does. The difference is that the former is smoother than the latter. So, the Slovak crown was initially overvalued but during the estimated period became undervalued. The overvaluation rate has a decreasing trend. While the actual effective exchange rate (NEER) is stable the BEER implies an appreciation trend. This contradiction is under consideration. Is the stability of the exchange rate natural or a consequence of a specific exchange rate policy?[135] In the beginning of the estimated period the exchange rate was overvalued by about 50%. In the first quarter of 1998 the BEER becomes equal to the

[135] National Bank of Slovakia was fixing exchange rates of selected currencies during the period 1993-1998. Slovak crown was pegged on a basket of two currencies (60% of Deutsche mark and 40% of US dollar), and it was allowed to fluctuate by no more than 7%. Since October 1998, Slovak crown is freely determined in the foreign exchange market.

actual rate. Thereafter, the BEER implies a stable exchange rate, while the actual exchange rate follows a slightly depreciation path. Instead of the former overvaluation period, these movements show that the exchange rate is undervalued. However, this deviation is not a significant one. During 2003 the Slovak crown was undervalued by about 5%, while at the end of the estimated period the misalignment rate was 7%. The declining trend of the actual exchange rate may be due to the effects of the former stabilisation exchange rate policy. The exchange rate can meet its equilibrium rate when these effects are totally absorbed.

The PEER estimate implies that the value of the Slovak currency should be higher than its observed value and the BEER estimate. As a matter of fact, the Slovak crown is undervalued during all the estimated period. While the BEER decomposes the estimated period into overvaluation and undervaluation periods, the PEER estimate shows that the exchange rate is clearly undervalued. An implicit difference in the misalignment rates is that according to the BEER-based estimation, the exchange rate was initially overvalued and at the end of the estimated period was very close to equilibrium. On the contrary, according to the PEER-based estimation, the exchange rate was initially very close to equilibrium and during the time becomes more and more undervalued.

In overall, the BEER seems to be more close to the actual exchange rate. Although, the BEER-based misalignment was about 50%, this rate has been reduced to 7% at the end of the estimated period. The PEER-based misalignment rate shows that the exchange rate moves away from its equilibrium. While the misalignment rate was only 5% at the beginning of the estimated period, this rate has been jumped to 50% at the end of this period. On average the Slovak crown deviates by 10% according to the BEER analysis and by 30% based on PEER analysis.

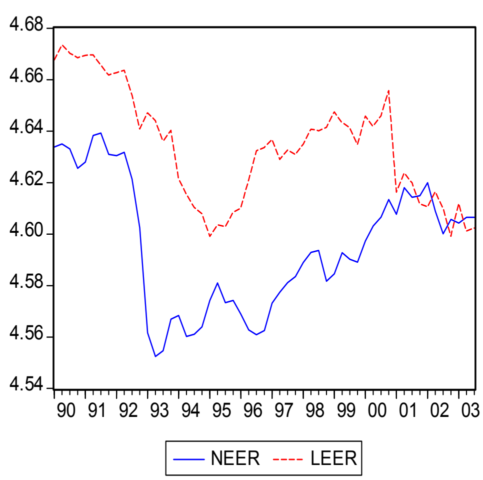
Maltese lira

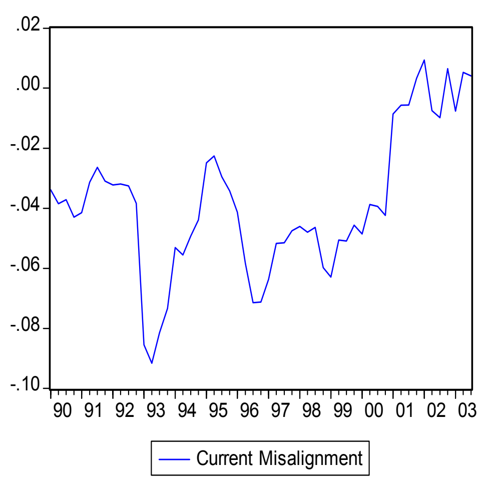
All of the fundamentals are weakly exogenous to the exchange rate, however the terms of trade variable is statistically insignificant. Given this finding and the inclusion of a constant term in the model, the Long run Effective Exchange Rate is estimated by:

$$leer_t = \underset{(0.13)}{5.24} + \underset{(0.001)}{0.008} \cdot (i - i^*)_t - \underset{(0.017)}{0.117} \cdot fa_t + \underset{(0.01)}{0.03} \cdot op_t \qquad (8.19)$$

This estimate is presented in the following graph against the actual exchange rate, while the second part of the figure presents the current misalignment rate. Once again the estimated period is divided in two sub-periods. The first period is from 1990 to 2001, in which the estimated rate is stably above the actual exchange rate. From 2001 a new period arises, in which the estimated long run exchange rate is very close, and in some cases equal, to the actual rate. This is easily observed in the current misalignment line (figure 8.10). At the end of the estimated period the misalignment rate lies around zero.

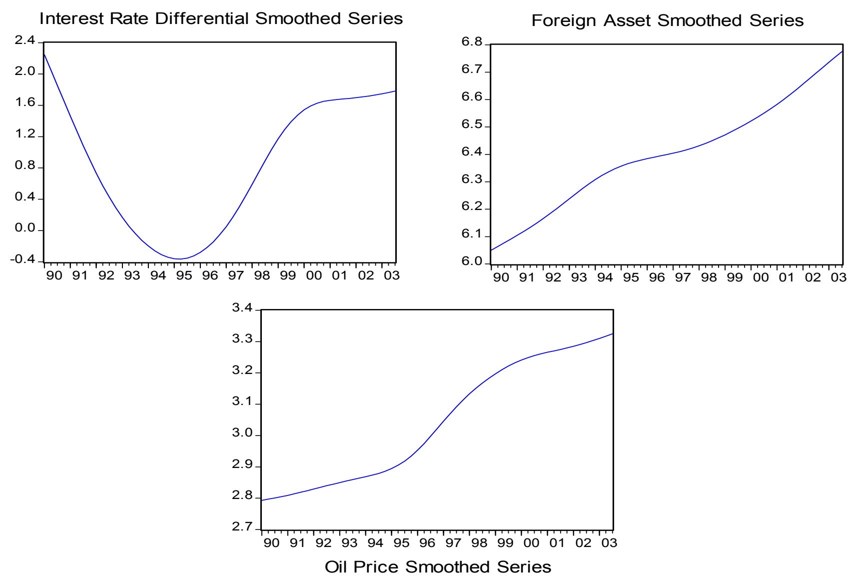
Figure 8.10: Long run Effective Exchange Rate, Current Misalignment





The Behavioural Equilibrium Exchange Rate is estimated by getting the sustainable values of the fundamentals. Then, we use these values in the regression equation to estimate the BEER. These sustainable series and the estimated BEER are shown in the following figures (8.11) and (8.12), respectively.

Figure 8.11: Smoothed Series



To estimate the Permanent Equilibrium Exchange Rate, the Gonzalo & Granger methodology requires the computation of the Alpha and Beta orthogonal matrices as well as the A_1 and A_2 matrices, defined in the econometric section. Since the cointegration analysis confirms the existence of a unique cointegration vector, we expect four common trends in this model. As a matter of fact the rank of the matrices is 5x4 apart from the A_2 matrix, which has rank 5x1.

Table 8.21: Alpha Orthogonal Components

	$a_{\perp}^{1}$	$a_{\perp}^{2}$	$a_{\perp}^{3}$	$a_{\perp}^{4}$
neer	1887.75	-569.66	-87.393	43.275
i-i*	-31.336	8.541	1.6	-0.8
fa	963.801	-277.18	-45.944	21.5
op	158.566	-42.89	-6.529	2.4
tot	234.874	-67.41	-11.727	4.442

Table 8.22: Beta Orthogonal Components

	$\beta_{\perp}^{1}$	$\beta_{\perp}^{2}$	$\beta_{\perp}^{3}$	$\beta_{\perp}^{4}$
neer	791.54	-224.78	-36.462	15.284
i-i*	132.97	-37.081	-6.632	3.271
fa	1098.95	-312.12	-50.554	21.174
op	517.74	-147.18	-23.896	10.083
tot	-73.047	20.723	3.374	-1.402

Table 8.23: A_1 Matrix

	A_1^{1}	A_1^{2}	A_1^{3}	A_1^{4}
neer	0.0039	-0.004	0.174	0.1369
i-i*	-0.417	-1.157	-4.936	-6.8551
fa	-0.029	-0.043	-0.568	-0.4307
op	0.073	0.121	0.88	0.1787
tot	-0.012	-0.02	-0.32	-0.368

Table 8.24: A_2 Matrix

	A_2
neer	0.003
i-i*	-0.17
fa	-0.026
op	-0.002
tot	0.034

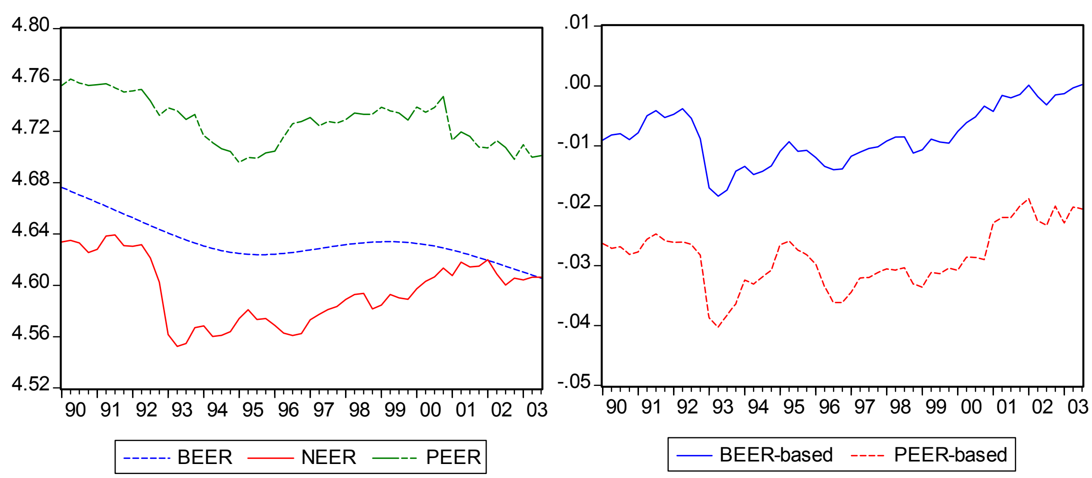
The transposed alpha orthogonal components matrix is multiplied by the A_1 matrix and the transposed beta matrix is multiplied by the A_2 matrix. The diagonal coefficients of these products provide the permanent and transitory rates of the fundamentals.

Table 8.25: Permanent – Transitory Decomposition

	i-i*	fa	op	tot
Permanent (P)	0.892	0.813	0.996	0.505
Transitory (T)	0.142	0.184	0.005	0.496
P + T	0.994	0.997	1.001	1.001

All summations (P+T) are very close to unity. Thus, the above decomposition can be considered as valid. So, about the 89% of the interest rate differential, the 81% of the foreign asset holding and the 99% of the oil price movements are allowed in equation (8.19) to measure the Permanent Equilibrium Exchange Rate (PEER). This rate, plotted against the BEER and the actual exchange rate, is shown in figure 8.12.

Figure 8.12: BEER, PEER, Total Misalignment



Although the BEER is higher than the actual exchange rate, the degree of misalignment is not too high. The highest rate of misalignment is observed in the second quarter of 1993 (1.8%), while the average misalignment rate is less than 1%. More satisfactory is the evidence at the end of the estimated period. The actual exchange rate deviates from the BEER by 0.01%. This implies that the Maltese lira completely meets its equilibrium rate.

On the other hand, the PEER implies a higher undervaluation rate. The PEER-based misalignment rate implies that during the estimated period the lira was undervalued, an implication which coincides with the BEER analysis. What is different is that the exchange rate never meets its equilibrium rate. It is always away from the PEER estimate. However, the magnitude of the misalignment is low. The highest undervaluation rate does not exceed the 4%, the lowest deviation is about 2%, while on average the Maltese lira deviates by less than 3%.

All of these enforce us to believe that the actual exchange rate does not deviate significantly from its equilibrium rate. In accordance, BEER and PEER estimates seem quite similar. This implies that the BEER estimate entails only a small percentage of transitory components.

8.6. Concluding Remarks

As we have already mentioned, the motivation of the present study was to examine the likelihood of emergence of significant exchange rate fluctuations in the future for the candidate EMU countries. In doing so, we estimated the equilibrium rate of the nominal effective exchange rates for selected EMU potential members: 3 Central Eastern European Countries (Poland, Hungary, Slovak Republic) and Malta. If significant misalignments persist, the behaviour of nominal exchange rate is expected to be unstable in its attempt to find its equilibrium rate. In contrast, an observed exchange rate close to its equilibrium implies that we do not expect large fluctuations in the future, excluding unanticipated shocks. Thus, the foregoing participation into EMU does not lead euro, regarding its stability, to any hazardous pathway.

In general, the PEER estimates imply a higher misalignment rate than the BEER estimates do.[136] The Polish zloty was very close to equilibrium at the end of the estimated period. Following BEER, it has been overvalued by less than 1% and by 7% according to PEER. The Hungarian forint was slightly overvalued (less than 10%) at the end of the estimated period, based on BEER estimation. In contrast, the PEER estimation shows that the overvaluation rate was high and sustainable. Similarly, the Slovak crown was both overvalued and undervalued. Although, the PEER misalignment rate implies a high misalignment rate (about 50%), the BEER estimate shows that the exchange rate does not deviate significantly. Specifically, at the end of the estimated period, the Slovak crown was undervalued by 7%. Finally, the BEER-based analysis shows that in the last quarter of 2003 the actual Maltese lira has been totally matched with its equilibrium rate. Following the PEER analysis, at the same time, the effective exchange rate was undervalued by only 2%.

To conclude, our analysis indicates that the actual effective exchange rates do not deviate significantly from their equilibrium rates. As a consequence, based on BEER analysis, we do not expect any anticipated large fluctuations in the examined effective exchange rates. Hence, the relevant effective exchange rates are expected to be relatively stable. This evidence persuades us to assert that those countries can successfully meet the exchange rate criterion. As a matter of fact, the introduction of those countries into EMU is not expected to weaken the stability of euro.

[136] This finding should worry us about robustness of the trend-cycle decomposition. This is not a panacea, since alternative procedures can lead to different, and in some cases contradictory, estimates.

9. Equilibrium Exchange Rates and Foreign Exchange Market Efficiency

In chapter 5 we discussed the properties of the applied tests on foreign exchange market efficiency and we argued that although the Forward Rate Unbiasedness Hypothesis (FRUH) is appropriate for testing FOREX efficiency between developed markets, this is not suitable when developing countries are involved. These countries do not have well developed and independent from the government financial systems. Therefore, forward rates may be highly regulated and as a consequence inappropriate for deriving any inferences about foreign exchange market efficiency. In some cases, forward markets are totally absent and the forward rates are unavailable. Aron (1997) proposes a test of foreign exchange efficiency by regressing the long run relationship of the spot rate with a vector of fundamentals.[137] Although, Wickremasinghe (2004) applies a cointegration test in the case of a developing country, we cannot adopt this methodology[138]. Hodrick (1987), Baffes (1994), Engel (1996) and others emphasize on the invalid properties of this test. As a consequence, the empirical tool for testing this hypothesis in developing markets is still missing.

The present chapter proposes an alternative way of testing Foreign Exchange Market Efficiency Hypothesis for developing countries. This methodology is based on the

[137] He uses an error correction model to examine the predictability of future excess returns via the lagged disequilibrium error term. This test entails a two-step procedure. Firstly, evidence of cointegrating vectors between the spot rate and the vector of fundamentals implies that exchange rate movements can be explained by the relevant fundamentals. But, the estimation of the error correction model shows that exchange rate returns are predictable by the fundamentals. Therefore, the efficiency hypothesis is rejected.

[138] He assumes that FOREX efficiency requires that two spot rates cannot be cointegrated.

Behavioural Equilibrium Exchange Rate (Clark & MacDonald, 1998). The FOREX market will be efficient if fully reflects all available information. If this holds, the actual exchange rate will not deviate significantly from its equilibrium rate. The proposed methodology concentrates on the statistical properties of the misalignment rate. Considering a Logistic Smooth Transition Autoregressive (LSTAR) model we test whether a nonlinear STAR model or a linear autoregressive model should be estimated. This test is applied to three Central & Eastern European Countries – members of the EU. In each case, we examine exchange rates per euro to find whether these rates imply efficient foreign exchange markets. The contribution of this study is twofold. Firstly, we find whether those countries' currencies are misaligned against euro. This is important information regarding their prospective membership of EMU. Secondly, this study provides an appropriate framework of examining FOREX market efficiency when a developing country is the case. To our knowledge of literature, this is the first time the concept of equilibrium exchange rate (BEER) is applied to characterize a foreign exchange market as efficient or inefficient.[139]

The model and the proposed test are described in the following section. Section 9.2 describes the dataset and section 9.3 presents our estimation. Section 9.4 summarizes and discusses the policy implications of this analysis by stressing the strong connection among equilibrium rates, market efficiency and currency crises.

[139] A similar study is this of Aron (1997). However, our approach differs significantly from this. Our test does not require unpredictable exchange rates.

9.1. Theoretical Framework

9.1.1 The Model

Although the BEER approach does not rely on any theoretical model, here we apply a modification of the monetary model of exchange rate determination. Consider the Monetary model of exchange rate determination (Frenkel, 1976, Kouri, 1976 and Mussa, 1976 & 1979), in which prices are flexible and PPP & UIP conditions hold all the time. Assuming that agents form rational expectations, the monetary model can be expressed by equation (3.11):[140]

$$e_t = \frac{1}{1+\mu}\sum_{0}^{\infty}\left(\frac{1}{1+\mu}\right)^i E_t[(m_{t+i} - m^*_{t+i}) - \phi(y_{t+i} - y^*_{t+i})] \tag{3.11}$$

Expression (3.11) implies that the exchange rate is forward looking and responds today to new information about future values of money stock and output. In other words, current values of exchange rates contain expectations for future values of the fundamentals. If the foreign exchange market is efficient, current spot rates reflect all available information for current and future values. So, a misaligned spot rate may exist because of new or unexploited information. In that case, the foreign exchange market is inefficient.

Therefore, assuming that the BEER is estimated based on the fundamentals of the monetary model (including the inflation rate)[141], if the current spot rate deviates

[140] To find more about how this equation is derived, see chapter 3.

[141] Here, we employ a modification of the monetary model. According to this model, the nominal exchange rate depends on the relative money supply, the relative output, and the interest rate differential. Applying the UIP condition and the PPP hypothesis, the exchange rate equation is expressed by equation (3.9). Now, assuming that agents have perfect foresight, we derive an equation similar to (9.1).

significantly from its equilibrium rate, the foreign exchange market does not incorporate efficiently all available information. As a consequence, the market cannot be efficient.

Let now discuss the way the Behavioural Equilibrium Exchange Rate (Clark & MacDonald, 1998) is estimated. Focused on the above fundamentals, the long run exchange rate is estimated by the following equation:

$$e_t = (m_t - m_t*) - \phi(y_t - y_t*) + \mu(\pi_t - \pi_t*) \tag{9.1}$$

where e = nominal exchange rate, m = money supply, y = output, π = inflation rate. The expected sign of the fundamentals is given by the corresponding signs in equation (9.1). Namely, a relatively higher increase in domestic money supply is expected to increase the exchange rate (i.e. to depreciate the domestic currency).[142] The same holds for the inflation rate differential. On the other hand, a relatively higher increase in domestic output is expected to appreciate the domestic currency.[143]

The estimated rate, implied by equation (9.1), corresponds to the long run exchange rate but not to the equilibrium rate. This rate will be estimated by capturing the sustainable values of the independent variables. Then, these values are included in equation (9.1), which has the following form:

$$BEER_t = (\tilde{m}_t - \tilde{m}_t*) - \phi(\tilde{y}_t - \tilde{y}_t*) + \mu(\tilde{\pi}_t - \tilde{\pi}_t*) \tag{9.2}$$

Comparing this rate with the actual exchange rate we find how the latter deviates from the former. In other words, this yields the misalignment rate, which shows whether

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[142] The increased money stock increases the domestic price level. This makes domestic goods less competitive than the foreign ones. Thus, demand for domestic goods decreases and this of foreign goods increases. As a result, the domestic currency depreciates.

[143] This will increase the demand for money and given the money supply constant, there is excess demand for the domestic money stock. The money market equilibrium will be restored if people reduce their expenditure on consumption. Domestic prices fall and through PPP the exchange rate decreases.

the exchange rate is overvalued or undervalued. According to the specification of the monetary model, an increase in the exchange rate means depreciation of the domestic currency. Thus, if e > beer, the domestic currency is undervalued. In contrast, if e < beer, the domestic currency is overvalued.

9.1.2. Foreign Exchange Market Efficiency

In terms of foreign exchange market efficiency, the misalignment rate should not be significantly high. This requirement is sensible since a high misalignment rate implies that the actual exchange rate is not in line with the fundamentals. However, this is not sufficient. What we actually mean by "high misalignment"? Is this 5%, 10% or higher? Thus, we need a more specific criterion. This comes by the statistical analysis of the misalignment rate. More specifically, we need to know about the stationary nature of the misalignment rate. If this is non-stationary [i.e. I(1)], it implies that past values can predict future values. When a series follows a random walk, previous shocks can have a continuous impact on the current values of the series. As a consequence, the misalignment rate contains unexploited information, which can be used for unusual profits. In other words, the available information is not efficiently exploited. In that case, the foreign exchange market is not efficient.

In contrast, an efficient foreign exchange market requires the misalignment rate to be stationary, i.e. I(0). This means that it contains no information. The BEER incorporates all the available information. Thus, the actual exchange rate is in line with the fundamentals. Under this circumstance, the foreign exchange market is efficient because it efficiently exploits all the available information. In other words, the stationary nature of the misalignment implies that the spot rate deviates from its equilibrium rate by only transitory components (i.e. it follows a white noise process). Under this circumstance the misalignment is mean reverting, indicating an equilibrium process.

The actual exchange rate may deviate from its equilibrium rate either because fundamentals are away from their sustainable values or because the foreign exchange market is not properly working. What make macroeconomic fundamentals to move away from their equilibrium values may be transaction costs, government intervention and inefficient exploitation of the available information. MacDonald (1988) mentions some of the reasons of foreign exchange market inefficiency. For instance, transaction costs, government intervention and incomplete information are some of those. As a consequence, the concepts of equilibrium and efficiency are very closely related.

Obviously, the exchange rate should not be highly volatile. Exchange rate fluctuation is directly related with exchange rate misalignment. The latter is the core of future exchange rate fluctuation. If significant misalignments persist, the behaviour of the exchange rate is expected to be unstable in its attempt to find its equilibrium rate. On the other hand, an observed exchange rate close to its equilibrium implies that we do not expect high fluctuations in the future, excluding unanticipated shocks. Therefore, foreign exchange market efficiency requires a stable and not misaligned spot rate.

Since our main concern is foreign exchange market efficiency, we need to know whether the spot rate moves self-directed towards equilibrium or instead it is driven by government interventions. To capture this we employ official exchange rates as well as cross exchange rates. The latter is this exchange rate if any intervention is absent. In other words, triangular arbitrage is held perfectly. If the cross and the official rates are identical, the official spot rate is determined under no intervention. In contrast, if the official spot rate deviates significantly from the cross exchange rate, we imply that the monetary authorities intervene in the foreign exchange market to correct the disequilibrium. Strictly speaking, interventions are not consistent with efficiency. However, an intervention can drive the exchange rate closer to equilibrium. In other words, it may help the foreign exchange market to work efficiently. But, this may be misleading because any presence of intervention is evidence that the FOREX market cannot efficiently exploit all the available information.

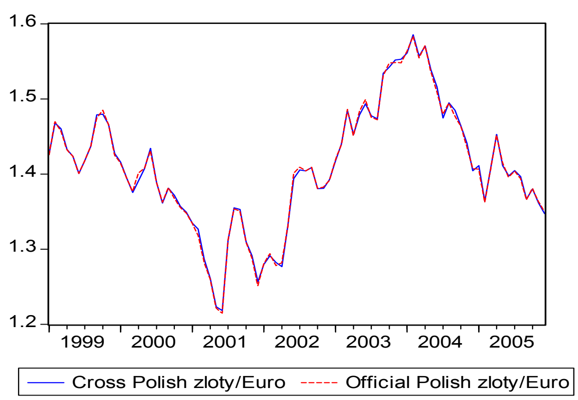
Moreover, the presence of structural breaks is very common in the case of developing countries. Changes in the monetary policy, exchange rate regime-switching and other structural reforms in these economies can affect exchange rate movements and as a consequence can interrupt the mean-reverting process of the misalignment rate. This implies that by taking into account these developments we may find a mean reverting - but interrupted for a short period – process. Therefore, if by excluding any break we reject the mean reverting process and by allowing the presence of a break we find that the misalignment follows a white noise process, the FOREX market is said to be "quasi-efficient". By this term we mean that a shock can cause market inefficiency only temporarily. While the mean reverting process is interrupted, this process is continued after a short period. Finally, we examine whether the exchange rate misalignment is characterized by a nonlinear mean reverting process. In line with recent empirical findings[144], we test whether a linear autoregressive model or a nonlinear STAR model should be estimated.

9.2. Data Description

The data set, collected mainly from IFS CD-ROM (2006), consists of monthly observations on exchange rates, inflation rates, money supply and output, from 1999:1 to 2006:2, for Czech Republic, Slovak Republic, Poland and euro area.

Nominal exchange rates (e) stand for bilateral exchange rates per euro. In each case we employ two different types of exchange rates. Official exchange rates per euro are taken from those countries' Central Bank databases. The other type of exchange rates corresponds to cross exchange rates. They are computed through US dollar exchange rates assuming perfect triangular arbitrage. For instance, the Polish zloty/euro exchange rate is estimated using the Polish zloty/US dollar and euro/US dollar exchange rates. An increase in both types of exchange rates implies depreciation of the national currency against euro.

Figure 9.1: Polish zloty/euro



[144] To find more about nonlinear models and their application on exchange rates, see chapter 2 (section 2.1.4.), which reviews the empirical literature on relevant nonlinear models.

Figure 9.2: Slovak crown/euro

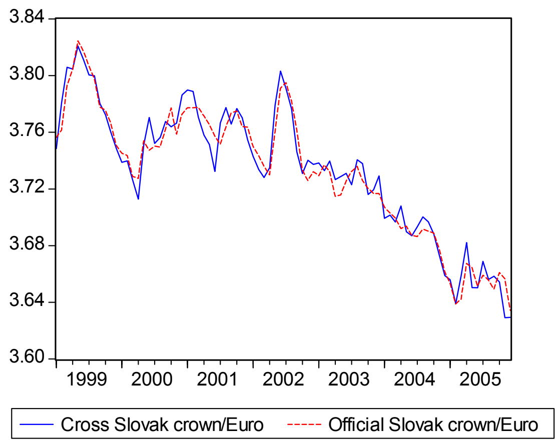
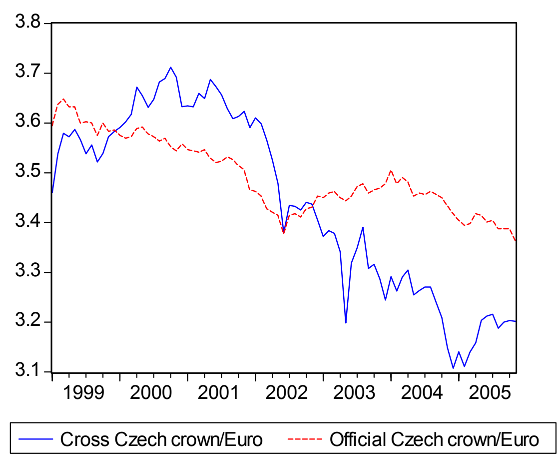


Figure 9.3: Czech crown/euro



The above graphs plot official against cross exchange rates (both in natural logarithms). These rates are identical for the case of Polish zloty per euro, while they are almost equal for the Slovak crown/euro. This implies that spot rates against euro are determined under no (or at least little) intervention in the foreign exchange market. In contrast, the official Czech crown/euro differs significantly from the corresponding cross exchange rate. The former is less volatile, which may be attributed to government interventions in the foreign exchange market.

Money supply (m) corresponds to change in money supply and it is presented as a percentage. Similarly, inflation rate (π) is based on the Consumer Price Index. Euro area's inflation rate is computed as the average of the CPI-inflation rates of Germany, France, Italy and Spain. Finally, output variable (y) is represented by industrial production. Likewise, euro area's industrial production is the average of the corresponding values of Germany, France, Italy and Spain. All variables, apart from money supply and inflation rate, are presented in natural logarithms.

9.3. Empirical Analysis

9.3.1 Behavioural Equilibrium Exchange Rate

Estimation procedure is performed by the Johansen cointegration technique (Johansen, 1988). Under this framework, the fundamentals and the exchange rate must form a long-run linear combination. We start by regressing VAR models[145] in levels to select the appropriate lag length by the Akaike Information Criterion (AIC). Next, including the implied number of lags, we estimate the corresponding VAR models in first differences and we check their robustness by testing their parameters constancy. The next table tests whether the VAR-residuals are normally distributed, homoskedastic and serially uncorrelated. Values presented first are test statistics, while values in parentheses are probabilities of accepting the null.

[145] Given that the official Czech crown/euro is different from the cross exchange rate, we have to regress two VAR models for the case of Czech crown per euro exchange rate. For the rest of the examined exchange rates, only one VAR model is estimated because cross and official exchange rates coincide.

Table 9.1: Diagnostics

Model / **Null Hypothesis**	**Lags**	**No autocorrelation**	**Homoskedasticity**	**Normality**
Poland/euro	9	9.42 (0.39)	327.6 (0.61)	*58.26 (0)*
Czech/euro (official)	5	6.13 (0.72)	180.42 (0.71)	*40.47 (0.02)*
Czech/euro (cross)	5	7.87 (0.54)	116.7 (0.01)	*101.4 (0)*
Slovak/euro	8	24.4 (0.08)	663.7 (0.45)	*113.6 (0)*

The no-autocorrelation hypothesis is a Lagrange Multiplier test, while White's heteroskedasticity and Jarque-Bera (normality) test statistics follow the Chi-square distribution. There is strong evidence that errors are not serially correlated. Similarly, the evidence is strong against heteroskedasticity, apart from Czech/euro (cross) model, in which there is weaker evidence. In contrast, normality can be accepted only in the Czech/euro (official) model at the 1% significance level. However, this is not going to violate our estimation output. Since our data set is quite large (more than 80 observations), the errors are asymptotically normal (Central Limit Theorem). In overall, diagnostics imply that the corresponding VEC models do not suffer from any misspecification problem. Thus, robustness of our estimation is confirmed.

The acceptance of at least one cointegrating vector establishes a valid long run relationship between the exchange rate and the vector of fundamentals. In other words, this evidence implies that exchange rate movements are explained by the monetary fundamentals. Cointegration tests are presented in table 2. The second column of the table shows the variables included in the vector of fundamentals. At a first stage we include all variables in the vector. However, weak exogeneity is not accepted in some cases.

Table 9.2: Cointegration test – Weak Exogeneity test

Model	Variables	Cointegration Sub-model	Number of C.V.		Weak Exog. test: LR statistic
			Trace	*Max Eig.*	
Poland/euro	s, m, y, π	2^{nd}	1	0	**
Czech/euro (cross)	s, m, y, π	2^{nd}	2	1	13.52 (0.003)
Czech/euro (offic)	s, m, y, π	2^{nd}	1	0	**
Slovak/euro	s, m, y, π	2^{nd}	1	1	1.42 (0.69)

** means that convergence is not achieved

This may mean that some variables are endogenous to the exchange rate equation. To avoid this, we exclude those variables for the VECMs. So, given the results on Table 9.3, industrial production and money supply differentials are found to be endogenous to the Poland/euro and Czech/euro, respectively. Only by accepting the weak exogeneity restriction, the implied cointegrating relationship is valid. This means that movements towards equilibrium are due to exchange rate correction movements.

Table 9.3: Updated Cointegration test – Weak Exogeneity test

Model	Variables	Cointegration Sub-model	Number of C.V.		Weak Exog. test: LR statistic
			Trace	*Max Eig.*	
Poland/euro	s, m, π	2^{nd}	1	0	4.69 (0.09)
Czech/euro (cross)	s, y, π	2^{nd}	1	1	8.68 (0.01)
Czech/euro (offic)	s, y, π	2^{nd}	1	0	1.04 (0.59)
Slovak/euro	s, m, y, π	2^{nd}	1	1	1.42 (0.69)

Table 9.3 presents two cointegration test statistics, the trace and the max-eigenvalue. While the latter finds no evidence of cointegration in the Poland/euro model, the former finds evidence of a unique cointegrating vector in each model. Hence, based on trace statistic, the fundamentals can explain exchange rate fluctuations. Furthermore, the

acceptance of the weak exogeneity assumption validates the implied cointegrating relationships.

The estimated coefficients are presented in table 9.4. Values on the second column of the table correspond to the estimated adjustment coefficients. Since they are all statistically significant, these values show the speed of adjustment. For instance, misalignments are reduced by 12% in a month for the Poland/euro exchange rate. Similarly, the cross and the official Czech/euro exchange rates move closer to equilibrium - in a month - by about 25% and 8%, respectively. Stronger convergence to equilibrium is observed in the Slovak/euro case. In this case, deviations from equilibrium damp out by 64% during a month.

Table 9.4: Adjustment Coefficient - Estimated Coefficients

Model	**Alpha** (s.e.)	**constant** (s.e.)	**m-m*** (s.e.)	**y-y*** (s.e.)	**π-π*** (s.e.)
Poland/euro	-0.12 (0.03)	1.31 (0.05)	0.02 (0.007)	---------------	0.004 (0.007)
Czech/euro (cross)	-0.25 (0.05)	3.61 (0.02)	-------------	-1.36 (0.13)	0.02 (0.01)
Czech/euro (official)	-0.08 (0.02)	3.57 (0.03)	-------------	-0.78 (0.17)	-0.05 (0.01)
Slovak/euro	-0.64 (0.13)	3.81 (0.01)	-0.0003 (0.0003)	-0.32 (0.05)	-0.006 (0.001)

The inflation rate differential (Poland/euro) and the money supply differential (Slovak/euro) are statistically insignificant. Therefore, they should be excluded from the foregoing analysis. When it comes to the sign of the estimated coefficients, money supply and output differentials are as expected. According to the monetary model of exchange rate determination, a higher increase in the domestic money supply depreciates the domestic currency. This is in line with the positive sign, shown in Poland/euro exchange rate equation. Moreover, if the domestic country grows more than the foreign one, then we expect the domestic currency to appreciate. In our case, the negative sign of the industrial production differential is consistent with the above statement. However, the evidence is not clear for the inflation rate differential. This is correctly signed in the Poland/euro and Czech/euro (cross) models, while it has the opposite sign in the (official) Czech/euro and Slovak/euro models. A higher domestic inflation rate makes domestic goods less competitive than the foreign ones. Thus, demand for domestic goods decreases and this of foreign goods increases. As a result, the domestic currency depreciates.

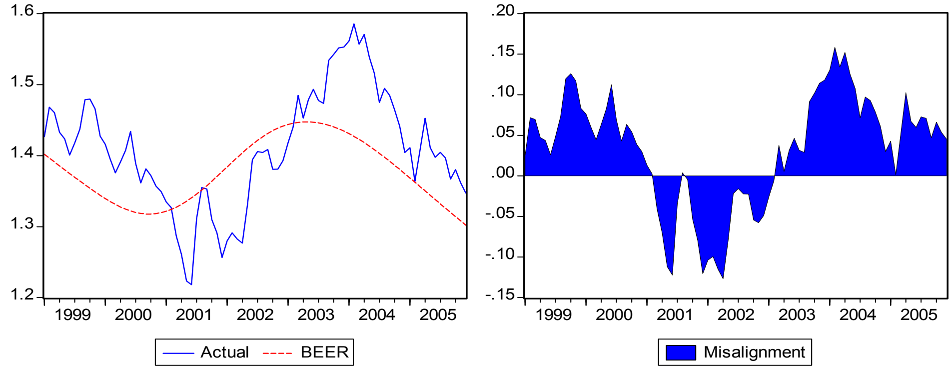
Polish zloty per euro Equilibrium Exchange Rate

The long run exchange rate equation, excluding any insignificant variables, is presented by the following equation:

$$lrer = 1.31 + 0.02(m - m^*) \tag{9.3}$$

This rate corresponds to the current equilibrium exchange rate, while the deviation of this rate from the actual exchange rate stands for the current misalignment rate. However, what exactly matters is total misalignment. This is estimated only by estimating the behavioural equilibrium exchange rate. In this case, we get the smoothed value of the money supply differential by the Hodrick-Prescott (1997) filter. Next, we replace, in equation (9.3), its actual value by the smoothed one to get the BEER. This is shown in the following figure, plotted with the actual exchange rate.

Figure 9.4: Polish zloty/euro



The left hand-side of the graph illustrates the above relationship, while the right hand-side shows the total misalignment rate. If the actual rate is higher than the BEER, the domestic currency is undervalued. This corresponds to positive misalignment values. In contrast, if the actual exchange rate is lower than the estimated BEER, the national currency is said to be overvalued. This is shown by negative misalignment values.

The evidence shows that the exchange rate is misaligned through time. There are two undervaluation eras and a unique overvaluation period for the Polish zloty. On average, the actual exchange rate deviates by about 4%. The highest misalignment rate (overvaluation by 10%) is observed in June 2001. At the end of the estimated period (December 2005), the Polish zloty was undervalued by 3%.

The observed exchange rate follows a downward path from 1999 to 2002, implying an appreciation trend for the Polish zloty. In contrast, the period 2002-2004 corresponds to a significant devaluation of the Polish zloty against euro. Specifically, during this period, the Polish currency depreciated by 19% against euro. This may be attributed to the failure of matching the inflation and interest rate targets. For the period 1999-2003, the inflation target was set to a rate less than 4%. However, in 2000 this target was re-set to 5.4%-6.8%. In 2001, the inflation target was 6%-8%, but it was not fulfilled because of supply shocks. During the estimated period, the long-term interest rate was decreasing but slightly above the reference rate. It is worth notable that during this period, the depreciation trend was consistent with the estimated BEER. In other words, the BEER was increasing as well. However, the fluctuation was smoother and the devaluation period was shorter. On the other hand, the BEER implied even higher exchange rate. This means that the Polish zloty was overvalued.

The BEER follows a downward path from 2003, while the actual exchange rate starts decreasing from 2004. Namely, the appreciation trend of the Polish zloty has been delayed by a year. Furthermore, BEER implies that during the period 2003-2005 the Polish zloty was undervalued. The zloty's appreciation trend is the outcome of a tight monetary policy, applied by the Polish monetary authorities.

Czech Crown per euro Equilibrium Exchange Rate

The current equilibrium of the cross exchange rate is given by the following equation:

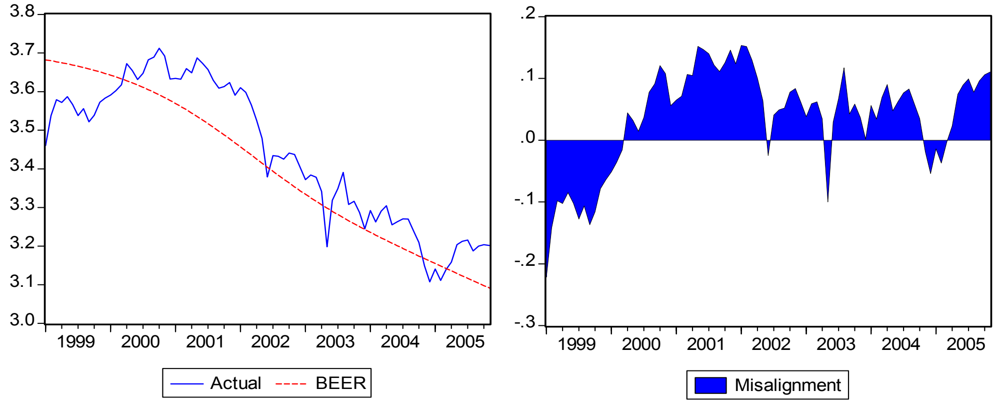
$$lrer = 3.61 - 1.36(y - y^*) + 0.02(\pi - \pi^*) \tag{9.4}$$

Similarly, the current equilibrium of the official exchange rate is given by equation (9.5):

$$lrer = 3.57 - 0.78(y - y^*) - 0.05(\pi - \pi^*) \tag{9.5}$$

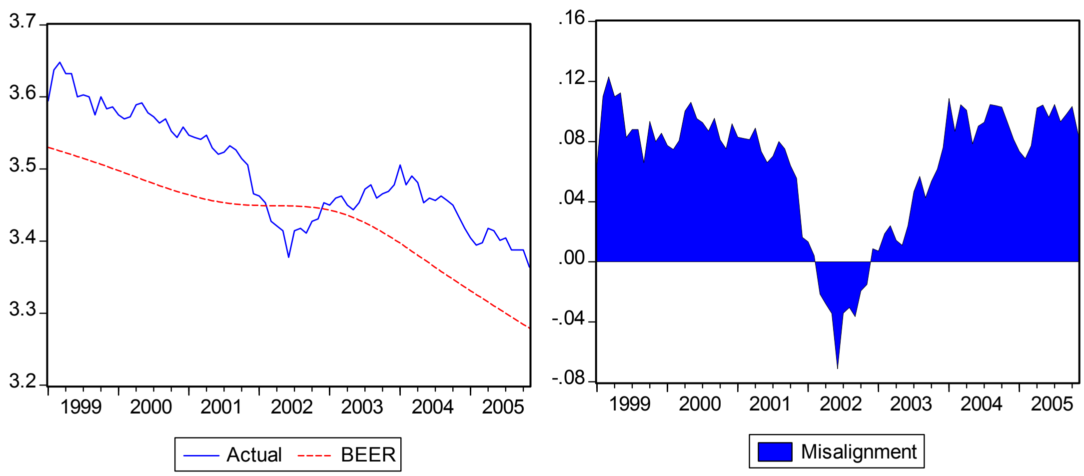
Then, by applying the modified Hodrick-Prescott filter, we estimate the sustainable values of the fundamentals. The smoothed values substitute their actual values, in equations (9.4) and (9.5), to get the Behavioural Equilibrium Exchange Rate. By subtracting this rate from the actual exchange rate, we derive the total misalignment rate. These rates are shown below:

Figure 9.5: Cross Czech crown/euro



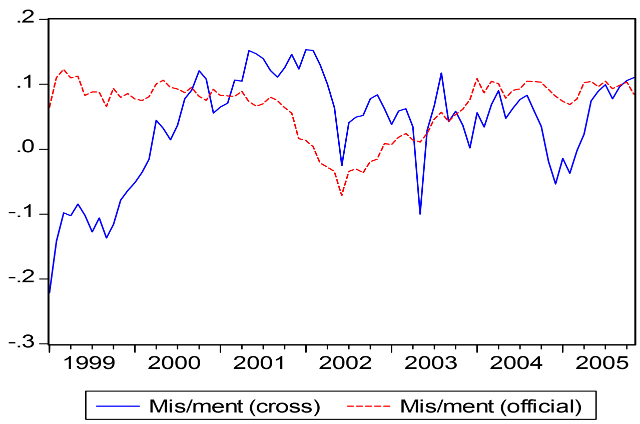
Starting with the cross exchange rate, Czech crown was mainly undervalued against euro. However, the beginning of the estimated period is an overvaluation period, which lasts until 2000. The highest misalignment rate (overvaluation by 6%) is observed in January 1999. On average, the exchange rate is misaligned by 2%, while at the end of the estimated period the Czech crown was undervalued against euro by 3%.

Figure 9.6: Official Czech crown/euro



Now turning to the official exchange rate we can see from figure 9.6 that BEER implies a lower exchange rate. Namely, there is evidence that the Czech crown was mainly undervalued, except a single overvaluation period during 2002. In overall, this is not contradictory to the above implication (based on cross exchange rate analysis). But, as exchange rates are different, equilibrium exchange rates are different as well. As a consequence, the implied misalignment rates are not equal. This is shown in the following figure:

Figure 9.7: Comparing the Misalignment Rates



Specifically, the misalignment rate based on cross exchange rate is more volatile and higher than the other one. When overvaluation is the case the highest (cross) misalignment rate is 6.5%, while the corresponding (official) misalignment rate is 2%. In the case of undervaluation, the cross and official misalignment rates mention undervaluation by 4% and 3%, respectively. However, on average the two misalignment rates are equal (about 2%). All these imply that foreign exchange interventions have driven the exchange rate closer to equilibrium.

In 1997 Czech Republic abandoned the fixed peg exchange rate regime. Since then, the Czech crown is determined under a managed floating exchange rate regime. This means that although the currency can fluctuate, the Central Bank retains the right of intervention in the foreign exchange market. In most of the estimated period the Czech crown appreciates against euro. This is a natural consequence of the evolutionary process of the Czech economy. In 2004, the Czech economy grew by 4% - the same rate as in 2003 – which was higher than the average GDP growth rate of the former EU members.

The appreciation trend of the Czech crown is in line with the macroeconomic developments. In other words, the BEER – estimated by the macroeconomic fundamentals – establishes the appreciation of the Czech currency. Thus, this can be characterized as an equilibrium movement.[146] The Czech inflation rate follows a downward path. In 1997 the inflation rate was 8%, while in 2004 prices were higher by only 1.8% - compared to 2003 – which was lower than the reference rate (2.4%). The lower inflation rate and in general the increased credibility of the national monetary system, helped the long term interest rate to follow a decreasing trend as well. During the period 2003-2004, the Czech interest rate was 4.7%, lower than the reference rate (6.4%).

In terms of its fiscal discipline, the government deficit as a ratio of GDP was 12.6% in 2003. Specifically, this rate has been increased by 5.8% relative to the previous year's rate. In contrast, public debt as a ratio of GDP was 37.8% in 2003 (i.e. lower than 60%). However, this rate was increased by 9% compared to 2002. These developments may explain the depreciation of the Czech crown against euro during 2003 (cross) and for the period 2002-2004 (official).

[146] Though, the depreciation of the cross and official Czech crown during 2003 and 2002-2004, respectively, was not in line with the BEER. In other words, the fundamentals included in the BEER equation do not dictate this movement. This can be explained by other macroeconomic conditions, shown in few lines below.

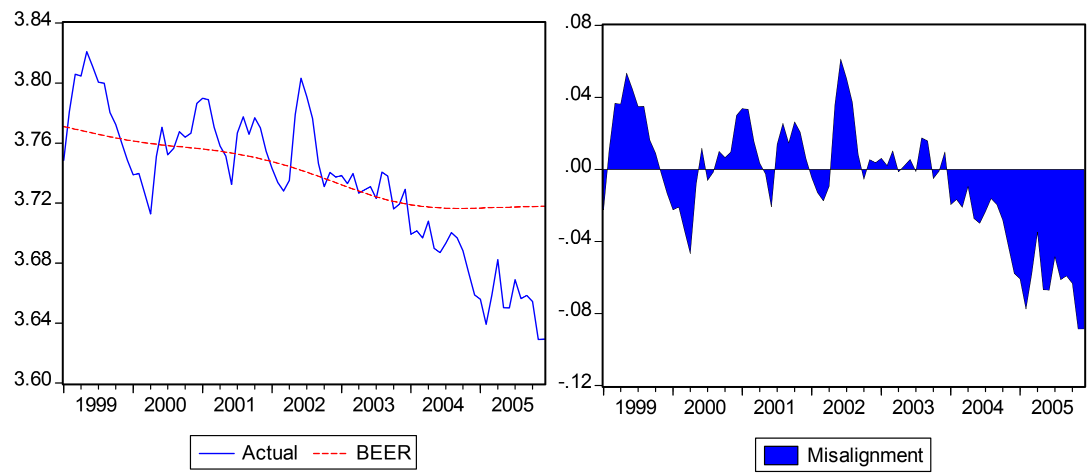
Slovak Crown per euro Equilibrium Exchange Rate

Similarly, the long run exchange rate equation is given by:

$$lrer = 3.81 - 0.32(y - y^*) - 0.006(\pi - \pi^*) \qquad (9.6)$$

Then, we estimate the sustainable values of the output and inflation rate differentials, applying the modified H-P filter. The actual values of the fundamentals are substituted by their smoothed series. As a consequence, equation (9.6) becomes the Behavioural Equilibrium Exchange Rate equation. Total misalignment is the difference of the actual exchange rate from the estimated BEER. These rates are shown in the following figure.

Figure 9.8: Slovak crown/euro



The actual exchange rate fluctuates around BEER, indicating small in duration and value misalignment rates. Namely, the Slovak crown was both slightly overvalued and undervalued against euro. On average, the exchange rate is misaligned by less than 1% (0.7%). The highest misalignment rate is observed at the end of the estimated period. While the BEER implies a stable exchange rate, the domestic currency follows an appreciation trend. This yields the overvaluation of the Slovak crown by 2% (December 2005).

The estimated period can be decomposed into two periods. The first one starts in 1999 and ends in 2004, while the other starts in 2004 and lasts until the end of the estimation period. The former period corresponds to a small and controlled appreciation trend for the Slovak Crown, while during the latter period the Slovak currency appreciates rapidly. The appreciation trend - during the first period - is consistent with the fundamentals, since the BEER follows the same trend. After a year of the creation of the Slovak Republic (1993) GDP increased by 4.3%, while at the same time inflation rate decreased from 20% to 12%. In 2003, the Slovak economy grows by 4.5% and in 2004 grows by 5.5%. When it comes to the inflation rate, this was 5,9% in December 2004, lower by 3.4% compared to 2003. This is still higher than the reference rate, but it follows a declining trend.

On the other hand, the long-term interest rate is lower than the reference rate. Similarly, Slovak Republic has a well-specified public finance position, since the public debt criterion is already fulfilled and the government deficit criterion is expected to be fulfilled by 2007. A question arises is why the exchange rate falls rapidly after 2004. This movement is not dictated by the fundamentals, since in the second period the BEER implies a stable exchange rate. The true reason is the exchange rate regime switch. The Slovak crown is determined under a floating exchange rate regime since 2004. However, the National Bank of Slovakia retains the right of intervention in the foreign exchange market to manage exchange rate fluctuations. This means that although the BEER was able to capture all the previous positive facts of the Slovak economy, these facts seem to be discounted by delay (retroaction) during the free float era or at least they create favorable expectations for the Slovak economy.

9.3.2. Foreign Exchange Market Efficiency

As mentioned earlier, the efficiency market hypothesis is tested through examining the stationary nature of the misalignment series. Here we relax the linearity hypothesis and we test whether the misalignment exhibits a nonlinear behaviour. This test is pivotal for the validity of our analysis. If a series follows a nonlinear adjustment, the autoregressive parameter will be biased upward and the unit root test will be biased against rejecting nonstationarity. Next, we present an LSTAR model and we examine whether this or a linear autoregressive model should be estimated.

Testing Linearity Hypothesis

Following Terasvirta (1994) we consider a Logistic Smooth Transition Autoregressive (LSTAR) model of order l for the misalignment series (ξ).[147]

$$\xi_t = \varphi_{10} + \varphi_1^{'} w_t + (\varphi_{20} + \varphi_2^{'} w_t) \cdot [(1+\exp\{-\gamma(\xi_{t-d} - c)\})^{-1} - 0.5] + u_t \qquad (9.7)$$

$$\begin{aligned} &u_t \sim NID(0, \sigma_u^2) \\ &\varphi_j = (\varphi_{j1}, \ldots\ldots, \varphi_{jk})^{-1}, j = 1, 2 \\ &w_t = (\xi_{t-1}, \ldots\ldots, \xi_{t-k})^{-1} \\ &\gamma > 0 \end{aligned}$$

The term $(1+\exp\{-\gamma(\xi_{t-d} - c)\})^{-1}$ stands for the transition function while d is the delay parameter, which presents the possibility that the FOREX market will react to deviations from equilibrium with a delay. The parameter γ determines the speed of the transition process between the upper and the bottom regimes. The process becomes linear

[147] Actually, Terasvirta (1994) considers a Logistic Smooth Transition (LSTAR) model as well as an Exponential Smooth Transition (ESTAR) model and proposes a test procedure to choose between those models.

when the transition function is equal to zero. That means that linearity is confirmed if the null hypothesis H_0: $\gamma = 0$ is accepted against the alternative H_1: $\gamma > 0$. Expression (9.7) can be estimated only under the alternative hypothesis because the parameters c, φ_{20} and $\varphi_2^{'}$ can take any value. The Lagrange Multiplier test statistic has an asymptotic Chi-square distribution under the null, but the distribution is dependent on φ. Davies (1977) suggests an alternative LM test statistic, which has an unknown distribution under the null. Furthermore, in order to avoid any lack of power of the proposed LM test statistic, Luukkonen et al (1988) replace the transition function in equation (9.7) with its third-order Taylor approximation. Terasvirta (1994) tests linearity against LSTAR or ESTAR by estimating the following expression:

$$\xi_t = \beta_{00} + \sum_{j=1}^{l} \beta_{0j}\xi_{t-j} + \sum_{j=1}^{l} \beta_{1j}\xi_{t-j}\xi_{t-d} + \sum_{j=1}^{l} \beta_{2j}\xi_{t-j}\xi_{t-d}^2 + \sum_{j=1}^{l} \beta_{3j}\xi_{t-j}\xi_{t-d}^3 + u_t \qquad (9.8)$$

The null hypothesis of linearity is tested by $H_0 : \beta_{1j} = \beta_{2j} = \beta_{3j} = 0$, j = 1,…..,$l$., against the alternative that the null is not valid. Here we perform an F test as an approximation of the LM test. This approach has been undertaken by Michael et al (1997) in order to increase the power of the test. Harvey (1990) shows that when the lag length is large and the number of observations is small, the LM test suffers from low power. Terasvirta (1994) argues than in those cases LM-type tests should be avoided.

The estimation procedure begins with selecting the appropriate length of the autoregression of the misalignment series. This information is derived based on the Akaike Information Criterion (AIC) which suggests 5 lags for the Slovak misalignment, 4 lags for the cross exchange rate – based Czech misalignment, 1 lag for the official exchange rate – based Czech misalignment and 2 lags for the Polish misalignment. Once the order of the autoregression process has been identified, the null hypothesis of linearity is tested for different values of the delay parameter. Tsay (1989) determines the parameter d, which corresponds to the lowest p-value of the linearity test. Hence, we allow d to take values between 1 and 4 and we select this value of d such that the p-value of the F-type linearity test is minimized. The test is performed in RATS econometric software package using Doan's procedure.

Table 9.5: Linearity Test

Misalignment	*l*	d	F-statistic	Probability
Slovak	5	3	0.98	0.47
Czech(cross)	4	1	1.85	0.06
Czech(official)	1	2	2.11	0.10
Polish	2	2	2.06	0.07

The results imply that the linearity hypothesis is strongly accepted for the Slovak and Czech (official-based) misalignment rates, while the Polish and the Czech (cross-based) misalignment series follow a linear autoregressive process at 5% significance level. Since these series do not exhibit any nonlinear behaviour we should not estimate an LSTAR model. Instead, we can get valid implications based on linear unit root tests such as the Augmented Dickey-Fuller test.

Linear Unit Root Tests

Given that different tests may provide different results, we employ three alternative procedures to test for misalignment stationarity. To confirm robustness we perform two tests in which the null states that the series is non-stationary (ADF, PP) and a test with the opposite null hypothesis (KPSS). The results are shown in table 9.6, while table 9.7 summarizes these results at 5% and 10% significance level.

Table 9.6: ADF, PP & KPSS Unit Root Tests

Misalignment	Augmented Dickey-Fuller		Phillips-Perron		KPSS	
	Exogenous Term (lags)	Statistic (probability)	Exogenous Term (bandwidth)	Statistic (probability)	Exogenous Term (bandwidth)	LM Statistic
Poland/euro (levels)	none (1)	-2.06 (0.03)	none (3)	-1.75 (0.07)	constant (6)	0.24***
Poland/euro (1st dif)	none (0)	-7.77 (0.00)	none (7)	-7.76 (0.00)	----------	--------------
(cross) Czech/euro (levels)	none (0)	-2.60 (0.00)	none (2)	-2.60 (0.00)	constant (6)	0.39**
(official) Czech/euro (levels)	none (0)	-0.74 (0.39)	none (4)	-0.75 (0.38)	constant (6)	0.23***
(official) Czech/euro (1st dif)	none (0)	-10.07 (0.0)	none (4)	-10.00 (0.00)	-----------	-------------
Slovak/euro (levels)	none (4)	-0.73 (0.39)	none (2)	-1.55 (0.11)	μ & τ (6)	0.229
Slovak/euro (1st dif)	none (4)	-5.54 (0.00)	none (1)	-8.27 (0.00)	constant (0)	0.156***

Notes:
1. The null under the ADF and the PP tests assume that the series is not stationary. The null under the KPSS test assumes that the series is stationary.
2. MacKinnon (1996) one-sided p-values are shown in parentheses.
3. * means acceptance of the null at 1% significance level.
4. ** means acceptance of the null at 5% significance level.
5. *** means acceptance of the null at 10% significance level.

Table 9.7: Unit Root Tests

Misalignment	ADF	PP	KPSS
Poland/euro	I(0) I(0)	I(1) I(0)	I(0) I(0)
Czech/euro (cross)	I(0) I(0)	I(0) I(0)	I(1) I(0)
Czech/euro (official)	I(1) I(1)	I(1) I(1)	I(0) I(0)
Slovak/euro	I(1) I(1)	I(1) I(1)	I(1) I(1)

first row: 5% significance level
second row: 10% significance level

Although at 5% significance level the three tests do not provide identical results, the evidence is clearer at 10% significance level. So, the misalignment in the Poland/euro model is covariance stationary, i.e. I(0), while the exchange rate misalignment of the Slovak/euro model is non-stationary, i.e. I(1). These results imply that the former misalignment is mean reverting but the latter follows a random walk. As a consequence, the Slovak/euro FOREX market is not efficient because the misalignment contains information, not relevant with the estimated equilibrium exchange rate. On the other hand, the Poland/euro FOREX market can be characterized as efficient because the misalignment contains no information useful for predicting its future value. As a result, all available information is relevant with the estimated BEER. In other words, the market exploits efficiently all the available information.

When it comes to the Czech/euro FOREX market, the results based on the official exchange rate imply that this market is not efficient as the misalignment rate follows a random walk. On the other hand, the analysis based on cross exchange rate implies an efficient foreign exchange market. However, only the official exchange rate matters. As a matter of fact, this FOREX market is inefficient because of the government intervention. Although, these interventions help the exchange rate to move closer to the equilibrium rate, these are also the true reason for the implied inefficiency. Speculators with perfect foresight can predict the response of the monetary authorities. Thus, this is information, not relevant with the macroeconomic fundamentals, which can be used by economic agents. Recall that in the previous section we saw that the cross exchange rate implies a higher misalignment rate than the official one does. So, we would expect inefficiency when the cross exchange rate is the case. This finding enforces the idea that the magnitude of exchange rate misalignment is not the only factor that matters for FOREX market efficiency. Another important implication is that any kind of intervention in the foreign exchange market is contradictory to efficiency.

Unit Root Tests and Structural Breaks

Even though nonlinearities in the form of multiple thresholds have been rejected, a single structural break may exist in the examined non-stationary misalignment series. Under the presence of structural breaks conventional unit root tests are biased against rejecting non-stationarity. For this reason we apply Perron's (1997) unit root test, which allows the presence of a single break to the misalignment process.[148] In this study we perform this test by the Colletaz & Serranito (1998) procedure for RATS. While the l-lag length is selected by the general to specific method, the break date is selected by minimizing the t_ρ-statistic.

Next, we test whether the non-stationary nature of the misalignment is described by a constant non-stationary process or by a stationary, but interrupted, process. In other words, we test stationarity in the presence of a possible structural break. The following table presents the results by the Perron (1997) unit root test.

Table 9.8: Unit Root Test with Structural Breaks

Misalignment	**Model**	**Break Time**	l	**μ**	**β**	**γ**	ρ	t_ρ
Czech/euro (official)	AO	2001:12	5	0.13 (12.73)	-0.003 (-8.13)	0.005 (8.53)	0.86 (16.00)	-2.50
Slovak/euro	AO	2003:05	3	0.008 (1.70)	5.15 (0.34)	-0.003 (-7.57)	0.47 (4.80)	-5.41**

** means rejection of the null at 5% significance level.
t-statistics in parentheses.

[148] The properties of this test have been illustrated in chapter 2.

The specification of this test is the Additive Outlier model, which allows a change in the slope. The date of the structural break in the two misalignment series is linked with the rapid appreciation of the domestic currencies. In the case of the Czech/euro exchange rate, the appreciation of the Czech crown at the end of 2001 was consistent with the equilibrium rate but not in that magnitude. Furthermore, the appreciation of the Slovak crown in 2003 was not consistent with the macroeconomic fundamentals, since the BEER implies a stable exchange rate. When it comes to the unit root test, the Czech/euro misalignment is still non-stationary even by allowing the presence of the break. In contrast, the Slovak/euro misalignment is found to be stationary when the break is considered. These findings imply that the Czech/euro (official) FOREX market is not efficient, while the Slovak/euro market is "quasi-efficient".

9.4. Concluding Remarks

The Forward Rate Unbiasedness Hypothesis (FRUH), as an instrument of testing foreign exchange market efficiency, is appropriate only when developed countries are examined. Even if forward markets in developing countries exist, forward rates may be highly regulated by governments. This is because many developing countries have not well developed and independent from the government financial systems. As a matter of fact, we cannot rely on forward rates in order to make valid implications on FOREX market efficiency. Here we propose a test procedure based on equilibrium exchange rates, i.e. Behavioural Equilibrium Exchange Rate (BEER). An efficient FOREX market requires the exchange rate (spot rate) not to be highly unstable and misaligned and to deviate from its equilibrium rate by only transitory components. The statistical sense of this final requirement is that the misalignment should follow a white noise process.

Based on BEER analysis, on average the Polish zloty/euro exchange rate is away from its equilibrium rate by 4%, the Czech crown/euro exchange rate deviates by 2%, while the Slovak crown/euro exchange rate is misaligned by less than 1%. These estimates provide positive implications regarding the low misalignment condition. However, the magnitude of the misalignment cannot be alone a useful tool. According to the proposed methodology, the misalignment should be characterized by a stationary mean reverting process. Considering an LSTAR model we find no evidence of nonlinear adjustment in the examined series. So, linear unit root tests imply that the Poland/euro FOREX market is efficient; the Czech/euro FOREX market[149] is not, while the Slovak/euro FOREX market is quasi-efficient. This implies that a stationary process, interrupted by a structural break, characterizes the latter misalignment.

A question arises is whether the monetary authorities should respond to the inefficiency of the foreign exchange market. In other words, what are the policy implications of this analysis? Should the Central Bank leave the market alone to be driven to equilibrium by its own forces or it should intervene to correct any misalignments. In terms of foreign exchange market efficiency, any government intervention is a sign as well as a source of inefficiency. But, by intervening in the FOREX market, the exchange rate is driven closer to its equilibrium. We saw in the case of Czech/euro exchange rate that a lower misalignment rate (manipulated by the

[149] It is worth notable that the Czech/euro market is inefficient when the official exchange rate is applied. In contrast, when the cross exchange rate is applied, the misalignment rate is stationary, which implies an efficient FOREX market. The implication of this finding has been discussed in the previous section.

monetary authorities) does not necessarily imply efficiency. But, what we actually desire more, a misaligned self-driven exchange rate (consistent with efficiency) or a manipulated equilibrium exchange rate (inconsistent with efficiency)? This is a dilemma because a misaligned exchange rate can create a competitiveness problem (when overvaluation is the case) or inflationary pressures (when undervaluation is the case). On the other hand, speculators can see government interventions as evidence of inefficiency. When a market is inefficient there is room for speculative attacks, which may lead to a currency crisis.

It seems sensible that we cannot provide a unique answer. The response of the Central Bank should be subject to the specific conditions of the market as well as to the nature of the exchange rate misalignment. In other words, if the possibility of speculative attacks is high, they should avoid any kind of intervention. But how can we figure out if a currency crisis is possible to occur? We have to examine a number of economic conditions in the domestic economy, such as macroeconomic fundamentals' performance, monetary and fiscal position, financial sector's stability and political situation. Economic performance is poor before crises. Moreover, there is a bi-directional relation between banking and currency crises (Kaminsky & Reinhart, 1999). Namely, financial instability can import problems to the foreign exchange market. Finally, political situation is an important factor for crises. The empirical evidence shows that speculative attacks are more possible to succeed in countries with unstable political systems (Eichengreen et al, 1996). In addition, although fiscal situation is not directly linked with currency crises (only money-financed deficits are sources of speculative attacks), the evidence shows that some times it is related with attacks. This is because governments apply expansionary fiscal policies to reduce political cost.

This study stresses the strong linkages among equilibrium exchange rates, market efficiency and currency crises. When it comes to the examined foreign exchange markets, two of them are found to be efficient. This means that no government intervention is needed. On the other hand, the Czech/euro FOREX market is found to be inefficient. The following chapter provides a brief review on the currency crisis literature, including implications for the examined countries.

10. Exchange Rate Misalignment, Forex Efficiency and Currency Crises

In the presence of significant exchange rate misalignments the domestic currency is not valued as the macroeconomic fundamentals dictate. An important issue is the response of Central Banks in case of currency misalignments. Should they intervene in the foreign exchange market to correct the disequilibrium or they should leave the market to be driven towards equilibrium by its own forces? It seems sensible that we cannot provide a unique answer. The response of the Central Bank should be subject to the specific conditions of the market as well as to the nature of the exchange rate misalignment.

If the exchange rate misalignment is mean reverting (i.e. stationary), the foreign exchange market is said to be efficient since the exchange rate is misaligned only temporarily. This means that the exchange rate is self-driven towards equilibrium. Thus, there is no need for any action. In contrast, if the exchange rate misalignment is non-stationary, the exchange rate follows a disequilibrium pathway. In that case the foreign exchange market is not efficient because equilibrium cannot be restored.

Central Banks usually intervene in FOREX markets because a continual exchange rate misalignment is costly for the domestic economy. An undervalued domestic currency creates inflationary pressures, while overvaluation leads to loss of competitiveness in the domestic economy. But, these interventions (open market operations, direct operations on foreign assets, e.t.c.) are not costless. Krugman (1979) shows that if the Central Bank prevents its currency from depreciation, at some time there is loss of foreign exchange reserves. When appreciation is prevented, Central Bank's actions may increase inflation more than expected. When the authorities stop defending the currency, because of the above restrictions, successful speculative attacks are more possible. This pressure can lead to a currency crisis.

10. 1. Basic Concepts

Before we move to the analysis of currency crisis models and the factors that cause a crisis, it is useful to explain some basic concepts. According to Eichengreen et al (1996), speculative attack is a period of extreme pressure in the foreign exchange market. In other words, a speculative attack occurs when the speculative pressure index reaches extreme values.[150] A speculative pressure can affect foreign exchange reserves, interest rates and (or) exchange rates. The attack can lead either to depreciation of the domestic currency or to extremely high interest rates as a consequence of the response of the authorities to defend the domestic currency. But, not all speculative attacks can lead to devaluations. Some of them are not successful and some are successfully defended by the government.

Let now make a crucial distinction between devaluation and crisis. In general, devaluation is caused by a speculative attack, while a crisis entails a speculative attack. Similarly, not all crises lead to currency depreciation. Usually, attacks can lead to devaluations when:

(i) unemployment is high

(ii) monetary policy is loose

(iii) inflation is high

(iv) external accounts are weak

[150] Speculative pressure is measured as a weighted average of exchange rate changes, interest rates changes and foreign exchange reserves changes (relative to the corresponding changes for Germany).

After depreciation:

(i) reserves flow back

(ii) current account is improved (because of reduction in private spending)

(iii) external balance is restored

(iv) monetary and fiscal policy are tight

A common fact is that monetary policy is loose before devaluations and crises. This implies that there are warning signs of possible speculative attacks. But, Eichengreen et al (1996) argue that currency crises are not predictable. Macroeconomic fundamentals can give only a sign, but they cannot predict the timing of crises. Furthermore, a currency crisis may occur even if there is no macroeconomic imbalance.

Finally, based on empirical evidence, devaluations and crises differ in the following points:

(i) Monetary policy is tight before devaluation, while a crisis comes after monetary policy relaxation.

(ii) Stock prices decrease before the depreciation because of the increased interest rates. However, this does not happen before a currency crisis. This implies that either market is myopic (agents do not foresee the attack) or agents do not expect that a speculative attack can cause monetary tightening.

(iii) After devaluation, monetary policy is more restrictive in order to restore internal and external balance. Although, after a crisis monetary policy becomes tight, the restriction in money growth is not as high as after devaluation. As a result, interest rates are higher after a depreciation rather than after a crisis.

(iv) When macroeconomic imbalance is the source of the event, devaluation may occur when policy corrections have to be applied. In contrast, a currency crisis occurs when macroeconomic fundamentals are out of control.

10.2. Theoretical Models

The theoretical models of currency crises can be categorized into two major groups. The first one includes models in which a crisis is the result of macroeconomic imbalance, while the second category includes models that explain the currency crisis as a result of self-fulfilling expectations.

The first group of models is based on the seminal paper of Krugman (1979). In that model, monetary authorities keep the exchange rate fixed while they apply an expansionary monetary policy. He shows that the crisis is a result of the investors maximizing behaviour. They change the composition of their portfolios by selling domestic assets for foreign assets. The monetary authorities defend the currency using the existing foreign exchange reserves. The final step of the crisis entails a massive and discrete loss of reserves as a result of a speculative attack. The crisis comes before the authorities would have run out of reserves in the absence of speculation. Suppose that under the presence of the balance of payments problem (i.e. gradual loss of reserves), the agents do not foresee the time of abandonment of the fixed rate. Then, foreign exchange reserves run out, the currency depreciates and agents generate loss of capital. In contrast, if the agents can anticipate the time of the end of the fixed regime, they attack the currency (i.e. change their portfolio preferences) before the exhaustion of reserves. Then, a currency crisis occurs. Foreign exchange reserves are exhausted, the currency depreciates but speculators have avoided any capital losses. This model explains how governments' efforts to defend the fixed exchange rate can lead to currency crises.

A similar model in this category is that of Flood & Garber (1984). In their model the government generates a domestic credit expansion, while it defends the fixed exchange rate in the usual way (i.e. using the existing foreign exchange reserves). Foreign exchange reserves are decreasing at a rate proportional to the rate of domestic credit expansion. Suppose that the government stops defending the fixed rate when reserves reach a predetermined lower value. Then, speculators will foresee this point and they will deplete all reserves before that point is reached. According to that model the timing of the crisis depends on the initial level of reserves, the minimum limit of reserves and the rate of domestic credit expansion.

The second category of currency crisis models explains the existence of a crisis even if there is no macroeconomic instability. This category originates from Obstfeld (1986) model, in which a speculative attack occurs because of private sector expectations of a loose monetary policy after the collapse of the fixed exchange rate regime. Agents expect that monetary authorities will adopt an inflationary domestic-credit growth rule at time the fixed exchange rate collapses. The expectations of currency devaluation force agents to sell domestic currency because any switch to the above policy is unprofitable for any speculator. Then, they join the attack, which exhausts foreign exchange reserves, and the authorities switch the exchange rate regime. The domestic currency depreciates and the expectations are fulfilled.

Another model in this category is the Ozkan & Sutherland (1995), where an optimizing policymaker causes a switch from a fixed to a floating exchange rate regime.

The policymaker has well-defined objective functions and the choice of the exchange rate regime (fixed or floating) affects policymaker's welfare function. The main variable in this model is demand shock. Here, the policy maker's optimizing problem is to choose that level of demand shock at which to leave the fixed rate in order to maximize social welfare. Thus, the collapse of the fixed exchange rate regime is not because of loss of reserves. Instead, this is dictated by an optimizing policymaker's incentives in response to the existing economic conditions. An empirical application of this model is the ERM crisis in 1992. The evidence shows large and sudden loss of reserves for UK and Italy. This development is consistent with fundamental-based crisis models (i.e. Krugman, 1979), but we cannot argue that macroeconomic imbalance was the main source of this crisis. On the contrary, the Ozkan & Sutherland (1995) model captures the German unification effect on ERM. High German interest rates caused higher interest rates in the other ERM country-members. As a result, these developments caused negative demand shocks in the ERM members.

10.3. Twin Crises: Banking and Currency Crises

The relation between banking and currency crises is bi-directional. Some theoretical models show that currency crises can cause banking crises, while others show that a banking crisis precedes a currency crisis. For example, Stoker (1994) argues that an increase in foreign interest rates, combined with a fixed exchange rate, causes loss of reserves or extremely high short run interest rates. These developments create a lot of problems in the domestic banking sector. Similarly, Mishkin (1996) shows that a currency crisis (i.e. large domestic currency depreciation) deteriorates banks' position because of their liabilities in foreign currencies. In other words, the Central Bank's incentives to defend the fixed rate create financial instability. On the other hand, Velasco (1987) stresses the role of banking crises as a precedent of currency crises. Specifically, he shows that an unstable financial sector creates macroeconomic instability. For example, suppose that the banking sector generates excessive money and credit expansion. According to the fundamental-based currency crisis models, this makes a successful speculative attack more possible. Therefore, financial instability can lead to macroeconomic instability and as a consequence to a currency crisis.

Kaminsky & Reinhart (1999), dealing with the existing empirical evidence, examine whether both crises are preceded by the same macroeconomic instability. They observe that the linkage between banking and currency crises are stronger after financial market liberalization. Moreover, a banking crisis starts before a currency crisis occurs. But, the peak of the banking crisis comes after the currency crisis. This means that problems in the banking sector can help in predicting a possible currency crisis. When it comes to the source of economic instability, both crises come after economic recession and in general after poor performance of the macroeconomic fundamentals. Finally, they find that economic performance (i.e. macroeconomic fundamentals) is worse when both crises are jointly occurred compared to an isolated episode.

10.4. Implications for the examined countries (CEEC)

The empirical application in chapter 8 shows that the examined nominal effective exchange rates are not highly misaligned. In addition, chapter 9 shows that the exchange rates of selected currencies vis-à-vis euro do not deviate significantly from their equilibrium rates. These findings imply that we do not expect high instability in these currencies. This is consistent with the exchange rate convergence criterion, which states that their exchange rates per euro should not deviate more than +/- 15%. Even if the exchange rate regime is a floating one, Central Banks retain the right of intervention in the foreign exchange markets (i.e. managed floating regime). Most countries employ an inflation targeting regime. These characteristics cannot provide a clear view about the emergence of currency crises in the examined forex markets. However, they warn that the possibility of speculative attacks and crises should be examined. Although, high misalignment rates are not observed, policy objectives (i.e. controlled exchange rate fluctuation) and governments' intervention in forex markets may generate expectations of a successful speculative attack when fluctuation reaches the pre-determined band (i.e. +/- 15%).

Two major issues arise here. Firstly, should Central Banks intervene in the forex markets? Secondly, if they do so are there any signs of a prospective currency crisis? When the exchange rate misalignment is sufficiently low and there is evidence of forex efficiency, monetary authorities should not intervene at all, since market forces can drive the exchange rate towards equilibrium. In contrast, if the misalignment rate is high and the market is inefficient (according to the definition shown in chapter 9), Central Banks may intervene under conditions. In other words, if the possibility of speculative attacks is high, they should avoid any kind of intervention.

But how can we figure out if a currency crisis is possible to occur? According to the theoretical currency crisis models, we have to examine a number of economic conditions in the domestic economy, such as macroeconomic fundamentals' performance, monetary and fiscal position, financial sector's stability and political situation. We saw above that economic performance is poor before crises. Moreover, there is a bi-directional relation between banking and currency crises. Namely, financial instability can import problems to the foreign exchange market. Finally, political situation is an important factor for crises. The empirical evidence shows that speculative attacks are more possible to succeed in countries with unstable political systems. Eichengreen et al (1996) argue that governments avoid taking serious steps due to political cost. In addition, while fiscal situation is not directly linked with currency crises (only money-financed deficits are sources of speculative attacks), the evidence shows that some times it is related with attacks. This is because governments apply expansionary fiscal policies to reduce political cost.

10.5. Concluding Remarks

This chapter briefly reviews the literature on currency crises. A currency crisis may occur because of unstable macroeconomic performance (i.e. monetary policy relaxation) as well as due to self-fulfilling expectations. Moreover, a currency crisis may be preceded by a banking sector crisis, and vice-versa. The motivation was to examine the response of Central Banks when highly misaligned currencies are observed. When the forex market is efficient, there is no room for any intervention. However, the answer is not straightforward when the market is not efficient. One could say that the monetary authorities should intervene to correct the source of inefficiency. One the other hand, government intervention is not costless and in some cases is hazardous for the domestic currency. Therefore, monetary authorities have to examine the recent macroeconomic conditions before they map out the way they will defend the domestic currency. If the monetary policy is loose, the economic performance is poor and the political situation is unstable, Central Banks should avoid interventions because speculators will attack the currency.

In the previous chapter we found that the Polish zloty per euro forex market is efficient. Thus, there is no need for any intervention in the forex market. Similar implications are derived for the Slovak Republic case, in which inefficiency is present only temporarily. On the contrary, the corresponding market in Czech Republic is found to be inefficient.[151] But, what the Central Bank should do? A misaligned exchange rate can create a competitiveness problem (when overvaluation is the case) or inflationary pressures (when undervaluation is the case). On the other hand, speculators can see government interventions as evidence of inefficiency. When a market is inefficient there is room for speculative attacks, which may lead to a currency crisis. Given that Czech Republic performs successful economic and political reforms, combined with a tight monetary policy (inflation and interest rates are decreasing over time), we can argue that a controlled and moderate intervention will not be so dangerous for the domestic currency. However, a more detailed examination is required, which is left for a future study.

[151] Recall that the cross-based misalignment implies market efficiency, while inefficiency is implied by the official-based misalignment. However, the rate that actually matters is the official one because it can captures interventions in the forex market.

11. Conclusion

The main aim of this PhD thesis was to evaluate, paying attention to exchange rate dynamics, the integration process of the new EU country–members towards EMU. We showed that current exchange rate stability does not ensure future exchange rate stability. The sustainability of low exchange rate volatility requires the nominal exchange rate not to be highly and persistently away from its equilibrium rate.

The first part of this thesis (chapters 2 to 5) presented the theoretical and empirical literature on exchange rate models. First, PPP hypothesis has been considered as a long run equilibrium phenomenon. The evidence in the empirical literature is mixed. Especially, when structural breaks and the nonlinear behaviour of the real exchange rate are examined, PPP seems to be a valid long run relationship. Second, the empirical validity of traditional exchange rate determination models (flexible-price and sticky-price Monetary models, Portfolio-Balance model) is not strong enough. However, the Dornbush model has a better empirical application.

In overall, the poor empirical application of the above models generated the necessity to employ up-to-date exchange rate models, known as Equilibrium Exchange Rate models. The FEER approach is a medium-run equilibrium model, consistent with internal and external balance. The BEER and PEER approaches are short-run equilibrium models, which rely on the direct econometric analysis of the nominal (or real) exchange rate. The NATREX approach is a medium and long run equilibrium model, consistent with internal, external and portfolio balance.

The NATREX approach seems to be the most appropriate model, especially for developing countries, because it is a dynamic stock-flow equilibrium model. However, its quite strong assumptions and the fact that some variables cannot be easily measured and some of them do not affect the exchange rate directly, make the direct econometric analysis (i.e. the BEER and PEER approaches) a more feasible methodology. When it comes to the Efficient Market Hypothesis, the majority of the empirical studies do not support the validity of the EMH. Although in chapter 5 we presented some of the reasons for this failure, an important argument of this thesis is that the FRUH is not appropriate when FOREX efficiency in emerging markets is tested.

In the empirical part of this thesis, chapter 6 has shown that a multivariate cointegration test provides stronger evidence of PPP compared to univariate unit root tests. Although three types of exchange rates for Hungary, Poland, Czech Republic and Slovakia have been examined, the main interest is focusing on bilateral rates vis-à-vis euro. The results imply that trade relationships between EU and CEEC are well developed. Furthermore, there is evidence of preliminary equilibrium exchange rate.

In chapter 7 we examined the adjustment process of real exchange rates per euro, paying attention to the validity of PPP hypothesis and the degree of trade rigidities in Europe. The characteristic difference from chapter 6 is that we performed both a linear ADF test as well as a nonlinear SETAR model. Moreover, we focused on ten EMU candidate countries and an analogous analysis on current EMU countries has been undertaken to justify that integration in Europe is currently more mature than two decades ago. The evidence of nonlinearities implies that the true reverting process is given by the nonlinear SETAR model. The results imply that all real exchange rates (candidate countries) are consistent with PPP hypothesis, while the fast reversion implies an equilibrium process for their currencies.

Chapter 8 explicitly examined if the currencies of Hungary, Poland, Slovakia and Malta are significantly misaligned. The results imply that nominal effective exchange rates do not deviate significantly from their equilibrium rates. So, we do not expect large fluctuations in the examined currencies. In consistency with these findings, chapter 9 has found that Czech crown, Slovak crown and Polish zloty exchange rates vis-à-vis euro are close to their equilibrium rates. According to the definition of forex market efficiency (as explained in chapter 9), the percentage rate of exchange rate misalignment cannot on its own provide valid implications about forex market efficiency. So, by examining the stationary nature of the misalignment series, we have found that the Polish zloty/euro market is efficient, the Czech crown/euro market is not efficient, while the Slovak crown/euro market is quasi-efficient. In line with this analysis, chapter 10 shows that in efficient markets (Polish zloty/euro and Slovak crown/euro) Central Banks should avoid any kind of intervention, while in inefficient markets (Czech crown/euro) interventions may be hazardous for the domestic currency, as they can make it more vulnerable to speculative attacks.

In overall, the empirical findings of the present PhD thesis imply that the candidate countries follow a normal integration process towards EMU. The evidence in favour of PPP (chapters 6 & 7) shows absence of trade frictions and signs of well-developed trade relations between the candidate countries and the EU. Furthermore, the fast mean reverting process of real exchange rates implies an equilibrium process for the nominal exchange rates consistent with price movements. Nonetheless, the evidence that selected countries' currencies are close to their equilibrium rates imply that nominal effective exchange rates (chapter 8) and bilateral exchange rates against euro (chapter 9) are in line with the sustainable values of the macroeconomic fundamentals. As a consequence, there are no signs of expected significant exchange rate fluctuations in the future. Namely, these findings persuade us to assert that the candidate countries, considered in this PhD thesis, will successfully meet the exchange rate criterion and the more restrictive condition of the sustainability of exchange rate stability (which has been introduced in the present thesis). In consistency with our analysis, the Council of the European Union approved Cyprus' and Malta's application to join the euro area on 1 January 2008. Therefore, the prospective entry of those countries into EMU is going to be normal and it is not expected to weaken the stability of euro.

Although this PhD thesis provides important information about exchange rate developments in candidate countries, a number of policy issues are still open and require further research. First, in a future study we aim to examine if the exchange rate and the macroeconomic fundamentals form a long run relationship subject to regime switching. Some studies fail to find evidence of cointegration between the exchange rate and the macroeconomic fundamentals. Others, although they find evidence of cointegration, fail to accept the theoretical restrictions. These relations may be characterized by a regime-switching process. For example, exchange rate movements may not be explained by fundamentals in a regime but may be well explained in the other regime. Thus, we can test for a nonlinear behaviour and if this is the case we can estimate the equilibrium exchange rate for the candidate countries (per euro or the effective exchange rate) by a Markov Switching Vector Error Correction Model (MS-VECM), introduced by Krolzig (1997).

Furthermore, in line with chapter 9, it is interesting to examine if the exchange rate misalignment is subject to regime switching. Specifically, we can test if this follows a 2-state Markov process. Then, by applying a MS-ADF test we can examine:

(i) stationarity in each regime. Namely, it is possible to have stationary misalignment in one regime and non-stationary in the other. This implies that the exchange rate moves towards equilibrium in one regime, while in the other follows a disequilibrium pathway. This could imply evidence of forex efficiency in one regime, even if there is evidence of inefficiency in the whole sample.

(ii) stationarity and volatility. We can compare stationarity and volatility across regimes. For instance, suppose that in regime 1, the misalignment is low volatile, while in regime 2 it is highly volatile. What happens in the stationary nature of the misalignment rate? Is there any relation between stationarity, volatility and forex market efficiency regarding the proposed efficiency test? Since BEER is smooth, misalignment volatility is due to exchange rate volatility. Based on this, we can link exchange rate volatility and forex market efficiency. We should expect that efficiency is consistent with low exchange rate volatility.

Second, we aim to define the sources of volatility of those exchange rates vis-à-vis euro. In a future study we will allow for monetary variables, real variables, financial variables and spillovers from an external forex market to assess the relevant importance of each of the variables to (potential) exchange rate volatility. Thanks to this information, policy makers are aware of the channels which transmit volatility to the exchange rate and by applying the appropriate policy can stabilize those disturbances in order to avoid excessive fluctuation of their exchange rates per euro (for those countries which follow a free floating or managed floating regime) and excessive pressure on the currency (for those countries which have chosen to peg the exchange rate at the fixed central rate). In addition, we can infer whether monetary-based or real-based shocks are most important in explaining exchange rate behaviour. This information is helpful in evaluating the applied exchange rate policy against euro (in the examined countries) until the time of adoption of the single currency. If monetary shocks are more important then, a fixed regime is appropriate. In contrast, if real shocks drive exchange rate developments then, a floating exchange rate regime seems to be appropriate. We aim to find out how a potential membership into EMU can affect the euro zone itself. We investigate whether exchange rate volatility across countries has a common source, which can be treated by a common monetary policy (i.e. ECB's monetary policy). Finally, this analysis shows if the source of exchange rate volatility across countries is compatible with a monetary union. The theory of common currency area states that the more synchronized the business cycles among the candidate's country and that of EMU, the lower is the cost of abolishing monetary policy independence and the lower is the probability of asymmetric shocks across EMU members. Here we need to know if output differential variability (i.e. indicating low business cycle synchronization)[152] has significant spillover effects to exchange rate volatility, opposed to the common currency area principles. The applied econometric methodology is based on linear VAR models (Granger causality and Variance Decomposition analysis) and GARCH models.

Third, it is interesting to examine the effect of forex interventions on the exchange rate in levels as well as in terms of volatility. Usually Central Banks intervene in the forex markets by open market operations, e.t.c. Recently, most of the examined countries

[152] High output differential volatility implies low income convergence.

have adopted an inflation targeting policy, but their monetary authorities retain the right of intervention in the foreign exchange market. In general, forex market interventions aim to stabilize the exchange rate. However, when these are not systematic and inefficient, exchange rate volatility can increase. Then, the currency is vulnerable to speculative attacks and a crisis seems possible. So, we can test the effectiveness of forex market intervention on the examined exchange rates (i) in levels, i.e. appreciation or depreciation; (ii) in exchange rate volatility. The methodology will be based on GARCH models. Especially, we can employ Component GARCH models in order to capture short-run effects as well as long-run effects. This is because an intervention may reduce only short-run volatility but not long-run volatility. This information will be useful for policy makers. Furthermore, this is relevant with the issue of forex market efficiency (inefficient interventions lead to inefficient markets) and as a consequence with currency crises (inefficient interventions create space for speculative attacks).

Finally, when a currency crisis occurs it is possible that other currencies are affected as well. In a future study, we can test how currency crises in Russia (1998), Argentina (2001), Turkey (2000), Mexico (1995), East Asia (1997) and other crises have affected the currencies considered in this PhD thesis. This analysis is going to let us know which currencies have been more affected, i.e. which are the most vulnerable to speculative attacks. Moreover, the results will show which currency crisis has affected most the examined currencies. We would expect that the Russian crisis, due to contiguity, is the one with the strongest effect on the examined currencies. We can examine these interdependencies through GARCH models. Similarly, we can divide the examined period into pre-crisis and post-crisis periods. If a currency is vulnerable to other currencies' crises, then we expect volatility transmission to be stronger in the post-crisis period. This evidence would imply signs of nonlinearities. So, it would be useful to estimate nonlinear GARCH models, such as a Markov Switching GARCH (MS-GARCH) model and a Smooth Transition GARCH (ST-GARCH) model.

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APPENDIX

Part 1: Symbols Definition

e	Nominal exchange rate (spot rate)
p	Price level
$\sum(\cdot)$	Summation
l	Lag length of the autoregressive process
d	Delay parameter
s_{t-d}	Threshold variable
ϑ	Threshold parameter
q	Number of thresholds
m	Log of money supply
y	Real income
i	Nominal interest rate
$E_t[\cdot]$	Expectations at time t
$\Delta(\cdot)$	First difference
r	Real interest rate
$I(0)$	Covariance stationarity
$I(1)$	Difference stationarity
θ	Coefficient of exchange rate adjustment
du	Demand for domestic output
δ	Coefficient of price adjustment
$\hat{y}$	Full employment level
ζ	First-order serially correlated random variable
W	Wealth
M	Money supply
B	Net holding of domestic bonds
F	Net holding of foreign bonds

CA	Current account
EX	Exports
IM	Imports
FP	Private foreign asset stock
NF	National claims on foreigners
FG	Government net claims
KA	Capital account
s	Real exchange rate
SA	Savings
IN	Investment
G	Government spending
TR	Tax revenues
Z	Vector of fundamentals
Z_1	Vector of fundamentals that affect the exchange rate in the long run
Z_2	Vector of fundamentals that affect the exchange rate in the medium run
T	Vector of fundamentals that affect the exchange rate only in the short run
u	Error term
ξ	Exchange rate misalignment
rp	Risk premium
nfa	Net foreign asset position
tot	Terms of trade
tnt	Relative price of traded to non-traded goods
$gdebt / gdebt^*$	Relative supply of domestic to foreign government debt
k	Capital stock (or capital intensity)
TB	Trade Balance
C	Consumption
cp	Parameter of the capital productivity

η	Growth of effective labour
$\bar{k}$	Steady state value of capital stock
h	Forecast horizon
$N = n$	Number of observations
σ^2	Residual variance
$neer$	Nominal effective exchange rate
$leer$	Long run effective exchange rate
$lrer$	Long run exchange rate
op	Oil price
fa	Domestic holding of foreign assets
f	Forward rate
Ω	Informational set
τ	linear trend term
$\lvert\Sigma\rvert$	Variance/covariance matrix of the residuals
T_b	Time break
Π	Matrix which determines the rank of cointegrating relationships
Γ	Coefficient matrix
v	Number of variables
rc	Rank of cointegrating relationships
α	Matrix of Error Correction Coefficients
β	Matrix of cointegrating vectors
$\hat{\lambda}$	Eigenvalue
$\hat{V}$	Eigenvector
$\alpha_{\perp}$	Alpha orthogonal matrix
$\beta_{\perp}$	Beta orthogonal matrix
Ξ	Number of parameters
MB	Monetary base
BR	Bank reserves

CN	Coins and notes held by domestic agents
λ	Smoothing parameter
π	Inflation rate
γ	Speed of the transition process in the nonlinear LSTAR model

Part 2: Abbreviations List

2SLS	Two Stage Least Squares
ADF	Augmented Dickey-Fuller
A-Hm	Homoskedastic Asymptotic Distribution
A-Ht	Heteroskedastic Asymptotic Distribution
AIC	Akaike Information Criterion
AO	Additive Outlier Model
APEER	Atheoretical Permanent Equilibrium Exchange Rate
AR	Autoregression
ARDL	Autoregressive Distributed Lag
ARIMA	Autoregressive Integrated Moving Average
ARMA	Autoregressive Moving Average
BEER	Behavioural Equilibrium Exchange Rate
B-Hm	Homoskedastic Bootstrap Distribution
B-Ht	Heteroskedastic Bootstrap Distribution
CBM	Central Bank of Malta
CEEC	Central & Eastern European Country
CGER	IMF's Coordinating Group on Exchange Rate Issues
CHEER	Capital Enhanced Equilibrium Exchange Rate
CPI	Consumer Price Index
CYP	Cyprus pound

CZK	Czech crown
d.f.	Degrees of Freedom
DEER	Desired Equilibrium Exchange Rate
DEM	Deutsche mark
DM	Diebold – Mariano
DOLS	Dynamic Ordinary Least Squares
EC	European Community
ECB	European Central Bank
ECM	Error Correction Model
ECU	European Currency Unit
EKK	Estonian kroon
EMH	Efficient Market Hypothesis
EMS	European Monetary System
EMU	Economic Monetary Union
EQ-TAR	Equilibrium Threshold Autoregression
ERM	Exchange Rate Mechanism
ERT	Exchange Rate Targeting
ESTAR	Exponential Smooth Transition Autoregression
ESTR	Exponential Smooth Transition Regression
EU	European Union
FDI	Foreign Direct Investment
FEER	Fundamental Equilibrium Exchange Rate
FGLS	Feasible Generalized Least Squares
F-Het	F-type Heteroskedasticity test
FILM	Full Information Maximum Likelihood
FOREX	Foreign Exchange
FRUH	Forward Rate Unbiasedness Hypothesis
GARCH	Generalized Autoregressive Conditional Heteroskedasticity
GDP	Gross Domestic Product
GLS	General Least Squares

GNP	Gross National Product
HICP	Harmonized Index of Consumer Price
H-P	Hodrick – Prescott
IFS	International Financial Statistics
IID	Independently and Identically Distributed
IO1	Innovational Outlier Model 1
IO2	Innovational Outlier Model 2
IPS	Im – Pesaran – Shin
IT	Inflation Targeting
ITMEER	Intermediate – Term Model Based Equilibrium Exchange Rate
JLR	Johansen Likelihood Ratio
KPPS	Kwiatkowski – Phillips – Schmidt – Shin
LLC	Levin – Lin – Chu
LM	Lagrange Multiplier
LOP	Law of One Price
L-S	Lee – Strazicich
LSTAR	Logistic Smooth Transition Autoregression
LTL	Lithuanian litas
MADF	Multivariate Augmented Dickey - Fuller
MAE	Mean Absolute Error
MAE	Mean Absolute Error
ME	Mean Error
MEH	Market Efficiency Hypothesis
MIT	Massachusetts Institute of Technology
MLE	Maximum Likelihood Estimation
MNB	Magyar Nemzeti Bank
MS-ADF	Markov Switching Augmented Dickey-Fuller
MSE	Mean Square Error
MS-GARCH	Markov Switching GARCH
MS-VECM	Markov Switching Vector Error Correction Model

NAIRU	Non-Accelerating Inflation Rate of Unemployment (or Natural Rate of Unemployment)
NATREX	Natural Real Exchange Rate
NBP	National Bank of Poland
NBS	National Bank of Slovakia
NID	Normally and Identically Distributed
NIGEM	National Institute Global Econometric Model
NOLS	Nonlinear Ordinary Least Squares
OLS	Ordinary Least Squares
PEER	Permanent Equilibrium Exchange Rate
PP	Phillips – Perron
PPI	Producer Price Index
PPP	Purchasing Power Parity
P-T	Permanent – Transitory
p-value	Probability
RD-TAR	Returning-Drift Threshold Autoregression
REH	Rational Expectations Hypothesis
RMB	Chinese Renminbi Yuan
RMSE	Root Mean Square Error
RPI	Retail Price Index
RRV	Ratio of Residual Variances
RWM	Random Walk Model
s.e.	Standard Error
SDR	Special Drawing Right
SETAR	Self Exciting Threshold Autoregression
SKK	Slovak crown
STAR	Smooth Transition Autoregression
ST-GARCH	Smooth Transition GARCH
SUR	Seemingly Unrelated Regression
TAR	Threshold Autoregression

UCL	Unit Labour Cost
UIP	Uncovered Interest Parity
VAD	Value – Added Deflator
VAR	Vector Autoregression
VECM	Vector Error Correction Model
WPI	Wholesale Price Index

Part 3: Candidate EMU Countries

Candidate Country	ERM II	Central rate (& fluctuation band)	Monetary policy	Exchange rate regime	Exchange rate volatility
Czech Republic	Not a member	----------------	Inflation targeting	Until 1996: pegged to a currency basket Since 1997: managed floating regime	High
Estonia	A member since June 2004	1EUR = 15.6466 EEK (0%)	Currency board	Fixed to central parity	Low
Cyprus	A member since May 2005	1EUR = 0.585274 CYP (+/- 15%)	Inflation targeting	Managed floating regime	Low
Latvia	A member since May 2005	1EUR = 0.702804LVL (+/- 1%)	Exchange rate targeting	Since 1994: pegged to SDR Since 2005: pegged to euro	Low
Hungary	Not a member	1EUR = 282.36 (+/- 15%)	Inflation targeting	managed floating regime	High
Malta	A member since May 2005	1EUR = 0.4293 (0%)	Currency board	Since 2005: pegged to euro	Low
Poland	Not a member	--------------	Inflation targeting	Free floating regime	High
Slovakia	A member since May 2005	1EUR = 35.4424 SKK (+/- 15%)	Inflation targeting	managed floating regime	High
Lithuania	A member since June 2004	1EUR = 3.45280 (0%)	Currency board	Fixed to central parity	Low
Bulgaria	Not a member	1EUR = 1.95583 (0%)	Currency board	Pegged to euro	
Romania	Not a member	--------------	Inflation targeting	Free floating regime	

Part 4: Empirical Evidence on Purchasing Power Parity Hypothesis

Study	Exchange Rates	Estimation Period	Econometric Methodology	Results
Abuaf & Jorion (1990)	10 developed countries	1973-1987	AR(1), Dickey-Fuller estimated by OLS and GLS	PPP is accepted
Aggarwal et al (2000)	7 Asian currencies against Japanese yen	1974-1997	Univariate Unit Root with and without Breaks	Quasi-PPP is accepted
Alba & Park (2003)	65 developing against US dollar	1976-1999	Panel Unit Root	Weak Support of PPP
Bahmani-Oskooee & Mirzai (2000)	Effective Exchange Rates of 20 developing countries	1973-1997	Univariate Unit Root (KPSS)	PPP is accepted
Basher & Mohsin (2004)	10 Asian countries against US dollar	1980-1999	Panel Unit Root Panel Cointegration	PPP is rejected
Boyd & Smith (1999)	25 developing countries against US dollar	1966-1990	Panel Data	Evidence of PPP equilibrium
Calderon & Duncan (2003)	Chile against US dollar and a basket of US dollar and UK pound	1810-2002	Univariate Unit Root Multivariate Cointegration Non-linear TAR	PPP is accepted
Corbae & Ouliaris (1988)	Canadian dollar, French franc, UK pound, Japanese yen, Italian lira, Deutsche mark, all against US dollar	1973-1986	univariate cointegration, ADF, PP	Absolute PPP is not accepted
Diamandis (2003)	Argentina, Brazil, Chile, Mexico against US dollar	1973-1993	Multivariate Cointegration	PPP is accepted in parallel forex

Study	Exchange Rates	Estimation Period	Econometric Methodology	Results
Drine & Rault (2003)	73 developed and developing countries	1964-1998	Panel Unit Root Panel Cointegration	PPP is rejected for developing countries
Enders (1988)	Canadian dollar, Japanese yen, Deutsche mark, all against US dollar	1960-1986	cointegration	mixed results
Holmes (2000)	27 African countries against US dollar	1974-1997	Panel Unit Root	Strong Support
Liew (2003)	5 Asian countries against US dollar	1975-2001	Non-linear Unit Root	PPP is accepted
Lothian & Taylor (1996)	US/UK & French franc/UK	1791-1990	univariate unit root tests, AR	PPP is accepted
MacDonald (1993)	US, Canada, France, UK, Germany, Japan	1974-1990	cointegration	weak form PPP is accepted. Strong form PPP is accepted only among European countries
Mahdavi & Zhou (1994)	13 high inflation countries	1973-1991	Multivariate Cointegration	Stronger evidence for high inflation countries
Michael et al (1997)	US, UK, France, Germany	1791-1992 (the data span varies across countries)	Nonlinear ESTAR	Nonlinear mean reversion to PPP is accepted

Study	Exchange Rates	Estimation Period	Econometric Methodology	Results
Nagayasu (1998)	16 African countries against US dollar	1981-1994	Panel Cointegration	Semi-Strong PPP is accepted
O'Connell (1988)	18 countries	1973-1995	Nonlinear EQ-TAR	PPP is accepted. But, small deviations are mean reverting
Obstfeld & Rogoff (2000)	Canada, France, Germany, US, Japan	1973-1995	ADF regression	slow convergence to PPP equilibrium
Obstfeld & Taylor (1997)	32 countries	1980-1995	Nonlinear TAR	Nonlinear mean reversion to PPP is accepted
Oh (1996)	88 developing countries	1950-1990	Panel Unit Root	Mixed Results
Patel (1990)	UK, Canada, Germany, Netherlands, all against US dollar	1974-1986	cointegration	PPP is not accepted
Payne et al (2005)	Effective Exchange Rate of Croatia	1992-1999	Univariate Unit Root with Breaks	PPP is rejected
Razzaghipour et al (2001)	5 Asian countries against US dollar	1992-1999	Statistical Analysis of PPP divergence	PPP is accepted
Sabate et al (2003)	Peseta-Sterling exchange rate	1870-1935	Univariate Unit Roots with Breaks	PPP is accepted
Salehizadech & Taylor (1999)	27 developing countries against US dollar	1975-1997	Multivariate Cointegration	PPP is accepted

Study	Exchange Rates	Estimation Period	Econometric Methodology	Results
Sarno (2000)	11 Middle Eastern countries against US dollar	Post Bretton-Woods period	Non-linear ESTR	PPP is accepted
Sarno et al (2004)	US, UK, Italy, France, Germany, Japan	1974-1993	Nonlinear SETAR	Nonlinear mean reversion to PPP is accepted
Taylor et al (2001)	US, UK, Germany, France, Japan	1973-1996	Nonlinear ESTAR	Nonlinear mean reversion to PPP is accepted
Wang (2000)	7 Asian countries against US dollar	1973-1996	Multivariate Cointegration	PPP is rejected
Zurbruegg & Allsopp (2004)	8 Asian countries against US dollar	1990-2002	Multivariate Cointegration with Breaks	Mixed Results

Part 5: Empirical Evidence on the monetary model (flexible & sticky price models)

Study	Assumption	Exchange Rates	Estimation Period	Econometric methodology	Main Implication
Cushman (2000)	Price flexibility	Canadian – US dollar	1970-2000	Johansen's cointegration technique, DOLS approach by Stock & Watson (1993)	Using more appropriate critical values rejects monetary model's validity.
Driskill (1981)	Price stickiness	Swiss franc/US dollar	1973-1977	Single-equation estimation	There is evidence of exchange rate overshooting, but the direction is not monotonic. Moreover, the estimated coefficients are not correctly signed.
Faust & Rogers (2000)	Price Stickiness	US/UK, US/Germany	1974-1997	VAR	There is no strong evidence of delayed overshooting. Furthermore, there is evidence of significant UIP deviations.
Groen (1999)	Price flexibility	Canada, France, Germany, Netherlands against US	1973-1994	Cointegration analysis, Out-of-Sample forecasting estimation by the RMSE statistic	There is no supporting evidence for the predictability of the monetary model. It is neither accepted as a long run relationship.
Groen (2000)	Price flexibility	14 bilateral exchange rates against US dollar and Deutsche mark	1973-1994	Time Series Cointegration, Cross sectional analysis, Panel data analysis	Unclear statement (time series analysis rejects the monetary model while cross sectional and panel data analyses accept it.

Study	Assumption	Exchange Rates	Estimation Period	Econometric methodology	Main Implication
Hacche & Townend (1981)	Price Stickiness	US dollar, French frank, Deutsche mark, Japanese yen, Italian lira against UK pound	1972-1980	Random Walk analysis	Exchanges Rates overshoot their long run values, but many coefficients are statistically significant and wrongly signed.
Kilian (1999)	Price flexibility	Canadian dollar, Deutsche mark, Swiss frank, Japanese yen against US dollar	1973-1997	Testing long run exchange rate predictability by two criteria: joint test statistic and p-values.	There is some evidence of exchange rate predictability, but there is no evidence of long-horizon forecasting ability.
Kouretas (1997)	Price flexibility	Canadian – US dollar	1970-1994	Johansen's cointegration technique, DOLS approach by Stock & Watson (1993)	There is some supporting evidence but the monetary model cannot be accepted as a long-run forward-looking relationship.
MacDonald & Taylor (1994b)	Price flexibility	US dollar/French franc	1976-1990	Johansen's cointegration technique	Accept Validity only in the Long Run.
MacDonald & Taylor (1994a)	Price flexibility	UK pound/US dollar	1976-1990	Engle-Granger two-step cointegration, Johansen's cointegration	Accept Validity in the Long Run as well as in the Short Run.

Study	Assumption	Exchange Rates	Estimation Period	Econometric methodology	Main Implication
Mark (1995)	Price flexibility	Canadian dollar, Deutsche mark, Swiss frank, Japanese yen against US dollar	1973-1991	Testing the Out-of-Sample forecasting ability by the RMSE statistic	The monetary model can predict the exchange rate in the long run.
McNown & Wallace (1994)	Price flexibility	Argentina/US, Chile/US, Israel/US	1977-1986, 1973-1985, 1979-1988 (respectively)	Johansen's cointegration technique	Unclear statement (coefficients have not the expected sign).
Meese & Rogoff (1983)	Price flexibility	UK pound, Deutsche mark and Japanese yen against US dollar	1973-1981	Testing the Out-of-Sample forecasting ability by three statistics: ME, MAE, RMSE	The monetary model does not provide any better information on future exchange rate movements.
Papadopoulos & Zis (2000)	Price flexibility	ECU/drachma	1980-1991	Johansen's cointegration technique, VAR-VECM	Monetary model is a valid long run equilibrium condition with highly complex short run dynamics.
Papell (1988)	Price Stickiness	US, UK, Japan and Germany effective exchange rates	1973-1984	ARMA, Maximum Likelihood Approach	German effective exchange rate overshoots while the Japan effective exchange rate undershoots. There is no clear view for US and UK rates.

Study	Assumption	Exchange Rates	Estimation Period	Econometric methodology	Main Implication
Rapach & Wohar (2002)	Price flexibility	14 bilateral exchange rates against US dollar	1900-2000	Unit Root tests, Cointegration tests [P-O, Johansen, Hansen L_c (1992), Shin Cμ (1994)], Test of long run exchange rate predictability.	In general, the monetary model is a valid long run relationship. However, the evidence for predictability is inconclusive.
Rogoff (2002)	Price Stickiness	US dollar/Deutsche mark, Japanese yen/US dollar, UK pound/US dollar	1979-2000	Analysis of real exchange rate against real interest rate differential and spot rates against forward rates.	His results are not very supportive for the sticky price model.

Part 6: Equilibrium Exchange Rate Models

Name of Approach	Theoretical Assumption	Time Horizon	Estimation Methodology	Main Advantage	Main Disadvantage
FEER	Simultaneous internal and external balance	Medium-run	Macroeconometric models, cointegration analysis	Does not rely ondirect econometric analysis. Given that exchange rates are very volatile it is difficult to establish a valid long run relationship by a direct econometric analysis	(i)It is not a dynamic solution, (ii)it is not suitable for forecasting purposes, (iii) some variables do not affect the exchange rate directly
DEER	As in FEER				
BEER	UIP condition with a risk-premium	Short-run	Direct econometric analysis: cointegration, H-P filter	All variables included have direct effect on the exchange rate	Direct econometric analysis may suffer from serious problems
PEER	As in BEER				
NATREX	Simultaneous internal, external and portfolio balance	Medium-run Long-run	Cointegration analysis: Engle-Granger, Johansen, ARDL	It is a dynamic stock-flow equilibrium concept	(i)Some variables cannot be easily measured, (ii)it is based on "strong" assumptions, (iii) some variables do not affect the exchange rate directly

Study	Methodology	Exchange Rates	Estimation	Fundamentals	Main Implication
Clark & MacDonald (1998)	BEER	effective rates of US dollar, Deutsche mark and Japanese yen	Johansen Cointegration technique	tot, relative price of non-traded to traded goods, net foreign assets and relative stock of government debt.	actual real effective exchange rates were away from their equilibrium values
Clostermann and Schnatz (2000)	BEER	euro/US dollar	VECM	Price level, oil price, government expenditure	euro/dollar is highly volatile. Higher oil price depreciates euro because EMU is more oil dependent
Coudert & Couharde (2002)	FEER	Central and Eastern European Countries' currencies	NIGEM macroeconometric model	Output gap, current account target, trade elasticities	Real exchange rates do not deviate significantly from equilibrium
Detken et al (2002)	NATREX	Real effective exchange rate of euro	VEC models	Investment, consumption, trade balance, national account identity	During the period 1997-2000, euro was undervalued. So, the following appreciation trend of euro can be accepted as a correction movement.
Egert (2002)	FEER	Czech Republic, Hungary, Poland, Slovakia, Slovenia	Cointegrated VAR	Current account, tot, relative prices	Overvaluation for Czech, Slovakia and Poland. Hungary's exchange rate was undervalued and Slovenia's rate was very close to equilibrium

Study	Methodology	Exchange Rates	Estimation	Fundamentals	Main Implication
Fernandez et al (2001)	BEER & PEER	euro real effective exchange rate	VAR and VECM	Productivity differential, real interest rate differential, oil price	euro was close to its equilibrium rate before 2000 but undervalued afterwards
Feyziogly (1997)	Similar to FEER	Real effective exchange rate of the Finnish markka	Johansen Cointegration technique	Tot, world interest rate, productivity differential	Exchange rate deviates from its long run equilibrium rate
Frait & Komarek (2001)	NATREX	Czech crown/Deutsche mark	Cointegration analysis by ARDL approach	tot, productivity (real GDP), world real interest rate, and foreign direct investment	Czech Koruna has an overvaluation trend, which entails a danger for the Czech economy.
Gandolfo & Felettigh (1998)	NATREX	Italian lira	Nonlinear model estimated by FILM	Net social investment, social consumption, trade balance, real interest rate	Italian lira was either undervalued or overvalued
Hallet & Richter (2004)	FEER	US dollar, euro, Canadian dollar and other currencies	MULTIMOD macroeconometric model	Current account, GDP	US dollar depreciated against the other currencies
MacDonald (2002)	BEER	Effective rate of the New Zealand dollar	VAR and VECM	ratio of net foreign assets to GDP, relative labor productivity, relative output gap, terms of trade and interest rate differential	New Zealand dollar was undervalued in the period after 1999.

Study	Methodology	Exchange Rates	Estimation	Fundamentals	Main Implication
Melecky & Komarek (2005)	BEER	Czech crown/German mark	Johansen's Cointegration technique, ARDL method and Dynamic OLS	Productivity differential, foreign direct investment, tot, real interest rate differential, trade openness, net foreign assets, government consumption	Czech Coruna was in general undervalued
Osbat et al (2003)	BEER	euro/yen	Cointegration techniques	Relative productivity, relative net foreign asset position, government expenditure, oil price	euro appreciation against yen is 2001 was a result of equilibrium correction of its previous depreciation
Paiva (2002)	FEER & CGER	Costa Rica's currency	Error Correction Model	Tot, degree of economic openness, fiscal position, net capital flows	Actual exchange rate was undervalued
Rajan & Siregar (2003)	NATREX	real effective exchange rate of Singapore dollar	Johansen's Cointegration technique	terms of trade, productivity, world interest rate and government spending	in average Singapore dollar was undervalued.
Smidkova (1998)	FEER	Real effective exchange rate of Czech crown	NIGEM macroeconometric model	CA, FDI, real GDP, domestic CPI	Czech crown was overvalued

Study	Methodology	Exchange Rates	Estimation	Fundamentals	Main Implication
Stein (1994)	NATREX	US dollar/G-10	Johansen Cointegration technique combined with OLS and Nonlinear OLS	US growth rate, foreign growth rate, foreign debt, capital intensity and social consumption	in general actual real exchange rates seem to be very similar to NATREX, but there are significant deviations in the short run,
Williamson (1985)	FEER	US dollar, UK pound, Japanese yen, French Frank, Canadian dollar, Deutsche mark, Italian lira	GEM macroeconometric model	Current account, asset accumulation, oil price, productivity	All currencies except Japanese yen and Deutsche mark were overvalued
Zhang (2001)	BEER	Chinese RMB	Cointegration techniques	Degree of openness, relative investment rate, government consumption and exports growth rate	Actual exchange rate was overvalued
Zhang (2002)	BEER	Chinese RMB	Cointegration techniques	Tot, productivity, money supply (M2), net foreign assets	Chinese RMB was either undervalued or overvalued

Part 7: Empirical Evidence on FOREX Efficiency

Study	Exchange Rates	Estimation Period	Econometric Methodology	Results
Aron (1997)	South Africa's currency	1979-1995	VECM among a spot rate and a vector of macroeconomic fundamentals	EMH is rejected
Aroskar et al (2005)	UK pound, Italian lire, Deutsche mark, French franc against US dollar	1990-1999	cointegration	EMH is rejected
Backus et al (1993)	5 currencies against US dollar	1974-1990	OLS	EMH is rejected
Baillie & Bollerslev (1989)	7 currencies against US dollar	1980-1985	cointegration	EMH is rejected
Bilson (1981)	9 currencies per US dollar		OLS & GLS	EMH is rejected
Corbae et al (1992)	6 currencies against US dollar	1976-1985	cointegration	mixed evidence
Cornell (1977)	7 currencies against US dollar	1973-1977	statistical analysis of the forecast error	evidence of forex efficiency
Dutt (1994)	5 currencies per US dollar	1981-1988	cointegration	weak-form efficiency is accepted
Fama (1984)	9 currencies against US dollar	1973-1982	OLS	EMH is rejected

Study	**Exchange Rates**	**Estimation Period**	**Econometric Methodology**	**Results**
Frankel & Froot (1987)	5 currencies against US dollar	1976-1985	statistical analysis of the expected future spot rate	EMH is rejected
Hai et al (1997)	UK pound, French franc, Japanese yen per US dollar	1976-1992	P-T decomposition using the Kalman filter	EMH is rejected
Hakio (1981)	5 currencies against US dollar	1973-1977	OLS	EMH is rejected
Hakkio & Rush (1989)	UK pound, Deutsche mark	1975-1986	cointegration & VECM	EMH is rejected
McCallum (1994)	Japanese yen, Deutsche mark, UK pound against US dollar	1978-1990	OLS	EMH is rejected
Naka & Whitney (1995)	7 currencies against US dollar	1974-1991	OLS & Non-linear Least Squares	evidence of forex efficiency
Sephton & Larsen (1991)	Canadian dollar, Japanese yen, Deutsche mark against US dollar	1975-1988	cointegration	mixed evidence
Taylor (1989)	US dollar/UK pound	1981-1985	OLS	EMH is rejected
Wickremasinghe (2004)	Sri Lanka's currency against 6 major currencies	1986-2000	cointegration	EMH is rejected
Zivot (2000)	Japanese yen, UK pound, Canadian dollar against US dollar	1976-1996	cointegration & VECM	EMH is rejected