FIRM-UNION OBJECTIVES IN A STRATEGIC CONTEXT

by

Stefanos Mamakis

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DEDICATION

Commitment, effort, and dedication were fundamental elements for the completion of my doctoral dissertation, but even more was the support of my family. To my wife **Katerina** and the two greatest projects of my life: my kids **Maria** and **Emmanuella**, today I dedicate them this work, because without their love, presence, support, encouragement and comprehension I would have not have finished this thesis.

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Introduction

Labour Economics may be considered as the implementation of both micro- and macro- economic techniques in the labour market. The micro-economic frame focuses on the role of individuals in the labour market, while macro-economic analysis investigates the interrelationships created among labour, goods and money market, considering as well the effect of globalization. It also investigates the effects of these factors on the macro variables, such as employment, total income and GDP.

Considering a micro-economic frame, labour market is similar to any other market, given that demand and supply of labour jointly define the price and the quantity (in this case, the wage and the employment, respectively). However, labour market differs from other markets, such as goods or money markets, in various ways. That is the most important reason that labour economics constitutes a distinct field of economics, with notably great interest of research.

One of the major research achievements of the past 20 years is the development of a theoretical framework, applying dynamic analysis, matching and bargaining techniques. The development of this framework began in the early 80s with contributions from Peter A. Diamond, Dale T. Mortensen and others, who applied the equilibrium in economies' models. Later, this framework was also adapted to the labour market.

The fields of research in this field of Economics are vastly, and despite the existing quite sizable bibliography, there are still unexplored areas. And since new strategies, that change the labour market's structure, are formed in the real economy, these unexplored areas are expanding, while the need of in-depth research turns more and more critical than ever.

For all these reasons, the present thesis investigates the objectives of labour unions and firms in a strategic context. In particular, the research is focalized on the following topics:

- Union-Oligopoly Bargaining and Foreign Direct Investments
- Union Oligopoly Bargaining and Undeclared Labour

- Efficiency of Price Competition Versus Quantity Competition in Unionized Oligopoly.

Chapter 1:

Union-Oligopoly Bargaining and Foreign Direct Investments (F.D.I.)

1.1. Introduction

Foreign direct investments (FDI) and unionization in the labour market, separately, is a multi-dimensional field of research in economics. The interaction between them is more complicated, yet quite promising for generating findings furnishing interesting policy implications.

Focusing on the economic analysis of FDI, it appears that there are three different types of models which have been widely used to explain the nature and impact of (inward-outward) foreign direct investments: (a) real capital arbitrage models (b) market power / industrial organization models and (c) firm-theoretic models. Hymer (1960) has been the first to argue that real capital arbitrage models have basic shortages, and that a multinational company should rather possess a competitive advantage (e.g. higher productivity than local firms) in order to serve a foreign market. Regarding market structure, on the other hand, though earlier contributions have been mainly dealing with international monopolistic markets, most contemporary researchers focus their analysis on oligopolistic markets. Whilst, based on the works of Coase (1937), Arrow (1964) and Williamson (1975), and infused with ideas and surveys of internalization and endogenous approach, a multinational firm-theoretic paradigm has already been established.

As in particular regards the impact of FDI on labour market(s), and vice versa, Gaston and Nelson (2001) argue that FDI have negative effects on immigration, while the same authors (2000) claim that the most reasonable conclusion to draw is that the actual impact of FDI on the developed countries' labour markets is negligible. Furthermore, there is a growing interest on the unionization and/or the wage bargaining structure as important factors for firms, and social planners, regarding FDI decisions, and relevant policies, respectively [see e.g., Brander and Spencer (1988), Mezzetti and Dinopoulos (1991), Ishiguro and Shirai (1998)].

One of the most interesting folds of the latter issue is the manipulation of the labour market institutional set-up in order to induce or deter FDI. Contributions to this framework mainly come from Naylor and Santoni (2003), who proposed that the greater unions' bargaining power is, the less likely FDI is to emerge. Moreover,

Vlassis (2009) stressed out that if the FDI-associated unit costs are not high enough, then employment-neutral inward FDI will emerge if the domestic wage setting is credibly centralized (so that the foreign and the domestic firms to pay equal wages) and the unemployment benefit is sufficiently high.

Along similar lines of research, in the present analysis we consider two firms (home and abroad) which compete a la Cournot in a host country. The foreign firm has two options, either to build a plant abroad and serve the host country via exports or to invest in the host country and thus serve the local market via FDI. Each choice is considered to be credible due to the sunk cost of building a plant for serving the host market. Following Hymer (1960), we consider that the foreign firm possesses higher productivity than the home firm. Given the possibility of FDI, as above, two different unionization structures, centralized and decentralized, may then arise in the host country, giving rise to centralized or decentralized wage bargaining, respectively, as follows: Under the centralized union structure/wage bargaining, the home union bargains with both the home and the foreign firm about firm-specific wages considering that, in the event of a failure in any of those firm-specific negotiations, all union members will be employed only by the other firm (which will then become a monopolist). On the other hand, under the decentralized union structure/wage bargaining, on the other hand, the home union splits in two different firm-specific unions which, independently and separately, bargain with the home and the foreign firm over firm-specific wages.

In the above context, the sequence of events has as follows:

Stage 1: A benevolent social planner – if needed – establishes and legally enforces the unionization structure in the home country.

Stage 2: The foreign firm chooses to serve the local market either via exports or FDI.

Stage 3: The labour unions chose to bargain the wages either decentralized or centralized (unions' coordination)

Stage 4: Depending on the outcome of the previous events, the foreign firm's as well as the home firm's employees' wages are determined via centralized or decentralized firm-union wage bargains.

Stage 5: The foreign firm and the home firm compete in the home market by adjusting their quantities.

Our analysis illustrates the conflicts arising among the agents' optimal strategies and shows that inward FDI are not axiomatically desirable by all agents. Our findings suggest that, under certain circumstances, the unionization structure is an effective policy tool to induce or deter FDI. Otherwise, it is useless, since it cannot affect the (FDI inducing vs. FDI deterring) state of the equilibrium. Last but not least, in some cases the unionization structure must be used as a policy tool, to maximize social welfare, within an option of two different equilibrium states.

The rest of the analysis is organized as follows.

- In Section 1.2. we illustrate and solve our structural model and the game arising in its context.
- In Section 1.3. we examine the influences of unit cost in exports and in FDI case in the final equilibrium.
- In Section 1.4. we focus on the role of the reservation wages (in home and abroad) in the formation of the equilibrium.

Finally, we summarize our major results and propose directions for further research in the epilogue. All proofs are relegated to the Appendix.

1.2. Optimal Strategies in Unionized Oligopoly and Inward FDI

1.2.1. Abstract

In a union-oligopoly context, we interpret the optimal equilibria may arise from the implementation of any possible policies of a benevolent social planner in the labour market. The applied policies may contradict or correspond with unions' and firms' objectives, while in other cases institutional arrangements of labour market appear to be inefficient to induce or deter FDI and thus social planner must search for alternative strategic devices. Given the complexity of the model, which must be solved computationally to obtain results, there are several outcomes depending on the values of the parameters.

1.2.2. The Model

Consider a homogeneous good sector in a host country, where one home (h) firm and one foreign (f) firm compete by adjusting their quantities. The h-firm always produces and sells exclusively domestically. The f-firm, nonetheless, may alternatively

- produce abroad and sell its output in the host country (exports case), facing a unit cost x[1], plus a sunk cost F_x, made up of building a plant in its own country to produce the quantity exported in the host market or
- produce and sell in the host country, with an FDI-associated unit cost c[2], plus a sunk cost F_d, made up of building a plant in the host country to produce the quantity sold in the host market.

In the present research we focus on the role of the labour market's setup along with the associated variable costs, and given that the sunk costs in each case

[1] It represents - constant per unit of sales - export-marketing costs, made up of transport, packaging, insurance, tariffs, etc.

[2] Following Hirsch (1976), in the above setting, the parameter c formally represents coordination and control costs - assumed to be constant per unit of production - which are incurred when the f-firm runs its production in the host market. These costs arise from cross-border differences in legislation, taxation, language, work ethics, personnel procedures, etc.

affect only the type of the equilibrium, F_d and F_x are assumed to be symmetric and, for simplicity, are normalized to zero.

Production, wherever, exhibits constant returns to scale and requires only labour input to produce the good. Moreover, each firm possesses a Leontief technology, so the capital stock is always sufficient to produce the good. Nevertheless, let the f-firm enjoy a technological advantage over its rival h-firm. Therefore, the production function of the h-firm (f-firm) can be defined as $Q_h = L_h$ $\left(Q_f = k \cdot L_f \; ; \; k > 1\right)$, where Q (L) denotes output (employment), and the productivity of labour is normalized to unity. Moreover, let the inverse demand function specified of the simple normalized linear form, P(Q) = 1 - Q, where Q is the aggregate output: $Q = Q_h + Q_f$.

The labour market is unionized at home and abroad, while the union structure is centralized in any separate labour market[3]. Hence, we assume that there is one union abroad and one union in the host country (home and foreign union). Given risk-neutral fixed membership and immobile labour, according to the utilitarian hypothesis [4], unions are assumed to maximize rents, $U(w_i, L_i) = (w_i - w_0) \cdot L_i$, where w_i and L_i are the wage and employment arguments, i stands for home or abroad firm, and w_0 stands for the local reservation wage - unemployment benefit (w_{0h} for the domestic market, w_{0f} for abroad). Unions (firms), wherever located, are moreover assumed to possess a bargaining power of b (1-b) during labour-management negotiations.

As regards to the wage-setting structure, if the f-firm produces abroad, then the wage setting is de facto decentralized across firms. However, if the f-firm locates production in the host country, the wage setting can be decentralized, or centralized, across firms, depending on the host labour market's institutional framework:

- If the latter imposes wage bargaining centralization (CB), there will be coordination between the two unions during the bargaining process with each firm separately. The unions will maximize both utilities, having in mind

[3] In this case, we follow Dhillon and Petrakis (2002).
[4] See Oswald, 1982; Booth, 1995.

that if the negotiations with one firm fail, then there will be a reservation utility derived from the fact that all workers will be occupied at the other firm.

- Otherwise, if the wage-bargaining structure in the host country is decentralized bargaining (DB), then each union will negotiate the wage (and thus the employment level) with the relevant firm, considering the maximization of its own utility.

One of the major matters that we investigate is what labour market's setup leads to a time-consistent equilibrium, deterring or inducing FDI. The policy maker will, in any case, make those arrangements, that will maximize the social welfare. For the needs of the present analysis, social welfare is defined as the sum of home unions' utilities, the profits of the home firm and the consumer surplus ($SW = U_h + U_f + \Pi_h + CS$). In case of equivalent outcome, and since knowledge, know-how and technology can be better diffused with FDI rather than international trade, FDI comprises a preference to the policy maker's goals.

Arising from the above, a five-stage game can be formally addressed as follows:

- Stage 1: Policy Maker's Decision.

  The policy maker settles or reforms labour market institutional arrangements in the host country, so that the Social Welfare will maximise. Labour's market institutional arrangements include the wage-bargaining structure (DB or CB), the level of the unemployment benefit and taxes or/and penalties to the labour market agents.

- Stage 2: F Firm's Decision.

  Given the labour market institutional resolutions in the host country, the f-firm decides to serve the home market via either exports or FDI. As already stated, at this entry stage, the sunk costs of either option are assumed to be symmetric and for convenience are normalized to zero. Though, we consider that f firm will be consistent with its decision, due to the sunk cost.

- Stage 3: Unions' Decision.

  Considering the payoffs of each case, unions decide to act coordinated or not. Prerequisite for unions to coordinate is that both utilities (strictly) should increase. If the utility of at least one union decreases (comparing to the decentralized bargaining), then it will be motivated to decline from the coordination, so the equilibrium will be time-inconsistent.

- Stage 4: Wage Determination.

  Given the final labour market institutional set-up in the host country (delivered from the above stages), optimal wages (home firm / foreign firm) are in all candidate cases defined as follows:

  - *Export case:*

$$w_{he} = \arg\max \left((w_{he} - w_{0h}) \cdot q_{he} \right)^{b} \cdot \Pi_{he}^{(1-b)} \quad (1)$$

$$w_{fe} = \arg\max \left((w_{fe} - w_{0f}) \cdot \left(\frac{q_{fe}}{k} \right) \right)^{b} \cdot \Pi_{fe}^{(1-b)} \quad (2)$$

  - *FDI under DB case:*

$$w_{hdb} = \arg\max \left((w_{hdb} - w_{0h}) \cdot q_{hdb} \right)^{b} \cdot \Pi_{hdb}^{(1-b)} \quad (3)$$

$$w_{fdb} = \arg\max \left((w_{fdb} - w_{0h}) \cdot \left(\frac{q_{fdb}}{k} \right) \right)^{b} \cdot \Pi_{fdb}^{(1-b)} \quad (4)$$

  - *FDI under CB case:*

$$w_{hcb} = \arg\max \left((w_{hcb} - w_{0h}) \cdot q_{hcb} + (w_{fcb} - w_{0h}) \cdot \left(\frac{q_{fcb}}{k} \right) - \overline{U}_2 \right)^{b} \cdot \Pi_{hcb}^{(1-b)} \quad (5)$$

$$w_{fcb} = \arg\max \left((w_{hcb} - w_{0h}) \cdot q_{hcb} + (w_{fcb} - w_{0h}) \cdot \left(\frac{q_{fcb}}{k} \right) - \overline{U}_1 \right)^{b} \cdot \Pi_{fcb}^{(1-b)} \quad (6)$$

  Where:

  - w_{ij} : the wage paid in each i firm (i: h=home firm, f=foreign firm), under each j case (j: e=exports case, db=decentralized bargaining, cb=centralized bargaining).

- q_{ij} : the Cournot quantity of each i firm and under each j case. Note here, from the production functions of the firms we resume: for the home firm q=L, for the foreign firm $q=k\cdot L \Rightarrow L=\frac{q}{k}$.
- Π_{ij} : the Cournot profits of each i firm and under each j case.
- w_{0h}, w_{0f} : the reservation wage paid in host country and abroad, respectively.
- b : stands for the bargaining power that unions have, while (1-b) is the bargaining power of the firms.
- $U_{1(2)}$: is the reservation utility that the unions will have, if the negotiations with the foreign (home) firm fail, knowing that, in that case, home (foreign) firm will act as a monopolist and will sell monopoly's quantity.

- Stage 5: Cournot Competition.

  Given any output level of its rival firm, each firm adjusts its output in order to maximize its profits.

  In the exports case, profit is given by:

  $\Pi_h = (p - w_h)\, q_h$, (7)

  for the h firm, though for the f firm is given by:

  $$\Pi_f = \left(p - \left(\frac{w_f}{k} \right) - x \right) \cdot q_f \quad (8)$$

  In the FDI case, profit is given by:

  $\Pi_h = (p - w_h)\, q_h$, (9)

  for the h firm, though for the f firm is given by:

  $$\Pi_f = \left(p - \left(\frac{w_f}{k} \right) - c \right) \cdot q_f \quad (10)$$

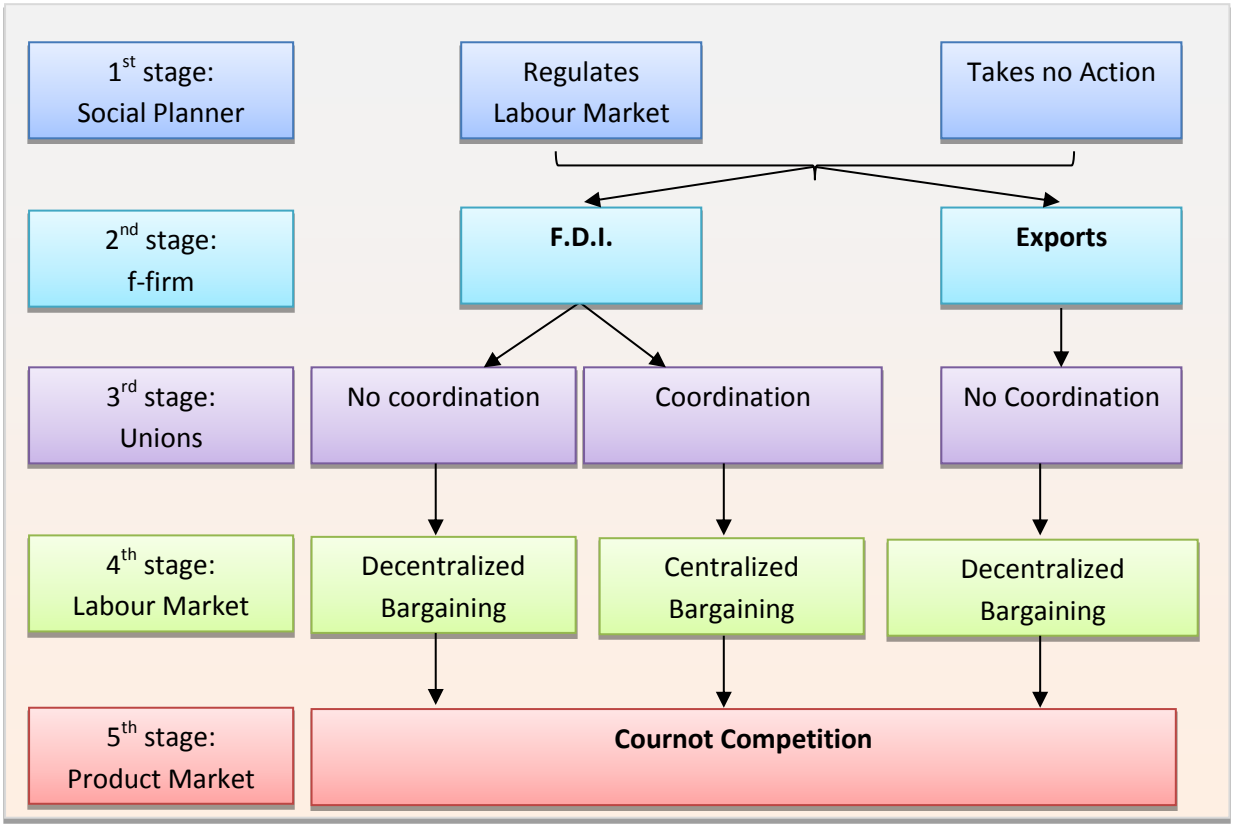
1.2.3. Theoretical Approach

Economic theory on F.D.I. assumes that there must be a condition in order F.D.I. to take place. Assuming that this condition is the productivity advantage of the f firm, denoted as *k*, the structure of the game has as follows:

The f-firm decides to accommodate the host market via exports (ex-ante situation) or F.D.I. depending on which case its profits is greater, calculating and quantifying all the effects derived from the choices of unions and social planner.

Labour Unions decide to coordinate or not depending on their utility. Both unions' utility must strictly increase to coordinate - or even better defined, any of them should not decrease - or else there will be a motive to decline from the coordination. At this point, we should stress out that unions will take into account all the changes of the market's setup, which will be caused by their choice. For example, the unions' decision to coordinate will affect firms' profit as well as social welfare. Social planner will act proportionally.

According to the above, the following diagram-tree arises including all 5 steps.



The game seems more than simple. However, the complexity of the model emerges if we try to illustrate the strategies of each agent combined with each other. Using the unionization of the labour market as a strategic tool, we can eventually say that

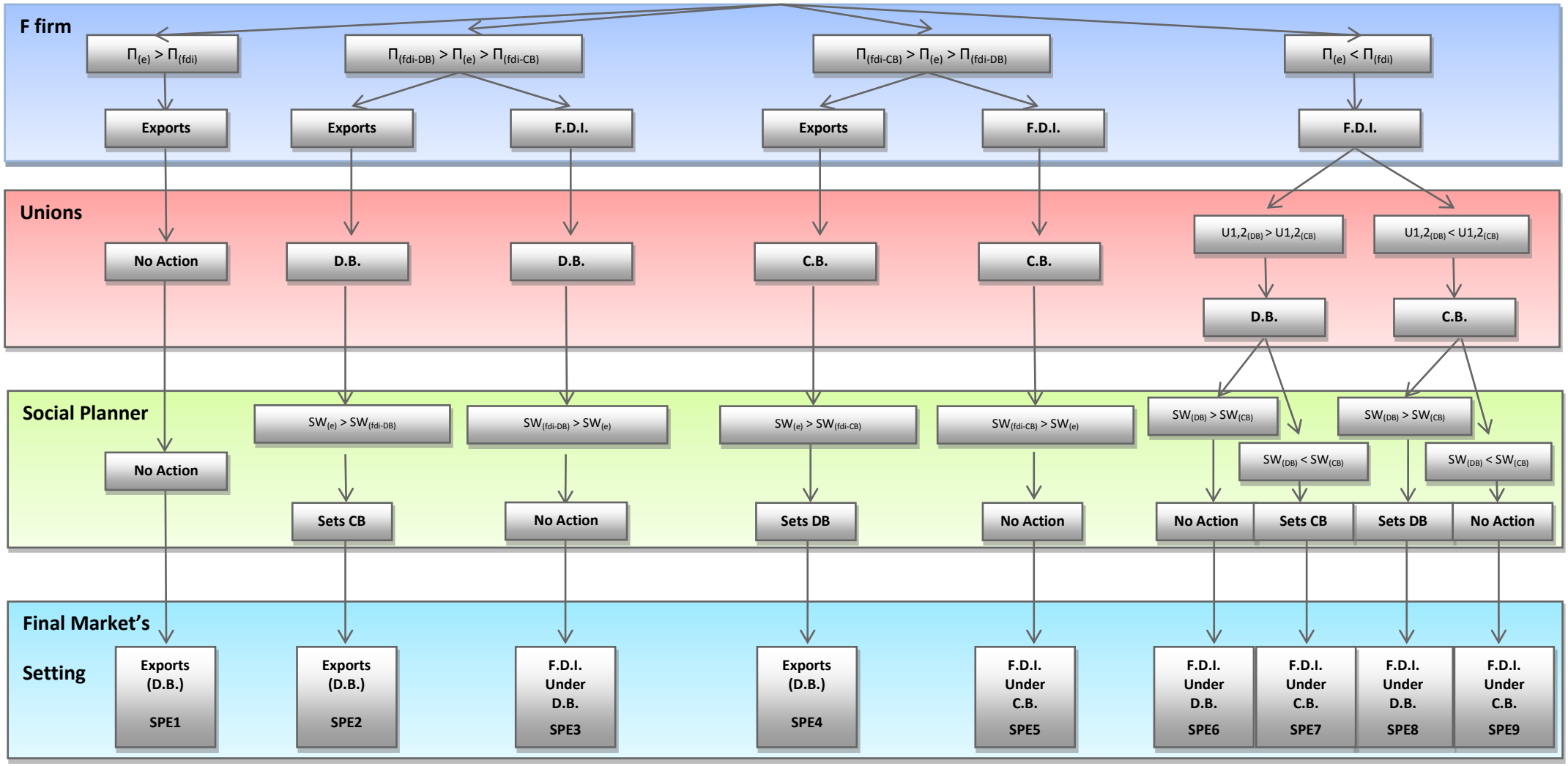
- in some cases, there will be no intervention from the social planner, as the market auto-regulates, maximizing thereby social welfare
- in some cases, the policy maker legislates certain wage bargaining structure, possibly contrasting to the goals of the unions, in order to ensure the social optimum and finally
- in some cases, the policy maker simply won't be able to affect the market by regulating labour market and consequently he will have to find other policies to induce or deter FDI.

We can show all possible results – SPE – in the following diagram - tree[5].

As it is shown, not surprisingly given the complexity of the model, a variety of outcomes are possible under variant values of parameters.

[5] Although the policy maker makes his decisions on the first stage of the game, the diagram is better understood if we illustrate that stage after f-firm's & unions' choice (policy maker applies his policy considering both f-firm's and unions' afterwards behavior), as social planner takes into consideration their decisions in order to modulate his policy.

Possible Nash Equilibrium (SPE)



There are three different cases in our analysis:

1. Definite Emerge of Exports.

If f-firm's profit under export's case is greater than the profit under any FDI case (either under decentralised or centralised bargaining), the f-firm will prefer to accommodate the market via exports. In this case, neither unions nor the social planner can use the unionisation setup as a policy tool in order to induce FDI (SPE1). In this case, social planner should apply different policies (e.g. lowering w_0 of the host country) to achieve his objectives.

2. Definite Emerge of F.D.I.

On the other hand, if f-firm's profit in any case of FDI (either under DB or CB) is greater than the profit in exports case, f-firm will choose to settle its production in the host country and accommodate the local market via FDI (SPE6-9). In this case, unions will coordinate only if both utilities (home firm's and foreign firm's union) remain the same or become even greater compared to the corresponding ones in the decentralized unionization case. The social planner will regulate labour market, aiming to social welfare's maximization, either by changing the bargaining status from decentralized to centralized bargaining (and conversely) or by letting the market auto-regulate itself. Essentially, since the emergence of FDI is definite, the mode of unionization will maximize social welfare within the FDI frame.

3. Undefined Outcome.

Game's strategic becomes even more interesting when f-firm's profit under exports is greater than the one mode of bargaining, but less than the other mode of bargaining under FDI. If, for example, stands $\Pi_{(fdi\text{-}DB)} > \Pi_{(e)} > \Pi_{(fdi\text{-}CB)}$ (SPE2-3), we assume that FDI will emerge only under decentralized bargaining status. Facing this situation, unions will not coordinate, as the f-firm's union will not exist under centralized bargaining (and therefore that union has a strong incentive to decline from that collusion). So, the optimal strategy for unions will be to bargain their wages decentralized. On the other hand, social planner will make such a decision that will maximize social welfare, even if it means that no FDI will emerge but

exports. So, if social welfare in export case is greater than the respective one in FDI under decentralized mode, the social planner will impose centralized wage bargaining, in order to deter FDI. On the contrary, if social welfare in the case of FDI under decentralized wage bargaining is greater, the social planner will let the market auto-regulate and conclude to its equilibrium, as by this choice, he maximizes the social welfare.

Proportional analysis stands for the $\Pi_{(fdi\text{-}CB)} > \Pi_{(e)} > \Pi_{(fdi\text{-}DB)}$ case (SPE4-5).

1.2.4. Solving the Model

Proceeding with the resolution of the model, we assume that the wage-setting structure in the host country is DB and using backward induction let us consider **the fifth stage of the game** first: in the subgame perfect equilibrium (SPE) each firm independently chooses its employment/output level so as to maximize its profit, given the firm-specific wage contract resulting from Stage 4 and the f-firm's -entry - decision at Stage 2. Thus, the derived optimal **output functions** - in any instance - appear to be as follows:

Exports case:

$$q_{he} = \frac{k + w_{fe} - 2 k w_{he} + k x}{3 k}, \text{ for h firm} \quad (11)$$

$$q_{fe} = \frac{k - 2 w_{fe} + k w_{he} - 2 k x}{3 k}, \text{ for f firm} \quad (12)$$

Where w_{he} (w_{fe}) is the wage that h(f)-firm will pay in exports case

FDI case:

$$q_{hf} = \frac{k + c k + w_{ff} - 2 k w_{hf}}{3 k}, \text{ for h firm} \quad (13)$$

$$q_{ff} = \frac{k - 2 c k - 2 w_{ff} + k w_{hf}}{3 k}, \text{ for f firm} \quad (14)$$

Where w_{hf} (w_{ff}) is the wage that h (f) -firm will pay in F.D.I. case

As expected, in either FDI (under DB) or Exports case, unit costs are strategic substitutes from the rival firms' point of view. Moreover, note that the partial derivative of q_{he} (the same result applies also for the FDI case) with respect to k, is $\frac{\partial q_{he}}{\partial k} = \frac{1 - 2\,w_{he} + x}{3\,k} - \frac{k + w_{fe} - 2\,k\,w_{he} + k\,x}{3\,k^2}$. For $w_{he}, w_{fe}, x \in (0,1)$ and k > 1, it applies that $\frac{\partial q_{he}}{\partial k} < 0$, meaning that (as expected) as the productivity of the f firm increases, the output of the h-firm decreases (and so its profit).

Respectively, the partial derivative of q_{fe} (the same result applies also for the FDI case) with respect to k, is $\frac{\partial q_{fe}}{\partial k} = \frac{1 + w_{he} - 2\,x}{3\,k} - \frac{k - 2\,w_{fe} + k\,w_{he} - 2\,k\,x}{3\,k^2}$. For $w_{he}, w_{fe}, x \in (0,1)$ and k > 1, it applies that $\frac{\partial q_{fe}}{\partial k} > 0$, meaning that (as expected) as the productivity of the f firm increases, the output of the f-firm increases too (and so its profit).

It follows that the f-firm's relative technological advantage (k) over the h-firm can render the f-firm dominant in the home market despite the fact that f-firm always faces extra costs (c or x) to serve this market. On the other hand, nonetheless, it, in either instance, depends on the wage contract whether the f-firm's cost per efficient unit of labour would be low enough so as to make F.D.I. the f-firm's optimal strategy.

The **price** that will be set in the market in the exports (FDI) case is:

$p_e = \frac{w_{fe} + k\,(1 + w_{he} + x)}{3\,k}$ $\left(p_f = \frac{w_{ff} + k\,(1 + c + w_{hf})}{3\,k} \right)$.

The partial derivative of the price relative to k, is

$\frac{\partial p_e}{\partial k} = \frac{1 + w_{he} + x}{3\,k} - \frac{w_{fe} + k(1 + w_{he} + x)}{3\,k^2}$ $\left(\frac{\partial p_f}{\partial k} = \frac{1 + c + w_{hf}}{3\,k} - \frac{w_{ff} + k(1 + c + w_{hf})}{3\,k^2} \right)$.

Both partial derivatives of the price relative to k are negative for $w_h, w_f, x, c \in (0,1)$ and k > 1, meaning that as the productivity of the f firm increases, the price in the market decreases in any case (exports or FDI).

Let us therefore proceed to **Stage 4 of the game**. By virtue of the previous stage and the maximization of the arguments [1]-[6], the following wages are specified:

For the exports case:

$$w_{he} = \frac{-16kw_{0h} - 4\,b\left(w_{0f} + k\left(1-2w_{0h}+x\right)\right) + b^2\left(2w_{0f} + k\left(-1+2x\right)\right)}{(-16+b^2)k} \tag{15}$$

$$w_{fe} = \frac{-16w_{0f} + b\left(8\,w_{0f} + k\left(-4\left(1+w_{0h}-2x\right) + b\left(-1+2w_{0h}-x\right)\right)\right)}{-16+b^2} \tag{16}$$

For the FDI case, under DB:

$$w_{hdb} = \frac{b\left(-4-b+2\left(-2+b\right)c\right)k + 2\left(-2+b\right)\left(b+4k\right)w_{0h}}{\left(-16+b^2\right)k} \tag{17}$$

$$w_{fdb} = \frac{-b\left(4+b+\left(-8+b\right)c\right)k + 2\left(-2+b\right)\left(4+b\,k\right)w_{0h}}{(-16+b^2)} \tag{18}$$

For the FDI case, under CB:

$$w_{hcb} = \frac{b + 2\,w_{0h} - b\,w_{0h}}{2} \tag{19}$$

$$w_{fcb} = \frac{2\,w_{0h} - b\,\left(\left(-1+c\right)k + w_{0h}\right)}{2} \tag{20}$$

Replacing [15]-[20] into [11]-[14] and solving the game, we have the following final output:

The Exports Case:

$$p_e = \frac{2\left(-2+b\right)w_{0f} + k\left(-4\left(1+w_{0h}+x\right) + b\left(-1+2w_{0h}+2x\right)\right)}{3k\left(-4+b\right)} \tag{21}$$

$$q_{he} = \frac{2\left(-2+b\right)\left(-2\left(-2+b\right)w_{0f} + k\left(4-8w_{0h} + b\left(1+w_{0h}-2x\right)+4x\right)\right)}{3\,k\left(-16+b^2\right)} \tag{22}$$

$$q_{fe} = \frac{2\left(-2+b\right)\left(\left(-8+b\right)w_{0f} + k\left(4+b+4w_{0h}-2bw_{0h} + \left(-8+b\right)x\right)\right)}{3k\left(-16+b^2\right)} \tag{23}$$

$$\Pi_{he}=\frac{4(-2+b)^2\left(-2(-2+b)w_{0f}+k\left(4-8w_{0h}+b(1+w_{0h}-2x)+4x\right)\right)^2}{9k^2\left(-16+b^2\right)^2} \quad (24)$$

$$\Pi_{fe}=\frac{4(-2+b)^2\left((-8+b)w_{0f}+k\left(4+b+4w_{0h}-2bw_{0h}+(-8+b)x\right)\right)^2}{9k^2\left(-16+b^2\right)^2} \quad (25)$$

$$U_{he}=\frac{2b(2-b)\left(-2(-2+b)w_{0f}+k\left(4-8w_{0h}+b(1+w_{0h}-2x)+4x\right)\right)^2}{3\left(-16+b^2\right)^2k^2} \quad (26)$$

$$U_{fe}=\frac{2b(2-b)\left((-8+b)w_{0f}+k\left(4+b+4w_{0h}-2bw_{0h}+(-8+b)x\right)\right)^2}{3\left(-16+b^2\right)^2k^2} \quad (27)$$

Where

p_e the price,

q_{he}, q_{fe} the output (quantity) of h-firm and f-firm respectively,

Pr_{he}, Pr_{fe} the profits of h-firm and f-firm respectively,

U_{he}, U_{fe} the utility of home / foreign union

at the export case.

The F.D.I. case under decentralized wage bargaining:

$$p_{db}=\frac{(-4-b+2(-2+b)c)k+2(-2+b)(1+k)w_{0h}}{3k\left(-4+b\right)} \quad (28)$$

$$q_{hdb}=\frac{2(-2+b)\left(-2(-2+b)w_{0h}+k\left(4+b+4c-2bc+(-8+b)w_{0h}\right)\right)}{3k\left(-16+b^2\right)} \quad (29)$$

$$q_{fdb}=\frac{2(-2+b)\left(\left(4+b+(-8+b)c\right)k+(-8+b+4k-2bk)w_{0h}\right)}{3k\left(-16+b^2\right)} \quad (30)$$

$$\Pi_{hdb}=\frac{4(-2+b)^2\left(k\left(-4(1+c-2w_{0h})+b(-1+2c-w_{0h})\right)+2(-2+b)w_{0h}\right)^2}{9k^2\left(-16+b^2\right)^2} \quad (31)$$

$$\Pi_{fdb}=\frac{4(-2+b)^2\left(\left(4+b+(-8+b)c\right)k+(-8+b+4k-2bk)w_{0h}\right)^2}{9k^2\left(-16+b^2\right)^2} \quad (32)$$

$$U_{hdb} = \frac{2b(2-b)\left(-2(-2+b)w_{0h} + k\left(4+b+4c-2bc+(-8+b)w_{0h}\right)\right)^2}{3\left(-16+b^2\right)^2 k^2} \quad (33)$$

$$U_{fdb} = \frac{2b(2-b)\left(-2(-2+b)w_{0h} + k\left(4+b+4c-2bc+(-8+b)w_{0h}\right)\right)^2}{3\left(-16+b^2\right)^2 k^2} \quad (34)$$

Where

p_{fdb} *the price,*

q_{hdb}, q_{fdb} *the output (quantity) of h-firm and f-firm respectively,*

Pr_{hdb}, Pr_{fdb} *the profits of h-firm and f-firm respectively,*

U_{hdb}, U_{fdb} *the utility of home / foreign union*

at the F.D.I. under decentralized wage bargaining case.

The F.D.I. case under centralized wage bargaining:

$$p_{cb} = \frac{(2-b)w_{0h} + k\left(-b(-2+c+w_{0h}) + 2(1+c+w_{0h})\right)}{6k} \quad (35)$$

$$q_{hcb} = \frac{(2-b)\left(k(1+c-2w_{0h}) + w_{0h}\right)}{6k} \quad (36)$$

$$q_{fcb} = \frac{(-2+b)\left(k(-1+2c-w_{0h}) + 2w_{0h}\right)}{6k} \quad (37)$$

$$\Pi_{hcb} = \frac{(-2+b)^2\left(k(1+c-2w_{0h}) + w_{0h}\right)^2}{36k^2} \quad (38)$$

$$\Pi_{fcb} = \frac{(-2+b)^2\left(-2w_{0h} + k(1-2c+w_{0h})\right)^2}{36k^2} \quad (39)$$

$$U_{hcb} = \frac{b(-2+b)(-1+w_{0h})\left(k(1+c-2w_{0h}) + w_{0h}\right)}{12k} \quad (40)$$

$$U_{fcb} = \frac{b(2-b)\left((-1+c)k + w_{0h}\right)\left(k(-1+2c-w_{0h}) + 2w_{0h}\right)}{12k^2} \quad (41)$$

Where

p_{fcb} *the price,*

q_{hcb}, q_{fcb} *the output (quantity) of h-firm and f-firm respectively,*

Pr_{hcb}, Pr_{fcb} *the profits of h-firm and f-firm respectively,*

U_{hcb}, U_{fcb} *the utility of home / foreign union*

at the F.D.I. under centralized wage bargaining case.

Stages 3 & 2 do not have any new outputs, other than the ones from the last two stages. Let us therefore proceed to **stage 1 of the game**. The social welfare results from the aggregation of the utility of the home union, the utility of the foreign union (only in the F.D.I. case) the profits of the h-firm and the consumer surplus. Thus, the derived social welfare - in any instance - appears to be as follows:

$$SW_e = \frac{2(-2+b)\left(\begin{array}{l}-(-2+b)w_{0f}^{\,2}+2(-2+b)kw_{0f}(w_{0h}-x)+\\ k^2\left(4+b-8w_{0h}-2bw_{0h}+6w_{0h}^{\,2}+2(-2+b)w_{0h}x-(-2+b)x^2\right)\end{array}\right)}{3k^2\left(-16+b^2\right)} \quad (42)$$

$$SW_{db} = \frac{4(-2+b)\left(\begin{array}{l}-\left(2(4+b)^2+(-8+b)b(4+b)c+\left(16+b\left(24+(-9+b)b\right)\right)c^2\right)k^2\\ +\left(\begin{array}{l}b^2\left(4+c(18-22k)\right)+16b\left(2+c(-3+k)\right)+32c(-1+k)+64k+\\ b^3\left(-1+k+c(-2+3k)\right)\end{array}\right)w_{0h}k\\ -\left(\begin{array}{l}b^3(-1+k)(-1+2k)+b^2\left(-9-11(-2+k)k\right)+8b\left(3+(-2+k)k\right)+\\ 16\left(1+k(-2+3k)\right)\end{array}\right)w_{0h}^{\,2}\end{array}\right)}{3k^2\left(-16+b^2\right)^2} \quad (43)$$

$$SW_{cb} = \frac{(2-b)\left(\begin{array}{l}\left(4+2c^2+b\left(2+c(-4+3c)\right)\right)k^2-2k\left(b\left(2+c(-3+k)\right)+2c(-1+k)+4k\right)w_{0h}\\ +\left(2+3b-2(2+b)k+(6+b)k^2\right)w_{0h}^{\,2}\end{array}\right)}{24k^2} \quad (44)$$

Where:

SWe the social welfare in the exports case

SWdb the social welfare in the F.D.I. under decentralized wage bargaining

SWcb the social welfare in the F.D.I. under centralized wage bargaining

1.2.5. Solvability conditions of the model.

At this point, we check under which conditions the model has internal solutions. Due to the mentioned normalizations as well as model's assumptions, the parameters range as follows:

$$w_{0h} \in (0,1),\ w_{0f} \in (0,1),\ b \in (0,1),\ c \in (0,1),\ x \in (0,1),\ k > 1$$

Additionally, the quantities and the wages must be greater than zero - in any instance. After the proper calculations, we conclude to the following restrictions:

$$\text{Max}\left\{\begin{array}{c} 0 \\ \frac{(8-b)\,w_{0f} - k\,(4+b+(-8+b)\,x)}{(4-2\,b)\,k} \\ \frac{b\,(-2\,(-2+b)\,w0f + k\,(4+b+4\,x-2\,b\,x))}{(b-2)\,8\,k} \\ \frac{(-4-b+2\,(-2+b)\,c)\,b\,k}{2\,(2-b)\,(b+4\,k)} \\ \frac{16\,w_{0f} + b\,(-8\,w_{0f} + k\,(4+b+(-8+b)\,x))}{(b-2)\,2\,b\,k} \\ \frac{b\,(4+b+(-8+b)\,c)\,k}{2\,(-2+b)\,(4+b\,k)} \end{array}\right\} < w_{0h} < \text{Min}\left\{\begin{array}{c} 1 \\ \frac{-(4+b)\,k + 2\,(-2+b)\,w_{0f} + 2\,(-2+b)\,k\,x}{(-8+b)\,k} \\ \frac{-k\,(4+b+4\,c-2\,b\,c)}{4+b\,(-2+k)-8\,k} \\ \frac{k\,(1+c)}{2\,k-1} \\ \frac{-(4+b+(-8+b)\,c)\,k}{-8+4\,k+(1-2\,k)\,b} \\ \frac{k\,(1-2\,c)}{2-k} \end{array}\right\}$$

$$\text{Max}\left\{\begin{array}{c} 0 \\ \frac{(4+b\,(1-2\,x)+4\,x)\,k}{2\,(b-2)} \\ \frac{(16+(-4+b)\,b)\,k}{2\,b\,(-2+b)} - k\,x \\ \frac{-(-8+b)\,(-1+x)\,b\,k}{8\,(2-b)} \end{array}\right\} < w_{0f} < \text{Min}\left\{\begin{array}{c} 1 \\ (1-x)\,k \end{array}\right\}$$

$$0 < b < \text{Min}\left\{\begin{array}{c} 1 \\ -4\,\frac{1+k\,(1+x)}{(1-2\,x)\,k-2} \end{array}\right\}$$

The model must be solved computationally to obtain results, due to its complexity. However, for a certain range of values, the following analysis sustains. For the purposes of this analysis, we assume the following restrictions: $0 < x < \frac{1}{2}$, $0 < c < \frac{1}{2}$, $1 < k < \frac{2}{1-2\,x}$. And finally, since $x \in \left(0, \frac{1}{2}\right) \Rightarrow \frac{2}{1-2\,x} \in (2, +\infty)$, we can reasonably accept (assuming no great productivity differences between the two firms) that: $1 < k < 2$.

1.2.6. Optimal Strategies

In this section, we examine the formulated optimal strategic choices of each agent under alternative wage-bargaining structures in the host country. If it proves that, the f-firm, unions and the social planner, have no incentive to deviate from the suggested market's setup, its institutional component (e.g. DB or CB) can be characterized as part of the Nash equilibrium, and it is only then that inward FDI would emerge in equilibrium. Otherwise, exports would be accommodated in the host country in the equilibrium.

Starting with **f-firm's choices**, let us first assume that the wage-bargaining structure in the host country is DB and, by backward induction, the derived optimal output functions appear as above (section 1.2.4). Since $\Pi = q^2$ in Cournot competition - and under the constraint in §1.2.5. - the f-firm will choose either F.D.I. (under DB) or Exports, depending on where its output is greater. Subtracting $\boldsymbol{q}_{fdb}$ (30) from $\boldsymbol{q}_{fe}$ (23) and simplifying, we conclude to the following:

- if $w_{0h} > cr_1 = w_{0f} + (x - c)\,k \Rightarrow q_{fe} > q_{fdb}$
- if $w_{0h} < cr_1 = w_{0f} + (x - c)\,k \Rightarrow q_{fe} < q_{fdb}$

Interpreting this conclusion, we conclude to:

$$q_{fe} > q_{fdb} \Rightarrow w_{0h} - w_{0f} > (x - c)\,k \Rightarrow c + \frac{w_{0h}}{k} > x + \frac{w_{0f}}{k} \quad \text{and}$$

$$q_{fe} < q_{fdb} \Rightarrow w_{0h} - w_{0f} < (x - c)\,k \Rightarrow c + \frac{w_{0h}}{k} < x + \frac{w_{0f}}{k}$$

If the sum of the FDI's associated unit cost plus the unemployment benefit in home country under effective labour is less than the sum of the Exports' associated unit cost plus the unemployment benefit in foreign country under effective labour, then the institutionalization of Decentralized Wage Bargaining in home Labour Market will induce FDI.

The previous statement nominates decentralized bargaining regime as an institutional formation that can – under circumstances – effectively induce FDI.

However, we must stress out here that the above condition although necessary, yet is not sufficient, due to the strategic choices of the other agents in the game.

Interpreting the above conclusion, f-firm will face

- unit cost *c* and unemployment benefit w_{0h} for the FDI case
- unit cost *x* and unemployment benefit w_{0f} for the Exports case,

counting in its productivity *k* as well. As it is proven, f-firm will examine only the associated costs (unit cost and the unemployment benefit under effective labour) in each case, in order to serve the home market via FDI or via Exports.

Thereafter, we continue comparing exports case to FDI under centralized bargaining regime. Subtracting $\boldsymbol{q}_{fcb}$ (37) from $\boldsymbol{q}_{fe}$ (23) and simplifying, it proves that:

- $\mathrm{q_{fe}} > \mathrm{q_{fcb}} \Rightarrow \mathrm{w_{0h}} > cr_2 = \frac{b^2(k-2ck)-32\mathrm{w_{0f}}+32k(c-x)+4b(k+\mathrm{w_{0f}}+kx)}{-b^2k+2b^2-32+8bk}$
- $\mathrm{q_{fe}} < \mathrm{q_{fcb}} \Rightarrow \mathrm{w_{0h}} < cr_2 = \frac{b^2(k-2ck)-32\mathrm{w_{0f}}+32k(c-x)+4b(k+\mathrm{w_{0f}}+kx)}{-b^2k+2b^2-32+8bk}$

Meaning that, if $\mathrm{w_{0h}}$ is less than a critical value $cr_2 = \frac{b^2(k-2ck)-32\mathrm{w_{0f}}+32k(c-x)+4b(k+\mathrm{w_{0f}}+kx)}{-b^2k+2b^2-32+8bk}$, then f-firm will choose to serve home market via FDI under centralized bargaining regime over exports and conversely.

Finally, subtracting $\boldsymbol{q}_{fdb}$ (30) from $\boldsymbol{q}_{fcb}$ (37) and simplifying, it proves that:

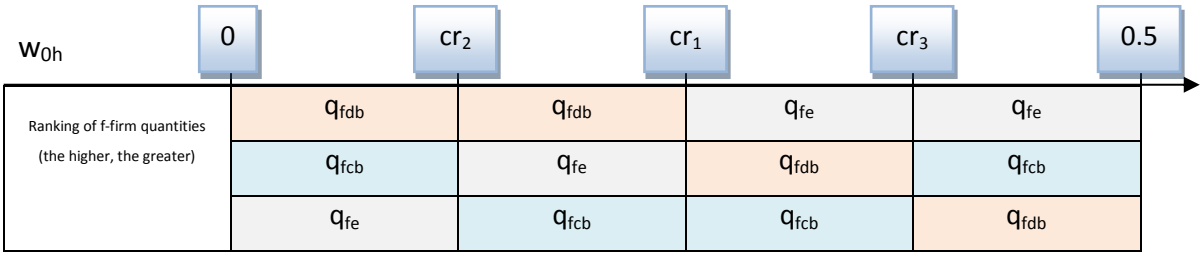
- $\mathrm{q_{fdb}} > \mathrm{q_{fcb}} \Rightarrow \mathrm{w_{0h}} < cr_3 = \frac{4k+bk+4ck-2bck}{-4+2b+8k-bk}$
- $\mathrm{q_{fdb}} < \mathrm{q_{fcb}} \Rightarrow \mathrm{w_{0h}} > cr_3 = \frac{4k+bk+4ck-2bck}{-4+2b+8k-bk}$

Interpreting the above lines, if $\mathrm{w_{0h}}$ is less than a critical value $cr_3 = \frac{4k+bk+4ck-2bck}{-4+2b+8k-bk}$, then f-firm will enjoy greater market share, and thus profits, in FDI under decentralized bargaining regime over FDI centralized bargaining regime and conversely.

For any values of the parameters as cited in 1.2.5 section, it is proven that

$$cr_3 = \frac{4k+bk+4ck-2bck}{-4+2b+8k-bk} > \mathrm{cr_1} = \mathrm{w_{0f}} + (\mathrm{x} - \mathrm{c})\,\mathrm{k} > cr_2 = \frac{b^2(k-2ck)-32\mathrm{w_{0f}}+32k(c-x)+4b(k+\mathrm{w_{0f}}+kx)}{-b^2k+2b^2-32+8bk}.$$

Summarizing, we sort the profits of f-firm (higher the greater, lower the less), depending on the value of $\mathrm{w_{0h}}$ in each case to the following matrix:



Ranking of f-firm quantities (the higher, the greater)				
	q_{fdb}	q_{fdb}	q_{fe}	q_{fe}
	q_{fcb}	q_{fe}	q_{fdb}	q_{fcb}
	q_{fe}	q_{fcb}	q_{fcb}	q_{fdb}

From the examination of the matrix above, we come to the following conclusions:

Proposition 1

If w_{0h} is low enough (less than $cr_2 = \frac{b^2(k-2ck)-32w_{0f}+32k(c-x)+4b(k+w_{0f}+kx)}{-b^2k+2b^2-32+8bk}$), then any institutional arrangement of labour market is insufficient to deter FDI. If on the other hand w_{0h} is great enough (greater than $cr_1 = \mathrm{w_{0f}} + (\mathrm{x} - \mathrm{c})\,\mathrm{k}$), then any institutional arrangement of labour market is insufficient to induce FDI.

Notice that, if w_{0h} ranges from zero to cr_2, then f-firm's quantities in each case of FDI (either under centralized or under decentralized bargaining) are greater than the quantity in exports case. Thus, f-firm will accommodate home market via FDI, in any case. Once again, if w_{0h} is greater than cr_1, then f-firm's quantity in exports case is greater than the respective ones in any case of FDI (either under centralized or under decentralized bargaining). Thus, f-firm will eventually choose to serve the home market via exports.

Let us now proceed with **unions' strategic decisions**. Labour unions will either stay decentralized or will coordinate and bargain their wage in a centralized regime with the firms. Obviously, centralized bargaining regime is an option only in case that FDI emerges. As mentioned above, both unions' utility must increase with

centralized bargaining (vs DB), else unions will have an incentive to decline from the coordination. In case that any unions' utility decrease after the coordination, that union will be motivated to decline and thus decentralized wage bargaining will emerge.

Regarding **home union**, we first examine its utility under exports case versus FDI under DB case. Abstracting U_{hdb} (33) from U_{he} (26), we conclude to the following:

- if $w_{0h} > cr_1 = w_{0f} + (x - c)\,k \Rightarrow U_{he} < U_{hdb}$
- if $w_{0h} < cr_1 = w_{0f} + (x - c)\,k \Rightarrow U_{he} > U_{hdb}$

Therefore, if w_{0h} is low enough, less than $cr_1 = w_{0f} + (x - c)\,k$, we conclude that $U_{he} > U_{hdb}$. So, for home union, the FDI under decentralized wage bargaining is rather damaging in comparison to exports case, meaning that home union has incentive to prevent FDI under DB with its choices.

Note that, regarding exports versus FDI under decentralized wage bargaining case, f-firm and home union have exactly opposite behaviors; if w_{0h} is less than cr_1, then f-firm will choose to serve home market via exports, while home union would prefer FDI under DB to emerge.

Continuing with the comparison of FDI under decentralized wage bargaining versus centralized wage bargaining regime, and abstracting U_{hcb} (40) from U_{hdb} (33), we obtain the following results:

$$U_{hdb} - U_{hcb} = \frac{b(b-2)\left(k\,(w_{0h}-1)\left(k\,(1+c-2w_{0h}) + w_{0h}\right) + \dfrac{(8(-2(b-2)w_{0h} + k(4+b+4c-2bc+(b-8)w_{0h}))^2)}{\left(-16 + b^2\right)^2}\right)}{12\,k^2}$$

Since $12\,k^2 > 0$, $b(b-2) < 0$ and for $w_{0h} < \frac{1}{2}$, $\left(k\,(w_{0h}-1)\left(k\,(1+c-2w_{0h}) + w_{0h}\right) + \dfrac{(8(-2(b-2)w_{0h} + k(4+b+4c-2bc+(b-8)w_{0h}))^3)}{\left(-16 + b^2\right)^2}\right) > 0$, we conclude to $U_{hdb} < U_{hcb}$.

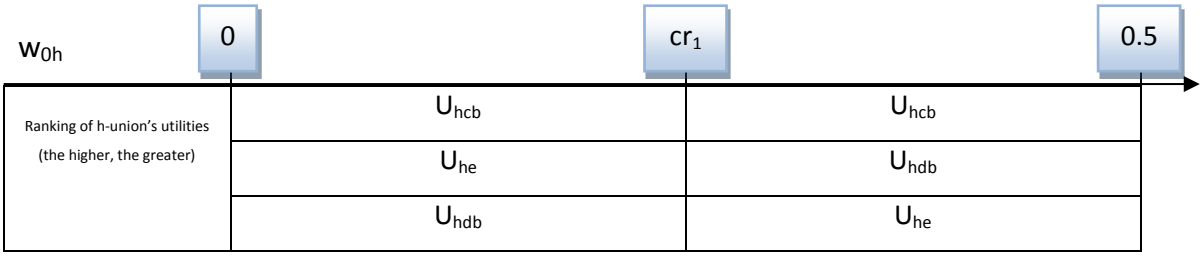
Finally, let us compare home union's utility under exports and FDI (CB) case. Abstracting U_{hcb} (40) from U_{he} (26) and simplifying, we conclude to the following:

$$U_{he} - U_{hcb} =$$
$$-\left(b^2-16\right)^2 k\left(w_{0h}\text{-}1\right)\left(k\ \left(1\text{+}c\text{-}2w_{0h}\right)\text{+}w_{0h}\right)\text{-}8\left(\text{-}2\left(b\text{-}2\right)w_{0f}\text{+}k\left(4\text{-}8w_{0h}\text{+}b\left(1\text{+}w_{0h}\text{-}2x\right)\text{+}4x\right)\right)^2 < 0 \Rightarrow$$
$$U_{he} < U_{hcb}$$

Proposition 2:

In case that FDI emerges, home union will prefer to coordinate with the other union in order to bargain their wages under a centralized regime.

The analysis above reveal that centralized wage bargaining appears to be an optimal strategy for home union in each case. Summarizing the choices of home union, we sort its utilities (higher the greater, lower the less), depending on the value of w_{0h} in each case to the following matrix:



Ranking of h-union's utilities (the higher, the greater)	U_{hcb}	U_{hcb}
	U_{he}	U_{hdb}
	U_{hdb}	U_{he}

Regarding **f-union**, it exists only if f-firm will accommodate home market via FDI. Therefore, we check if foreign union has an incentive to coordinate with the home union. Abstracting U_{fcb} (41) from U_{fdb} (34), we conclude to the following:

$$U_{fdb} - U_{fcb}$$
$$= \frac{(-2+b)b(((-1+c)k+w0h)(k(-1+2c-w0h)+2w0h)-\frac{8((4+b+(-8+b)c)k+(-8+b+4k-2bk)w0h)^2}{(-16+b^2)^2})}{12k^2}$$

Given the complexity of the model, no solid strategy can be revealed, as the model must be solved computationally to obtain solutions [6]. Nevertheless, constraining $c \in (0,0.25)$[7], we observe that applies $U_{fdb} < U_{fcb}$.

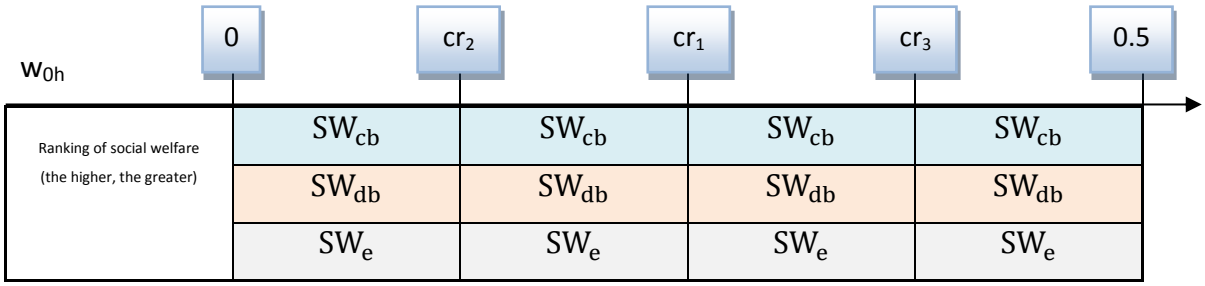
Finally, in order to rationalize social planner's choices, let us examine how **social welfare** formulates in each case. Dividing SW_e (42) by SW_{db} (43), it can be proven that $\frac{SW_e}{SW_{db}} < 1 \rightarrow SW_e < SW_{db}$. In the same way (abstracting SW_{cb} (44) from SW_e (42) and SW_{cb} (44) from SW_{db} (43)) it proves that it also applies $SW_e < SW_{cb}$, while $SW_{db} < SW_{cb}$. Proposition 3 summarizes.

Proposition 3:

FDI proves to be social optimal frame rather than exports regime. Within FDI frame, centralized wage bargaining regime will yield greater social welfare rather than decentralized wage bargaining setup.

1.2.7. Subgame perfect equilibrium (S.P.E.)

Summarizing all the above, we can illustrate all strategies in the following matrix:



[6] Simplifying the above expression,

- if $k \in (1, \frac{256-320b+64b^2-b^4-(-16+b^2)\sqrt{256-384b+160b^2+b^4}}{2(128-128b+32b^2)})$, and considering as x_1 and x_2 the roots of the formulated trinomial, then
  - for $0 < w_{0h} < x_1$ & $x_2 < w_{0h} < 0.5 \rightarrow U_{fdb} < U_{fcb}$
  - for $x_1 < w_{0h} < x_2 \rightarrow U_{fdb} > U_{fcb}$
- if $k \in (\frac{256-320b+64b^2-b^4-(-16+b^2)\sqrt{256-384b+160b^2+b^4}}{2(128-128b+32b^2)}, 2)$, and considering as x_1 and x_2 the roots of the formulated trinomial, then
  - for $0 < w_{0h} < x_1$ & $x_2 < w_{0h} < 0.5 \rightarrow U_{fdb} > U_{fcb}$
  - for $x_1 < w_{0h} < x_2 \rightarrow U_{fdb} < U_{fcb}$

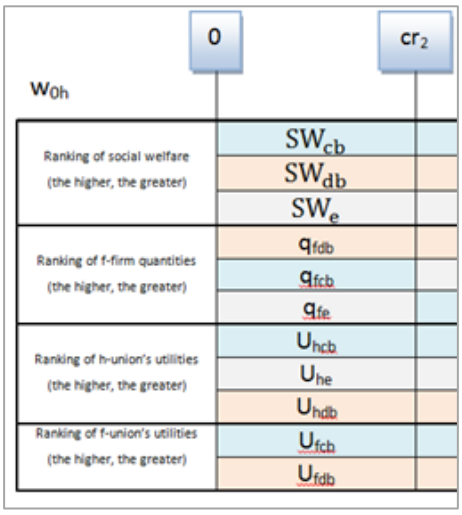
[7] The restriction is made for the analysis purposes and for better understanding of the game flow.

Ranking of f-firm quantities (the higher, the greater)	q_{fdb}	q_{fdb}	q_{fe}	q_{fe}
	q_{fcb}	q_{fe}	q_{fdb}	q_{fcb}
	q_{fe}	q_{fcb}	q_{fcb}	q_{fdb}
Ranking of h-union's utilities (the higher, the greater)	U_{hcb}	U_{hcb}	U_{hcb}	U_{hcb}
	U_{he}	U_{he}	U_{hdb}	U_{hdb}
	U_{hdb}	U_{hdb}	U_{he}	U_{he}
Ranking of f-union's utilities (the higher, the greater)	U_{fcb}	U_{fcb}	U_{fcb}	U_{fcb}
	U_{fdb}	U_{fdb}	U_{fdb}	U_{fdb}

Given the complexity of the model and the restrictions mentioned, we proceed with the examination of the Subgame Perfect Equilibria (SPE).

Proposition 4: SPE 1

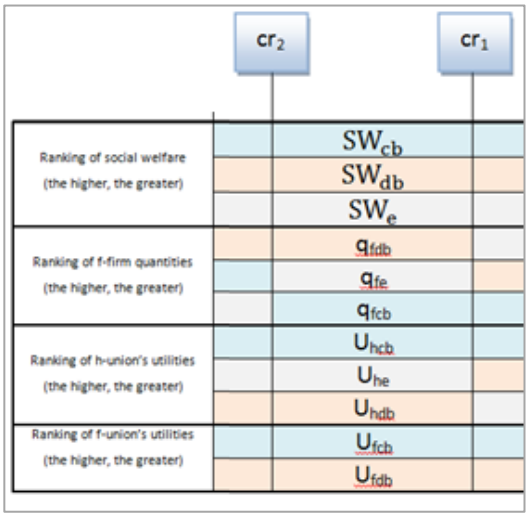
If $w_{0h} \in \left(0, cr_2 = \frac{b^2(k-2ck)-32w_{0f}+32k(c-x)+4b\left(k+w_{0f}+kx\right)}{-b^2k+2b^2-32+8bk}\right)$ *, then f-firm will accommodate home market via FDI. The labour market will auto-regulate to centralized wage bargaining regime, maximizing that way the social welfare.*



Analyzing the optimal strategies of each agent comparatively, let us first approach f-firm's alternatives. As mentioned above, since w_{0h} is low enough, f-firm's profits under FDI is greater than profits under exports in either case (either decentralized or centralized bargaining regime). Therefore, the optimal choice of f-firm is to serve the home market via FDI. Even if centralized wage bargaining regime finally emerges in home's labour market, f-firm will still enjoy greater profits versus the exports case. Unions will coordinate and bargain their wages under centralized regime, since they both enjoy greater utility in this case, rather than decentralized bargaining. Social planner will let labour market to auto-regulate, as this proposed equilibrium maximizes social welfare. Since no agent has any incentive to decline, the proposed equilibria consists a Nash subgame perfect equilibria.

Proposition 5: SPE 2

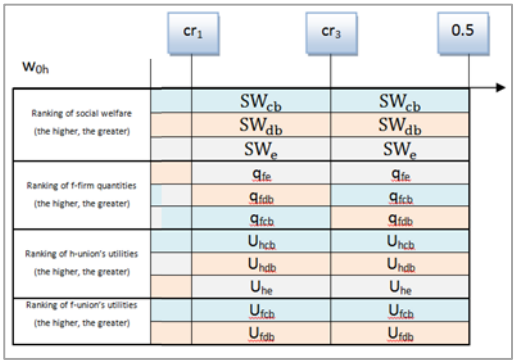
If $w_{0h} \in \left(cr_2 = \frac{b^2(k-2ck)-32w_{0f}+32k(c-x)+4b(k+w_{0f}+kx)}{-b^2k+2b^2-32+8bk},\ cr_1 = w_{0f} + (x - c)\,k\right)$*, then FDI will finally emerge. Social planner will legislate (impose) decentralized wage bargaining regime – in contrast to unions' interests – in order to ensure the maximization of social welfare.*



Interpreting the lines above, f-firm will serve the home market via FDI only in the case that home's labour market is adjusted to decentralized wage bargaining regime; otherwise, f-firm's second best choice is exports. Since FDI under CB is a non-feasible option, home union will choose centralized bargaining aiming to a dual purpose; first to deter FDI and second to enjoy second-best utility (the one under exports case). However, the social planner is obliged to interfere and impose DB, to ensure the second-best social welfare. Thus, in this case, FDI under decentralized wage bargaining regime consists a Nash Subgame Perfect Equilibria.

Proposition 6: SPE 3

If $w_{0h} > cr_1 = w_{0f} + (x - c)\,k$*, then f-firm will serve home market via exports. As mentioned in Proposition 2, in this case, any institutional arrangement of labour market is insufficient to induce FDI and thus social planner must seek for an alternative institutional tool to induce FDI.*



In this last proposed equilibria, FDI appears as a less profitable choice for f-firm. F-firm will serve the home market via exports in any instance, maximizing its profits. The institutional arrangement of labour market in this case is insufficient to induce

FDI, and thus union's utility and social welfare will adjust to their minimum values. In order FDI to emerge, the social planner has to find an alternative institutional tool.

1.2.8. Conclusions

In this section, we have examined whether enforcing a particular unionization structure in a host labour market is an effective policy tool in order to induce or deter inward FDI. Our analysis diverts from previous works [see, e.g., Vlassis (2009) and the references therein] in two major aspects. **First**, we have considered the home union's choice about the domestic unionization structure as a strategy to deter or accommodate inward FDI at the union's best interest. **Second**, we have inbuilt to our model the concept of the home union's reservation utility under the centralized unionization structure and the ensuing wage bargaining regime.

We focused in a union-oligopoly context interpreting the optimal equilibria may arise from any possible policies of a benevolent social planner. Furthermore, we investigated the circumstances under which the institutional arrangements of labour market (decentralized versus centralized wage bargaining) consist effective policy tools to induce or deter FDI.

Given the complexity of the model, we applied extended restrictions for the values of the parameters, and consequently the results - although applied - are not widely applicable.

Through our analysis, we provided a consistent model as an analytical tool, which combines the strategies and the goals of all agents (f-firm, unions, social planner) and analyze all possible equilibria.

Our findings suggest that the institutional arrangement of labour market may be insufficient to induce (if $w_{0h}>cr_1$) or to deter (if $w_{0h}<cr_2$) FDI. In other cases ($w_{0h}\in (cr_2, cr_1)$), institutional arrangement of labour market proves to be an efficient policy device to induce FDI and maximize social welfare, even in contrast to unions' objectives. While in other cases ($w_{0h}<cr_2$), the social planner should let the labour market to auto-regulate itself, gaining the maximum social welfare.

Furthermore, FDI appears to be social welfare maximizing rather than exports regime. We should also stress out that centralized wage bargaining regime maximizes not only unions' utility, but social welfare as well.

Notwithstanding, it is most possible that we revealed only some of the possible SPE, due to the complexity of the model and the extended restrictions we assumed in our effort to illustrate the flow of the game.

In the next 2 sessions, the model is properly adjusted in order to focus our analysis on the role of unit cost (c or x) and the reservation wage / unemployment benefit (w_0) in the final equilibria.

1.2.9. Appendix

1. Solving the Model

Using backward induction, we first begin from **the last – 5th – stage** of the game, Cournot competition.

For the **exports case**, the definition of the functions:

- $\mathrm{pe} = 1 - (\mathrm{qhe} + \mathrm{qfe})$
- $\mathrm{prhe} = (\mathrm{pe} - \mathrm{whe})\mathrm{qhe}$
- $\mathrm{prfe} = (\mathrm{pe} - (\mathrm{wfe}/k) - x)\mathrm{qfe}$

From the expressions above, we extract the reaction functions:

- $\mathrm{qhe} \rightarrow \frac{1}{2}(1 - \mathrm{qfe} - \mathrm{whe})$
- $\mathrm{qfe} \rightarrow \frac{k - k\mathrm{qhe} - \mathrm{wfe} - kx}{2k}$

Solving the system of reaction functions, we obtain the results for the last stage of the game:

- $\mathrm{qhe} = \frac{k + \mathrm{wfe} - 2k\mathrm{whe} + kx}{3k}$
- $\mathrm{qfe} = \frac{k - 2\mathrm{wfe} + k\mathrm{whe} - 2kx}{3k}$
- $\mathrm{prhe} = \frac{(\mathrm{wfe} + k(1 - 2\mathrm{whe} + x))^2}{9k^2}$
- $\mathrm{prfe} = \frac{(-2\mathrm{wfe} + k(1 + \mathrm{whe} - 2x))^2}{9k^2}$
- $\mathrm{pe} = \frac{\mathrm{wfe} + k(1 + \mathrm{whe} + x)}{3k}$

Proportionally, for the **FDI case**:

- $\mathrm{pf} = 1 - (\mathrm{qhf} + \mathrm{qff})$
- $\mathrm{prhf} = (\mathrm{pf} - \mathrm{whf})\mathrm{qhf}$
- $\mathrm{prff} = (\mathrm{pf} - (\mathrm{wff}/k) - c)\mathrm{qff}$

Reaction functions:

- $\mathrm{qhf} \to \frac{1}{2}(1 - \mathrm{qff} - \mathrm{whf})$
- $\mathrm{qff} \to \frac{k - ck - k\mathrm{qhf} - \mathrm{wff}}{2k}$

Solving the equation system above:

- $\mathrm{qhf} = -\frac{-k - ck - \mathrm{wff} + 2k\mathrm{whf}}{3k}$
- $\mathrm{qff} = -\frac{-k + 2ck + 2\mathrm{wff} - k\mathrm{whf}}{3k}$
- $\mathrm{prhf} = \frac{(\mathrm{wff} + k(1 + c - 2\mathrm{whf}))^2}{9k^2}$
- $\mathrm{prff} = \frac{(-2\mathrm{wff} + k(1 - 2c + \mathrm{whf}))^2}{9k^2}$
- $\mathrm{pf} = \frac{\mathrm{wff} + k(1 + c + \mathrm{whf})}{3k}$

Continuing to the **4th stage** of the game, we determine the wages in each instance.

For the exports case, the wage bargaining is expressed by the following expressions:

- $B_{he} = \left((\mathrm{whe} - \mathrm{w0h})\mathrm{qhe}\right)^b \cdot \mathrm{prhe}^{(1-b)}$
- $B_{fe} = \left((\mathrm{wfe} - \mathrm{w0f})(\mathrm{qfe}/k)\right)^b \cdot \mathrm{prfe}^{(1-b)}$

Taking first order conditions and solving the equation system, we obtain the wages:

- $\mathrm{whe} = \frac{-16k\mathrm{w0h} - 4b(\mathrm{w0f} + k(1 - 2\mathrm{w0h} + x)) + b^2(2\mathrm{w0f} + k(-1 + 2x))}{(-16 + b^2)k}$
- $\mathrm{wfe} = \frac{-16\mathrm{w0f} + b(8\mathrm{w0f} + k(-4(1 + \mathrm{w0h} - 2x) + b(-1 + 2\mathrm{w0h} - x)))}{-16 + b^2}$

Substituting the wages:

- $\mathrm{qhe} = \frac{2(-2 + b)(-2(-2 + b)\mathrm{w0f} + k(4 - 8\mathrm{w0h} + b(1 + \mathrm{w0h} - 2x) + 4x))}{3(-16 + b^2)k}$
- $\mathrm{qfe} = \frac{2(-2 + b)((-8 + b)\mathrm{w0f} + k(4 + b + 4\mathrm{w0h} - 2b\mathrm{w0h} + (-8 + b)x))}{3(-16 + b^2)k}$
- $\mathrm{prhe} = \frac{4(-2 + b)^2(-2(-2 + b)\mathrm{w0f} + k(4 - 8\mathrm{w0h} + b(1 + \mathrm{w0h} - 2x) + 4x))^2}{9(-16 + b^2)^2k^2}$
- $\mathrm{prfe} = \frac{4(-2 + b)^2((-8 + b)\mathrm{w0f} + k(4 + b + 4\mathrm{w0h} - 2b\mathrm{w0h} + (-8 + b)x))^2}{9(-16 + b^2)^2k^2}$

- $\mathrm{pe} = \frac{2(-2+b)\mathrm{w0f}+k(-4(1+\mathrm{w0h}+x)+b(-1+2\mathrm{w0h}+2x))}{3(-4+b)k}$

For the FDI under decentralized wage bargaining, the wage bargaining is expressed by the following expressions:

- $\mathrm{B_{hdb}} = \big((\mathrm{whf} - \mathrm{w0h})\mathrm{qhf}\big)^b \cdot \mathrm{prhf}^{(1-b)}$
- $\mathrm{B_{fdb}} = \big((\mathrm{wff} - \mathrm{w0h})(\mathrm{qff}/k)\big)^b \cdot \mathrm{prff}^{(1-b)}$

Taking first order conditions and solving the equation system, we obtain the wages:

- $\mathrm{whf} \to \frac{4k\mathrm{w0h}+b(k(1+c-2\mathrm{w0h})+\mathrm{wff})}{4k}$
- $\mathrm{wff} \to \frac{1}{4}(4\mathrm{w0h} + b(-2\mathrm{w0h} + k(1 - 2c + \mathrm{whf})))$

Substituting the wages:

- $\mathrm{qhdb} = \frac{2(-2+b)(-2(-2+b)\mathrm{w0h}+k(4+b+4c-2bc+(-8+b)\mathrm{w0h}))}{3(-16+b^2)k}$
- $\mathrm{qfdb} = \frac{2(-2+b)((4+b+(-8+b)c)k+(-8+b+4k-2bk)\mathrm{w0h})}{3(-16+b^2)k}$
- $\mathrm{prhdb} = \frac{4(-2+b)^2(k(-4(1+c-2\mathrm{w0h})+b(-1+2c-\mathrm{w0h}))+2(-2+b)\mathrm{w0h})^2}{9(-16+b^2)^2k^2}$
- $\mathrm{prfdb} = \frac{4(-2+b)^2((4+b+(-8+b)c)k+(-8+b+4k-2bk)\mathrm{w0h})^2}{9(-16+b^2)^2k^2}$
- $\mathrm{pdb} = \frac{(-4-b+2(-2+b)c)k+2(-2+b)(1+k)\mathrm{w0h}}{3(-4+b)k}$

For the FDI under centralized wage bargaining, the wage bargaining is expressed by the following expressions:

- $\mathrm{B_{hcb}} = (Uhc + Ufcb + \overline{U_2})^b \cdot \mathrm{prhf}^{(1-b)} = \Big(\big((\mathrm{whf} - \mathrm{w0h}) \cdot \mathrm{qhf}\big) + \big((\mathrm{wff} - \mathrm{w0h})(\mathrm{qff}/k)\big) - \Big((\mathrm{wff} - \mathrm{w0h})\Big(\frac{1-c-(\mathrm{wff}/k)}{2k}\Big)\Big)\Big)^b \cdot \mathrm{prhf}^{(1-b)}$

- $\mathrm{B_{fcb}} = (Uhc + Ufcb + \overline{U_1})^b \cdot \mathrm{prff}^{(1-b)} = \Big(\big((\mathrm{whf} - \mathrm{w0h}) \cdot \mathrm{qhf}\big) + \big((\mathrm{wff} - \mathrm{w0h})(\mathrm{qff}/k)\big) - \Big((\mathrm{whf} - \mathrm{w0h})(\frac{1-\mathrm{whf}}{2})\Big)\Big)^b \cdot \mathrm{prff}^{(1-b)}$

Taking first order conditions and solving the equation system, we obtain the wages:

- $\mathrm{whcb} = \frac{1}{2}(b + 2\mathrm{w0h} - b\ \mathrm{w0h})$
- $\mathrm{wfcb} = \frac{1}{2}(bk - bck + 2\mathrm{w0h} - b\mathrm{w0h})$

Substituting the wages:

- $\mathrm{qhcb} = -\frac{(-2+b)(k(1+c-2\mathrm{w0h})+\mathrm{w0h})}{6k}$
- $\mathrm{qfcb} = \frac{(-2+b)(k(-1+2c-\mathrm{w0h})+2\mathrm{w0h})}{6k}$
- $\mathrm{prhcb} = \frac{(-2+b)^2(k(1+c-2\mathrm{w0h})+\mathrm{w0h})^2}{36k^2}$
- $\mathrm{prfcb} = \frac{(-2+b)^2(-2\mathrm{w0h}+k(1-2c+\mathrm{w0h}))^2}{36k^2}$
- $\mathrm{pcb} = \frac{-(-2+b)\mathrm{w0h}+k(-b(-2+c+\mathrm{w0h})+2(1+c+\mathrm{w0h}))}{6k}$

1.3. Union Structure and Inward FDI Focusing on Unit Cost Factor Analysis

1.3.1. Abstract

In a union-duopoly strategic context, we explore the endogenous determination and the effects of the unionization structure in a market facing the possibility of inward foreign direct investments (FDI). Our findings suggest that, if the foreign firm's unit cost under exports-x is lower than its unit cost under FDI-c, then the domestic unionization structure is irrelevant with FDI decisions. If on the other hand c is lower than x, yet high enough, inward FDI will be – optimally in terms of social welfare – deterred in the equilibrium, so long as the domestic labour market is left to auto-regulate to a centralized union structure, hence, to a centralized wage bargaining regime. If however c is low enough, then a benevolent social planner will have to enforce decentralized union structure and wage bargaining – optimally inducing or accommodating inward FDI – in contrast to the domestic union's best interest which would have otherwise – sub-optimally led to a centralized union structure/wage bargaining regime.

1.3.2. The Model

The model's framework herein follows the corresponding structural model. Since we focus in the role of firms' unit costs, we normalize unions' bargaining power (home and abroad) to one (monopoly unions) and the reservation wages to zero. Although this modified model leads to a new equilibrium, the qualitative findings remain forceful, while they reveal the role of unit cost in inducing or deterring FDI.

Consider a homogeneous good sector where two firms, a home firm (*h-firm*) and a foreign firm (*f-firm*), are competing in the home market by adjusting their quantities. The *f-firm* may either produce its quantity abroad and serve the home market via international trade or produce and sell in the host country via FDI. If the *f-firm* chooses international trade (FDI), then f-firm will face a unit cost *x (c)*[8]. In

[8] According to Vlassis' (2000) terminology, "*c* formally represents coordination and control costs, assumed to be constant per unit of production, which are incurred when the f-firm runs local

either case, the *f-firm* will face a sunk cost (say *F*) made up by building a plant to serve the home market, which for simplicity is normalized to zero.[9] Production everywhere exhibits constant returns to scale and both firms possess *Leontief* technology. Therefore, provided that its capital stock is sufficient to produce the good, each firm effectively needs to adjust only its labour input in order to adjust its output. Following Hymer (1960), it is moreover assumed that the *f-firm* enjoys a technological advantage over the *h-firm*, hence, the production function of the *h-firm* (*f-firm*) is of the form: $Q_h = L_h$ ($Q_h = kL_h;\ k > 1$), where Q_i (L_i) denotes output (employment) of *i* firm. Whilst, keeping things as simple as possible, the inverse market demand is defined to be of the simple linear form, $P(Q) = 1 - Q$, where *Q* stands for the aggregate output ($Q=Q_h + Q_f$).

Consider next that the labour market is unionized both at home and abroad: *Ex-ante*, there is one union in the host country (the home union) and one abroad (the foreign union). Given risk-neutral fixed membership and immobile labour in both markets, and assuming utilitarian behavior under zero reservation wages, each union aims to maximize $U_i(w_i, L_i) = w_i.L_i$, where *w* is the wage argument and *L* stands for employment with the *i* firm *(i=h, f)*. We also assume that unions possess a bargaining power of one (zero) during the negotiations over the wage (employment), acting as quasi-monopoly unions. *Ex-post*, and given the possibility of inward FDI, it then follows that, if the *f-firm* decides to serve the home market via exports, then the home firm-union pair and the foreign firm-union pair will naturally negotiate over firm/country-specific wages hence, the unionization structure and the wage bargaining regime would both be *de facto* decentralized across countries/firms. In case, however, the *f-firm* via FDI locates its production in the home country, then – in the absence of any legal/institutional constraint, and given the irreversibility of the *f-firm*'s decision (due to the FDI sunk cost) – the home workers/prospective employees in the *h-firm* and/or the *f-firm* will have two options: Either to remain members of one (i.e., of the existing home) union, and jointly negotiate wages with

production. These costs arise from cross-border differences in (other than the labour market's) legislation, taxation, language, work ethics, personnel procedures etc. Respectively, *x* represents (constant) export marketing costs per unit of sales, made up of transport, packaging, insurance, tariffs, etc".

[9] We assume a symmetric *F* in both cases (a plant for exports or a plant for FDI), therefore the normalization of *F* to zero will not affect the equilibrium.

both the *h-firm* and the *f-firm* (centralized union structure/wage bargaining), or to split in two separate unions that will enter into wage negotiations independently with the *f-firm* and the *h-firm* (decentralized union structure/wage bargaining). As we show later on, this speculative possibility on the part of the home union of an *ex-post* adjustment of the unionization structure and wage bargaining may in turn raise the need for active institutional intervention in the labour market: In its absence, the *f-firm* may, sub-optimally for social welfare, yet at the home union's best interest, be deterred to settle production in the home market. Whilst, by enforcing the necessary unionization/wage bargaining structure, a benevolent social planner may optimally induce inward FDI, even if that proves to be sub-optimal for the home union.

The sequence of the events unravels as follows:

Stage 1: A benevolent social planner – if needed – establishes (or reforms) the unionization/wage bargaining structure at home so that to maximize social welfare. The social planner's decision may be in accordance or in contrast to the home union's goals, given that the latter do not always coincide with the socially optimal strategies. Therefore, using the unionization structure as a policy tool, the social planner may sometimes leave the labour market to optimally auto-regulate, whilst under different circumstances she/he must issue labour market legislation and enforce a particular unionization structure. Also, in some cases she/he may have to accept the second best regarding social welfare, while in other cases she/he may be unable to induce or deter FDI, and she/he will consequently be bound to find an alternative policy tool. In any instance, the social planner's criterion is as follows:

$$Max\ SW\ \{= pr_h + U_h + U_f + CS\} \quad (1)$$

Where, *SW* stands for social welfare, pr_h stands for the profits of *h*-firm, U_i stands for the utility of (sub) union *i* (i.e., the utility of the home union's members who would respectively be employed by firm *i=h-, f-*) and *CS* stands for consumer surplus. Note that U_h and U_f are separately considered into the calculations only if the *f-firm* chooses to settle in the host market via FDI.

Stage 2: Given the labour market institutional resolutions in the host country, the *f-firm* decides to serve the home market via either exports or FDI, its goal being to maximize its profits, defined as follows:

$$Max\{pr_f = P \cdot q_f - w_f \cdot \frac{q_f}{k} - x \cdot q_f = \left(P - \frac{w_f}{k} - x\right) \cdot q_f \} \quad (2)$$

Where, pr_f stands for f-firm's profit, q_f stands for *f-firm's* quantity and w_f is the *f-firm*-specific wage bargain.

Stage 3: Given the labour market institutional resolutions, and the *f-firm*'s irreversible decision to settle (or not) its production plant in the host market, firm(s) and union(s) bargain over wages. The optimal wages in all candidate equilibria are defined as follows:

(i) Exports Case:

$$arg\ max\ \{w_{he} \cdot q_{he}\} \xrightarrow{optimal} w_{he} \quad (3)$$

$$arg\ max\ \left\{w_{fe} \cdot \frac{q_{fe}}{k}\right\} \xrightarrow{optimal} w_{fe} \quad (4)$$

Where, $w_{he\ (fe)}$ stand for the home (the foreign) union's bargained wages, and $q_{he\ (fe)}$ is the home (the foreign) firm's output.

(ii) FDI under Decentralized Union Structure/Wage Bargaining Case:

$$arg\ max\ \{w_{hdb} \cdot q_{hdb}\} \xrightarrow{optimal} w_{hdb} \quad (5)$$

$$arg\ max\ \left\{w_{fdb} \cdot \frac{q_{fdb}}{k}\right\} \xrightarrow{optimal} w_{fdb} \quad (6)$$

Where, $w_{hdb\ (fdb)}$ is the wage bargain for the domestic (sub) union of workers who find employment with the home (the foreign) firm, and $q_{hdb\ (fdb)}$ is the output of the home (the foreign) firm, under FDI and a decentralized union structure/ wage bargaining regime.

(iii) FDI under Centralized Union Structure/Wage Bargaining Case:

$$arg\ max\ \left\{w_{hcb} \cdot q_{hcb} + w_{fcb} \cdot \frac{q_{fcb}}{k} - U^{fmon}\right\} \xrightarrow{optimal} w_{hcb} \quad (7)$$

$$arg\ max\ \left\{w_{hcb} \cdot q_{hcb} + w_{fcb} \cdot \frac{q_{fcb}}{k} - U^{hmon}\right\} \xrightarrow{optimal} w_{fcb} \quad (8)$$

Where, $w_{hcb\ (fcb)}$ is the wage bargain for the domestic union workers who find employment with the home (the foreign) firm, $q_{hcb\ (fcb)}$ is the home (the foreign) firm's output, and $U^{fmon(hmon)}$ stands for the domestic union's (reservation) utility, in

case that the negotiations with the home (the foreign) firm fail, under the centralized union structure/wage employment regime.[10]

Stage 4: Firms compete *a la Cournot* in the home product market. That is, for any output level of its rival firm, each firm independently adjusts its output so that to maximize its profits:

$$Max\{pr_h = P(Q) \cdot q_h - C_h(q_h)\} \quad (9)$$

$$Max\{pr_f = P(Q) \cdot q_f - C_f(q_f)\} \quad (10)$$

Where, the cost functions $C_{h(f)}$ are later on explicitly defined according to the outcomes of the previous stages.

1.3.3. Unionization Structure and Wage Bargaining, International Trade and FDI

In this section, we examine whether, under the possibility of inward FDI, the domestic unionization/wage bargaining structure can be effectively used as a policy tool in order to maximize social welfare at home. Using backward induction (to ensure subgame perfection), we first obtain the considered *(i)-(iii)* candidate equilibria, and figure out in each the range of values for all structural parameters that ensures consistent (internal) solutions for all endogenous arguments. We subsequently explore all possible Nash equilibria, by investigating if there is any motivation, on the part of any of the involved agents, to deviate from the (considered) candidate equilibrium.

Solving the model.

Starting from the (last) *Stage 4*, where Cournot competition takes place, using the (simultaneous and independent profit maximization) first order conditions, we derive the rival (*h* and *f*) firms' reaction functions and, by those, their optimal outputs and profits, in each instance[11].

[10] Following Milliou and Petrakis (2007), yet in a quite different context of analysis, the union must in this case take into account the possibility of a failure in the negotiations with either the *h-firm* or the *f-firm*, any of those instances implying that union members would then prospect to be employed by a monopolist (to be either the *h-firm* or the *f-firm*) in the product market.

[11] The analytical results of each stage are listed in Appendix 5.1.

Note that, if wages are equal ($w_{he} = w_{fe}$), in the exports case, then the *f-firm* will enjoy greater market share and profits only if $exp(A1) - exp(A2) = q_{he} - q_{fe} > 0 \leftrightarrow x > \frac{k-1}{k} w$. Hence, if the *f-firm* possesses no greater productivity than the *h-firm* (*k=1*), then the *h-firm* will always enjoy greater market share and profits than the *f-firm*, due to the latter firm's (extra) unit cost *x*. While, if the *f-firm's* relative technological advantage (k) over the *h-firm* is high enough, then it can render the *f-firm* dominant in the home market, despite the fact that *f-firm* always faces the (extra) unit cost x to serve this market. A similar analysis applies to the FDI case.

Proceeding (backward), at *Stage 3*, unions set firm-specific wages so that to maximize the home union's (or the home sub-unions') relevant utility (utilities) in any instance. Thus, from the first order conditions of (3) - (8), we obtain optimal wages, for each instance, and substituting them back we derive the firms' outputs and profits, as well as the home union's (or the home sub-unions') utility (utilities'), for all candidate equilibria. At this point, it must be stressed out that the domestic labour union may (at *Stage 3*) − prior to wage bargaining and without delay − decide to split into two sub-unions, who will separately and independently bargain the wages of those workers who (will) find employment with the *f-firm* and the *h-firm*. This case, of course, applies only in the event of inward FDI, since the *f-firm* in the exports case will only deal with the foreign union abroad. For such a split to emerge, nonetheless, the home unions' utility [which is always (i.e., under any unionization structure) comprised by the sum of sub-utilities of workers who find employment with the foreign and the home firm] must be strictly greater than under the centralized union structure/wage bargaining regime.[12]

At *Stage 2*, the *f-firm* decides whether to settle its (new) production (plant) in the host country or abroad, and materializes its choice. At this stage, neither unions nor the social planner can do something in order to alter the *f-firm's* decision: If, for instance, given the host labour market's institutional set-up, the *f-firm's* profits under exports are (predicted to be) less than under FDI, then the *f-firm* will choose and materialize inward FDI in the (sub-game perfect) equilibrium. Therefore, if social

[12] Since the home union's members are identical, and treated identically, any decision to split, or not, requires the consent of everyone. Such a unanimous consensus is in turn expected to occur only if the average member's (expected) utility is maximized under the considered unionization structure.

welfare is optimized under this – inward FDI − state of the equilibrium, the social planner (if needed) must, at *Stage 1*, institutionalize and enforce the contingent unionization structure/wage bargaining regime.

In order to assure that our model retains its consistency with non-trivial internal solutions, we apply the following restrictions: $0 < x < \frac{5}{7}$; $0 < c < \frac{1}{2}$; $k > 1$.[13]

Equilibrium analysis.

Given the above findings, we may now proceed to the determination of the Nash equilibria.

1st Case: *High values of c –* ***Exports*** *equilibrium*

If the *f-firm's* profits under exports are greater than the respective ones in all FDI cases (i.e., under decentralized or centralized union structure/wage bargaining), then the *f-firm's* choice will be to serve the local market via exports. It proves[14] that this optimal strategy occurs if $c > x(= c_{cr1})$, since then, $pr_{fe} > pr_{fdb} > pr_{fcb}$. Note that, since the choice of the *f-firm* is independent of the unionization/wage bargaining structure in the host labour market, the social planner cannot, in this case, effectively manipulate/enforce the unionization structure in order to induce FDI. Proposition 1 summarizes.

Proposition 1*:*

If the f-firm's FDI-associated unit cost (c) is greater than its export-associated unit cost (x), then exports will always emerge in the equilibrium. Hence, neither the social planner nor the home union can use the unionization/wage bargaining structure as an effective tool to alter the f-firm's optimal strategy and induce FDI.

An interesting point to note here is the absence of the productivity element (*k>1*) from the *f-firm's* exports choice criterion ($c > x$). Seemingly, therefore, the *f-firm's* higher relative productivity is not taken into account in choosing between

[13] The relevant calculations are listed in the Appendix.
[14] The relevant calculations are listed in the Appendix.

international trade and FDI. However, the latter is not literally true. What happens in the background is that whenever wage bargaining is effectively decentralized across (the *h* and *f*) firms, for the *f-firm* to engage in cross-border rivalry, via either exports or FDI, its − lower unit cost of production − advantage over the *h-firm* must be sufficient to over-compensate its extra unit cost (*x* or *c*) to serve the home market with either strategy. Therefore, the *f-firm* will choose exports instead of FDI, if the extra unit cost of exports (*x*) is lower than the extra unit cost of FDI (*c*). Yet, as it will become evident later on, under a centralized wage bargaining regime (e.g., under a centralized union structure) in the host market, the opposite (i.e., $x > c$) is not a sufficient condition for FDI to be the *f-firm's* optimal strategy to serve the home market.

2nd – 3rd Case(s): *Intermediate values of c –* ***FDI/Decentralized Union Structure*** *and* ***Exports/Centralized Union Structure*** *equilibria*

If $c_{cr2} = \frac{-5+28x}{30} < c < x$, then the profits of *f-firm* under FDI will be greater than its profits under exports, only if the *f-firm's* employment/production plans in the host market are implemented under a decentralized wage bargaining regime. However, given the *f-firm's* (irreversible) choice to locate production in the host country, it proves[15] that the home union will always $\left(0 < c < \frac{1}{2}\right)$ choose the centralized wage bargaining regime, thus deterring inward FDI. The reason is that the sum of the sub-unions' utilities is always greater under the centralized, than under the decentralized, wage bargaining setup, hence, there is no motivation for the home union to split in two sub-unions, each one setting independently the (*h* and *f*) firm-specific wages. As a consequence, in the absence of any legislation restricting the unionization/wage bargaining structure to the decentralized regime, the *f-firm* will never choose the FDI strategy to serve the home market.

Therefore, the social planner will effectively face two options to evaluate in terms of social welfare: Exports vs. FDI under a decentralized union structure/wage

[15] The relevant calculations are listed in the Appendix.

bargaining setup. It proves that,[16] if $c < c_{cr3} = \frac{1}{64}\left(35 - \sqrt{15}\sqrt{-25 + 64x^2}\right)$, then $SW_{db} > SW_e$, hence, in order to induce FDI, and thus maximize social welfare, the social planner will have to establish a decentralized union structure, assuring decentralized wage bargaining, in the labour market, in contrast to home union's optimal choice. If, on the other hand, $c > c_{cr3} = \frac{1}{64}\left(35 - \sqrt{15}\sqrt{-25 + 64x^2}\right)$, then $SW_{db} < SW_e$. In this case the social planner's choice will line up with the home union's one and he/she must simply leave the labour market to auto-regulate to the centralized union structure/wage bargaining regime, deterring inward FDI. Proposition 2 summarizes.

Proposition 2:

(a). *If* $c_{cr2} = \frac{-5+28x}{30} < c < c_{cr3} = \frac{1}{64}\left(35 - \sqrt{15}\sqrt{-25 + 64x^2}\right) < x$, *then the social planner must impose a decentralized union structure/wage bargaining regime, thus inducing inward FDI, and maximizing social welfare, in the equilibrium.*

(b). *If* $c_{cr3} < c < x$, *then the social planner must leave the home labour market to auto-regulate to the centralized union structure and wage bargaining regime, thus deterring inward FDI, and maximizing social welfare, in the equilibrium.*

4th Case: *Low values of c –* ***FDI/Decentralized Union Structure*** *equilibrium*

If c is low enough$\left(0 < c < c_{cr2} = \frac{-5+28x}{30}\right)$, then the *f-firm's* profits under exports are less than its profits in both instances of FDI (i.e., under a centralized or a decentralized unionization structure in the host labour market)[17]. It is then clear that inward FDI will emerge, since the *f-firm* will gain fewer profits under the exports strategy, anyway. Nonetheless, the domestic unionization structure may still remain a worthy policy tool, the question here being: given that inward FDI will emerge, which regime is welfare maximizing, the centralized or the decentralized one?

As it regards the home union, we have already shown that in the FDI context it maximizes its utility (and/or the sum of utilities of its sub-unions) under the centralized regime (for any $c\epsilon[0,0.5]$). However, what is best for the home union, is

[16] The relevant calculations are listed in the Appendix.
[17] The relevant calculations are listed in the Appendix 5.3.

not necessary social welfare optimizing. It, in fact, proves that,[18] within the above range of (low) c values, social welfare is greater under the decentralized, than under the centralized, wage bargaining regime, in the FDI equilibrium. Thus, also in this case, the social planner must actively intervene in the home labour market and enforce the decentralized union structure, in contrast to the home union's best interest. Proposition 3 summarizes.

Proposition 3:

If c is low enough $\left(i.e., 0 < c < c_{cr2} = \frac{-5+28x}{30}\right)$*, then inward FDI will always emerge. However, the social planner– in contrast to the home union's best interest –must enforce the decentralized union structure/wage bargaining regime, to achieve social welfare maximization in the equilibrium.*

The outcomes of the above analysis can be briefly illustrated at the following table.

Critical values of c	*0* c_{cr2}	c_{cr3}	*x*	*0.5*
f-firm's optimal strategy	FDI	FDI	Exports	Exports
Home union's optimal strategy	Centralized union Structure/Wage bargaining (C.B.)	C.B.	C.B.	Indifferent
Social Planner's	Enforces Decentralized Union	Enforces D.B. (In contrast to the home	Allows C.B. (allows labour	Indifferent

[18] The relevant calculations are listed in the Appendix 5.5.

Choice	Structure/Wage Bargaining (D.B.) (In contrast to the home union's best interest)	union's best interest)	market to auto-regulate)	
Equilibrium	FDI under the D.B. regime	FDI under the D.B. regime	Exports under the C.B. regime	Exports under the C.B. regime

1.3.4. Conclusions

In this section, we have examined whether enforcing a particular unionization structure in a host labour market is an effective policy tool in order to induce or deter inward FDI. We adjusted the model from 1.2. section properly and therefore new interesting findings are brought in the surface, regarding the status and the behavior of a host labour market's institutions under the possibility of inward FDI.

Appealing for further/empirical investigation, it seems that the centralized union/wage bargaining setup is a factor deterring inward FDI, thus accommodating exports, while its decentralized counterpart seems to be associated with FDI accommodation. Most important, yet quite challenging (and even heretic) for conventional wisdom, we hereby propose that a policy maker may sometimes need to intervene against the unions' free choice regarding their own structure and organization, in order to serve the society's best interest.

Two possible extensions of the present model are left open for further research. The first is to address in the analysis the union bargaining power to be less than one, and also consider reservation wages.

1.3.5. Appendix

1. Results per stage

4th stage: Cournot Competition

Exports case:

$$q_{he} = \frac{k + w_{fe} - 2\,k\,w_{he} + k\,x}{3\,k} \quad \text{(A1)}$$

$$q_{fe} = \frac{k - 2\,w_{fe} + k\,w_{he} - 2\,k\,x}{3\,k} \quad \text{(A2)}$$

$$\Pi_{he} = \frac{\left(w_{fe} + k\,(1 - 2\,w_{he} + x)\right)^2}{9k^2} \quad \text{(A3)}$$

$$\Pi_{fe} = \frac{\left(-2\,w_{fe} + k\,(1 + w_{he} - 2\,x)\right)^2}{9k^2} \quad \text{(A4)}$$

$$P_e = \frac{w_{fe} + k\,(1 + w_{he} + x)}{3\,k} \quad \text{(A5)}$$

FDI case:

$$q_{hf} = \frac{(1 + c)\,k + w_{ff} - 2\,k\,w_{hf}}{3\,k} \quad \text{(A6)}$$

$$q_{ff} = \frac{(1 - 2\,c)\,k - 2\,w_{ff} + k\,w_{hf}}{3\,k} \quad \text{(A7)}$$

$$\Pi_{hf} = \frac{\left(w_{ff} + k\,\left(1 + c - 2\,w_{hf}\right)\right)^2}{9\,k^2} \quad \text{(A8)}$$

$$\Pi_{ff} = \frac{\left(-2\,w_{ff} + k\,\left(1 - 2\,c + w_{hf}\right)\right)^2}{9\,k^2} \quad \text{(A9)}$$

$$P_f = \frac{w_{ff} + k\,(1 + c + w_{hf})}{3\,k} \quad \text{(A10)}$$

3rd stage: Wage Bargaining

Exports case:

$$w_{he} = \frac{5 + 2\,x}{15} \quad \text{(A11)}$$

$$w_{fe} = \frac{5 - 7x}{15}\ k \tag{A12}$$

$$q_{he} = \frac{2\ (5 + 2x)}{45} \tag{A13}$$

$$q_{fe} = \frac{2\ (5 - 7x)}{45} \tag{A14}$$

$$\Pi_{he} = \frac{4\ (5 + 2x)^2}{2025} \tag{A15}$$

$$\Pi_{fe} = \frac{4\ (5 - 7x)^2}{2025} \tag{A16}$$

$$p_e = \frac{5 + 2\ x}{9} \tag{A17}$$

FDI under decentralized wage bargaining case:

$$w_{hdb} = \frac{5 + 2\ c}{15} \tag{A18}$$

$$w_{fdb} = \frac{5 - 7\ c}{15}\ k \tag{A19}$$

$$q_{hdb} = \frac{2\ (5 + 2\ c)}{45} \tag{A20}$$

$$q_{fdb} = \frac{2\ (5 - 7\ c)}{45} \tag{A21}$$

$$\Pi_{hdb} = \frac{4\ (5 + 2\ c)^2}{2025} \tag{A22}$$

$$\Pi_{fdb} = \frac{4\ (5 - 7\ c)^2}{2025} \tag{A23}$$

$$p_{db} = \frac{5 + 2\ c}{9} \tag{A24}$$

FDI under centralized wage bargaining case:

$$w_{hcb} = \frac{1}{2} \tag{A18}$$

$$w_{fcb} = \frac{1 - c}{2} \cdot k \tag{A19}$$

$$q_{hcb} = \frac{1 + \ c}{6} \tag{A20}$$

$$q_{fcb} = \frac{1 - 2c}{6} \tag{A21}$$

$$\Pi_{hcb} = \frac{(1+c)^2}{36} \quad \text{(A22)}$$

$$\Pi_{fcb} = \frac{(1-2c)^2}{36} \quad \text{(A23)}$$

$$p_{cb} = \frac{4+c}{6} \quad \text{(A24)}$$

2nd stage: *f-firm's* choice (Exports vs. FDI)

See in 3rd stage for the relevant profit outcomes in each instance.

1st stage: Social Planner

Exports case:

$$U_{he} = \frac{2\,(5+2x)^2}{675} \quad \text{(A25)}$$

$$U_{fe} = \frac{2\,(5-7x)^2}{675} \quad \text{(A26)}$$

$$CS_e = \frac{2(-2+x)^2}{81} \quad \text{(A27)}$$

$$\mathrm{SW_e} = \frac{2\,(5+x^2)}{45} \quad \text{(A28)}$$

FDI under decentralized wage bargaining case:

$$U_{hdb} = \frac{2\,(5+2c)^2}{675} \quad \text{(A29)}$$

$$U_{fdb} = \frac{2\,(5-7c)^2}{675} \quad \text{(A30)}$$

$$CS_{db} = \frac{2\,(-2+c)^2}{81} \quad \text{(A31)}$$

$$SW_{db} = \frac{4\left(50+c\,(-35+32c)\right)}{675} \quad \text{(A32)}$$

FDI under centralized wage bargaining case:

$$U_{hcb} = \frac{1+c}{12} \quad \text{(A33)}$$

$$U_{fcb} = \frac{(1-c)(1-2c)}{12} \quad \text{(A34)}$$

$$CS_{cb} = \frac{(-2+c)^2}{72} \quad \text{(A35)}$$

$$SW_{cb} = \frac{\big(6 + c(-4+5c)\big)}{24} \quad \text{(A36)}$$

2. Parameter restrictions

We have checked for the sufficient restrictions of the parameter values so that the model to be consistent and entailing non-trivial interior solutions for all endogenous variables. We conclude that $w_{he}, q_{he}, pr_{he}, pr_{fe}, p_e$ are all positive for any $x \in (0,1)$. However, $w_{fe} = \frac{5-7x}{15} \cdot k > 0 \leftrightarrow 5 - 7x > 0 \leftrightarrow x < \frac{5}{7}$. The same restriction applies for $q_{fe} > 0$.

For the FDI under decentralized bargaining case, it can be easily checked that $w_{hdb}, q_{hdb}, pr_{hdb}, pr_{fdb}, p_{db}$ are all positive for any $c \in (0,1)$. However, $w_{fdb} = \frac{5-7\,c}{15}\ k > 0 \leftrightarrow 5 - 7c > 0 \leftrightarrow c < \frac{5}{7}$. The same restriction applies for $q_{fdb} > 0$.

For the FDI under centralized bargaining case, all results are positive for any $c \in (0,1)$, exept for $q_{fcb} = \frac{1-2c}{6} > 0 \leftrightarrow c < \frac{1}{2}$.

No special analysis is needed to find out that $U_{he}, U_{fe}, CS_e, \mathrm{SW_e}$ are all positive for any $x \in (0,1)$. The same findings also apply for $U_{hdb},\ U_{fdb}, CS_{db}, U_{hcb}, CS_{cb}$ which are all positive for any $c \in (0,1)$. Moreover, it can be checked that:

$SW_{db} = \frac{4\,(50+c\,(-35+32c))}{675} > 0\big(50 + c\,(-35+32c)\big) > 0$, which is valid for any $0 < c < \frac{1}{2}$.

$U_{fcb} = \frac{(1-c)(1-2c)}{12} > 0 \leftrightarrow (1-c)(1-2c) > 0$, which is valid for any $0 < c < \frac{1}{2}$.

$SW_{cb} = \frac{(6+c(-4+5c))}{24} > 0 \leftrightarrow\ 6 + c(-4+5c) > 0$, which is valid for any $0 < c < \frac{1}{2}$.

Summarizing the above, the following restrictions apply:

$0 < x < \frac{5}{7}$, $0 < c < \frac{1}{2}$ and $k > 1$.

3. *f-firm's* choice

The following critical profit differentials arise.

- $\Pi_{fcb} - \Pi_{fdb} = \frac{(5+2c)(-35+58c)}{8.100}$

  Hence, $0 < c < \frac{1}{2} \rightarrow pr_{fcb} < pr_{fdb}$.

- $\Pi_{fe} - \Pi_{fdb} = -\frac{28(c-x)(-10+7c+7x)}{2025}$. The term $-\frac{28(-10+7c+7x)}{2025}$ is always positive, hence, if $c > x \rightarrow pr_{fe} > pr_{fdb}$, while, if $c < x \rightarrow pr_{fe} < pr_{fdb}$.

- $\Pi_{fe} - \Pi_{fcb} = -\frac{1}{36}(1-2c)^2 + \frac{4(5-7x)^2}{2025}$. The roots of this expression are $c_1 = -\frac{7}{30}(-5+4x)$ and $c_2 = \frac{1}{30}(-5+28x)$. For $0 < x < \frac{5}{7}$, $c_1 < 0$, so we reject it. Furthermore, it can be checked that if $0.5 > c > c_2 = \frac{1}{30}(-5+28x) \rightarrow pr_{fe} > pr_{fcb}$,while if $0 < c < c_2 = \frac{1}{30}(-5+28x) \rightarrow pr_{fe} < pr_{fcb}$.

Hence, there are two critical values of c, $c_{cr1} = x$, and $c_{cr2} = \frac{-5+28x}{30}$. Since $c_{cr2} - c_{cr1} = \frac{-5+28x}{30} - x = -\frac{5+2x}{30} < 0 \rightarrow c_{cr2} < c_{cr1}$, we can subsequently sort the profits of the *f-firm* against these c-critical values, as in the following table (*profits in row 1 > profits in row 2 > profits in row 3*).

0	$c_{cr2} = \frac{-5+28x}{30}$	$c_{cr1} = x$	0.5
$\xrightarrow{row1}$	Π_{fdb}	Π_{fdb}	Π_{fe}
$\xrightarrow{row2}$	Π_{fcb}	Π_{fe}	Π_{fdb}
$\xrightarrow{row3}$	Π_{fe}	Π_{fcb}	Π_{fcb}

4. Home Union's choice

The sum of the sub-unions' utilities under the centralized union/wage bargaining structure is,

$$\text{Exp(A33)} + \text{Exp(A34)} = U_{hcb} + U_{fcb} = \frac{1+c}{12} + \frac{(1-c)(1-2c)}{12} = \frac{1}{6}(1+(-1+c)c)$$

While, the sum of the sub-unions' utilities under the decentralized union/ wage bargaining structure is,

$$\text{Exp(A29)} + \text{Exp(A30)} = U_{hdb} + U_{fdb} = \frac{2\,(5+2c)^2}{675} + \frac{2\,(5-7c)^2}{675} = \frac{2}{675}(50 + c(-50+53c))$$

Subtracting − the first minus the second expression− we subsequently get,

$$\left(\frac{1}{6}(1+(-1+c)c)\right) - \left(\frac{2}{675}\left(50 + c(-50+53c)\right)\right) = \frac{25+c(-25+13c)}{1350},$$

The latter expression is positive for any $c \in [0,0.5]$. Thus, the home union's utility in the FDI case(s) is greater under the centralized, than under the decentralized regime.

5. Social Welfare.

The following social welfare differentials arise.

- $SW_{cb} - SW_{db} = \frac{-250+c(220+101c)}{5400} < 0$ for $0 < c < 0.5 \rightarrow SW_{cb} < SW_{db}$
- $SW_{db} - SW_e = \frac{2}{675}(25 - 70c + 64c^2 - 15x^2)$.

  If $0 < c < \frac{1}{64}\left(35 - \sqrt{15}\sqrt{-25+64x^2}\right) = c_{cr3} \rightarrow \frac{2}{675}\left(25 - 70c + 64c^2 - 15x^2\right) > 0 \rightarrow SW_{db} > SW_e$,

  else, if $\frac{1}{64}\left(35 - \sqrt{15}\sqrt{-25+64x^2}\right) = c_{cr3} < c < 0.5 \rightarrow \frac{2}{675}(25 - 70c + 64c^2 - 15x^2) < 0 \rightarrow SW_{db} < SW_e$.

1.4. Union Structure and Inward FDI Focusing on Reservation Wage Factor Analysis

1.4.1. Abstract

In a union-duopoly strategic context, we explore the endogenous determination and the effects of the unionization structure in a market facing the possibility of inward foreign direct investments (FDI). We focus our analysis on the role of the reservation wages in home and foreign market and their influence in the final equilibrium. Our findings suggest that, if the reservation wage in home market is higher than the corresponding one in foreign market, the institutionalization of certain wage bargaining regime (i.e. either centralized or decentralized) will be insufficient to induce FDI, and thus a multinational firm would accommodate home market via exports. On the other hand, if the reservation wage in home market is low enough (less than a critical value cr_1), then FDI will finally emerge; in this case, a benevolent social planner would be able to maximize social welfare within the FDI frame, however the deterrence of FDI using the wage bargaining regime as a policy tool won't comprise a valid effect. We also illustrate that agents may contradict with each other, as they aim in different objective; the actions of a benevolent social planner may come in contrast to unions' interest, as the maximization of social welfare does not always come along with the maximization of unions' utility.

1.4.2. The Model

The model's framework and the flow of the game herein follow the corresponding ones of our structural model. Since we focus in the role of firms' reservation wage, we normalize unit costs (x and c) to zero[19], while we assume unions' bargaining power equals to unity (monopoly unions). Although the model leads to a new equilibrium, the qualitative findings remain forceful, while, at the same time, they reveal the role of the reservation wages in inducing or deterring FDI.

[19] Note that parameters' notation remains the same.

Once more, a five-stage game is formally addressed as follows:

- *Stage 1: Policy Maker's Decision.*

  The policy maker settles or reforms labour market institutional arrangements in the host country, so that the Social Welfare will maximise. Labour's market institutional arrangements include the wage-bargaining structure (DB or CB), the level of the unemployment benefit and taxes or/and penalties to the labour market agents.

- *Stage 2: F Firm's Decision.*

  Given the labour market institutional resolutions in the host country, the f-firm decides to serve the home market via either exports or FDI. As already mentioned, at this entry stage, the sunk costs of either option are assumed to be symmetric and for convenience are normalized to zero. We further assume that f firm will be consistent with its decision, due to the sunk cost.

- *Stage 3: Unions' Decision.*

  Considering the payoffs of each case, unions decide to act coordinated or not. Prerequisite for unions to coordinate is that both utilities (strictly) should increase. If the utility of at least one union decreases (comparing to the decentralized bargaining), then it will be motivated to decline from the coordination, so the equilibrium will be time-inconsistent.

- *Stage 4: Wage Determination.*

  Given the final labour market institutional set-up in the host country (delivered from the above stages), optimal wages (home firm / foreign firm) are in all candidate cases defined as follows:

  - *Export case:*

$$w_{he} = \arg\max\left((w_{he} - w_{0h}) \cdot q_{he}\right) \quad (1)$$

$$w_{fe} = \arg\max\left((w_{fe} - w_{0f}) \cdot \left(\frac{q_{fe}}{k}\right)\right) \quad (2)$$

- *FDI under DB case:*

$$w_{hdb} = \arg\max\left((w_{hdb} - w_{0h}) \cdot q_{hdb}\right) \quad (3)$$

$$w_{fdb} = \arg\max\left((w_{fdb} - w_{0h}) \cdot \left(\frac{q_{fdb}}{k}\right)\right) \quad (4)$$

- *FDI under CB case:*

$$w_{hcb} = \arg\max\left((w_{hcb} - w_{0h}) \cdot q_{hcb} + (w_{fcb} - w_{0h}) \cdot \left(\frac{q_{fcb}}{k}\right) - \overline{U}_2\right) \quad (5)$$

$$w_{fcb} = \arg\max\left((w_{hcb} - w_{0h}) \cdot q_{hcb} + (w_{fcb} - w_{0h}) \cdot \left(\frac{q_{fcb}}{k}\right) - \overline{U}_1\right) \quad (6)$$

- *Stage 5: Cournot Competition.*

Given any output level of its rival firm, each firm adjusts its output in order to maximize its profits.

In the exports case, profit is given as:

$\Pi_h = (p - w_h)\, q_h$, (7)

for the h firm, while for the f firm is given as:

$$\Pi_f = \left(p - \frac{w_f}{k}\right) \cdot q_f \quad (8)$$

In the FDI case, profit is given as:

$\Pi_h = (p - w_h)\, q_h$, (9)

for the h firm, while for the f firm is given as:

$$\Pi_f = \left(p - \frac{w_f}{k}\right) \cdot q_f \quad (10)$$

1.4.3. Solving the Model

In this section, we use backward induction to solve the model. Considering the 5th stage of the game first, we assume Cournot competition where each firm

chooses its employment / output level independently, in order to maximize its profits. The derived profit functions have as follows:

Exports case:

$$\Pi_{he} = \frac{\left(k + w_{fe} - 2\,k\,w_{he}\right)^2}{9\,k^2}, \text{ for h firm} \tag{11}$$

$$\Pi_{fe} = \frac{\left(k - 2\,w_{fe} + k\,w_{he}\right)^2}{9\,k^2}, \text{ for f firm} \tag{12}$$

FDI case:

$$\Pi_{hf} = \frac{\left(k + w_{ff} - 2\,k\,w_{hf}\right)^2}{9\,k^2}, \text{ for h firm} \tag{13}$$

$$\Pi_{ff} = \frac{\left(k - 2\,w_{ff} + k\,w_{hf}\right)^2}{9\,k^2}, \text{ for f firm} \tag{14}$$

Let us now proceed to the 4th stage of the game where optimal wages are determined in each case. Following the previous section, and taking the first order conditions for the arguments [1]-[6], optimal wages are formed in each instance as follows:

Exports case:

$$w_{he} = \frac{1}{15}\left(5 + \frac{2\,w_{0f}}{k} + 8\,w_{0h}\right) \tag{15}$$

$$w_{fe} = \frac{1}{15}\left(8\,w_{0f} + k\left(5 + 2\,w_{0h}\right)\right) \tag{16}$$

FDI case, under DB:

$$w_{hdb} = \frac{1}{15}\left(5 + 2\left(4 + \frac{1}{k}\right)w_{0h}\right) \tag{17}$$

$$w_{fdb} = \frac{k}{3} + \frac{2}{15}\left(4 + k\right)w_{0h} \tag{18}$$

FDI case, under CB:

$$w_{hcb} = \frac{1 + w_{0h}}{2} \tag{19}$$

$$w_{fcb} = \frac{k + w_{0h}}{2} \tag{20}$$

Replacing [15]-[20] into [11]-[14] and simplifying, we have the following final results:

The Exports Case:

$$p_e = \frac{1}{9}\left(5 + \frac{2\,w_{0f}}{k} + 2\,w_{0h}\right) \tag{21}$$

$$q_{he} = \frac{2}{45}\left(5 + \frac{2\,w_{0f}}{k} - 7\,w_{0h}\right) \tag{22}$$

$$q_{fe} = \frac{2\left(-7\,w_{0f} + k\left(5 + 2\,w_{0h}\right)\right)}{45\,k} \tag{23}$$

$$\Pi_{he} = \frac{4\left(2\,w_{0f} + k\left(5 - 7\,w_{0h}\right)\right)^2}{2025\,k^2} \tag{24}$$

$$\Pi_{fe} = \frac{4\left(-7\,w_{0f} + k\left(5 + 2\,w_{0h}\right)\right)^2}{2025\,k^2} \tag{25}$$

$$U_{he} = \frac{2\left(2\,w_{0f} + k\left(5 - 7\,w_{0h}\right)\right)^2}{675\,k^2} \tag{26}$$

$$U_{fe} = \frac{2\left(-7\,w_{0f} + k\left(5 + 2\,w_{0h}\right)\right)^2}{675\,k^2} \tag{27}$$

The F.D.I. case under decentralized wage bargaining:

$$p_{db} = \frac{1}{9}\left(5 + \frac{2\left(1 + k\right)w_{0h}}{k}\right) \tag{28}$$

$$q_{hdb} = \frac{2}{45}\left(5 + \left(-7 + \frac{2}{k}\right)w_{0h}\right) \tag{29}$$

$$q_{fdb} = \frac{2}{45}\left(5 + \left(-7 + \frac{2}{k}\right)w_{0h}\right) \tag{30}$$

$$\Pi_{hdb} = \frac{4\left(k\left(5 - 7\,w_{0h}\right) + 2\,w_{0h}\right)^2}{2025\,k^2} \tag{31}$$

$$\Pi_{fdb} = \frac{4\left(-7\,w_{0h} + k\left(5 + 2\,w_{0h}\right)\right)^2}{2025\,k^2} \tag{32}$$

$$U_{hdb} = \frac{2\left(k\left(5 - 7\,w_{0h}\right) + 2\,w_{0h}\right)^2}{675\,k^2} \tag{33}$$

$$U_{fdb} = \frac{2\left(-7\,w_{0h} + k\left(5 + 2\,w_{0h}\right)\right)^2}{675\,k^2} \tag{34}$$

The F.D.I. case under centralized wage bargaining:

$$p_{cb} = \frac{w_{0h} + k\left(4 + w_{0h}\right)}{6\,k} \tag{35}$$

$$q_{hcb} = \frac{k + w_{0h} - 2\,k\,w_{0h}}{6\,k} \tag{36}$$

$$q_{fcb} = \frac{k + \left(-2 + k\right)\,w_{0h}}{6\,k} \tag{37}$$

$$\Pi_{hcb} = \frac{\left(k + w_{0h} - 2\,k\,w_{0h}\right)^2}{36\,k^2} \tag{38}$$

$$\Pi_{fcb} = \frac{\left(k + \left(-2 + k\right)w_{0h}\right)^2}{36\,k^2} \tag{39}$$

$$U_{hcb} = \frac{\left(1 - w_{0h}\right)\left(w_{0h} + k\left(1 - 2\,w_{0h}\right)\right)}{12\,k} \tag{40}$$

$$U_{fcb} = \frac{\left(k - w_{0h}\right)\left(k + \left(k - 2\right)\,w_{0h}\right)}{12\,k^2} \tag{41}$$

Stages 3 & 2 do not have any new outputs, other than the ones from the previous two stages. Let us, therefore, proceed to **1st stage of the game**. The social welfare results from the aggregation of the utility of the home union, the utility of the foreign union (only in the F.D.I. case) the profits of the h-firm and the consumer surplus. Thus, the derived social welfare - in any instance - appears as follows:

$$SW_e = \frac{2\left(w_{0f}^{\,2} - 2k\,w_{0f}\,w_{0h} + k^2\left(5 + 2\,w_{0h}\left(-5 + 3\,w_{0h}\right)\right)\right)}{45\,k^2} \tag{42}$$

$$SW_{db} = \frac{4\left(50\,k^2 - 5\,k\left(7 + 13\,k\right)w_{0h} + \left(32 + k\left(47\,k - 29\right)\right)w_{0h}^{\,2}\right)}{675\,k^2} \tag{43}$$

$$SW_{cb} = \frac{5\,w_{0h}^{\,2} - 2k\,w_{0h}\left(2 + 3\,w_{0h}\right) + k^2\left(6 + w_{0h}\left(7\,w_{0h} - 8\right)\right)}{24\,k^2} \tag{44}$$

1.4.4. Solvability conditions of the model

In this section, we establish the existence of solutions for the model, determining the range of the values that parameters may fluctuate. First, we take into account the restrictions emanated from the normalizations of the model;

$$w_{0h} \in (0,1),\ w_{0f} \in (0,1),\ k > 1$$

Thereafter, we determine the range of the values, in order quantities and wages in each instance are greater than zero, but simultaneously less than the unity. It can be proven that under the following restrictions:

$$0 < w_{0h} < \min\left\{2 - k,\ \frac{1}{2}, \frac{(15 - 8\cdot w_{0f} + 5\,k)}{2k}\right\},\ 0 < w_{0f} < \frac{1}{2} \text{ and } 1 < k < 2,$$

the model has internal solutions.

1.4.5. Unionization Structure and Reservation Wages, International Trade and FDI

Let us now proceed to the game analysis. Using the former methodology we determine the critical values that define the strategy of each agent.

Sorting **f-firm's** profit, we abstract expression [32] of [25]:

$$\Pi_{fe} - \Pi_{fdb} = \frac{28(w_{0f} - w_{0h})\left(7(w_{0f} + w_{0h}) - 2k(5 + 2w_{0h})\right)}{2025k^2}$$

The expression above has 2 roots, $w_1 = w_{0f}, w_2 = \frac{-10k+7w_{0f}}{-7+4k}$. We reject the second one, since $\frac{-10k+7w_{0f}}{-7+4k} \notin (0,0.5)$ and we conclude that if $w_{0h} - w_{0f} > 0 \rightarrow w_{0h} >$

$w_{0f} \rightarrow \Pi_{fe} - \Pi_{fdb} > 0 \rightarrow \Pi_{fe} > \Pi_{fdb}$. Otherwise, if $w_{0h} < w_{0f} \rightarrow \Pi_{fe} < \Pi_{fdb}$. Abstracting expression [39] of [25]:

$$\Pi_{fe} - \Pi_{fcb} = \frac{-225(k + (-2 + k)w_{0h})^2 + 16(-7w_{0f} + k(5 + 2w_{0h}))^2}{8100k^2}$$

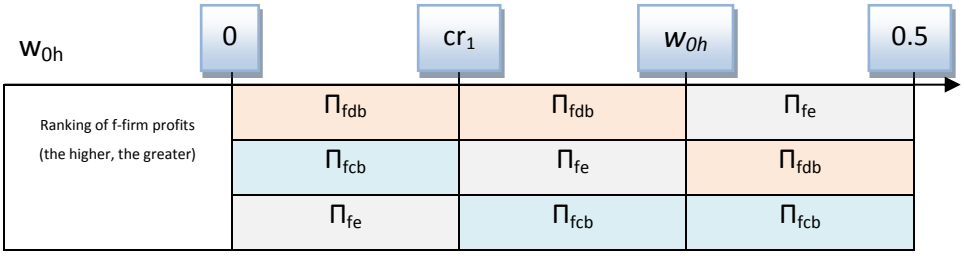
The expression above has 2 roots, $w_1 = \frac{5k-28w_{0f}}{-30+7k}$, $w_2 = -\frac{7(5k-4w_{0f})}{-30+23k}$. We reject the second one, since $-\frac{7(5k-4w0f)}{-30+23k} \notin (0,0.5)$ and we conclude that if $w_{0h} > cr_1 = \frac{-5k+28w_{0f}}{(30-7k)} \rightarrow \Pi_{fe} > \Pi_{fcb}$ and reversely, if $w_{0h} < cr_1 = \frac{-5k+28w_{0f}}{(30-7k)} \rightarrow \Pi_{fe} < \Pi_{fcb}$.

Finally, abstracting expression [39] of [32]:

$$\Pi_{fdb} - \Pi_{fcb} = -\frac{(-2w_{0h} + k(-5 + 7w_{0h}))(-58w_{0h} + k(35 + 23w_{0h}))}{8100k^2}$$

It can be shown that for any $k \in (1,2)$ and $w_{0h} \in (0,0.5)$, the above expression is greater than zero, and therefore $\Pi_{fdb} - \Pi_{fcb} > 0 \rightarrow \Pi_{fdb} > \Pi_{fcb}$.

Bringing all the above evidence together, and since $cr_1 - w_{0f} = \frac{k(5-7w_{0f})+2w_{0f}}{-30+7k} < 0 \rightarrow w_{0f} > cr_1$,we sort f-firm's profit in each instance, depending on the values of w_{0h}:



From the examination of the matrix above, we come to the following conclusions:

Proposition 1

If w_{0h} is low enough (less than $cr_1 = \frac{-5k+28w_{0f}}{(30-7k)}$), then any institutional arrangement of labour market is insufficient to deter FDI.

Notice that, if w_{0h} ranges from zero to cr_1, then f-firm's profits in each instance of FDI (either under centralized or under decentralized bargaining) is greater than the profits in exports case. Thus, f-firm will accommodate home market via FDI, in any case. The social planner may maximize social welfare within FDI frame using the institutional labour's market setup; however this policy tool highlights insufficient to deter FDI.

Proposition 2

If w_{0h} is great enough (greater than w_{0f}), then exports will emerge, whatever the institutional labour market's setup is.

If the reservation wage in foreign country is greater than the one in home market, then f-firm's profits under exports regime will be greater than the respective ones in the FDI case (either under centralized or under decentralized bargaining).

Continuing our analysis, we focus on unions, starting with **h-union**. Abstracting expression [33] of [26] we conclude to the following:

$$\mathrm{U_{he}} - \mathrm{U_{hdb}} = \frac{8(\mathrm{w_{0f}} - \mathrm{w_{0h}})(\mathrm{w_{0f}} + k(5 - 7\mathrm{w_{0h}}) + \mathrm{w_{0h}})}{675k^2}$$

From the expression above, the term $\frac{8(\mathrm{w_{0f}}+k(5-7\mathrm{w_{0h}})+\mathrm{w_{0h}})}{675k^2}$ remains positive for any $k \in (1,2)$ and $w_{0h} \in (0,0.5)$, thereafter we result that if $\mathrm{w_{0f}} - \mathrm{w_{0h}} > 0 \rightarrow \mathrm{w_{0f}} > \mathrm{w_{0h}} \rightarrow \mathrm{U_{he}} - \mathrm{U_{hdb}} > 0 \rightarrow \mathrm{U_{he}} > \mathrm{U_{hdb}}$, and conversely, if $\mathrm{w_{0f}} < \mathrm{w_{0h}} \rightarrow \mathrm{U_{he}} < \mathrm{U_{hdb}}$.

Abstracting expression [40] of [33] we conclude to the following:

$$\mathrm{U_{hdb}} - \mathrm{U_{hcb}} = \frac{k(\mathrm{w_{0h}} - 65)\mathrm{w_{0h}} + 32{\mathrm{w_{0h}}}^2 + k^2\left((115 - 58\mathrm{w_{0h}})\mathrm{w_{0h}} - 25\right)}{2700k^2}$$

The expression above has 2 roots, $\mathrm{w_1} = \frac{5(-13k+23k^2-3\sqrt{33}\sqrt{k^2-2k^3+k^4})}{2(-32-k+58k^2)}$ and $\mathrm{w_2} = \frac{5(-13k+23k^2+3\sqrt{33}\sqrt{k^2-2k^3+k^4})}{2(-32-k+58k^2)}$. We reject the second root w_2, since w_2>1 for any $k \in (1,2)$. Thus, we result that if $\mathrm{w_{0h}} > cr_2 = \frac{5(-13k+23k^2-3\sqrt{33}\sqrt{k^2-2k^3+k^4})}{2(-32-k+58k^2)} \rightarrow \mathrm{U_{hdb}} - \mathrm{U_{hcb}} > 0 \rightarrow \mathrm{U_{hdb}} > \mathrm{U_{hcb}}$, and conversely, if $\mathrm{w_{0h}} < cr_2 = \frac{5(-13k+23k^2-3\sqrt{33}\sqrt{k^2-2k^3+k^4})}{2(-32-k+58k^2)} \rightarrow \mathrm{U_{hdb}} - \mathrm{U_{hcb}} < 0 \rightarrow \mathrm{U_{hdb}} < \mathrm{U_{hcb}}$.

Finally, dividing expression [26] by [40] we obtain the following:

$$\mathrm{U_{he}} - \mathrm{U_{hcb}} = \frac{8(2\mathrm{w_{0f}} + k(5 - 7\mathrm{w_{0h}}))^2 - 225k(-1 + \mathrm{w_{0h}})(-\mathrm{w_{0h}} + k(-1 + 2\mathrm{w_{0h}}))}{2700k^2}$$

The expression above has 2 roots,

$cr_3 = \frac{-225k+115k^2-224k\mathrm{w0f}-15\sqrt{225k^2-130k^3+33k^4-192k^2\mathrm{w0f}-64k^3\mathrm{w0f}-128k\mathrm{w0f}^2+256k^2\mathrm{w0f}^2}}{2(-225k+58k^2)}$ and

$cr_4 = \frac{-225k+115k^2-224k\mathrm{w0f}+15\sqrt{225k^2-130k^3+33k^4-192k^2\mathrm{w0f}-64k^3\mathrm{w0f}-128k\mathrm{w0f}^2+256k^2\mathrm{w0f}^2}}{2(-225k+58k^2)}$

It can be shown that for any $cr_4 < w_{0h} < cr_3 \rightarrow \mathrm{U_{he}} - \mathrm{U_{hcb}} < 0 \rightarrow \mathrm{U_{he}} < \mathrm{U_{hcb}}$ and for any $w_{0h} < cr_4$ *or* $w_{0h} > cr_3 \rightarrow \mathrm{U_{he}} - \mathrm{U_{hcb}} > 0 \rightarrow \mathrm{U_{he}} > \mathrm{U_{hcb}}$.

H-union exists only if FDI occurs. So, we examine only its utilities under centralized or decentralized wage bargaining regime. Abstracting expression [41] of [34] we conclude to the following:

$\mathrm{U_{fdb}} - \mathrm{U_{fcb}} = \frac{-58\mathrm{w_{0h}}^2+k\mathrm{w_{0h}}(115+\mathrm{w_{0h}})+k^2(-25+\mathrm{w_{0h}}(-65+32\mathrm{w_{0h}}))}{2700k^2} < 0 \rightarrow \mathrm{U_{fdb}} < \mathrm{U_{fcb}}$ for any $k \in (1,2)$ and $\mathrm{w_{0h}} \in (0,0.5)$.

Last, the **social planner** aims to maximize social welfare, as defined in section 1.2.2. Abstracting expression [43] of [42], we result to the following:

$$\mathrm{SW_e} - \mathrm{SW_{db}} = -\frac{2(-15\mathrm{w_{0f}}^2 + 2k(-35 + 15\mathrm{w_{0f}} - 29\mathrm{w_{0h}})\mathrm{w_{0h}} + 64\mathrm{w_{0h}}^2 + k^2(5 + 2\mathrm{w_{0h}})^2)}{675k^2}$$

The expression above remains negative for any $k \in (1,2)$ and $\mathrm{w_{0h}}, \mathrm{w_{0f}} \in (0,0.5)$. Therefore, $\mathrm{SW_e} - \mathrm{SW_{db}} < 0 \rightarrow \mathrm{SW_e} < \mathrm{SW_{db}}$.

Abstracting expression [44] of [43]:

$$\mathrm{SW_{db}} - \mathrm{SW_{cb}} = \frac{250k^2 - 20k(11 + 14k)\mathrm{w_{0h}} + (-101 + (422 - 71k)k)\mathrm{w_{0h}}^2}{5400k^2}$$

The expression above remains positive for any $k \in (1,2)$ and $\mathrm{w_{0h}} \in (0,0.5)$. Therefore, $\mathrm{SW_{db}} - \mathrm{SW_{cb}} > 0 \rightarrow \mathrm{SW_{db}} > \mathrm{SW_{cb}}$.

Abstracting expression [44] of [42]:

$$\mathrm{SW_e} - \mathrm{SW_{cb}} = \frac{16\mathrm{w_{0f}}^2 - 75\mathrm{w_{0h}}^2 + 2k\mathrm{w_{0h}}(30 - 16\mathrm{w_{0f}} + 45\mathrm{w_{0h}}) - k^2(10 + \mathrm{w_{0h}}(40 + 9\mathrm{w_{0h}}))}{360k^2}$$

The expression above has 2 roots,

$\mathrm{w_1} \rightarrow -\frac{-60k+40k^2+32k\mathrm{w0f}+\sqrt{16k^2(-15+10k+8\mathrm{w0f})^2-24(25+3(-10+k)k)(5k^2-8\mathrm{w0f}^2)}}{6(25+3(-10+k)k)}$

$$w_2 \to \frac{-2k(-15+10k+8w0f)+\sqrt{10}\sqrt{k^2(15+k(-30+31k))+32k^2(-3+2k)w0f+8(15+k(-18+5k))w0f^2}}{75+9(-10+k)k}$$

Since $w_2 < 0$, the following inequities arise;

If $w_{0h} < cr_5 = -\frac{-60k+40k^2+32kw0f+\sqrt{16k^2(-15+10k+8w0f)^2-24(25+3(-10+k)k)(5k^2-8w0f^2)}}{6(25+3(-10+k)k)} \to SW_e - SW_{cb} < 0 \to SW_e < SW_{cb}$.

If on the other hand $w_{0h} > cr_5 = -\frac{-60k+40k^2+32kw0f+\sqrt{16k^2(-15+10k+8w0f)^2-24(25+3(-10+k)k)(5k^2-8w0f^2)}}{6(25+3(-10+k)k)}$

$\to SW_e - SW_{cb} > 0 \to SW_e > SW_{cb}$

1.4.6. Subgame Perfect Equilibrium

While in some cases the policy of one agent forms clearly (e.g. f-firm), in other cases no certain strategy reveals. Due to the complexity of the model, which must be solved numerically to obtain results, the ranking of critical values (w_{0f}, $cr_{1\text{-}5}$) turns rather restrictive. Nevertheless, we can distinguish two different subgame perfect equilibria.

Proposition 3:

If w_{0h} is low enough, less than $cr_1 = \frac{-5k+28w_{0f}}{30-7k}$, then FDI under decentralized wage bargaining will emerge in the final equilibrium.

Note than for $0 < w_{0h} < cr_1 = \frac{k(5-7w_{0f})+2w_{0f}}{-30+7k}$, f-firm enjoys greater profit under FDI (in each instance) rather than under exports. Therefore, it follows that FDI will emerge in the final equilibrium. Social planner will adjust labour market so to maximize social welfare within FDI frame. In this case, we observe that $SW_{db} > SW_{cb}$ for any $k \in (1,2)$ and $w_{0h} \in (0,0.5)$. Therefore, the social planner will implement decentralized wage bargaining to ensure the maximization of social welfare. Worth mentioning that all the above remain valid regardless unions' choices.

We should, also, notice that, the analysis concludes to that if $0 < w_{0h} < cr_1 = \frac{k(5-7w_{0f})+2w_{0f}}{-30+7k}$, then labour market's institutional wage bargaining setup will prove insufficient as a policy tool to deter FDI.

Proposition 4:

If w_{0h} is high enough - greater than w_{0f}, then f-firm will serve the home market via exports in the final equilibrium.

As it follows from our analysis, under $w_{0h} > w_{0f}$, f-firm's profits in exports case is greater than its profits in FDI – in each instance, either under centralized or decentralized wage bargaining. It appears that neither unions' choices, nor the institutionalization of a solid wage bargaining regime in labour market by the social planner consist sufficient and effective conditions to induce FDI. Given that $SW_{db} > SW_e, SW_{cb}$, social welfare will be limited to SW_e , and will suffer losses. Nevertheless, in the latter case, institutional setting of the labour market appears to be insufficient policy tool for the social planner to induce FDI, and thus he should search for an alternative policy to succeed his purpose.

For the interval values of w_{0h} ($cr_1 < w_{0h} < w_{0f}$), there is a set of solutions, depending on the ranking of critical values of w_{0h} (cr_1-cr_5). Due to the complexity of the model, it is both prohibitive to illustrate all possible outcomes, other it may be unnecessary – by the meaning that such an illustration has not much to offer in our analysis. Thus, we shall focus our analysis to one of these possible outcomes, in order to highlight tactics, strategies and policy contrasts among the agents.

Consider a specific ranking of the critical values of w_{0h} – consistent with our findings, such as $0 < cr_1 < cr_3 < cr_5 < cr_4 < w_{0f} = cr_2 < 0.5$. Summarizing all the relevant evidence from the above analysis, the following matrix is formed:

Ranking (the higher, the greater)	0	cr_1	cr_3	cr_5	cr_4	$cr_2=w_{0f}$	0.5
f-firm profits	Π_{fdb}	Π_{fdb}	Π_{fdb}	Π_{fdb}	Π_{fdb}	Π_{fdb}	Π_{fe}
	Π_{fcb}	Π_{fe}	Π_{fe}	Π_{fe}	Π_{fe}	Π_{fe}	Π_{fdb}
	Π_{fe}	Π_{fcb}	Π_{fcb}	Π_{fcb}	Π_{fcb}	Π_{fcb}	Π_{fcb}
h-union utility	U_{he}	U_{he}	U_{hcb}	U_{hcb}	U_{he}	U_{hdb}	
	U_{hcb}	U_{hcb}	U_{he}	U_{he}	U_{hcb}	U_{he}	
	U_{hdb}	U_{hdb}	U_{hdb}	U_{hdb}	U_{hdb}	U_{hcb}	
f-union utility	U_{fcb}	U_{fcb}	U_{fcb}	U_{fcb}	U_{fcb}	U_{fcb}	
	U_{fdb}	U_{fdb}	U_{fdb}	U_{fdb}	U_{fdb}	U_{fdb}	
Social Welfare	SW_{db}	SW_{db}	SW_{db}	SW_{db}	SW_{db}	SW_{db}	
	SW_{cb}	SW_{cb}	SW_{cb}	SW_e	SW_e	SW_e	
	SW_e	SW_e	SW_e	SW_{cb}	SW_{cb}	SW_{cb}	

Consequently, under the $0 < cr_1 < cr_3 < cr_5 < cr_4 < w_{0f} = cr_2 < 0.5$ hypothesis, we conclude to the following possible subgame perfect equilibria:

SPE 1: $0 < w_{0h} < cr_1$

As already mentioned in proposition 3, in this case FDI will emerge in the final equilibrium, since f-firm's profits in FDI case (in each instance, either under centralized or decentralized wage bargaining) is greater than profits in exports regime. What is worth mentioned, h-union would rather prefer export case, as its utility maximizes in this case. As FDI will finally emerge, its second-best choice is centralized wage bargaining regime. We notice same motivation for f-union too, so we conclude that unions will bargain their wages in centralized regime. However, since $SW_{db} > SW_{cb}$, a benevolent social planner will adjust labour market to decentralized wage bargaining regime, in order to maximize social welfare, in contradiction to unions' objectives.

SPE 2: $cr_1 < w_{0h} < cr_2$

In case that $cr_1 < w_{0h} < cr_3$, f-firm will choose FDI only if decentralized wage bargaining regime constitutes a stable status and none of the agents has any incentive to decline; else, f-firm will accommodate home market via exports (second-best choice). H-union enjoys greater utility in exports case; thus, h-union will prefer a centralized wage bargaining frame, aiming to the deterrence of FDI. However, if exports emerges, none f-union will be formed. Thus, f-union has an incentive to decline from centralized wage bargaining. Thereafter, labour market will regulate itself to decentralized wage bargaining regime. The social planner will let labour market as is, as by this way social welfare is maximized. Summarizing the above, labour market will auto-regulate to decentralized wage bargaining regime and f-firm will serve the home market via FDI.

Similar analysis also stands for $cr_3 < w_{0h} < cr_2$.

SPE 3: $cr_2 < w_{0h} < 0.5$

As already analyzed in proposition 4, in this case f-firm will prefer to serve the local market via exports. Although unions would prefer the FDI under decentralized wage bargaining regime, they will be contented to export's utility, as they will be unable to act otherwise. Institutionalization of wage bargaining forms insufficient policy tool for the social planner to induce FDI, therefore another policy should be applied.

1.4.7. Conclusions

In this section, we examined – by properly adjusting the model and the game as described in section 1.2 - the role of the reservation wage in home and foreign market in the final equilibrium.

Our analysis predicts that if w_{0h} is higher than w_{0f}, the institutionalization of certain wage bargaining regime (i.e. either centralized or decentralized) will be insufficient to induce FDI, and thus a multinational firm will accommodate home market via exports. On the other hand, if w_{0h} is low enough (less than a critical value

$cr_1 = \frac{-5k+28w_{0f}}{30-7k}$), then FDI will finally emerge; in this case, a benevolent social planner will be able to maximize social welfare within the FDI frame. However, in this latter case, the institutional setting of the labour market will not consist of an effective policy tool to deter FDI. For the rest of the values of the reservation wage, and due to the complexity of the model, there is a set of possible SPE, depending on the ranking of the critical values. In our analysis, we illustrated one specific – possible – ranking and the possible equilibrium under those conditions. Our findings suggested that for the intermediate values of the reservation wage in home market, FDI will emerge while home labour market will auto-regulate to decentralized wage bargaining, thereby maximizing social welfare.

We also proved that agents may contradict with each other, as they aim in different objectives. The actions of a benevolent social planner may come in contrast to unions' interest, as the maximization of social welfare does not always come along with the maximization of unions' utility.

1.4.8. Appendix

1. Solving the Model

Using backward induction, we first begin from **the last – 5th – stage** of the game, Cournot competition.

For the **exports case**, the definition of the functions:

- $p_e = 1 - (q_{he} + q_{fe})$
- $\Pi_{he} = (p_e - w_{he})q_{he}$
- $\Pi_{fe} = \left(p_e - \frac{w_{fe}}{k}\right) q_{fe}$

From the expressions above, we extract the reaction functions:

- $q_{he} = \frac{1}{2}(1 - q_{fe} - w_{he})$
- $q_{fe} = \frac{k - kq_{he} - w_{fe}}{2k}$

Solving the system of reaction functions, we obtain the results for the last stage of the game:

- $q_{he} = \frac{k + w_{fe} - 2kw_{he}}{3k}$
- $q_{fe} = \frac{k - 2w_{fe} + kw_{he}}{3k}$
- $\Pi_{he} = \frac{(k + w_{fe} - 2kw_{he})^2}{9k^2}$
- $\Pi_{fe} = \frac{(k - 2w_{fe} + kw_{he})^2}{9k^2}$
- $p_e = \frac{k + w_{fe} + kw_{he}}{3k}$

Proportionally, for the **FDI case**:

- $p_f = 1 - (q_{hf} + q_{ff})$
- $\Pi_{hf} = (p_f - w_{hf})q_{hf}$
- $\Pi_{ff} = \left(p_f - \frac{w_{ff}}{k}\right) q_{ff}$

Reaction functions:

- $\mathrm{q_{hf}} = \frac{1}{2}(1 - \mathrm{q_{ff}} - \mathrm{w_{hf}})$
- $\mathrm{q_{ff}} = \frac{k - ck - k\mathrm{q_{hf}} - \mathrm{w_{ff}}}{2k}$

Solving the equation system above:

- $\mathrm{q_{hf}} = \frac{k + \mathrm{wff} - 2k\mathrm{whf}}{3k}$
- $\mathrm{q_{ff}} = \frac{k - 2\mathrm{wff} + k\mathrm{whf}}{3k}$
- $\Pi_{\mathrm{hf}} = \frac{(k + \mathrm{wff} - 2k\mathrm{whf})^2}{9k^2}$
- $\Pi_{\mathrm{ff}} = \frac{(k - 2\mathrm{wff} + k\mathrm{whf})^2}{9k^2}$
- $\mathrm{p_f} = \frac{k + \mathrm{wff} + k\mathrm{whf}}{3k}$

Continuing to the **4th stage** of the game, we determine the wages in each instance.

For the exports case, the wage bargaining is expressed by the following expressions:

- $\mathrm{B_{he}} = \left((\mathrm{whe} - \mathrm{w0h})\mathrm{qhe}\right)^b \cdot \Pi_{\mathrm{he}}{}^{(1-b)}$
- $\mathrm{B_{fe}} = \left((\mathrm{wfe} - \mathrm{w0f})(\mathrm{qfe}/k)\right)^b \cdot \Pi_{\mathrm{fe}}{}^{(1-b)}$

Taking first order conditions and solving the equation system, we obtain the wages:

- $\mathrm{w_{he}} = \frac{1}{15}(5 + \frac{2\mathrm{w0f}}{k} + 8\mathrm{w0h})$
- $\mathrm{w_{fe}} = \frac{1}{15}(8\mathrm{w0f} + k(5 + 2\mathrm{w0h}))$

Substituting the wages:

- $\mathrm{q_{he}} = \frac{2}{45}(5 + \frac{2\mathrm{w0f}}{k} - 7\mathrm{w0h})$
- $\mathrm{q_{fe}} = \frac{2(-7\mathrm{w0f} + k(5 + 2\mathrm{w0h}))}{45k}$
- $\Pi_{\mathrm{he}} = \frac{4(2\mathrm{w0f} + k(5 - 7\mathrm{w0h}))^2}{2025k^2}$
- $\Pi_{\mathrm{fe}} = \frac{4(-7\mathrm{w0f} + k(5 + 2\mathrm{w0h}))^2}{2025k^2}$

- $\mathrm{p_e} = \frac{1}{9}(5 + \frac{2\mathrm{w0f}}{k} + 2\mathrm{w0h})$

For the FDI under decentralized wage bargaining, the wage bargaining is expressed by the following expressions:

- $\mathrm{B_{hdb}} = \big((\mathrm{whf} - \mathrm{w0h})\mathrm{qhf}\big)^b \cdot \Pi_{\mathrm{hf}}{}^{(1-b)}$
- $\mathrm{B_{fdb}} = \big((\mathrm{wff} - \mathrm{w0h})(\mathrm{qff}/k)\big)^b \cdot \Pi_{\mathrm{ff}}{}^{(1-b)}$

Taking first order conditions and solving the equation system, we obtain the wages:

- $\mathrm{w_{hf}} = \frac{1}{15}(5 + 2(4 + \frac{1}{k})\mathrm{w0h})$
- $\mathrm{w_{ff}} = \frac{k}{3} + \frac{2}{15}(4 + k)\mathrm{w0h}$

Substituting the wages:

- $\mathrm{q_{hdb}} = \frac{2}{45}(5 + (-7 + \frac{2}{k})\mathrm{w0h})$
- $\mathrm{q_{fdb}} = \frac{2}{45}(5 + (2 - \frac{7}{k})\mathrm{w0h})$
- $\Pi_{\mathrm{hdb}} = \frac{4(k(5-7\mathrm{w0h})+2\mathrm{w0h})^2}{2025k^2}$
- $\Pi_{\mathrm{fdb}} = \frac{4(-7\mathrm{w0h}+k(5+2\mathrm{w0h}))^2}{2025k^2}$
- $\mathrm{p_{db}} = \frac{1}{9}(5 + \frac{2(1+k)\mathrm{w0h}}{k})$

For the FDI under centralized wage bargaining, the wage bargaining is expressed by the following expressions:

- $\mathrm{B_{hcb}} = (Uhc + Ufcb + \overline{U_2})^b \cdot \Pi_{\mathrm{hf}}{}^{(1-b)} = \Big(\big((\mathrm{whf} - \mathrm{w0h}) \cdot \mathrm{qhf}\big) + \big((\mathrm{wff} - \mathrm{w0h})(\mathrm{qff}/k)\big) - \Big((\mathrm{wff} - \mathrm{w0h})\big(\frac{1-(\mathrm{wff}/k)}{2k}\big)\Big)\Big)^b \cdot \Pi_{\mathrm{hf}}{}^{(1-b)}$

- $\mathrm{B_{fcb}} = (Uhc + Ufcb + \overline{U_1})^b \cdot \Pi_{\mathrm{ff}}{}^{(1-b)} = \Big(\big((\mathrm{whf} - \mathrm{w0h}) \cdot \mathrm{qhf}\big) + \big((\mathrm{wff} - \mathrm{w0h})(\mathrm{qff}/k)\big) - \Big((\mathrm{whf} - \mathrm{w0h})(\frac{1-\mathrm{whf}}{2})\Big)\Big)^b \cdot \Pi_{\mathrm{ff}}{}^{(1-b)}$

Taking first order conditions and solving the equation system, we obtain the wages:

- $\mathrm{w_{hcb}} = \frac{1+\mathrm{w0h}}{2}$
- $\mathrm{w_{fcb}} = \frac{k+\mathrm{w0h}}{2}$

Substituting the wages:

- $\mathrm{q_{hcb}} = \frac{k+\mathrm{w0h}-2k\mathrm{w0h}}{6k}$
- $\mathrm{q_{fcb}} = \frac{k+(-2+k)\mathrm{w0h}}{6k}$
- $\Pi_{\mathrm{hcb}} = \frac{(k+\mathrm{w0h}-2k\mathrm{w0h})^2}{36k^2}$
- $\Pi_{\mathrm{fcb}} = \frac{(k+(-2+k)\mathrm{w0h})^2}{36k^2}$
- $\mathrm{p_{cb}} = \frac{\mathrm{w0h}+k(4+\mathrm{w0h})}{6k}$

1.5. Epilogue

In this chapter, we have examined whether enforcing a particular unionization structure in a host labour market is an effective policy tool in order to induce or deter inward FDI. Our analysis diverts from previous works [see, e.g., Vlassis (2009) and the references therein] in two major aspects.

- First, we have considered the home union's choice about the domestic unionization structure as a strategy to deter or accommodate inward FDI at the union's best interest.
- Second, we have inbuilt to our model the concept of the home union's reservation utility under the centralized unionization structure and the ensuing wage bargaining regime.

Our research led to a general functional (structural) model, which describes analytically the critical values, the policies and the possible equilibria that may occur. Given the complexity of the model, which should be calculated numerically to obtain results, we proceeded to extensive restrictions and strict hypothesizes in order to accentuate the general flow of the game. Furthermore, we illustrated an analytic description of all potential choices of each agent of the game, as well as any potentially final equilibrium (possible subgame perfect equilibria). Consequently, we properly adjusted the model to focus on the role of both unit costs other reservation wages in the final setup.

The overall analysis proved that it does not exist any axiomatic interpretation of the game. The implementation of a certain wage bargaining regime in the labour market - under conditions – may be ineffective to induce or deter FDI. However, under different circumstances, the institutional bargaining regime will influence the policy of a multinational firm and induce (or deter) FDI, thereby maximizing social welfare.

The unit cost approach revealed important evidence. If the FDI-associated unit cost is greater than the corresponding export-associated one, then exports will emerge. Hence, in this case, it proves that the regulation of labour market forms an ineffective policy tool to induce FDI and, therefore, the social planner should inquire

an alternative policy instrument to succeed his aim. On the other hand, if the FDI-associated unit cost is low enough, then inward FDI will always emerge. For intermediary values of FDI-associated unit cost, the wage bargaining regime may be applied as an effective policy tool to induce FDI.

The reservation wage approach concluded to similarly interesting conclusions. It proved that if the reservation wage in home country is low enough, then any institutional arrangement of labour market is insufficient to deter FDI. On the other hand, if the reservation wage in home country is greater than the equivalent in foreign country, then international trade will emerge. The results of our analysis seem to associate low (high) values of the reservation wage in home country with the FDI (international trade) emergence. For intermediary prices of the reservation wage, it may - under conditions - constitute an effective policy tool in order to induce FDI and maximize the social welfare.

Finally, derived from the overall analysis, a benevolent social planner in some cases should leave the labour market to regulate itself, when the maximization of unions' utility is consistent to the maximization of social welfare. Most important, yet quite challenging (and even heretic) for conventional wisdom, we hereby propose that a policy maker may sometimes need to intervene against the unions' free choice regarding their own structure and organization, in order to serve the society's best interest.

Appealing for further/empirical investigation, two possible extensions of the present model are left open for further research. The first is to address in the analysis the union bargaining power to be less than one. The second and most ambitious one, is to conduct analysis on the critical scope of the labour market institutions regarding FDI.

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Chapter 2:

Union Oligopoly Bargaining and Undeclared Labour

Introduction

Undeclared work is defined as "any paid activities that are lawful as regards their nature but not declared to public authorities". It is a complex phenomenon associated with tax evasion and social security fraud. Undeclared labour concerns various types of activities, ranging from informal household services to clandestine work by illegal residents, but excludes criminal activities.

It is a process that may engage both employers and employees voluntarily, because of the potential gain in avoiding taxes and social security contributions, social rights and the cost of complying with regulations.

From a macroeconomic point of view, undeclared labour reduces tax revenues (since employees declare no income and then no taxes are imputed) and undermines the financing of social security systems. To the extent that undeclared work competes with and even crowds out activities that comply with regulations, it is the main source of social dumping. In the case of undeclared work performed by individuals who are receiving benefits compensating their inactivity, there is also a dimension of social fraud.

From a microeconomic perspective, undeclared labour distorts fair competition among firms and causes productive inefficiencies, as informal businesses typically avoid access to formal services and inputs (e.g. credit) and prefer to stay small.

Undeclared labour is a decomposite phenomenon, that is influenced by a great range of economic, social, structural and cultural factors, tending to comprise a constraint to economic, fiscal, and social policies applied for the economic growth of an economy.

The fact that undeclared labour on one hand cannot be observed and on the other hand may be otherwise defined among countries, makes it even more difficult to establish credible evaluations about the growth of this phenomenon. However, a research, conducted on behalf of European Committee at 2004, while it accented important differences among countries regarding the qualitative characteristics as

well as the size of undeclared labour, estimated undeclared labour's maximum values at 20% at some countries of Eastern and South Europe.

Given the complexity and the heterogeneity of the phenomenon, there is no simple solution to confront it. Nevertheless, the resolution of the European Union's Council of 29 October 2003 on transforming undeclared work into regular employment proposed the following policies:

- Reducing the financial attractiveness of undeclared work stemming from the design of tax and benefit systems, and the permissiveness of the social protection system with regard to the performing of undeclared work;
- Administrative reform and simplification, with a view to reducing the cost of compliance with regulations;
- Strengthening the surveillance and sanction mechanisms, with the involvement of labour inspectorates, tax offices and social partners;
- Trans-national cooperation between Member States, and
- Awareness raising activities.

Regarding the first policy group of meters, European Committee concluded that there is still a great deal of actions to be done in order to balance both the motives and the disincentives offered by the social security systems. In particular, proposed policies concern the reservation of adequate income levels (taking into account the relation between benefits and contributions), the enforcement of exercising control over the labour market and over the persons entitled to social benefits and the imposition of proper economic penalties for tax and contribution evasion.

To gain all the above, policies should emphasize in:

(i) Proper taxation of overtime work;
(ii) Maintaining the institutional minimum wages;

(iii) Regulating tax distortions between tax systems applied in wage earners and those applied to self-employed;

(iv) Reducing the taxation of low productivity activities.

Even though during the past decades a broad range of methods has been developed to analyze the undeclared labour phenomenon, to understand its dimensions and causes, to formulate an appropriate policy to constrain its spread, neither this phenomenon has been examined with any available method, nor the discussion about which methodology is the most appropriate has still not come to an end. In particular, there has been an extended use of econometrics and applied statistics in the relevant researches. Surveys from international organizations (such as OECD, ILO, EU etc) based mostly on evidence and results of state audits also consist a notable framework. However, undeclared labour has not yet been approached or analyzed using the framework of industrial organization and game theoretic analytical toolkit.

With this research, we aspire to deliver a different approach, using the industrial's organization framework. Moreover, one of the main goals of this work is to propose a different policy for restraining the phenomenon of undeclared labour. As it is shown, the use of proper tax rates relative to those of social insurance could – under certain circumstances – restrain the economic attractiveness of this phenomenon.

The present analysis is organized as follows:

- In Section 2.2. we consider a – rather innovative with quite strong results – model with exogenously determined wages, where two firms are competing a la Cournot, the first firm declares its workers while the second one does not. The research focuses on the determination of the circumstances under which the second firm switches in worse economic position than the first one.
- In Section 2.3. we endogenize the wage determination, inducting unionized oligopoly, as well as the percentage of undeclared labour that each firm uses to maximize its profits.

- In Section 2.4. (2.5.) the phenomenon of undeclared labour is analyzed in pure strategies context, looking into all the possible combinations that are formulated in a unionized oligopoly, in which each firm chooses to declare its personnel or not.

Finally, we summarize our major results and propose directions for further research at the end of each Section. All proofs are relegated to the Appendix.

2.1. Exogenous Wage and Undeclared Labour in Oligopoly

2.1.1. Abstract

In a duopoly where firms are competing by adjusting their quantities and the wages are exogenously determined, we analyze the undeclared labour phenomenon and its side effects in product market. Our analysis focuses on the opportunity cost between the taxation and the contributions for social security. The findings of our analysis indicate that there is a strong relationship between the tax rate, the rate of contributions for social insurance and undeclared labour. It is furthermore determined that any combination of tax (t) / contributions (k) rates under the $t_1^* = \frac{k}{1+k}$ *curve, will lead firms to practice undeclared labour, in order to avoid paying contributions for social security, since the alternative choice is more costly.*

2.1.2. The model

Consider a homogeneous good sector where two firms, f_1 and f_2, compete by adjusting their quantities. We also assume a production function $q_i=L_i$ for both firms (q_i: the production of *i* firm, L_i: the workers used in *i* firm to produce q_i, *i*: 1, 2). The first firm insures its personnel and faces $(1+k)\cdot w$ unit labour cost[20], including contributions for social insurance, where *w* stands for wage and *k* for the percentage of the wage for social insurance contributions. The second firm decides not to insure its personnel and faces *w* unit labour cost (just the wage).

Additionally, both firms pay taxes of rate *t* on their declared net profits. Notice that, since the first firm declares and insures its workers, the whole payroll costs (meaning both wages and contributions for social security) should decrease the final net profits; while the second firm doesn't have this option, since undeclared labour cannot be shown at any public authority, including tax office. The tax functions form as follows[21]:

[20] We normalize production per unit cost to zero.

[21] Quantities, profits and taxation for each firm must be a positive argument. Thus, in order our model to have internal solutions, we set $t < t_{cr} = \frac{1+(-1+k)w}{1+w+kw}$ and 0 < w < 0.5 .

f_1 profit's taxation $= t \cdot \left((p - (1 + k) \cdot w) \cdot q_1\right)$

f_2 profit's taxation $= t \cdot (p \cdot q_2)$

Therefore, the first firm will pay contributions for social insurance and fewer taxes (since declared profits will be fewer), while the second firm will pay nothing for social security but more taxes (since declared profits will be significantly higher). It is clearly shown that there is an opportunity cost for firms, between taxation and contributions for social insurance.

Notice that at this stage of our early analysis, any choice of the firms to declare their workers or not, as well as the wage determination, are both considered exogenously. We assume that one firm acts in reverse to the other and examine which one is finally in better position. On the other hand, the wages are considered to be institutionally announced and apply for all firms in the economy (i.e., w_1=w_2=w). Our analysis does not, also, include any governmental surveillance or compliance penalties. We simply examine the equilibrium of the market, when it is auto-regulated, without any further interventions.

2.1.3. Solving the Model

Let for tractability the reverse demand function be normalized to $P(Q) = 1 - Q$, where $Q = q_1 + q_2$. Then, given our setup, the firms' profit functions are as follows:

$$\Pi_1 = \left[P(Q) - (1+k) \cdot w\right] \cdot q_1 - t \cdot \left[\left(P(Q) - (1+k) \cdot w\right) \cdot q_1\right] \quad (1)$$

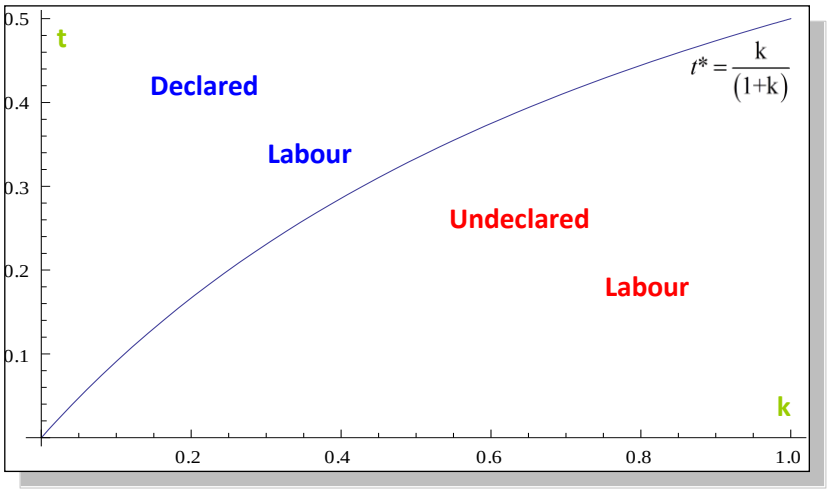
$$\Pi_2 = \left[P(Q) - w\right] \cdot q_2 - t \cdot \left[\left(P(Q) - w\right) \cdot q_2\right] \quad (2)$$

Taking the first order conditions and solving the model, we conclude that the quantities of each firm have as follows:

$$q_1 = \frac{1}{3}\left[1 - \frac{1 + 2k - 2t(1 + k)}{(1 - t)} \cdot w\right] \quad (3)$$

$$q_2 = \frac{1 - t - \left(1 - k(1 - t) + t\right) w}{3 \cdot (1 - t)} \quad (4)$$

Therefore, $q_1 - q_2 = \frac{(t\,(1+k) - k)}{1-t} \cdot w$, that is, if $t > \frac{k}{(1+k)}$ then $q_1 > q_2$, while if $t < \frac{k}{(1+k)}$ then $q_1 < q_2$. It is clear that if the implied tax rate is high enough (greater than $\frac{k}{1+k}$), then the firm that declares its personnel will enjoy higher market share. Otherwise, if the tax rate is low enough (less than $\frac{k}{1+k}$), then firm 2 enjoys higher market share. So, in terms of market share, we can illustrate the above with the following diagram:



It reveals that each combination of t & k above the curve $t^* = \frac{k}{1+k}$ obliterates any competitive advantage of the second firm, derived from the practice of undeclared labour, since in that case the first firm will enjoy greater market share. On the other hand, if any combination of t and k below the curve is applied, then the second firm will have an incentive to practice undeclared labour, since in this manner it will obtain greater market share.

The same result also applies with profit analysis. The profits of each firm, as they are derived, have as follows:

$$\Pi_1 = \frac{(-1 + t + w + 2\,k\,w - 2\,(1 + k)\,t\,w)^2}{9\,(1 - t)} \quad (5)$$

$$\Pi_2 = \frac{(-1 + t + (1 - k\,(1 - t) + t)\,w)^2}{9\,(1 - t)} \quad (6)$$

Abstracting (5)-(6) we have:

$$\Pi_1 - \Pi_2 = \frac{(k(-1+t)+t)\, w\, (2-(2+k)\, w\, +\, t\, (-2+w+kw))}{3(1-t)} \qquad (7)$$

The roots of the above expression are $t_1^* = \frac{k}{1+k}$ and $t_2^* = \frac{-2+2w+kw}{-2+w+kw}$. Since $t_{cr} = \frac{1+(-1+k)w}{1+w+kw} < t_2^* = \frac{-2+2w+kw}{-2+w+kw}$ for 0 < w < 0.5, we reject t_2^* as a critical value[22] and we conclude to the same results, as for the market share analysis; i.e. if $t < t_1^* = \frac{k}{1+k}$ then the firm that practices undeclared labour will gain more profits than the other one which declares its personnel. If, on the other hand, $t > t_1^*$, then the firm that declares its workers will gain more profits. Preposition 1 summarizes.

Proposition 1:

In the case of exogenous wage, the greater the tax rate than $\frac{k}{1+k}$ *is, the less strong is the incentive for undeclared labour. In other words, comparatively low enough taxation* $\left(less\ than\ \frac{k}{1+k}\right)$ *will create incentives for undeclared labour and conversely.*

2.1.4. Conclusions

Interpreting the results above, a comparatively low tax rate will enforce the phenomenon of undeclared labour. As a matter of fact, firms face an opportunity cost – dilemma:

- Either they practice undeclared work, pay no contributions for social insurance, but they state more profits and thus pay more taxes
- or they declare their personnel and pay the relevant contributions for social insurance, but they pay fewer taxes due to the fewer profits resulting for taxation.

Any combination of tax / contributions rates under the $t_1^* = \frac{k}{1+k}$ curve will indeed lead firms to practice undeclared labour, in order to avoid paying contributions for social security, since the alternative choice is more costly.

[22] As already mentioned, ***t*** should be less than $\boldsymbol{t_{cr}}$.

Continuing our analysis, we will focus on unionized oligopoly and investigate the role of undeclared labour in the market, in firms' profits, unions' utilities and social welfare.

2.2. Undeclared Labour in Unionized Oligopoly

2.2.1. Abstract

Undeclared labour constitutes a complex phenomenon that has not yet been analyzed within I/O framework. In a unionized duopoly under decentralized wage bargaining context, we reveal the opportunity cost that exists between the taxation and the contributions for social insurance. Comparing to a benchmarking state where no undeclared labour exist, our findings indicate that if the tax rate is low enough, the rate of undeclared labour that maximizes firms' profit will yield greater clearing wages, greater output and thus employment, greater consumer surplus and lower price. Furthermore, in contrast to common knowledge, we showed that under certain circumstances, undeclared labour may increase firms' profits and unions' utility, but it may also increase public revenues and social welfare. Finally, we propose a Pareto optimal tax rate for the case that firms practice undeclared labour. The proposed tax rate will render greater values in all market's magnitudes (wages, profits, quantities, consumer surplus, and social welfare). However, this policy proves that this specific policy lacks financing.

2.2.2. The Model

Consider a homogeneous good market, where two symmetric firms compete by adjusting their quantities. Production exhibits constant returns to scale and requires only labour input to produce the good. Moreover, each firm possesses a Leontief technology, so the capital stock is always sufficient to produce the good.

The production function of each firm can be defined as $q_i = L_i$ (i = 1, 2), where q (L) denotes output (employment), and the productivity of labour is normalized to unity. Moreover, let the inverse demand function specified of the simple normalized linear form, P(Q) = 1 - Q, where Q is the aggregate output: $Q = q_1 + q_2$.

Firms apply undeclared (declared) labour to $a_i \cdot L_i = a_i \cdot q_i$ $\left((1 - a_i) \cdot L_i = (1 - a_i) \cdot q_i\right)$, 0 < a < 1, of their workers. We assume that the unpaid contributions for social insurance are splitted between employer and employee, rate *z (1-z)* for employee (employer), where 0 < z < 1. Thus, the cost for undeclared labour

comprises from the wages $a_i \cdot w_i \cdot L_i = a_i \cdot w_i \cdot q_i$ plus the additional amount of splitted contributions paid to employees $z \cdot k \cdot a_i \cdot w_i \cdot L_i = z \cdot k \cdot a_i \cdot w_i \cdot q_i$, where *k* stands for the social insurance contribution rate (0 < k < 1). Adding the two expressions together, the total cost for undeclared labour forms as $(1 + z \cdot k) \cdot a_i \cdot w_i \cdot q_i$.

Respectively to undeclared labour cost, firms' cost for declared labour comprises from the wages $(1 - a_i) \cdot w_i \cdot L_i = (1 - a_i) \cdot w_i \cdot q_i$ plus the contributions for social insurance $k \cdot (1 - a_i) \cdot w_i \cdot L_i = k \cdot (1 - a_i) \cdot w_i \cdot q_i$. Thus, the total cost for declared labour forms as $(1 + k) \cdot (1 - a_i) \cdot w_i \cdot q_i$.

We also assume progressive direct taxation – rate denoted as t – for firms' profit formed as $t \cdot \Big((p \cdot q_i) - \big((1 + k) \cdot (1 - a_i) \cdot w_i \cdot q_i\big)\Big)^2$. Note here that the taxable profits arises abstracting from i's firm revenues only the cost for declared labour. The cost for undeclared labour remains unknown to the authorities.

Summarizing all the above, the firms' net profit function has as follows:

$$\Pi_i = [p \cdot q_i] - [(1 + z \cdot k) \cdot a_i \cdot w_i \cdot q_i] - [(1 + k) \cdot (1 - a_i) \cdot w_i \cdot q_i] - \left[t \cdot \Big((p \cdot q_i) - \big((1 + k) \cdot (1 - a_i) \cdot w_i \cdot q_i\big)\Big)^2\right] \quad (1)$$

Firms will choose in the last stage of the game those quantities and that rate of undeclared labour - simultaneously - in order to maximize their profit.

Given risk-neutral fixed membership and immobile labour, according to the utilitarian hypothesis, unions are assumed to maximize rents (for simplicity, we normalize reservation wage to zero, as such a normalization does not qualitatively affect the final state of the equilibrium), reflecting the aggregate labour market preferences of union members. Unions are assumed to be an insider in the labour market, thus having full knowledge of the undeclared labour phenomenon and its size. Assuming proportional taxation for the individuals – employees at the same tax rate *t*, unions' utility comprises from

- the income of the undeclared members $(1 + z \cdot k) \cdot a_i \cdot w_i \cdot q_i$

- the income of the declared members $(1 - a_i) \cdot w_i \cdot q_i$
- the cost of social insurance of the declared members, valued as a fringe benefit $k \cdot (1 - a_i) \cdot w_i \cdot q_i$
- minus the taxation of the declared members $t \cdot (1 - a_i) \cdot w_i \cdot q_i$.

Summarizing the above, unions' utility function forms as:

$$U_i = [(1 + z \cdot k) \cdot a_i \cdot w_i \cdot q_i] + [(1 - a_i) \cdot w_i \cdot q_i] + [k \cdot (1 - a_i) \cdot w_i \cdot q_i] - [t \cdot (1 - a_i) \cdot w_i \cdot q_i] \quad (2)$$

Regarding the wage-setting structure, we assume de-facto decentralized wage bargaining regime; each union will negotiate the wage (and thus the employment level) with the relevant firm, considering the maximization of its utility. Unions are moreover assumed to possess a bargaining power of one (monopoly unions) - for simplicity reasons - during labour-management negotiations.

Arising from the above, a two-stage game can be formally addressed as follows:

1. Decentralized wage bargaining takes place, where the wage - and thus the employment – is agreed among firms and unions.
2. Firms determine their quantities in the market (Cournot competition) as well as the optimal level of undeclared labour.

We shall proceed with the further research of the model, using backward induction.

2.2.3. Solving the model

Proceeding with the resolution of the model and using backward induction let us consider the second stage of the game first: in the subgame perfect equilibrium (SPE) each firm independently chooses its employment/output level as well as the rate of undeclared labour so as to maximize its profit, given the firm-specific wage contract resulting from Stage 1. Taking first order conditions of the profit functions [1] simultaneously as to quantities and the rates of undeclared

labour simultaneously, we derive the optimal output functions, appeared to be as follows:

$$q_1 = \frac{1}{3}(1 - 2(1+k)w_1 + w_2 + kw_2) \tag{3}$$

$$q_2 = \frac{1}{3}(1 - 2(1+k)w_2 + w_1 + kw_1) \tag{4}$$

Furthermore, the derived optimal levels of undeclared labour form as follows:

$$a_1 = \frac{\begin{matrix}2k^2t(6w_1 - 3w_2 - 2)(2w_1 - w_2) + 2k^3t(-2w_1 + w_2)^2 + 2t(1 - 2w_1 + w_2)^2 + \\ k(2t(-1 + 6w_1 - 3w_2)(-1 + 2w_1 - w_2) + 9(z-1))\end{matrix}}{6(1+k)^2tw_1(-1 + 2(1+k)w_1 - (1+k)w_2)} \tag{5}$$

$$a_2 = \frac{\begin{matrix}(2k^2t(2 + 3w_1 - 6w_2)(w_1 - 2w_2) + 2k^3t(w_1 - 2w_2)^2 + 2t(1 + w_1 - 2w_2)^2 + \\ k(2t(1 + 3w_1 - 6w_2)(1 + w_1 - 2w_2) + 9(z-1)))\end{matrix}}{6(1+k)^2tw_2(-1 + 2(1+k)w_2 - (1+k)w_1)} \tag{6}$$

Let us therefore proceed to Stage 1 of the game. By virtue of the previous stage and taking first order conditions of unions' utility [2], the following wages are specified:

$$w_1 = \frac{3 + t + k(-1 + 4z)}{(1+k)(9 - 5t + k(5 + 4z))} \tag{7}$$

$$w_2 = \frac{3 + t + k(-1 + 4z)}{(1+k)(9 - 5t + k(5 + 4z))} \tag{8}$$

Replacing expressions [7]-[8] into [1]-[6] and solving the game, we have the following final output:

$$q_1 = \frac{2(1 + k - t)}{9 - 5t + k(5 + 4z)} \tag{9}$$

$$q_2 = \frac{2(1 + k - t)}{9 - 5t + k(5 + 4z)} \tag{10}$$

$$a_1 = \frac{\begin{matrix}(-8(-1+t)^2t + k(81 - 114t + 57t^2 - 8t^3 - (9 - 5t)^2z) + k^3(-8t - (-1+z)(5+4z)^2) \\ +2k^2(8t^2 - 9(-5 + z + 4z^2) + t(-37 + 5z(1+4z))))\end{matrix}}{(4(1+k)(1+k-t)t(3 + t + k(-1+4z)))} \tag{11}$$

$$a_2 = \frac{\begin{matrix}(-8(-1+t)^2t + k(81 - 114t + 57t^2 - 8t^3 - (9 - 5t)^2z) + k^3(-8t - (-1+z)(5+4z)^2) \\ +2k^2(8t^2 - 9(-5 + z + 4z^2) + t(-37 + 5z(1+4z))))\end{matrix}}{(4(1+k)(1+k-t)t(3 + t + k(-1+4z)))} \tag{12}$$

$$U_1 = \frac{1}{2(1+k)^2 t(9-5t+k(5+4z))^2}(-4(-3+t)(-1+t)^2 t + kt(121-73z+t(-158+t(57 - 4t-17z)+74z)) + k^4(t(4+8z)-(-5+z+4z^2)^2) + k^2(-81(-1+z)^2 + 4t^3(3+2z) + 6t(38+z(-29+3z)) + t^2(-127+z(28+15z))) - k^3(4t^2(3+4z) + 18(-1+z)^2(5+4z) + 3t(-33+z(7+2(9-4z)z))))) \quad (13)$$

$$U_2 = \frac{1}{2(1+k)^2 t(9-5t+k(5+4z))^2}(-4(-3+t)(-1+t)^2 t + kt(121-73z+t(-158+t(57 - 4t-17z)+74z)) + k^4(t(4+8z)-(-5+z+4z^2)^2) + k^2(-81(-1+z)^2 + 4t^3(3+2z) + 6t(38+z(-29+3z)) + t^2(-127+z(28+15z))) - k^3(4t^2(3+4z) + 18(-1+z)^2(5+4z) + 3t(-33+z(7+2(9-4z)z))))) \quad (14)$$

$$\Pi_1 = \frac{1}{4(1+k)^2 t(9-5t+k(5+4z))^2}(16(-1+t)^2 t + 16k(-1+t)t(-3+t+(-1+t)z) + k^2(81 - 7t(6+t)-162z+2t(114+t(-57+8t))z+(9-5t)^2 z^2) + k^4(25 + z(16t+(1+4z)(-10+z+4z^2))) - 2k^3(16t^2 z - 9(-1+z)^2(5+4z) + t(17+z(-54+5z(-3+4z))))) \quad (15)$$

$$\Pi_2 = \frac{1}{4(1+k)^2 t(9-5t+k(5+4z))^2}(16(-1+t)^2 t + 16k(-1+t)t(-3+t+(-1+t)z) + k^2(81 - 7t(6+t)-162z+2t(114+t(-57+8t))z+(9-5t)^2 z^2) + k^4(25 + z(16t+(1+4z)(-10+z+4z^2))) - 2k^3(16t^2 z - 9(-1+z)^2(5+4z) + t(17+z(-54+5z(-3+4z))))) \quad (16)$$

$$p = \frac{5+k-t+4kz}{9+5k-5t+4kz} \quad (17)$$

Continuing our analysis, we further define social revenues and social welfare. Public revenues (R) consist of the contributions for social insurance (R_c) plus the revenues of taxation (R_t), illustrated as below:

$$R_c = \left((1-a_1)\cdot k\cdot w_1\cdot q_1\right) + \left((1-a_2)\cdot k\cdot w_2\cdot q_2\right) \quad (18)$$

$$R_t = (t\cdot(p\cdot q_1 - (1-a_1)\cdot(1+k)\cdot w_1\cdot q_1)^2) + (t\cdot(p\cdot q_2 - (1-a_2)\cdot(1+k)\cdot w_2\cdot q_2)^2) + (t\cdot w_1\cdot(1-a_1)\cdot q_1) + (t\cdot w_2\cdot(1-a_2)\cdot q_2) \quad (19)$$

$$R = R_c + R_t \quad (20)$$

The social welfare (SW) results from the aggregation of the unions' utility, the firms' profits and the consumer surplus (CM). Thus, the derived social welfare appears to be as follows:

$$SW = U_1 + U_2 + \Pi_1 + \Pi_2 + CS \quad (21)$$

Substituting the results [9]-[17] to the expressions [18]-[21] and simplifying, we obtain the following results:

$$R_c = \frac{k(-\frac{k}{t}+\frac{kz}{t}-\frac{16(1+k)(1+k-t)^2}{(9-5t+k(5+4z))^2}+\frac{4(1+k)(1+k-t)}{9-5t+k(5+4z)})}{(1+k)^2} \quad (22)$$

$$R_t = \frac{\begin{array}{c}(8(-5+t)(-1+t)t^2 + k^4(-5+z+4z^2)^2 + 2k^3(4t^2(1+4z) - t(-10+z)(-1+z)(5+4z) + \\ 9(-1+z)^2(5+4z)) + 2kt(81(-1+z) + t(134-74z+t(-57+4t+9z))) + \\ k^2(81(-1+z)^2 + 54t(-1+z)(5+z) - 16t^3(1+2z) + t^2(181 - z(6+55z))))\end{array}}{(2(1+k)^2t(9-5t+k(5+4z))^2)} \quad (23)$$

$$R = \frac{-\frac{k(k+2t)}{t} + 2kz + \frac{k^2z^2}{t} - \frac{32(1+k)(1+k-t)^2(k+t)}{(9-5t+k(5+4z))^2} + \frac{8(1+k)(1+k-t)(k+t)}{9-5t+k(5+4z)}}{2(1+k)^2} \quad (24)$$

$$CS = \frac{8(1+k-t)^2}{(9-5t+k(5+4z))^2} \quad (25)$$

$$SW = \frac{\begin{array}{c}(-8(-7+t)(-1+t)^2t - 2kt(-177 + t(238+4t^2+9t(-9+z)-58z)+65z) + k^4(8t(3+4z) - \\ (-5+z+4z^2)^2) + k^2(-81(-1+z)^2 + 8t^3(5+4z) - 6t(-85+z(20+9z)) + \\ t^2(-357+z(-58+55z))) + 2k^3(-9(-1+z)^2(5+4z) - 4t^2(7+8z) + \\ t(114+z(33+z(-39+4z)))))\end{array}}{(2(1+k)^2t(9-5t+k(5+4z))^2)} \quad (26)$$

2.2.4. Benchmarking Case

Consider a benchmarking state that no undeclared labour exists in the economy. Setting a_1 and a_2 to zero (zero undeclared labour), replacing output functions [3]-[4] and solving the model likewise, we conclude to the following results[23]:

$$\mathrm{w_{1b}} = \mathrm{w_{2b}} = \frac{1}{3+3k} \quad (27)$$

$$\mathrm{q_{1b}} = \mathrm{q_{2b}} = \frac{2}{9} \quad (28)$$

$$\mathrm{U_{1b}} = \mathrm{U_{2b}} = \frac{2(1+k-t)}{27(1+k)} \quad (29)$$

$$\mathrm{\Pi_{1b}} = \mathrm{\Pi_{2b}} = \frac{4(81-4t)}{6561} \quad (30)$$

$$\mathrm{p_b} = \frac{5}{9} \quad (31)$$

$$R_{cb} = \frac{4k}{27(1+k)} \quad (32)$$

$$R_{tb} = \frac{4(251+8k)t}{6561(1+k)} \quad (33)$$

$$R_b = \frac{4(251t+k(243+8t))}{6561(1+k)} \quad (34)$$

$$CS_b = \frac{8}{81} \quad (35)$$

[23] Note that we denote benchmark case with an index *b*.

$$SW_b = \frac{28}{81} - \frac{4(251 + 8k)t}{6561(1 + k)} \quad (36)$$

The side effects of undeclared labour in goods market as well as in labour market will be revealed by the comparison of the model's results to the corresponding ones of the benchmarking case.

2.2.5. Undeclared Labour in Unionized Oligopoly

In this section, we shall compare the results of our model vs. the benchmarking case, in order to reveal the role of undeclared labour in the economy and the nature of its influence. Begging with firms' output, abstracting expression [28] from [9]:

$$\mathrm{q}_1 - \mathrm{q}_{1b} = -\frac{8(t + k(-1 + z))}{9(9 - 5t + k(5 + 4z))}$$

The expression above has one root at $t^* = k - kz$, thus we conclude to:

- If $t > k - kz$, then $\mathrm{q}_1 - \mathrm{q}_{1b} < 0 \rightarrow \mathrm{q}_1 < \mathrm{q}_{1b}$ and
- If $t < k - kz$, then $\mathrm{q}_1 - \mathrm{q}_{1b} > 0 \rightarrow \mathrm{q}_1 > \mathrm{q}_{1b}$.

It proves that if the tax rate is low enough, lower than $k - kz$, then undeclared labour will increase the firms' output. And since we have made the assumption that the productivity equals to unity, the same results apply for employment proportionally. Reverse criterion applies for the price, though at the same critical value. Subtracting expression [31] from [17]:

$$p - p_b = \frac{16(t + k(-1 + z))}{9(9 - 5t + k(5 + 4z))}$$

The expression above has one root at $t^* = k - kz$, and thus

- If $t > k - kz$, then $\mathrm{p} - \mathrm{p}_b > 0 \rightarrow \mathrm{p} > \mathrm{p}_b$ and
- If $t < k - kz$, then $\mathrm{p} - \mathrm{p}_b < 0 \rightarrow \mathrm{p} < \mathrm{p}_b$.

Similar effects apply also for the wages in the equilibrium. Subtracting expression [27] from [7], we obtain the following results:

$$\mathrm{w}_1 - \mathrm{w}_{1b} = \frac{8(t+k(-1+z))}{3(1+k)(9-5t+k(5+4z))}$$

The expression above has one root at $t^* = k - kz$. Therefore,

- If $t > k - kz$, then $\mathrm{w}_1 - \mathrm{w}_{1b} > 0 \rightarrow \mathrm{w}_1 > \mathrm{w}_{1b}$ and
- If $t < k - kz$, then $\mathrm{w}_1 - \mathrm{w}_{1b} < 0 \rightarrow \mathrm{w}_1 < \mathrm{w}_{1b}$.

Proposition 1 summarizes:

Proposition 1:

If t is low enough, lower than $k - kz$, then undeclared labour will give more output – and therefore employment –, lower price at the final equilibrium and simultaneously lower clearing wages, compared to the full declared labour state. If on the other hand $t > k - kz$, the opposite state apply.

Proceeding with profit analysis, abstracting expression [30] from expression [15], we obtain the following results:

$$\Pi_1 - \Pi_{1b} = \frac{\begin{array}{c}(64t^2(-1377 + t(1044 + 25t)) + k^4(64t^2(5 + 4z)^2 - 1296t(-1 + z)(-25 + 16z) + 6561(-5 + z + 4z^2)^2) + \\ 2k^3(-320t^3(5 + 4z) + 59049(-1 + z)^2(5 + 4z) + 16t^2(2305 + z(-4637 + 64z)) - \\ 81t(-1 + z)(-2497 + z(661 + 1620z))) + 16kt(729(-1 + z) + t(-18(367 + 533z) + \\ t(1591 + 200t + 6401z))) + k^2(1600t^4 + 531441(-1 + z)^2 - 162t(-1 + z)(-3989 + 3773z) + \\ 16t^3(-2785 + 6241z) + t^2(218617 + z(-632498 + 165049z))))\end{array}}{(26244(1 + k)^2t(9 - 5t + k(5 + 4z))^2)}$$

The latter expression has no root determined. However, it can be shown that for specific values of t, the difference above turns out positive, meaning that profits under undeclared labour turns out greater than the corresponding ones in benchmarking case (declared labour). Furthermore, it can also be shown that the derivative of the difference above with respect to t, signs negative; interpreting the latter finding, we argue that as t increases, practicing undeclared labour becomes less attractive from the firms, as regard to their profit. Proposition 2 summarizes:

Proposition 2:

For any z, k $\epsilon(0,1)$, there exist a function of t_1(z,k) such as $\Pi_1 - \Pi_{1b} = 0$, with $\frac{\partial(\Pi_1 - \Pi_{1b})}{\partial t} < 0$, for which:

- if $t < t_1 \rightarrow \Pi_1 > \Pi_{1b}$, then profits under undeclared labour turns greater than profits gained in full declared labour state

- if $t > t_1 \rightarrow \Pi_1 < \Pi_{1b}$, then undeclared labour will grant firms with less profits rather than declared.

The proof of Proposition 2 is illustrated in the Appendix.

As $\frac{\partial(\Pi_1 - \Pi_{1b})}{\partial t} < 0$, we conclude that a low tax rate will strengthen the incentives for firms to practice undeclared labour. As the tax rate increases, firms pay even more taxes. Thus, their strategic choice will alter to declared labour, in order to properly declare their payroll costs and thus claim a tax deduction. Therefore, the lower the tax rate is, the more strengthened incentives are formulated for firms to practice undeclared labour.

Continuing with unions' utility, abstracting expression [29] from [13]:

$$U_1 - U_{1b} = -\frac{\begin{array}{c}(t + k(-1+z))(8(-9+t)(-1+t)t + k^3(27(-1+z)(5+4z)^2 + 8t(1+8z)) \\ -2k^2\left(8t^2(1+4z) - 243(-5+z+4z^2) + t\left(-719 + z(71+540z)\right)\right) + \\ k(2187(-1+z) + t(2582 - 2366z + t(-771 + 8t + 611z))))\end{array}}{54(1+k)^2 t(9 - 5t + k(5+4z))^2}$$

The latter expression has no root determined. However, it can be shown that for specific values of t, the difference above turns positive, proving that – under certain circumstances – unions' utility under undeclared labour may turn greater rather than the corresponding one in the benchmarking case (declared labour).

Proposition 3:

For any z, k $\epsilon(0,1)$, there exist functions of t_2(z,k) and t_3(z,k) such as $U_1 - U_{1b} = 0$, for which:

- if $t_2 < t < t_3 \rightarrow U_1 > U_{1b}$, then union's utility under undeclared labour turns greater than union's utility in full declared labour state

- if $t < t_2$ *or* $t > t_3 \rightarrow \mathrm{U}_1 < \mathrm{U}_{1b}$, then undeclared labour will lend unions with less utility rather than declared labour state.

The proof of Proposition 3 is illustrated in the Appendix.

Interpreting the above, firm's optimal undeclared labour rate may increase unions' utility. It can be shown that as the tax rate increases, it is more possible that unions' utility will be greater under undeclared labour. Thus, we can reasonably argue that as the tax rate increases, unions' incentive to collude with firms and practice undeclared labour is even more strengthened.

As regard to the public revenues, those can be categorized into two main categories; revenues from taxation and revenues from contributions for social insurance. Total public revenues result from the aggregation of these two illustrated categories. We shall examine each category discretely.

Let us examine revenues from taxation first. Abstracting expression [33] from expression [23], we obtain the following result:

$$\mathrm{R_t} - \mathrm{R_{tb}} = -\frac{-6561k^2 + 13122kt + 2008t^2 + 2072kt^2 + 64k^2t^2 + 13122k(k-t)z - 6561k^2z^2 + \frac{209952(1+k)(1+k-t)^2t^2}{(9-5t+k(5+4z))^2} - \frac{52488(1+k)(1+k-t)t^2}{9-5t+k(5+4z)}}{13122(1+k)^2t}$$

For the expression above, none analytically tractable formula can be obtained. Thus, it can be shown that there exist two different functions of t, $t_4(z,k)$: $\mathrm{R_t} - \mathrm{R_{tb}} = 0$ and $t_5(z,k)$: $\mathrm{R_t} - \mathrm{R_{tb}} = 0$, such as:

- If $\mathrm{t}_4(z,k) < t < \mathrm{t}_5(z,k) \rightarrow \mathrm{R_t} - \mathrm{R_{tb}} < 0 \rightarrow \mathrm{R_t} < \mathrm{R_{tb}}$ and
- If $t < \mathrm{t}_4(z,k)$ *or* $t > \mathrm{t}_5(z,k) \rightarrow \mathrm{R_t} - \mathrm{R_{tb}} > 0 \rightarrow \mathrm{R_t} > \mathrm{R_{tb}}$.

It reveals that, under $t < \mathrm{t}_4(z,k)$ *or* $t > \mathrm{t}_5(z,k)$, firms' optimal rate of undeclared labour may produce more public revenues from taxation, rather than the corresponding ones in benchmarking state (full declared labour).

Continuing our analysis, let us now proceed with public revenues from contributions for social insurance. Abstracting expression [32] from expression [22], we obtain the following results:

$$\mathrm{R}_c - \mathrm{R}_{\mathrm{cb}} = \frac{k(-4 + k(-4 - \frac{27}{t}) + \frac{27kz}{t} - \frac{432(1+k)(1+k-t)^2}{(9-5t+k(5+4z))^2} + \frac{108(1+k)(1+k-t)}{9-5t+k(5+4z)})}{27(1+k)^2}$$

For the expression above, once again, none analytically tractable formula can be obtained. Despite the limitation above, it can be shown that there exists a function of t, such as *t_6(k,z):* $R_c - R_{cb} = 0$, that applies:

- If $t < t_6(k,z) \rightarrow R_c - R_{cb} < 0 \rightarrow R_c < R_{cb}$ while
- If $t > t_6(k,z) \rightarrow R_c - R_{cb} > 0 \rightarrow R_c > R_{cb}$.

Interpreting the above, we observe that if $t > t_6(k,z)$, firms' optimal rate of undeclared labour may produce more public revenues from contributions for social insurance, rather than the corresponding ones in benchmarking state (full declared labour).

Finally, we examine total public revenues. Abstracting expression [34] from expression [24], we obtain the following results:

$$R - \mathrm{R}_{\mathrm{b}} = \frac{\begin{array}{c}-486k(31+4k) - \frac{6561k^2}{t} - 8(1+k)(251+8k)t + 13122kz + \\ \frac{6561k^2z^2}{t} - \frac{209952(1+k)(1+k-t)^2(k+t)}{(9-5t+k(5+4z))^2} + \frac{52488(1+k)(1+k-t)(k+t)}{9-5t+k(5+4z)}\end{array}}{13122(1+k)^2}$$

For the expression above, none analytically tractable formula can be obtained. It can be shown that there exists a function of t, such as *t_7(k,z):* $R - R_b = 0$, that applies:

- If $t < t_7(k,z) \rightarrow R - R_b < 0 \rightarrow R < R_b$ while
- If $t > t_7(k,z) \rightarrow R - R_b > 0 \rightarrow R > R_b$.

Therefore, we conclude that if t is high enough, higher than $t_7(k,z)$, then undeclared labour will yield more public revenues than the benchmarking case, where none undeclared labour exists. Proposition 4 summarizes.

Proposition 4:

For any z, k $\epsilon(0,1)$, there exist functions of t_4(z,k): $\mathrm{R_t} - \mathrm{R_{tb}} = 0$, t_5(z,k): $\mathrm{R_t} - \mathrm{R_{tb}} = 0$, t_6(z,k): $\mathrm{R_c} - \mathrm{R_{cb}} = 0$ and t_7(z,k): $\mathrm{R} - \mathrm{R_b} = 0$, for which:

- If $\mathrm{t_4}(z,k) < t < \mathrm{t_5}(z,k)$, then public revenues from taxation in the case of undeclared labour will be less than the corresponding ones in the case that no undeclared labour exists. If, on the other hand, $t < \mathrm{t_4}(z,k)$ *or* $t > \mathrm{t_5}(z,k)$, then undeclared labour will yield greater revenues from taxation.
- If $t < t_6(k,z)$, then public revenues from contributions for social insurance will be less in the case of undeclared labour, compared to the corresponding ones in the benchmarking case. Contrariwise, if $t > t_6(k,z)$, then undeclared labour will yield greater public revenues derived from contributions compared to the benchmarking case, where no undeclared labour exist.
- If $t < t_7(k,z)$, then total public revenues in the undeclared labour state will be less comparing to the case that no undeclared labour exists (benchmark). Contrary to common knowledge, if $t > t_7(k,z) \rightarrow R - R_b > 0 \rightarrow R > R_b$, then undeclared labour will contribute more to the state budget, comparing to the benchmarking case.

The proof of Proposition 4 is illustrated in the Appendix.

Examining the effect of undeclared labour in consumer surplus, we abstract expression [35] from [25] and we obtain the following results:

$$\mathrm{CS} - \mathrm{CS}_b = -\frac{64(t + k(-1+z))(9 - 7t + k(7+2z))}{81(9 - 5t + k(5+4z))^2}$$

The expression above has two roots,

- $t_1 = \frac{9}{7} + k + \frac{2kz}{7}$, which is rejected as greater than 1 for each and every $k, z \in (0,1)$ and
- $t_2 = k - kz$, which root is accepted.

Consequently,

- If $t > k - kz$, then $\mathrm{CS} - \mathrm{CS}_b < 0 \rightarrow \mathrm{CS} < \mathrm{CS}_b$ and
- If $t < k - kz$, then $\mathrm{CS} - \mathrm{CS}_b > 0 \rightarrow \mathrm{CS} > \mathrm{CS}_b$

Proposition 5 summarizes.

Proposition 5:

For any z, k $\epsilon(0,1)$, if $t > k - kz$, then undeclared labour will reduce consumer surplus, compared to the non-undeclared labour state. If on the other hand the sufficiently low, lower than $k - kz$, then undeclared labour will yield greater consumer surplus.

Recall Proposition 1; under the same criterion, $t < k - kz$, undeclared labour will modulate lower price and greater product in the market compared to the fully declared labour state. Thus, it results that consumer surplus will be greater too, since it jointly depends from price and the quantities.

Finally, let us now proceed with social welfare. Abstracting expression [36] from [26], we result to the following:

$$\mathrm{SW} - \mathrm{SW}_b = \frac{1}{13122(1+k)^2}(-162(28 + k(-25 + 28k)) - \frac{6561k^2}{t} + 8(1+k)(251 + 8k)t + \frac{13122k(k-t)z}{t} - \frac{6561k^2z^2}{t} - \frac{104976(1+k)(1+k-2t)(1+k-t)^2}{(9 - 5t + k(5+4z))^2} + \frac{52488(1+k)(1+k-t)^2}{9 - 5t + k(5+4z)})$$

For the expression above, none analytically tractable formula can be obtained. It can be shown that there exist two functions of t, such as $t_8(k,z)$: $SW - SW_b = 0$ and $t_9(k,z)$: $SW - SW_b = 0$, that applies:

- If $t_8(k,z) < t < t_9(k,z)$, then $\mathrm{SW} - \mathrm{SW}_b > 0 \rightarrow \mathrm{SW} > \mathrm{SW}_b$ and
- If $t < t_8(k,z)\ or\ t > t_9(k,z)$, then $\mathrm{SW} - \mathrm{SW}_b < 0 \rightarrow \mathrm{SW} < \mathrm{SW}_b$.

Proposition 6 summarizes.

Proposition 6:

For any z, k $\epsilon(0,1)$, if $t_8(k,z) < t < t_9(k,z)$, then undeclared labour will produce greater social welfare in comparison to declared labour case (benchmark). If on the other hand $t < t_8(k,z)$ *or* $t > t_9(k,z)$, then social welfare will be greater in fully declared labour state, rather than the undeclared one.

The proof of Proposition 6 is illustrated in the Appendix.

2.2.6. Pareto Optimal Tax Rate

In this section, we argue that, in the undeclared labour case, there exists such a tax rate that may consist a Pareto optimal compared to the benchmarking case. Interpreting the previous argument, there exists such a tax rate t* that all agents – firms, unions, consumers and community – enjoy equal or even greater payoffs in undeclared labour state rather than in the benchmarking one.

Consider the imposition of a tax rate $t^* = (1-z)\cdot k$. Replacing t^* to expressions [7] to [26] for the undeclared labour case and [27] to [36] for the benchmarking case, we obtain the following results:

Price

As mentioned in proposition 1, $t^* = (1-z)\cdot k$ equates p and p_b.

Quantity (Employment)

As mentioned in proposition 1, $t^* = (1-z)\cdot k$ equates q_i and q_{ib} and thus the employment, as the production function forms $q_i=L_i$ (i=1,2).

Wages

As mentioned in proposition 1, $t^* = (1-z)\cdot k$ equates w_i and w_{ib}.

Profits

Substituting t* into the profit expressions of each case, we obtain:

$\Pi_1^* = \frac{16+97k+k(-65+16k)z}{324(1+k)^2}$ and $\Pi_{1b}^* = \frac{4(81+4k(-1+z))}{6561}$, while their subtraction concludes to $\Pi_1^* - \Pi_{1b}^* = \frac{(73-8k)^2k(1-z)}{26244(1+k)^2}$. As $z\epsilon(0,1) \rightarrow (1-z) > 0$, the mark of all factors of the quotient remain positive, thus $\Pi_1^* - \Pi_{1b}^* > 0 \rightarrow \Pi_1^* > \Pi_{1b}^*$.

Unions' Utility

Substituting t* into the Utility expressions of each case, we obtain:

$U_1^* = U_{1b}^* = \frac{2(1+kz)}{27(1+k)}$

Thus, $t^* = (1-z) \cdot k$ equates U_i and U_{ib}.

Consumer Surplus

As mentioned in proposition 5, $t^* = (1-z) \cdot k$ equates CS and CS_b.

Social Welfare

Substituting t* into the Social Welfare expressions of each case, we obtain:

$SW^* = \frac{56+k(153-41z+8k(2+5z))}{162(1+k)^2}$ and $SW_b^* = \frac{4(567+k(316+8k(-1+z)+251z))}{6561(1+k)}$, while their subtraction concludes to $SW^* - SW_b^* = \frac{(73-8k)^2k(1-z)}{13122(1+k)^2}$. As $z\epsilon(0,1) \rightarrow (1-z) > 0$, the mark of all factors of the quotient remain positive, thus $SW^* - SW_b^* > 0 \rightarrow SW^* > SW_b^*$.

Proposition 7 summarizes the results.

Proposition 7:

Assume a labour market where firms determine their optimal rate of undeclared labour and a benchmarking case, where no undeclared labour is practiced. For any z, k $\epsilon(0,1)$, the imposition of a direct tax rate $t^* = (1-z) \cdot k$ consists a Pareto optimal for the first case compared to the second, as all agents enjoy equal or even greater payoffs; Unions' Utility and Consumer Surplus will remain immutable, while Firms' Profits and Social Welfare will increase.

We should also stress out that this Pareto optimal t* lacks of financing. Substituting t* into the Public Revenues expressions of each case, we obtain:

$R^* = \frac{k(-163-40k(-2+z)+41z)}{162(1+k)^2}$ and $R_b^* = -\frac{4k(-494+8k(-1+z)+251z)}{6561(1+k)}$, while their subtraction concludes to $R^* - R_b^* = \frac{k(-73+8k)(235+8k(-1+z)-73z)}{13122(1+k)^2}$. The mark of the quotient remains negative, thus $R^* - R_b^* < 0 \rightarrow R^* < R_b^*$.

Interpreting the above, if a benevolent social planner implies a policy setting t* in order to handle the undeclared labour phenomenon, then he will have to seek also for additional funding, as the public revenues will thereby suffer losses.

2.2.7. Conclusions

Undeclared labour constitutes a complex phenomenon, where tax evasion and social security fraud are involved. Both employers and employees voluntarily collude, because of the potential gain in avoiding taxes and social security contributions, social rights and the cost of complying with regulations. In our research, we highlighted this opportunity cost and revealed the effects that undeclared labour creates respectively to all market's major fundamentals.

As it concerns our present research, we introduced a model that endogenizes undeclared labour and analyzes the phenomenon within I/O framework. We endogenized the selection of the optimal rate of undeclared labour from the firms - simultaneously with the quantities. Furthermore, model's assumptions include progressive taxation for firms and proportional taxation for the rest (e.g. members of the union). We assumed that the extra cost for social insurance is splitted between employer and employee. Furthermore, the profit/utility functions were properly adjusted to reflect and highlight the opportunity cost between taxation and contributions for social insurance; firms will either declare their personnel and pay contributions - but less taxes - or they will practice undeclared labour and pay less contributions - but more taxes. Unions face relevant dilemma, either they collude

with firms to undeclared labour, and thus they are paid more, the pay less taxes but they lack of insurance, or they do not consent to undeclared labour, and thus they earn less, they pay more taxes and they enjoy insurance. Finally, we additionally constructed a benchmarking case with zero undeclared labour and compared those two cases.

The findings of our analysis evince that the side effects of undeclared labour are not clearly visible. Contrary to common knowledge, if t is low enough, the rate of undeclared labour that maximizes firms' profit will yield greater clearing wages, greater output and thus employment, greater consumer surplus and lower price. Moreover, we showed that under certain circumstances, undeclared labour may increase firms' profits and unions' utility, but may also increase public revenues and social welfare. Finally, we argue that an imposition of a tax rate $t^* = (1 - z) \cdot k$ consists a Pareto optimal policy for the case of undeclared labour case compared to the benchmarking one; the imposition of such a tax rate, will grant all agents, e.g. firms, unions, consumers and the community, with equal or even greater payoffs.

Since the project has not any relative research background, possible extensions of this research may be yet quite more promising. Further research may include different types of competition (e.g. Bertrand Competition), different types of wage bargaining (e.g. centralized bargaining, non-monopoly unions), endogenization of state's interference in labour market (e.g. screening for undeclared labour) and a cost-benefit analysis for the determination of the optimal governmental surveillance's cost or the social's optimal rate of undeclared labour. The forthcoming research will comprise a key role in order for us to acquire a spherical knowledge of the undeclared labour phenomenon and its side effects.

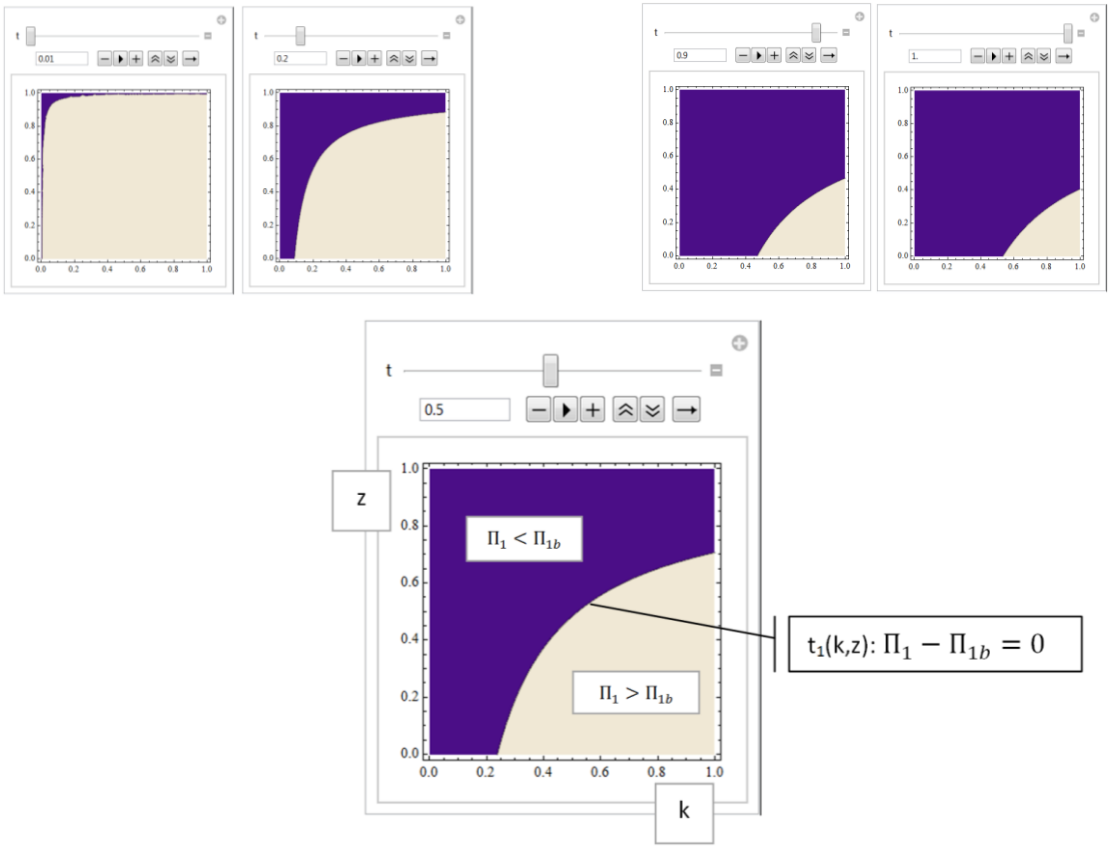
2.2.8. Appendix

Proof of Proposition 2:

Abstracting expression [30] from expression [15], we obtain the following results:

$$\Pi_1 - \Pi_{1b} = \frac{\begin{array}{c}(64t^2(-1377 + t(1044 + 25t)) + k^4(64t^2(5 + 4z)^2 - 1296t(-1 + z)(-25 + 16z) + 6561(-5 + z + 4z^2)^2) + \\ 2k^3(-320t^3(5 + 4z) + 59049(-1 + z)^2(5 + 4z) + 16t^2(2305 + z(-4637 + 64z)) - \\ 81t(-1 + z)(-2497 + z(661 + 1620z))) + 16kt(729(-1 + z) + t(-18(367 + 533z) + \\ t(1591 + 200t + 6401z))) + k^2(1600t^4 + 531441(-1 + z)^2 - 162t(-1 + z)(-3989 + 3773z) + \\ 16t^3(-2785 + 6241z) + t^2(218617 + z(-632498 + 165049z))))\end{array}}{(26244(1 + k)^2t(9 - 5t + k(5 + 4z))^2)}$$

For the expression above, none analytically tractable formula can be obtained. Nonetheless, we can still check for the sign of $\Pi_1 - \Pi_{1b}$ by contour-plotting the [15]-[30] difference over a fine grid of our critical z and k parameters.

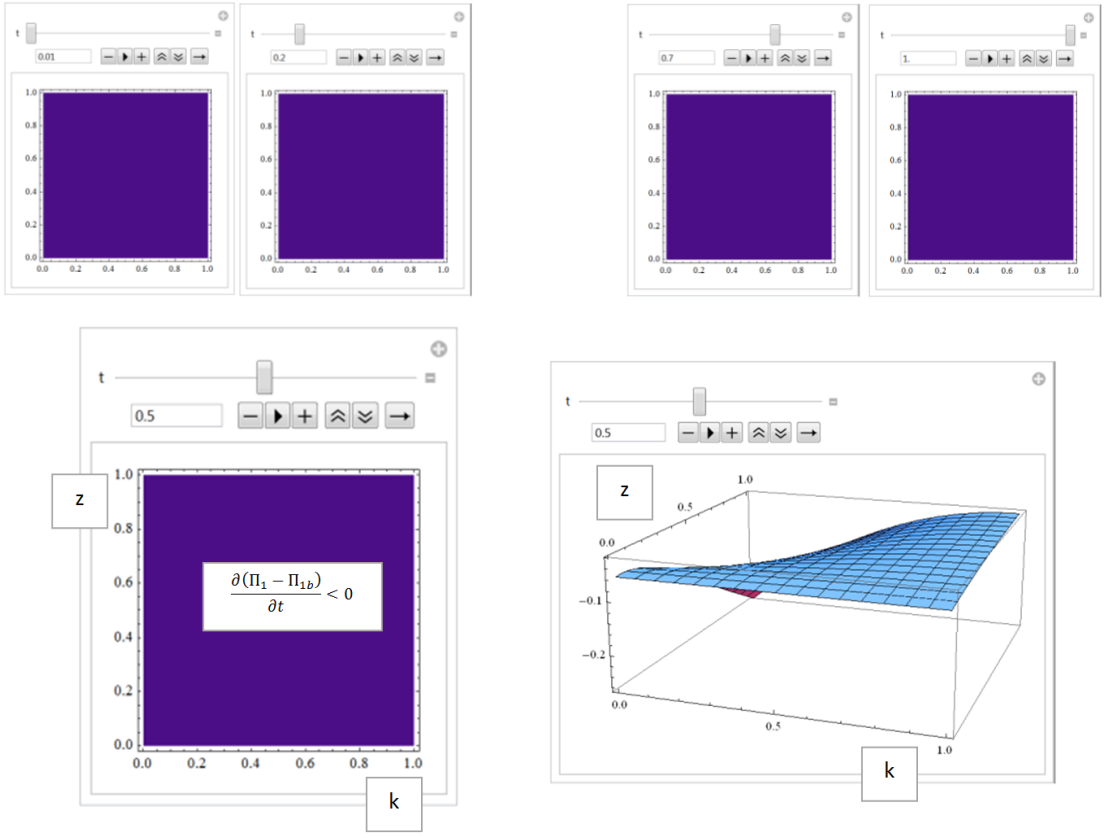


By inspecting the plots above, it can be checked that if $t < t_1 \rightarrow \Pi_1 > \Pi_{1b}$, while if $t > t_1 \rightarrow \Pi_1 < \Pi_{1b}$.

Moreover, to examine the influence of the variation of the tax rate t over the difference $\Pi_1 - \Pi_{1b}$, we take the first differentiate of $\Pi_1 - \Pi_{1b}$ respect to t.

$$\frac{\partial(\Pi_1 - \Pi_{1b})}{\partial t} = \frac{64(1+k)^2 - \frac{6561k^2}{t^2} + \frac{13122k^2z}{t^2} - \frac{6561k^2z^2}{t^2} - \frac{1312200(1+k)(1+k-t)^3}{(9-5t+k(5+4z))^3} + \frac{524880(1+k)(1+k-t)^2}{(9-5t+k(5+4z))^2} - \frac{52488(1+k)(1+k-t)}{9-5t+k(5+4z)}}{26244(1+k)^2}$$

Once again, none analytically tractable formula can be obtained for the derivative above. Thus, we check for its sign by contour-plotting the expression above over a fine grid of our critical z and k parameters.



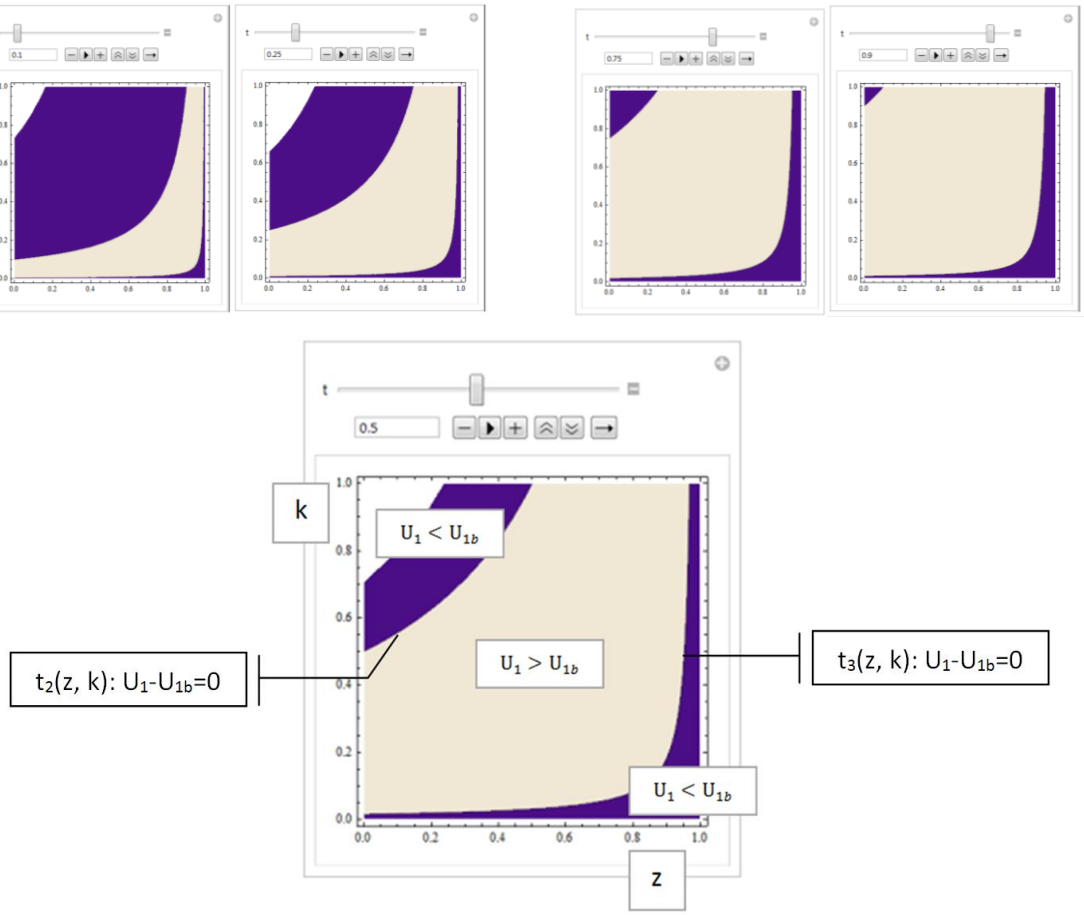
By inspecting these plots it can be checked the negative relationship between tax rate and the difference between the profits under undeclared labour minus the profits in a fully declared labour state; the lower the tax rate is, the more strengthened incentives are formulated for firms to practice undeclared labour.

Proof of Proposition 3:

Examining unions' utility, we abstract expression [29] from [13]:

$$U_1 - U_{1b} = -\frac{\begin{array}{c}(t+k(-1+z))(8(-9+t)(-1+t)t+k^3(27(-1+z)(5+4z)^2+8t(1+8z))\\ -2k^2\left(8t^2(1+4z)-243(-5+z+4z^2)+t\left(-719+z(71+540z)\right)\right)+\\ k(2187(-1+z)+t(2582-2366z+t(-771+8t+611z))))\end{array}}{54(1+k)^2t(9-5t+k(5+4z))^2}$$

Since there cannot be determined any root for the expression above, we shall check for the sign of $U_1 - U_{1b}$ by contour-plotting the [29]-[13] difference over a grid of our critical z and k parameters.



As illustrated above, firm's optimal undeclared labour rate may increase unions' utility. From the examination of the diagrams above (e.g., compare diagram for t=0.1 vs diagram for t=0.9), as the tax rate increases, it is more possilbe that unions' utility will be greater under undeclared labour. Thus, we can resonably argue that as the tax rate increases, unions' incentive to collude with firms and practice undeclared labour is even more strenghtened.

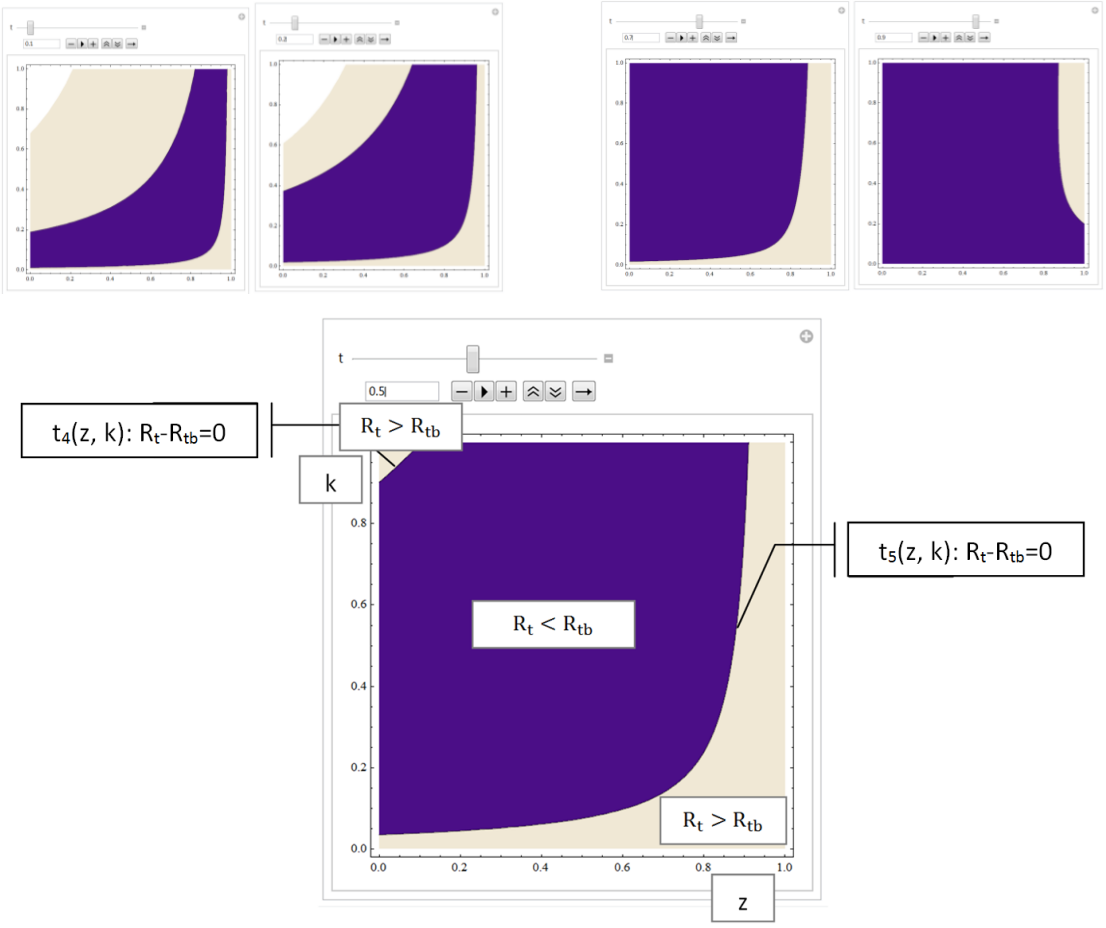
Proof of Proposition 4:

Public Revenues from Taxation:

Abstracting expression [33] from expression [23], we obtain the following results:

$$R_t - R_{tb} = -\frac{-6561k^2 + 13122kt + 2008t^2 + 2072kt^2 + 64k^2t^2 + 13122k(k-t)z - 6561k^2z^2 + \frac{209952(1+k)(1+k-t)^2t^2}{(9-5t+k(5+4z))^2} - \frac{52488(1+k)(1+k-t)t^2}{9-5t+k(5+4z)}}{13122(1+k)^2t}$$

For the expression above, none analytically tractable formula can be obtained. Nonetheless, we can still check for the sign of $R_t - R_{tb}$ by contour-plotting the [23]-[33] difference over a grid of our critical z and k parameters.

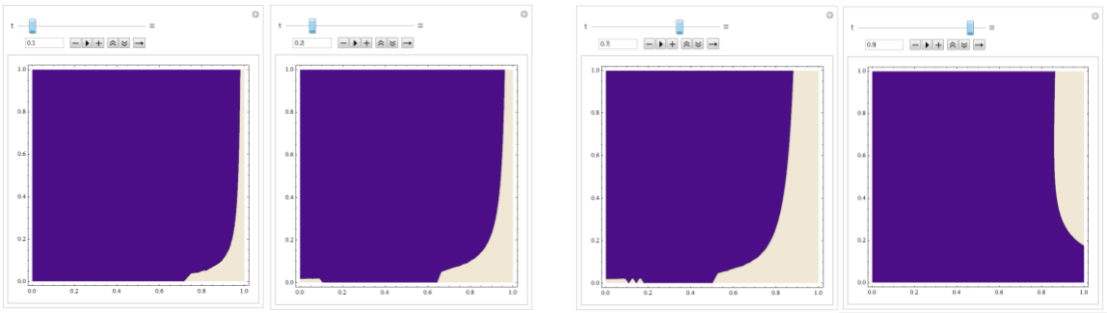


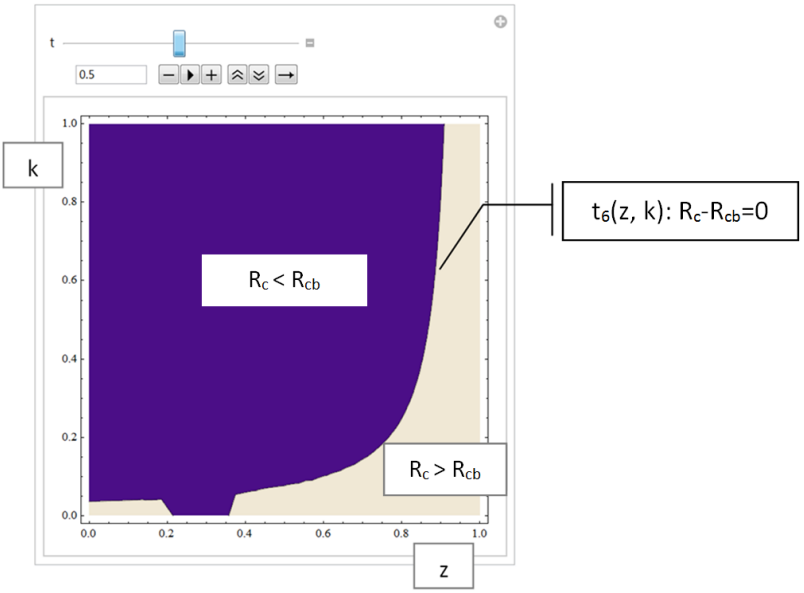
Public Revenues from Contributions:

Abstracting expression [32] from expression [22], we obtain the following results:

$$\mathrm{R}_c - \mathrm{R}_{\mathrm{cb}} = \frac{k(-4 + k(-4 - \frac{27}{t}) + \frac{27kz}{t} - \frac{432(1+k)(1+k-t)^2}{(9-5t+k(5+4z))^2} + \frac{108(1+k)(1+k-t)}{9-5t+k(5+4z)})}{27(1+k)^2}$$

For the expression above, none analytically tractable formula can be obtained. Nonetheless, we can still check for the sign of $\mathrm{R}_c - \mathrm{R}_{\mathrm{cb}}$ by contour-plotting the [22]-[32] difference over a grid of our critical z and k parameters.



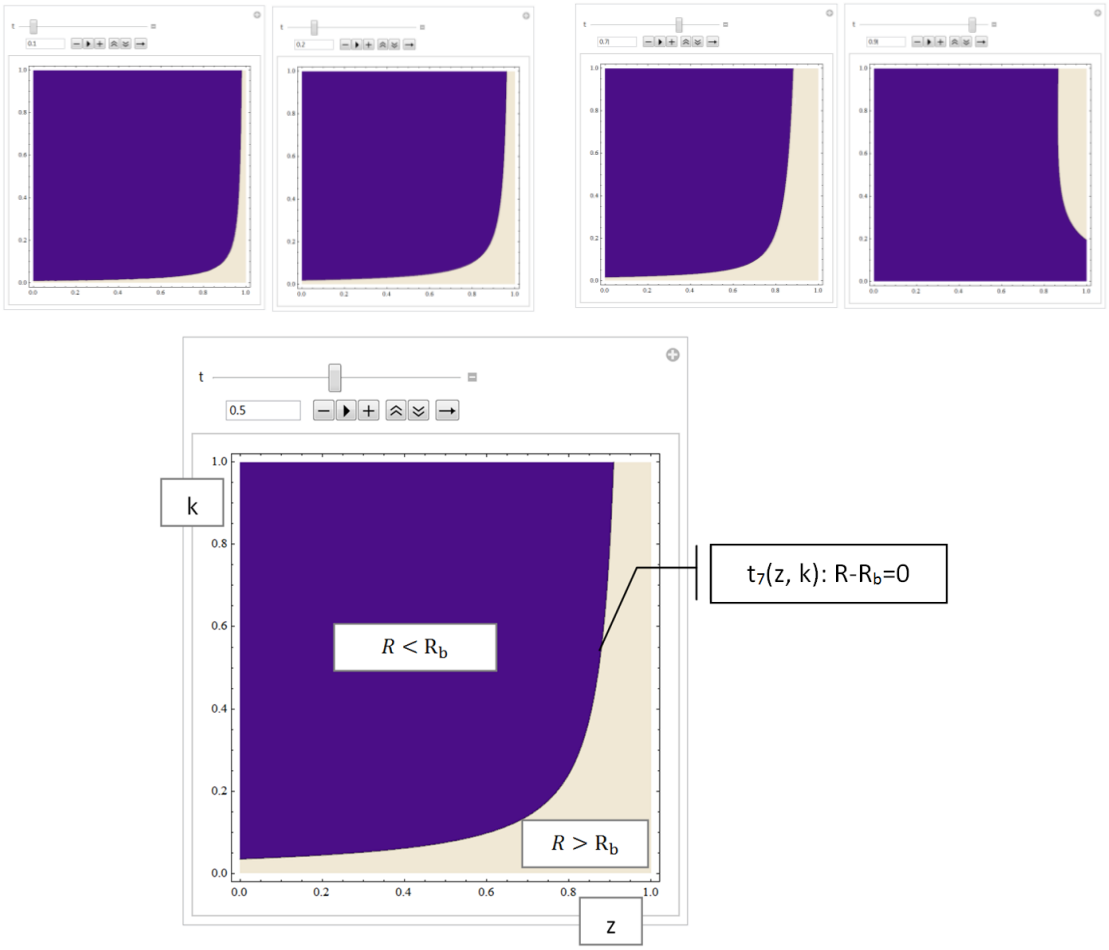


Total Public Revenues:

Abstracting expression [34] from expression [24], we obtain the following results:

$$R - \mathrm{R_b} = \frac{-486k(31+4k) - \frac{6561k^2}{t} - 8(1+k)(251+8k)t + 13122kz + \frac{6561k^2z^2}{t} - \frac{209952(1+k)(1+k-t)^2(k+t)}{(9-5t+k(5+4z))^2} + \frac{52488(1+k)(1+k-t)(k+t)}{9-5t+k(5+4z)}}{13122(1+k)^2}$$

For the expression above, none analytically tractable formula can be obtained. Nonetheless, we can still check for the sign of $R - \mathrm{R_b}$ by contour-plotting the [24]-[34] difference over a grid of our critical z and k parameters.

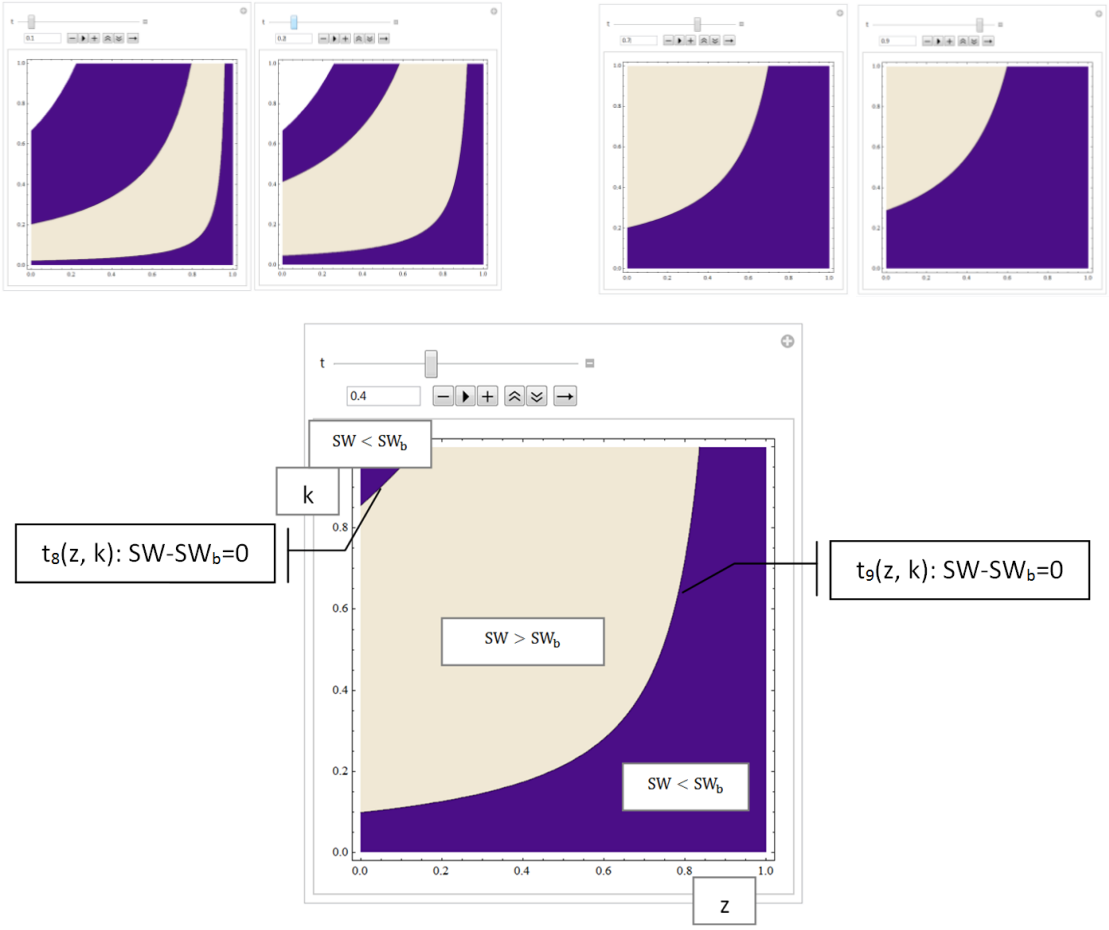


Proof of Proposition 6:

Abstracting expression [36] from expression [26], we obtain the following results:

$$\mathrm{SW} - \mathrm{SW_b} = \frac{-162\big(28+k(-25+28k)\big) - \frac{6561k^2}{t} + 8(1+k)(251+8k)t + \frac{13122k(k-t)z}{t} - \frac{6561k^2z^2}{t} - \frac{104976(1+k)(1+k-2t)(1+k-t)^2}{(9-5t+k(5+4z))^2} + \frac{52488(1+k)(1+k-t)^2}{9-5t+k(5+4z)}}{13122(1+k)^2}$$

For the expression above, none analytically tractable formula can be obtained. Nonetheless, we can still check for the sign of $SW - SW_b$ by contour-plotting the [26]-[36] difference over a grid of our critical z and k parameters.



2.3. Pure Strategies in Unionized Oligopoly with Undeclared Labour

2.3.1. Abstract

In a unionized duopoly under decentralized wage bargaining regime, we analyzed undeclared labour in a matrix game. We reveal the opportunity cost between taxation and contributions for social insurance that firms and unions face, while we examine all relevant possible unilateral deviations from firms and unions. Our research concludes in three different possible equilibria that all three of them – under certain circumstances – may constitute a Nash SPE. The findings of our research furthermore indicate that if both firms declare their labour, then the incentive for firm's deviation will arise if the bargaining power of unions is low enough ($b < b_{cr1}$), while unions will silently consent to undeclared labour if the rate for social insurance's contributions is great enough ($k > k_{cr1}$). If both firms practice undeclared labour, then there can be none critical value that will alter firms' policy to declared labour; thus, in this case, unions will consent to undeclared labour only if k is low enough ($k < k_{cr2}$). Finally, in the case that one firm declares its labour while the other one practices undeclared labour, firm's incentive to alter its policy to declared labour occurs if the direct tax rate is great enough ($t_a > 1- t_e$), while the incentive to discontinue practicing undeclared labour occurs if b is low enough ($b < b_{cr2}$). However, in this latter case, there can be none incentive for unions to consent to the change of declared to undeclared labour.

2.3.2. The Model

Consider a homogeneous good market, where two symmetric firms compete by adjusting their quantities. Production exhibits constant returns to scale and requires only labour input to produce the good. Moreover, each firm possesses a Leontief technology, so the capital stock is always sufficient to produce the good.

The production function of the first firm (second firm) can be defined as $q_1 = L_1$ ($q_2 = L_2$), where q (L) denotes output (employment), and the productivity of labour is normalized to unity. Moreover, let the inverse demand function specified of the

simple normalized linear form, P(Q) = 1 - Q, where Q is the aggregate output: Q = q_1 + q_2.

Firms have the option either to declare all their workers and pay contributions for social security, or to employ their staff undeclared to the authorities. If any firm decides to declare its employees, then an additional insurance cost will arise, calculated as a percentage of $k\epsilon(0,1)$ on employees' wages. Moreover, if a firm insures its personnel, then all payroll costs will be deducted from its profits, including insurance costs, and thus fewer taxes will be paid; whereas, if the firm does not insure its personnel, then – for the tax calculation only – payroll costs will not consist a deduction element of profits and therefore more taxes will be defrayed. Considering the imposition of two different types of taxation, indirect tax rate t_e, imposed on firm's revenues, and proportional direct tax rate t_a, imposed on firm's profits $\left(t_a, t_e\ \epsilon(0,1)\right)$, the profit functions form as follows:

- Case of undeclared labour:

$$\Pi_i = p \cdot q_i - w_i \cdot q_i - t_e \cdot p \cdot q_i - t_a \cdot (p \cdot q_i - t_e \cdot p \cdot q_i) \quad (1)$$

- Case of declared labour:

$$\Pi_i = p \cdot q_i - (1+k) \cdot w_i \cdot q_i - t_e \cdot p \cdot q_i - t_a \cdot (p \cdot q_i - (1+k) \cdot w_i \cdot q_i - t_e \cdot p \cdot q_i) \quad (2)$$

Given risk-neutral fixed membership and immobile labour, according to the utilitarian hypothesis, unions are assumed to maximize rents, $\mathrm{U}(\mathrm{w_i}, \mathrm{L_i}) = (\mathrm{w_i} - \mathrm{w_0}) \cdot \mathrm{L_i} = (\mathrm{w_i} - \mathrm{w_0}) \cdot \mathrm{q_i}$, where w_i and L_i are the wage and employment arguments, i stands for first or second firm, and w_0 stands for the reservation wage - unemployment benefit. For simplicity, we normalize w_0 to zero, as such a normalization does not qualitatively affect the final state of the equilibrium. Furthermore, if employees are declared, then social insurance will consist an additional – fringe – benefit for them; thus, it should be included to their utility. Additionally, declared employees reveal their income and, thus, they pay proportional taxes, calculated as a percentage t_a of their income. So, in the case of

declared employees, the utility function forms as $U_i(w_i, L_i) = (1 + k) \cdot w_i \cdot q_i - t_a \cdot (w_i \cdot q_i)$.

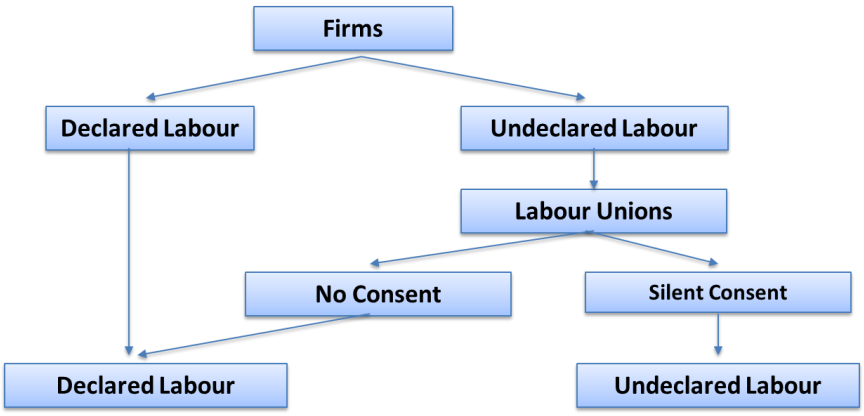
It is clear that an opportunity cost arises for unions; if unions consent to undeclared labor, it is more possible that more union's members will be employed (employment will increase), while its members will pay no taxes at all. In the case that employees are properly declared, they will benefit social security, but they will have to pay taxes, since their income will be declared to public authorities, and, thus, it will be taxable.

Regarding the wage-setting structure, we assume de facto decentralized wage bargaining regime; each union will negotiate the wage (and thus the employment level) with the relevant firm, considering the maximization of its utility. Unions (firms) are moreover assumed to possess a bargaining power of b (1-b) during labour-management negotiations.

Note that in order undeclared labour to be applied, firm and union (the latter most likely silently) must collude. On the other hand, declared labour may be practiced unilaterally; if one firm decides to properly declare its personnel to the authorities, union has to comply. Else, if unions disown undeclared labour for their members, then they will denounce any illegal practices to the authorities and restore declared labour status.

Arising from the above, a three-stage game can be formally addressed as follows:

1. Firms and unions mutually decide whether labour should be declared or not.



2. Decentralized wage bargaining takes place, where firms and unions bargain over wages – and, thus, employment.
3. Firms determine their quantities in the market (Cournot competition).

Regarding to the first stage of the game, four alternative cases are clearly distinguished, as displayed in the following matrix:

	f_2 Declared Labor	f_2 Undeclared Labor
f_1 Declared Labour	***f_1 Declared Labour, f_2 Declared Labour*** ❶	***f_1 Declared Labour, f_2 Undeclared Labour*** ❷
f_1 Undeclared Labour	***f_1 Undeclared Labour, f_2 Declared Labour*** ❸	***f_1 Undeclared Labour, f_2 Undeclared Labour*** ❹

Since cases 2 and 3 are symmetrical, the number of alternative cases is reduced to three.

We shall proceed with the further research of the model, using backward induction. Having the model solved, we will examine which case consist a possible Nash Subgame Perfect Equilibrium (SPE). Further, we will determine those circumstances, under which any agent of the game (e.g. firms or unions) are motivated to deviate from the equilibrium.

2.3.3. Pure Strategies Focusing on Undeclared Labour in Unionized Oligopoly

Let us now proceed solving the model. As mentioned before, 3 alternative possible equilibria are formed. Thus, we shall solve each case discrete.

a. 1st Case, Both Firms Declare Their Employees

Using backward induction, let us start with the final stage, Cournot competition. The profit functions of both firms have as follows[24]:

$$\Pi_{1i} = p_i q_{1i} - (1+k) w_{1i} q_{1i} - t_e p_i q_{1i} - t_a (p_i q_{1i} - (1+k) w_{1i} q_{1i} - t_e p_i q_{1i}) \quad (3)$$

$$\Pi_{2i} = p_i q_{2i} - (1+k) w_{2i} q_{2i} - t_e p_i q_{2i} - t_a (p_i q_{2i} - (1+k) w_{2i} q_{2i} - t_e p_i q_{2i}) \quad (4)$$

Taking first order conditions as to quantities and solving both equations simultaneously, we result to:

$$\mathrm{q_{1i}} = \frac{1 - \mathrm{t_e} - 2\mathrm{w_{1i}} - 2k\mathrm{w_{1i}} + \mathrm{w_{2i}} + k\mathrm{w_{2i}}}{3(1 - \mathrm{t_e})} \quad (5)$$

$$\mathrm{q_{2i}} = \frac{1 - \mathrm{t_e} - 2\mathrm{w_{2i}} - 2k\mathrm{w_{2i}} + \mathrm{w_{1i}} + k\mathrm{w_{1i}}}{3(1 - \mathrm{t_e})} \quad (6)$$

Let us now proceed to the 2nd stage, decentralized wage bargaining. Unions' utility functions have as follows:

$$\mathrm{U_{1i}} = ((1+k) \cdot \mathrm{w_{1i}} \cdot \mathrm{q_{1i}}) - \mathrm{t_a} \cdot (\mathrm{w_{1i}} \cdot \mathrm{q_{1i}}) \quad (7)$$

$$\mathrm{U_{2i}} = ((1+k) \cdot \mathrm{w_{2i}} \cdot \mathrm{q_{2i}}) - \mathrm{t_a} \cdot (\mathrm{w_{2i}} \cdot \mathrm{q_{2i}}) \quad (8)$$

The agreed wages will occur by the maximization as to w_{1i} and w_{2i} of the following expressions:

$$\mathrm{Max}\left\{(\mathrm{U_{1i}})^b \cdot (\Pi_{1i})^{(1-b)}\right\} \quad (9)$$

$$\mathrm{Max}\left\{(\mathrm{U_{2i}})^b \cdot (\Pi_{2i})^{(1-b)}\right\} \quad (10)$$

Maximizing as above, we obtain the following results:

$$\mathrm{w_{1i}} = \frac{b(1 - \mathrm{t_e})}{(4-b)(1+k)} \quad (11)$$

$$\mathrm{w_{2i}} = \frac{b(1 - \mathrm{t_e})}{(4-b)(1+k)} \quad (12)$$

[24] Index ***i*** is used to denote the case that both firms **i**nsure their employees.

$$q_{1i} = \frac{2(2-b)}{3(4-b)} \tag{13}$$

$$q_{2i} = \frac{2(2-b)}{3(4-b)} \tag{14}$$

$$\Pi_{1i} = \frac{4(-2+b)^2(1-t_a)(1-t_e)}{9(-4+b)^2} \tag{15}$$

$$\Pi_{2i} = \frac{4(-2+b)^2(1-t_a)(1-t_e)}{9(-4+b)^2} \tag{16}$$

$$U_{1i} = \frac{2(2-b)b(1+k-t_a)(1-t_e)}{3(-4+b)^2(1+k)} \tag{17}$$

$$U_{2i} = \frac{2(2-b)b(1+k-t_a)(1-t_e)}{3(-4+b)^2(1+k)} \tag{18}$$

$$p_i = \frac{4+b}{12-3b} \tag{19}$$

b. 2nd Case, Both Firms Practice Undeclared Labour

As above, let us start with the final stage, Cournot competition. The profit functions of both firms have as follows[25]:

$$\Pi_{1u} = (p_u \cdot q_{1u}) - w_{1u} \cdot q_{1u} - t_e \cdot (p_u \cdot q_{1u}) - t_a \cdot \left(p_u \cdot q_{1u} - t_e \cdot (p_u \cdot q_{1u})\right) \tag{20}$$

$$\Pi_{2u} = (p_u \cdot q_{2u}) - w_{2u} \cdot q_{2u} - t_e \cdot (p_u \cdot q_{2u}) - t_a \cdot \left(p_u \cdot q_{2u} - t_e \cdot (p_u \cdot q_{2u})\right) \tag{21}$$

Taking first order conditions as to quantities and solving both equations simultaneously, we result to:

$$q_{1u} = \frac{1 + t_a(-1+t_e) - t_e - 2w_{1u} + w_{2u}}{3(1-t_a)(1-t_e)} \tag{22}$$

$$q_{2u} = \frac{1 + t_a(-1+t_e) - t_e + w_{1u} - 2w_{2u}}{3(1-t_a)(1-t_e)} \tag{23}$$

[25] Index ***u*** is used to denote the case that both firms practice **u**ndeclared labour.

Let us now proceed to the 2nd stage, decentralized wage bargaining. Unions' utility functions have as follows:

$$U_{1u} = (w_{1u} \cdot q_{1u}) \quad (24)$$

$$U_{2u} = (w_{2u} \cdot q_{2u}) \quad (25)$$

The agreed wages will occur by the maximization as to w_{1u} and w_{2u} of the following expressions:

$$\text{Max}\left\{(U_{1u})^{b} \cdot (\Pi_{1u})^{(1-b)}\right\} \quad (26)$$

$$\text{Max}\left\{(U_{2u})^{b} \cdot (\Pi_{2u})^{(1-b)}\right\} \quad (27)$$

Maximizing as above, we conclude to the following results:

$$w_{1u} = \frac{b(1 - t_a - t_e + t_a t_e)}{4 - b} \quad (28)$$

$$w_{2u} = \frac{b(1 - t_a - t_e + t_a t_e)}{4 - b} \quad (29)$$

$$q_{1u} = \frac{2(2 - b)}{3(4 - b)} \quad (30)$$

$$q_{2u} = \frac{2(2 - b)}{3(4 - b)} \quad (31)$$

$$\Pi_{1u} = \frac{4(-2 + b)^2(1 - t_a)(1 - t_e)}{9(-4 + b)^2} \quad (32)$$

$$\Pi_{2u} = \frac{4(-2 + b)^2(1 - t_a)(1 - t_e)}{9(-4 + b)^2} \quad (33)$$

$$U_{1u} = \frac{2(2 - b)b(1 - t_a)(1 - t_e)}{3(-4 + b)^2} \quad (34)$$

$$U_{2u} = \frac{2(2 - b)b(1 - t_a)(1 - t_e)}{3(-4 + b)^2} \quad (35)$$

$$p_u = \frac{4 + b}{12 - 3b} \quad (36)$$

c. 3rd Case, f_1 Declares, f_2 Doesn't Declare Its Employees

Once more, we begin solving from the final stage, Cournot competition. The profit functions of both firms have as follows[26]:

$$\Pi_1 = (p \cdot q_1 - (1+k) \cdot w_1 \cdot q_1) - t_e \cdot (p \cdot q_1) - t_a \cdot (p \cdot q_1 - (1+k) \cdot w_1 \cdot q_1) \quad (37)$$

$$\Pi_2 = (p \cdot q_2) - w_2 \cdot q_2 - (t_e + t_a) \cdot (p \cdot q_2) \quad (38)$$

Taking first order conditions as to quantities and solving both equations simultaneously, we result to:

$$q_1 = \frac{-1 + t_a + t_e + 2(1+k)w_1 - 2(1+k)t_a w_1 - w_2}{3(-1 + t_a + t_e)} \quad (39)$$

$$q_2 = \frac{-1 + t_e - w_1 - kw_1 + t_a(1 + w_1 + kw_1) + 2w_2}{3(-1 + t_a + t_e)} \quad (40)$$

Let us now proceed to the 2nd stage, decentralized wage bargaining. Unions' utility functions have as follows:

$$U_1 = \big((1+k) \cdot w_1 \cdot q_1\big) - t_a \cdot (w_1 \cdot q_1) \quad (41)$$

$$U_2 = (w_2 \cdot q_2) \quad (42)$$

The agreed wages will occur by the maximization as to w_1 and w_2 of the following expressions:

$$\text{Max}\left\{(U_1)^b \cdot (\Pi_1)^{(1-b)}\right\} \quad (43)$$

$$\text{Max}\left\{(U_2)^b \cdot (\Pi_2)^{(1-b)}\right\} \quad (44)$$

Maximizing as above, we conclude to the following results:

$$w_1 = \frac{b(1 - t_a - t_e)}{(4-b)(1+k)(1-t_a)} \quad (45)$$

$$w_2 = \frac{b(1 - t_a - t_e)}{4-b} \quad (46)$$

$$q_1 = \frac{2(2-b)}{3(4-b)} \quad (47)$$

[26] We shall use no index for this case.

$$q_2 = \frac{2(2-b)}{3(4-b)} \tag{48}$$

$$\Pi_1 = \frac{4(-2+b)^2(1-t_a-t_e)}{9(-4+b)^2} \tag{49}$$

$$\Pi_2 = \frac{4(-2+b)^2(1-t_a-t_e)}{9(-4+b)^2} \tag{50}$$

$$U_1 = \frac{2\,(2-\,b)\,b\,(1\,+\,k\,-\,t_a)\,(1-\,t_a-\,t_e)}{3\,(-4\,+\,b)^2\,(1\,+\,k)\,(1-\,t_a)} \tag{51}$$

$$U_2 = \frac{2(-2+b)b(-1+t_a+t_e)}{3(-4+b)^2} \tag{52}$$

$$p = \frac{4+b}{12-3b} \tag{53}$$

2.3.4. Subgame Perfect Equilibrium

In this section, we check whether any (and which) of the candidate equilibria is a Nash equilibrium or there exists any motivation for any of the agents to deviate unilaterally from the proposed equilibrium.

Both firms and labour unions may have incentives to deviate from the proposed equilibrium. On one hand, firms make their choices opting to maximize their profits. Unions on the other hand may connive with firms at undeclared labor, and therefore effectively sustain undeclared labor, if their overall utility (taking into account wages, employment, social insurance and taxation) increases under such an arrangement. In any opposite case, unions will denounce firms to public authorities, forcing firms to comply with the regulations about social security.

All possible unilateral deviations are illustrated in the matrix below:

	Proposed SPE			**Possible Unilateral Deviation**		
Index	f_1	f_2		Index	f_1	f_2
(a)	Insures	Insures	⇨	(i)	Insures	NOT Insures
(b)	NOT Insures	NOT Insures	⇨	(ii)	Insures	NOT Insures
(c)	Insures	NOT Insures	⇨	(iii)	NOT Insures	NOT Insures
(c)	Insures	NOT Insures	⇨	(iv)	Insures	Insures

The rest cases of unilateral deviations (i.e. the reverse of the reported above) are skipped from the analysis, as being symmetrical to the above. Note that, since undeclared labor is a phenomenon generally blinded due to the consequences that may incur, we assume that any agent (firm or union) may deviate, given that the rival unit is not able to find it out. Therefore, the rival unit will act as if the deviant unit was maintaining its assumed decision.

Let us next examine each of the above cases separately.

(a) Deviation from {f_1: Insure, f_2: Insure} to { f_1: Insure, f_2: Not Insure}

First we examine if there is any motivation for any firm to unilaterally deviate from the state (the proposed equilibrium) where both firms declare their employees. Suppose that f_2 deviates. Then, its profit function becomes:

$$\Pi_{2id} = (p_{id} \cdot q_{2id}) - w_{2id} \cdot q_{2id} - t_e \cdot (p_{id} \cdot q_{2id}) - t_a \cdot (p_{id} \cdot q_{2id} - t_e \cdot (p_{id} \cdot q_{2id})) \quad (54)$$

Taking first order conditions for Π_{2id} as to q_{2id} and setting $q_{1id} = \frac{2(-2+b)}{3(-4+b)}$ [27], the output of f_2 is

$$q_{2id} = \frac{(-8+b)(-1+t_a+t_e) + 3(-4+b)w_{2id}}{3(-4+b)(-3+2t_a+2t_e)} \quad (55)$$

The utility of f_2 firm's union is given by the following expression:

$$U_{2id} = (w_{2id} \cdot q_{2id}) \quad (56)$$

Taking first order conditions for the expression $\left\{U_{2id}^{b} \cdot pr_{2id}^{(1-b)}\right\}$ as to w_{2id} we obtain the following results:

$$w_{2id} = \frac{(8-b)b(1-t_a-t_e)}{6(4-b)} \quad (57)$$

$$q_{2id} = \frac{(8-b)(2-b)(1-t_a-t_e)}{6(4-b)(3-2t_a-2t_e)} \quad (58)$$

[27] Even though f_2 may deviate, f_1 shall not be able to observe the deviation, so f_1 and its labor union will act and play like f_2 would insure its employees. That means we will have the same quantity and wage set up as for f_1 concerns, like there was no deviation.

$$\Pi_{2id} = \frac{(-8+b)^2(-2+b)^2(2-t_a-t_e)(-1+t_a+t_e)^2}{36(-4+b)^2(-3+2t_a+2t_e)^2} \quad (59)$$

To examine if f_2 has any motive to deviate, we abstract f_2's profit before and after deviation and we obtain the following results:

$$\Pi_{2id} - \Pi_{2i} = -\frac{1}{36(-4+b)^2(-3+2t_a+2t_e)^2}(-2+b)^2 \cdot (-16(-1+t_a+t_e) - 16b(-2+t_a+t_e)(-1+t_a+t_e)^2 + b^2(-2+t_a+t_e)(-1+t_a+t_e)^2 + 16t_at_e(-3+2t_a+2t_e)^2)$$

The expression $-\frac{1}{36(-4+b)^2(-3+2ta+2te)^2}(-2+b)^2$ is negative, thus we continue with the rest of the expression $R = (-16(-1+ta+t_e) - 16b(-2+ta+te)(-1+ta+te)^2 + b^2(-2+ta+te)(-1+ta+te)^2 + 16tate(-3+2ta+2te)^2)$.

R is trinomial expression of b, and its roots are:

$$b_1 = \frac{4(2(-2+ta+t_e)(-1+ta+t_e)^2 - \sqrt{-(-1+ta)(-1+t_e)(-2+ta+t_e)(-1+ta+t_e)^2(-3+2ta+2t_e)^2})}{(-2+ta+t_e)(-1+ta+t_e)^2}$$

$$b_2 = \frac{4(2(-2+ta+t_e)(-1+ta+t_e)^2 + \sqrt{-(-1+ta)(-1+t_e)(-2+ta+t_e)(-1+ta+t_e)^2(-3+2ta+2t_e)^2})}{(-2+ta+t_e)(-1+ta+t_e)^2}$$

Since $\boldsymbol{b_1}$ is always greater than 1[28], we reject it, and we accept $\boldsymbol{b_2}$ as root. Therefore,

- If $b < b_2 = b_{cr1}$, then $R < 0$ and then $\Pi_{2id} > \Pi_{2i}$, meaning that, under the condition $b < b_2 = b_{cr1}$, f_2 is motivated to deviate from the proposed equilibrium. In this case, the equilibrium that both firms declare their labour is not time-consistent.

- If $b > b_2 = b_{cr1}$, then $R > 0$ and then $\Pi_{2id} < \Pi_{2i}$, meaning that, under the condition $b < b_2 = b_{cr1}$, there is no motivation for f_2 to deviate from the equilibrium and thus its choice reveals as time-consistent.

Let us now check if there is any motivation for f_2 firm's union to deviate. Union's utilities before and after the deviation have as follows.

[28] Under 0 < ta, te <1 and 0 < b < 1.

$$U_{2i} = \frac{2(2-b)b(1+k-t_a)(1-t_e)}{3(-4+b)^2(1+k)} \quad (60)$$

$$U_{2id} = \frac{(-8+b)^2(2-b)b(-1+t_a+t_e)^2}{36(-4+b)^2(3-2t_a-2t_e)} \quad (61)$$

Abstracting the expressions above, we have:

$$U_{2id} - U_{2i} = \frac{((-2+b)b(-16b(1+k)(-1+t_a+t_e)^2 + b^2(1+k)(-1+t_a+t_e)^2 - 8(1+k+t_a+t_e) + 8(2t_a(t_a+k(-5+4t_a)) + (t_a(-5+6t_a)+k(-1+10t_a))t_e + 2(1+k+3t_a){t_e}^2)))}{(36(-4+b)^2(1+k)(-3+2t_a+2t_e))}$$

The root of the expression above $(U_{2id} - U_{2i} = 0)$ is

$$k_{cr1} = \frac{16b(-1+t_a+t_e)^2 - b^2(-1+t_a+t_e)^2 + 8(1+t_a+t_e) - 8(2{t_e}^2 + t_a t_e(-5+6t_e) + {t_a}^2(2+6t_e))}{-16b(-1+t_a+t_e)^2 + b^2(-1+t_a+t_e)^2 + 16(t_a+t_e)(4t_a+t_e) - 8(1+10t_a+t_e)}$$

Summarizing the above,

- If $0 < k < k_{cr1}$ then $U_{2id} > U_{2i}$; therefore, the union is motivated to deviate from the proposed equilibrium and amplify the undeclared labour phenomenon.
- If $k_{cr1} < k < 1$ then $U_{2id} < U_{2i}$; thus, under this condition, union's choice will be time-consistent.

Proposition 1 summarizes all the above conclusions;

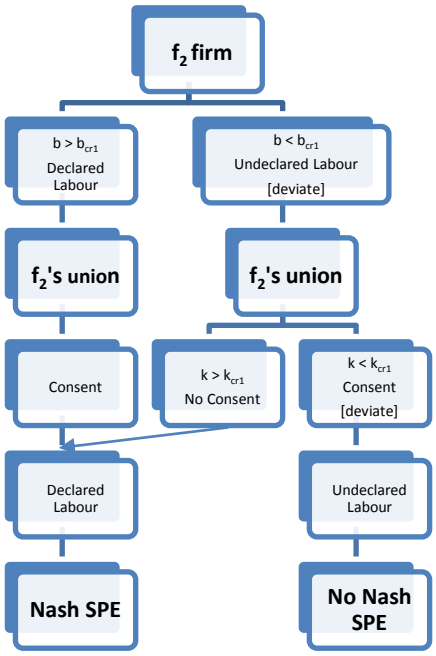
Proposition 1:

Assuming $b > b_2 = b_{cr1}$ [29], f_2 will practice anyhow declared labour and thus its union will be committed to f_2 's choice. However, if $b < b_2 = b_{cr1}$, then f_2 will acquire an incentive to decline from the proposed equilibrium and practice undeclared labour. In this case, if k is low enough ($k < k_{cr1}$), f_2 's union will consent (silently) to undeclared labour, and, therefore, undeclared labour will be practiced. On the other hand, assuming $k > k_{cr1}$, f_2 's union will enjoy greater utility under

[29] $b_2 = \frac{4(2(-2+t_a+t_e)(-1+t_a+t_e)^2+\sqrt{-(-1+t_a)(-1+t_e)(-2+t_a+t_e)(-1+t_a+t_e)^2(-3+2t_a+2t_e)^2)}}{(-2+t_a+t_e)(-1+t_a+t_e)^2}$

declared labour and, thus, it will denounce any firm's illegal practice, constraining, by this way, f_2 to practice declared labour.

Interpreting the above proposition, the conclusions may be illustrated in the diagram below:



(b) Deviation from { f_1: Not Insure, f_2: Not Insure} to { f_1: Insure, f_2: Not Insure}

Let us now examine if there is any motivation for a firm to deviate from the state that both firms use undeclared labor for all employees and declare them. Suppose that $\boldsymbol{f_1}$ deviates from the proposed SPE, its profit function forms as follows:

$$\Pi_{1ud} = (p_{ud} \cdot q_{1ud} - (1+k) \cdot w_{1ud} \cdot q_{1ud}) - t_e \cdot (p_{ud} \cdot q_{1ud}) - t_a \cdot (p_{ud} \cdot q_{1ud} - (1+k) \cdot w_{1ud} \cdot q_{1ud} - t_e \cdot (p_{ud} \cdot q_{1ud})) \quad (62)$$

Taking first order conditions for Π_{1ud} as to q_{1ud} and setting $q_{2ud} = \frac{2(-2+b)}{3(-4+b)}$ [30], the output of f_1 is

$$q_{1ud} = \frac{(t_a - 1)((b-8)(t_e - 1) + 3(b-4)(1+k)w_{1ud})}{3(b-4)(3 + 2t_a(t_e - 1) - 2t_e)} \quad (63)$$

[30] Even though f_2 deviates, f_1 cannot observe the deviation, so f_1 and its labor union will act as f_2 would insure its employees. That means we will have the same quantity and wage set up as for f_1 concerns, like there was no deviation.

The utility of f_1 firm's union is given by the following expression:

$$U_{1ud} = ((1+k)\cdot w_{1ud}\cdot q_{1ud}) - t_a\cdot(w_{1ud}\cdot q_{1ud}) \quad (64)$$

Taking first order conditions for the expression $\left\{U_{1ud}^{b}\cdot pr_{1ud}^{(1-b)}\right\}$ as to w_{1ud} we conclude to the following results:

$$w_{1ud} = -\frac{(b-8)(t_e-1)b}{6(b-4)(1+k)} \quad (64)$$

$$\Pi_{1ud} = \frac{(-8+b)^2(-2+b)^2(-1+t_a)^2(2+t_a(-1+t_e)-t_e)(-1+t_e)^2}{36(-4+b)^2(3+2t_a(-1+t_e)-2t_e)^2} \quad (65)$$

$$U_{1ud} = \frac{(-8+b)^2(-2+b)b(1+k-t_a)(-1+t_a)(-1+t_e)^2}{36(-4+b)^2(1+k)(3+2t_a(-1+t_e)-2t_e)} \quad (66)$$

To examine if f_1 has any motive to deviate, we abstract f_1's profit before and after deviation and we obtain the following results:

$$\Pi_{1u} - \Pi_{1ud} = -\frac{((-2+b)^2(-1+t_a)(-16+(-16+b)b(-1+t_a)(2+t_a(-1+t_e)-t_e)(-1+t_e))(-1+t_e))}{(36(-4+b)^2(3+2t_a(-1+t_e)-2t_e)^2)}$$

The expression above is always positive, resulting to $\Pi_{1u} > \Pi_{1ud}$. Interpreting the above, if both firms do not declare their staff, then none of them will be motivated to deviate (and thus to declare its employees).

Examining f_1 union's behavior, the utility functions, before and after the deviation, have as follows:

$$U_{1u} = -\frac{2(-2+b)b(-1+t_a)(-1+t_e)}{3(-4+b)^2} \quad (67)$$

$$U_{1ud} = \frac{(-8+b)^2(-2+b)b(1+k-t_a)(-1+t_a)(-1+t_e)^2}{36(-4+b)^2(1+k)(3+2t_a(-1+t_e)-2t_e)} \quad (68)$$

Abstracting the expressions above, we have:

$$U_{1u} - U_{1ud} = -\frac{((-2+b)b(-1+t_a)(-1+t_e)(-16b(1+k-t_a)(-1+t_e)+b^2(1+k-t_a)(-1+t_e)+8(1+k+2t_a-6kt_a+2(1+k-t_a+3kt_a)t_e)))}{(36(-4+b)^2(1+k)(3+2t_a(-1+t_e)-2t_e))}$$

The expression above turns positive for $0 < k < k_{cr2}$, where

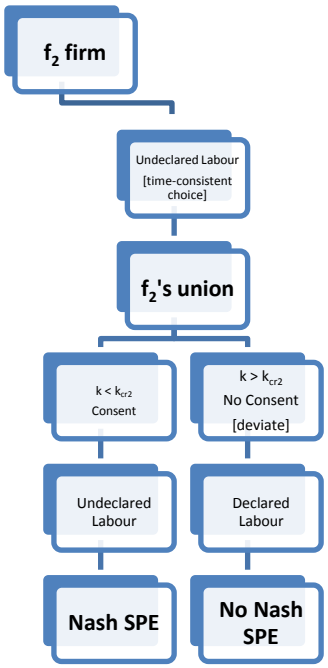
$$k_{cr2} = \frac{8(-1 + 2t_a(-1 + t_e) - 2t_e) - 16b(-1 + t_a)(-1 + t_e) + b^2(-1 + t_a)(-1 + t_e)}{-16b(-1 + t_e) + b^2(-1 + t_e) + 8(1 + 6t_a(-1 + t_e) + 2t_e)}$$

It can be shown that if k is low enough, $k < k_{cr2} \rightarrow U_{1u} > U_{1ud}$ and therefore union will prefer undeclared labor for its members. On the other hand, if *k* is high enough ($k > k_{cr2}$) union will then be motivated to denounce undeclared labor and deviate from the equilibrium. Proposition 2 summarizes:

Proposition 2:

If k is low enough ($0 < k < k_{cr2}$), then the proposed SPE, where both firms practice undeclared labour, will consist a Nash equilibrium. If, on the other hand, k is great enough ($k_{cr2} < k < 1$), this proposed equilibrium is time-inconsistent.

Interpreting the proposition above, the conclusions may be illustrated in the diagram below:



(c) Deviation from { f_1: Insure, f_2: Not Insure} to { f_1: Not Insure, f_2: Not Insure}

At this stage, we shall check the possibility of deviation from the proposed equilibrium (one firm practices declared labour while the other doesn't) to an alternative state, where both firms apply undeclared labor. Suppose $\boldsymbol{f_1}$ deviates from the proposed SPE, its profit function form as follows:

$$\Pi_{1d1} = (p \cdot q_{1d1}) - w_{1d1} \cdot q_{1d1} - (t_e + t_a) \cdot (p \cdot q_{1d1}) \tag{69}$$

Taking first order conditions for pr_{1d1} as to q_{1d1} and setting $q_{2d1} = \frac{2(-2+b)}{3(-4+b)}$ [31], the output of f_1 is

$$q_{1d1} = \frac{(8-b)(1-t_a-t_e) - 3(4-b)w_{1d1}}{3(4-b)(3-2t_a-2t_e)} \tag{70}$$

The utility of f_1 firm's union is given by the following expression:

$$\mathrm{U}_{1d1} = (w_{1d1} \cdot q_{1d1}) \tag{71}$$

Taking first order conditions for the expression $\left\{\mathrm{U}_{1d1}^{b} \cdot \mathrm{pr}_{1d1}^{(1-b)}\right\}$ as to w_{1d1} we have the following results:

$$\mathrm{w}_{1d1} = \frac{-8b + b^2 + 8bt_a - b^2t_a + 8bt_e - b^2t_e}{6(-4+b)} \tag{72}$$

$$\mathrm{U}_{1d1} = \frac{(-8+b)^2(-2+b)b(-1+t_a+t_e)^2}{36(-4+b)^2(-3+2t_a+2t_e)} \tag{73}$$

$$\Pi_{1d1} = \frac{(-8+b)^2(-2+b)^2(2-t_a-t_e)(-1+t_a+t_e)^2}{36(-4+b)^2(-3+2t_a+2t_e)^2} \tag{74}$$

To examine if f_1 has any motive to deviate, we abstract f_1's profit before and after deviation and we obtain the following results:

$$\Pi_{1d1} - \Pi_1 = \frac{(-2+b)^2(-1+t_a+t_e)(16 - \frac{(-8+b)^2(-2+t_a+t_e)(-1+t_a+t_e)}{(-3+2t_a+2t_e)^2})}{36(-4+b)^2}$$

The expression above

[31] Even though f_2 deviates, f_1 cannot observe the deviation, so f_1 and its labor union will act as f_2 would insure its employees. That means we will have the same quantity and wage set up as for f_1 concerns, like there was no deviation.

- If $-1 + t_a + t_e > 0 \Rightarrow t_a > 1 - t_e \Rightarrow \Pi_{1d1} - \Pi_1 > 0$, and thus $\Pi_{1d1} > \Pi_1$
- If $-1 + t_a + t_e < 0 \Rightarrow t_a < 1 - t_e \Rightarrow \Pi_{1d1} - \Pi_1 < 0$, and thus $\Pi_{1d1} < \Pi_1$

Therefore, if $t_a > 1 - t_e$, then f_1 has incentives to deviate from the proposed equilibrium (f_1 insures, f_2 not) and practice undeclared labour.

Examining f_1 union's behavior, the utility functions, before and after the deviation, have as follows:

$$U_1 = \frac{2\,(2 - b)\,b\,(1 + k - t_a)\,(1 - t_a - t_e)}{3\,(-4 + b)^2\,(1 + k)\,(1 - t_a)} \tag{75}$$

$$U_{1d1} = \frac{(-8 + b)^2(-2 + b)b(-1 + t_a + t_e)^2}{36(-4 + b)^2(-3 + 2t_a + 2t_e)} \tag{76}$$

Abstracting the expressions above, we get:

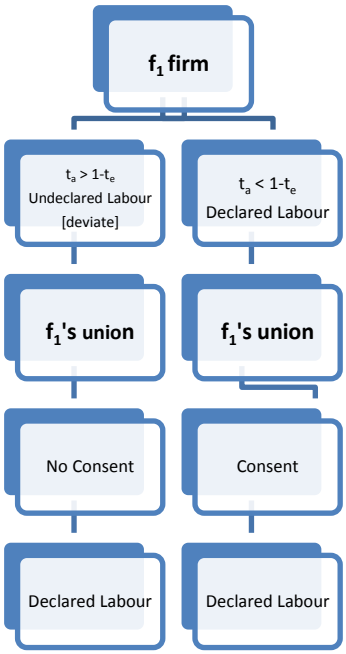
$$U_{1d1} - U_1 = \frac{\begin{matrix}(-2+b)b(-1+t_a+t_e) \\ \left(\begin{matrix}-16b(1+k)(-1+t_a)(-1+t_a+t_e)+b^2(1+k)(-1+t_a)(-1+t_a+t_e)+ \\ 8\left((-1+t_a)(1+2t_a+2t_e)+k(-1-2t_e+2t_a(-5+4t_a+4t_e))\right)\end{matrix}\right)\end{matrix}}{36(-4+b)^2(1+k)(-1+t_a)(-3+2t_a+2t_e)}$$

The expression above is always negative, implying that $U_{1d1} < U_1$, thus f_1's union will prefer declared labor and therefore it will not conclude with f_1 firm's decision for undeclared labor. Eventually, union will denounce possible undeclared labor policy to public authorities and reinstate f_1 to its initial state. Proposition 3 summarizes:

Remark 1:

Within the proposed SPE (f_1 insures its workers, f_2 does not), if $t_a < 1 - t_e$, then f_1's choice will be considered as time-consistent and, thus, declared labour will be applied. If, on the other hand, $t_a > 1 - t_e$, then f_1 will acquire an incentive to deviate and practice undeclared labour. Nevertheless, its union will not consent to undeclared labour, forcing f_1 to alter its choice.

Interpreting the above proposition, the conclusions may be illustrated in the diagram below:



(d) Deviation from {Insure, Not Insure} to {Insure, Insure}

The proposed SPE that one firm insures its personnel and the other doesn't has another possible deviation. Suppose f_2 deviates from the proposed SPE and decides to insure its personnel, the setup forms as follows:

$$\Pi_{1d2} = p_{d2}q_{1d2} - (1+k)w_{1d2}q_{1d2} - t_e p_{d2}q_{1d2} - t_a(p_{d2}q_{1d2} - (1+k)w_{1d2}q_{1d2} - t_e p_{d2}q_{1d2}) \quad (77)$$

$$\Pi_{2d2} = p_{d2}q_{2d2} - (1+k)w_{2d2}q_{2d2} - t_e p_{d2}q_{2d2} - t_a(p_{d2}q_{2d2} - (1+k)w_{2d2}q_{2d2} - t_e p_{d2}q_{2d2}) \quad (78)$$

$$p_{d2} = 1 - q_{1d2} - q_{2d2} \quad (79)$$

Taking first order conditions for Π_{2d2} as to q_{2d2} and setting $q_{1d2} = \frac{2(2-b)}{3(4-b)}$, the output of f_1 is

$$q_{2d2} = \frac{(-1+t_a)((-8+b)(-1+t_e) + 3(-4+b)(1+k)w_{2d2})}{3(-4+b)(3+2t_a(-1+t_e) - 2t_e)} \quad (80)$$

The utility of f_2 firm's union is given by the following expression:

$$U_{2d2} = ((1+k)\cdot w_{2d2}\cdot q_{2d2}) - t_a\cdot(w_{2d2}\cdot q_{2d2}) \quad (81)$$

Taking first order conditions for the expression $\left\{\mathrm{U}_{2\mathrm{d}2}^{b} \cdot \mathrm{pr}_{2\mathrm{d}2}^{(1-b)}\right\}$ as to $\mathrm{w}_{2\mathrm{d}2}$ we have the following results:

$$\mathrm{w}_{2\mathrm{d}2} = -\frac{(-8+b)b(-1+\mathrm{t_e})}{6(-4+b)(1+k)} \tag{82}$$

$$\mathrm{U}_{2d2} = \frac{(-8+b)^2(-2+b)b(1+k-\mathrm{t_a})(-1+\mathrm{t_a})(-1+\mathrm{t_e})^2}{36(-4+b)^2(1+k)(3+2\mathrm{t_a}(-1+\mathrm{t_e})-2\mathrm{t_e})} \tag{83}$$

$$\Pi_{2d2} = \frac{(-8+b)^2(-2+b)^2(-1+\mathrm{t_a})^2(2+\mathrm{t_a}(-1+\mathrm{t_e})-\mathrm{t_e})(-1+\mathrm{t_e})^2}{36(-4+b)^2(3+2\mathrm{t_a}(-1+\mathrm{t_e})-2\mathrm{t_e})^2} \tag{84}$$

To examine if f_2 has any motive to deviate, we abstract f_2's profit before and after deviation and we obtain the following results:

$$\Pi_{2\mathrm{d}2} - \Pi_2 = \frac{\begin{array}{c}((-2+b)^2(16(-1+\mathrm{t_a}+\mathrm{t_e})+\\(-1+\mathrm{t_a})(2+\mathrm{t_a}(-1+\mathrm{t_e})-\mathrm{t_e})(-1+\mathrm{t_e})(-16b(-1+\mathrm{t_a})(-1+\mathrm{t_e})\\+b^2(-1+\mathrm{t_a})(-1+\mathrm{t_e})+64\mathrm{t_a}\mathrm{t_e})))\end{array}}{(36(-4+b)^2(3+2\mathrm{t_a}(-1+\mathrm{t_e})-2\mathrm{t_e})^2)}$$

The expression above has 3 roots,

- $\mathrm{b}_1 = 2$, rejected as $0 < \mathrm{b} < 1$
- $\mathrm{b}_2 = \frac{\begin{array}{c}(8{\mathrm{t_a}}^3(-1+\mathrm{t_e})^3+8\mathrm{t_a}(-1+\mathrm{t_e})^2(-5+3\mathrm{t_e})\\-8{\mathrm{t_a}}^2(-1+\mathrm{t_e})^2(-4+3\mathrm{t_e})-4(2(-2+\mathrm{te})(-1+\mathrm{t_e})^2+\\\sqrt{-(-1+\mathrm{t_a})^2(3+2\mathrm{t_a}(-1+\mathrm{t_e})-2\mathrm{t_e})^2(2+\mathrm{t_a}(-1+\mathrm{t_e})-\mathrm{t_e})(-1+\mathrm{t_e})^2(-1+\mathrm{t_a}+\mathrm{t_e})}))\end{array}}{((-1+\mathrm{t_a})^2(2+\mathrm{t_a}(-1+\mathrm{t_e})-\mathrm{t_e})(-1+\mathrm{t_e})^2)}$
- $b_3 = \frac{\begin{array}{c}(-8(-2+\mathrm{t_a})(-1+\mathrm{t_a})^2+8(-1+\mathrm{t_a})^2(-5+3\mathrm{t_a})\mathrm{t_e}-\\8(-1+\mathrm{t_a})^2(-4+3\mathrm{t_a}){\mathrm{t_e}}^2+8(-1+\mathrm{t_a})^3{\mathrm{t_e}}^3+\\4\sqrt{-(-1+\mathrm{t_a})^2(3+2\mathrm{t_a}(-1+\mathrm{t_e})-2\mathrm{t_e})^2(2+\mathrm{t_a}(-1+\mathrm{t_e})-\mathrm{t_e})(-1+\mathrm{t_e})^2(-1+\mathrm{t_a}+\mathrm{t_e})})\end{array}}{((-1+\mathrm{t_a})^2(2+\mathrm{t_a}(-1+\mathrm{t_e})-\mathrm{t_e})(-1+\mathrm{t_e})^2)}$

  rejected as $\mathrm{b}_3 > 12$ (while $0 < \mathrm{b} < 1$).

We observe that:

- If $\mathrm{b} < \mathrm{b}_2 = \mathrm{b}_{cr2}$, then $\Pi_{2\mathrm{d}2} - \Pi_2 > 0$, or equivalently $\Pi_{2\mathrm{d}2} > \Pi_2$, and therefore there is motivation for f_2 firm to deviate from the proposed equilibrium and declare its employees.

- If $b_2 = b_{cr2} < b$, then $\Pi_{2d2} - \Pi_2 < 0$, or equivalently $\Pi_{2d2} < \Pi_2$, and, thus, there is no motivation for f_2 firm to deviate from the proposed equilibrium and will continue to practice undeclared labour.

Let us now check f_2 union's behavior. Union's utility before and after deviation has as follows:

$$U_2 = \frac{2(-2+b)b(-1+t_a+t_e)}{3(-4+b)^2} \quad (85)$$

$$U_{2d2} = \frac{(-8+b)^2(-2+b)b(1+k-t_a)(-1+t_a)(-1+t_e)^2}{36(-4+b)^2(1+k)(3+2t_a(-1+t_e)-2t_e)} \quad (86)$$

Abstracting expression [86] from [85], we obtain:

$$U_{2d2} - U_2 = \frac{\begin{array}{c}(-2+b)b(-16b(1+k-t_a)(-1+t_a)(-1+t_e)^2+ \\ b^2(1+k-t_a)(-1+t_a)(-1+t_e)^2+8\big((-1+t_a)(-1-2t_a+k(-1+6t_a))+ \\ (1+k+2(-7+k)t_a+2(5-3k){t_a}^2)te+2(1+k-4t_a)(-1+t_a){t_e}^2)\end{array}}{36(-4+b)^2(1+k)(3+2t_a(-1+t_e)-2t_e)}$$

The expression above has one root at:

$$k_{cr3} = \frac{(t_a-1)((-16+b)b(t_a+t_e-1)+8(1+2t_a+2t_e))}{(t_a-1)(-8+(b-16)b+48t_a)+(16+(b-16)b+48t_a)t_e}$$

It therefore can be shown that

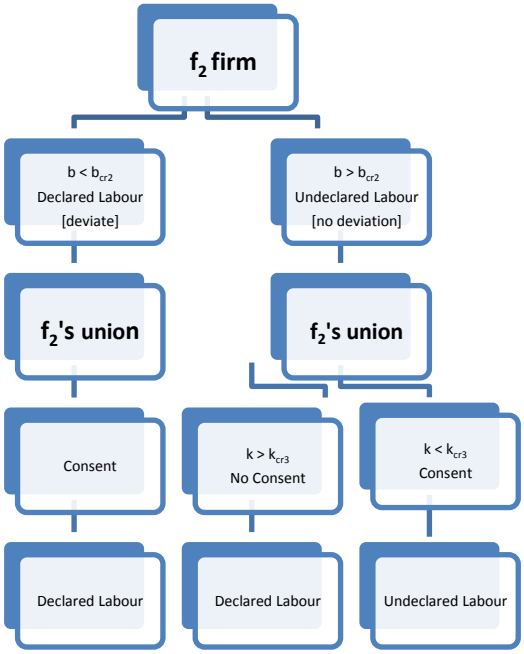
- if $k > k_{cr3} \rightarrow U_{2d2} - U_2 > 0 \rightarrow U_{2d2} > U_2$, else
- if $k < k_{cr3} \rightarrow U_{2d2} - U_2 < 0 \rightarrow U_{2d2} < U_2$

Interpreting the above, if k is great enough ($k > k_{cr3}$), then f_2's union will enjoy greater utility in the case that f_2 deviates, e.g. applies declared labour. If, on the other hand, k is low enough ($k < k_{cr3}$), then it will enjoy greater utility on the case that f_2 applies undeclared labour and remains time-consistent with its choice. Remark 2 summarizes:

Remark 2:

Within the proposed SPE (f_1 insures its workers, f_2 does not), if $b > b_{cr2}$[32], then f_2's choice will be considered as time-consistent and thus f_2 will practice undeclared labour. If k is low enough too ($k < k_{cr3}$[33]), then its union will consent to undeclared labour. On the other hand, if k is high enough (greater than k_{cr3}), then its union will not consent to undeclared labour and, thus, it will denounce any illegal practices, forcing f_2 to alter its choice. Finally, if b is low enough ($b < b_{cr3}$) f_2 has an incentive to deviate and declare its labour, and thus its union will be obliged to act along.

The conclusions of the Remark above may be illustrated in the diagram below:



Combining Remark 1 and Remark 2, we conclude to Proposition 3.

[32] $$b_2 = \frac{(8t_a^3(-1+t_e)^3+8t_a(-1+t_e)^2(-5+3t_e) -8t_a^2(-1+t_e)^2(-4+3t_e)-4(2(-2+te)(-1+t_e)^2+ \sqrt{-(-1+t_a)^2(3+2t_a(-1+t_e)-2t_e)^2(2+t_a(-1+t_e)-t_e)(-1+t_e)^2(-1+t_a+t_e)}))}{((-1+t_a)^2(2+t_a(-1+t_e)-t_e)(-1+t_e)^2)}$$

[33] $$k_{cr} = \frac{(t_a-1)((-16+b)b(t_a+t_e-1)+8(1+2t_a+2t_e))}{(t_a-1)(-8+(b-16)b+48t_a)+(16+(b-16)b+48t_a)t_e}$$

Proposition 3:

If $t_a < 1 - t_e$, $b > b_{cr2}$[34] and k < k_{cr3}[35], then the proposed equilibrium (f_1 insures its workers, while f_2 does not) will remain time-consistent and therefore will constitute a Nash SPE.

2.3.5. Conclusions

The analysis above represents an alternative approach of the undeclared labour phenomenon with analytical tools from Industrial Organization and Game Theory framework. In a unionized duopoly, we focused on the opportunity cost that arises by the implementation of undeclared labour; if a firm properly declares its personnel to the authorities, then the firm will have to pay contributions for social insurance, while less taxes will be defrayed. Exactly the opposite occurs in the other case, highlighting the alternative cost, thereby. labour unions face the same dilemma as well; if unions – silently – consent to undeclared labour, their members will enjoy greater payments (no contributions for social insurance will be withheld) and pay fewer taxes.

In this early analysis, we considered the firms' choice for applying undeclared labour or not exogenously. Therefore, a matrix game occurred, where we examined - under pure strategies – whether any of the proposed equilibria consists a Nash Subgame Perfect Equilibrium. Regarding the formation of agents' policies, we assumed that in order for undeclared labour to be applied, the collusion between firm and its union is a prerequisite, while declared labour may occur unilaterally (either from firm's or from union's choice). Furthermore, we endogenized any possible deviations in a more realistic frame, assuming that an agent deviates, given

[34] $b_2 = \frac{(8t_a^3(-1+t_e)^3+8t_a(-1+t_e)^2(-5+3t_e) -8t_a^2(-1+t_e)^2(-4+3t_e)-4(2(-2+te)(-1+t_e)^2+ \sqrt{-(-1+t_a)^2(3+2t_a(-1+t_e)-2t_e)^2(2+t_a(-1+t_e)-t_e)(-1+t_e)^2(-1+t_a+t_e)}))}{((-1+t_a)^2(2+t_a(-1+t_e)-t_e)(-1+t_e)^2)}$

[35] $k_{cr} = \frac{(t_a-1)((-16+b)b(t_a+t_e-1)+8(1+2t_a+2t_e))}{(t_a-1)(-8+(b-16)b+48t_a)+(16+(b-16)b+48t_a)t_e}$

that the rival unit is not able to find it out, and, thus, the rival unit will act as the deviant was maintaining its assumed – initial – decision.

The findings of our analysis suggest that all proposed equilibria (e.g. both firms insure, both firms do not insure, one firm insures while the other doesn't) may comprise a Nash SPE under certain circumstances. We furthermore investigated those critical values for an agent to obtain an incentive to deviate from the proposed equilibrium, and alter his policy (for example, a firm discontinue to declare its labour and practices undeclared labour). Our findings indicate that those critical values depend on the status quo of the market;

- If both firms declare their labour, then the incentive for firm's deviation will arise if b is low enough ($b < b_{cr1}$).
- If both firms practice undeclared labour, then none incentive to declare their labour may exist.
- In the case that one firm declares its personnel while the other doesn't,
    - The incentive to discontinue declaring its labour and practice undeclared labour occurs if t_a is great enough ($t_a > 1- t_e$).
    - On the other hand, the incentive to discontinue practicing undeclared labour and insures its personnel occurs if b is low enough ($b < b_{cr2}$).

Similar conclusions are revealed for labour unions too.

- If both firms practice declared labour, union will consent to a deviation to undeclared labour only if k is great enough ($k > k_{cr1}$).
- If both firms practice undeclared labour, union will consent to undeclared labour only if k is low enough ($k < k_{cr2}$).
- In the case that one firm practices undeclared labour while the other one doesn't, unions will not accept for their members to alter from declared to undeclared labour.

Several inquiries are still left open for further research. For instance, note that we have not examined the equilibrium prospects of the centralized wage-bargaining structure. The same applies for the cost of governmental surveillance or compliance penalties (or any else relevant policy meters) imposed for undeclared labour. Consequences to social welfare are another aspect that should furthermore be examined.

2.5. Epilogue

In this chapter, we approached the undeclared labour phenomenon within I/O framework. Most of the relevant work concerns empirical research on the work, relations and motives of those engaged in undeclared work. Nevertheless, there isn't still any research that makes use of the analytical tools of industrial organization and game theory.

Our purpose is to understand the real nature of undeclared labour and its side effects to the markets. We initially approached this phenomenon rather as a firm-specific factor than a delinquent behavior of employers and employees. We aim not – by no means – to legalize this phenomenon, however such an examination may reveal a way of internal discipline of firms and unions. If undeclared labour loses its economic attractiveness, firms (unions) will surely prefer declared labour, in order to maximize their profits (utility). Another interesting finding of our analysis indicates that under certain circumstances, undeclared labour may yield greater public revenues and social welfare. Although in this case, individuality is sidelined in favor of collegiality.

Furthermore, the present research focused into three main sections.

- First, we developed a simple model to examine whereas opportunity cost between taxation and contributions for social insurance has effect. In a Cournot duopoly, where wages are set exogenously, we concluded that if the selected combination of tax rate (t) and the contributions rate (k) lies below the $t_1^* = \frac{k}{1+k}$ curve, then the incentives for practicing undeclared labour shall be strengthen. It is therefore understood, that if a benevolent social planner chooses such a combination of (t, k) that lies above the $t_1^* = \frac{k}{1+k}$ curve, undeclared labour will be annihilated, without any need of surveillance.

- Second, we enriched our latter model with unionization - introducing decentralized wage bargaining regime, different type of taxation for firms (progressive) than for unions' members (proportional) and endogenous determination of the optimal rate of undeclared labour for each firm. Then,

the findings of our analysis were compared to a benchmarking case of only-declared labour. Our conclusions illustrated that undeclared labour is a rather multidimensional phenomenon without any predetermined result. So, compared to only-declared labour state, undeclared labour - under certain circumstances - may produce greater product and thus employment, greater profits, greater wages, lower prices and consumer surplus. Furthermore, and contrary to common knowledge and allegations, undeclared labour may yield greater unions' utility, greater public revenues (either derived from taxation or contributions) and finally greater social welfare.

- Third, we alternated our analysis tools and formed a matrix game with unilateral deviations. We assumed a unionized (decentralized wage bargaining regime) Cournot duopoly, where two different types of taxation are enforced: a direct tax t_a calculated on firms' profits and unions' members income, and an indirect tax t_e calculated on firms' revenues. Assuming strategic collusion among firms and unions as a perquisite for undeclared labour to arise, we concluded to three different possible final equilibria and examined whereas those could consist Nash Subgame Perfect Equilibria. We proved that, under different circumstances, all three of them consist Nash SPE and we furthermore determined the critical values of the parameters that a deviation should take place.

So far as we know, the examination of undeclared labour within Industrial Organization and Games Theory framework remains rather deficient, while the undeclared labour phenomenon constitutes a significant social deviant behavior with multidimensional side effects. Further research may and should include different types of competition and wage bargaining, alternative taxation and endogenization of state surveillance and penalty enforcement. In our opinion, ulterior purpose remains the formulation of a social planner's policy, that will obligate firms and unions into internal discipline without the need of any state surveillance.

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Chapter 3:

Efficiency of Price Competition Versus Quantity Competition in Unionized Oligopoly

3.1. Abstract

In a union-duopoly decentralized bargaining context we argue that prior to the realization of any employment and production plans firms and unions in each firm/union pair may collectively decide about their bargaining agenda, e.g., whether they will subsequently negotiate about only wages ("Right-to-Manage") or about both wages and employment ("Efficient Bargains"). We show that under price competition in the product market the equilibrium bargaining agendas would always regard only wages. Under quantity competition, however, and provided that the union bargaining power is low enough, one firm/union pair may agree on Efficient Bargains while the other pair agrees on Right-to-Manage. In contrast to conventional wisdom our findings suggest that, if sufficient product differentiation among firms exists, social welfare can be higher under quantity competition than under price competition – the role of unions in that being critical.

3.2. Introduction

The fundamentals of modern oligopoly theory are the models of Cournot-Nash, where firms compete in the product market by independently adjusting their own quantities, and Bertrand-Nash, where the rival firms independently adjust their own prices. These alternative hypotheses deliver highly significant implications to the theory and practice of industrial economics [see Vives (2001)] whilst, as argued by Tremblay and Tremblay (2011), Tremblay et al. (2013), both quantity and price rivalry have been observed in real life.

On the other hand regarding the labour market, the presence of trade unions and collective bargaining agreements are common in most imperfectly competitive industries, especially in Europe [see, e.g., Hartog and Theeuwes (1992)]. There are two ways in which unions negotiate with firms. The first involves bargaining about wages alone, "Right-to-Manage" [see, e.g., Nickell and Andrews (1983)]. The second, involves bargaining about both wages and employment, "Efficient Bargains" [see McDonald and Solow (1981), MacCurdy and Pencavel (1986), Alogoskoufis and Manning (1991), Petrakis and Vlassis (2000)].

Focusing on the welfare implications of the above behavioural and/or institutional structures, the union-oligopoly literature seems to suggest that − compared to quantity competition and right-to-manage bargaining, price competition and efficient bargains respectively entail higher output, employment, and consumer surplus. It has been also shown that, in contrast to the case of right-to-manage bargaining, under efficient bargains output and employment are not decreasing with union power, provided that union members are risk averse/neutral [see e.g., Booth (1996)]. Yet, the literature has not so far investigated whether efficient bargains and/or right-to-manage bargaining can be endogenously sustained under price competition in the product market. Therefore, a safe conclusion regarding the welfare properties of the alternative possible product −and− labour market equilibria is still to come: In a non-unionized duopoly context, price competition among firms producing substitute goods has long ago shown to be in equilibrium more efficient than quantity competition − in terms of output and consumer surplus [see, e.g., Singh and Vives (1984)]. This result does not however hold true as the industry expands to a higher number of firms [see, e.g., Hackner (2000)]. In the presence of unions and collective bargaining, nonetheless, Petrakis and Vlassis (2000) have shown that compared to right-to-manage bargaining efficient bargains may in equilibrium render higher efficiency to an n-symmetric oligopoly where firms compete in quantities. Still, it remains an open question whether efficient bargains can be sustained in equilibrium under oligopolistic price competition. If not, as we suggest later on, then an efficiency reversal in favor of quantity competition may interestingly arise adding to the existing knowledge.

In the present paper we develop a unionized duopoly model with decentralized bargaining, like Petrakis and Vlassis (2000) arguing that, prior to the realization of the firm-specific employment/production plans, and before entering in to pair-wise negotiations, firms and unions collectively decide about their bargaining agendas, independently in each firm/union pair.

Unlike the aforementioned authors we however consider that each pair's bargaining agenda is observable by the rival pair before pair-specific bargains are struck: In the broader context of contracting among upstream input suppliers and downstream producers the publicity of the bargaining agenda is a reasonable

postulate, due to the long-term nature and the exclusivity of such vertical relationships, which may amongst other clauses provide specific input- per- output rules. Similarly, firm-union contracts may apart from the wage specify employment, at least implicitly; via manning ratios, crew sizes, worker shifts, and other relevant rules which are often agreed among the union and the firm's management [see, e.g., McDonald and Solow (1981), Manning (1987), Rogers and Streek (1994)].

More importantly, while Petrakis and Vlassis (2000) have taken as given quantity competition in a homogeneous product market, we alternatively consider price and quantity competition in a market with differentiated products, in order to explore whether either of those alternative modes of product market rivalry can endogenously sustain right-to-manage bargaining and/or efficient bargains in the labour market.

Our findings show that under price competition the equilibrium bargaining agenda in each firm/union pair would always regard only wages. Under quantity competition, however, and if union bargaining power is sufficiently low, the firm and the union in one firm/union pair would agree over the efficient bargains agenda while the other pair's agents would collectively choose the right-to-manage one. Quite remarkably we further show that, if apart from union power the degree of substitutability among the firms' products is low enough, quantity competition can via efficient bargains prove to be more socially efficient compared to price competition. In contrast to conventional wisdom unions may thus prove to be an efficiency-enhancing institution in oligopoly markets.

The remainder of the paper is organized as follows. Section 2 presents our structural model and the sequence of events arising in its context. In Section 3 two alternative sets of candidate product and labour market equilibria are derived − each set corresponding to an alternative hypothesis about the mode of product market rivalry, and the Nash equilibrium is found for each set. In Section 4 our findings are evaluated in social welfare terms, and Section 5 concludes the paper.

3.3. The Model

The product market of our reference industrial sector consists of two unionized firms *i* (*=1,2*), producing differentiated goods, both of which may by assumption compete either by independently adjusting their own quantities or by independently adjusting their own prices. Firms exhibit symmetric *C.R.S* production technologies in the labour input– given that the deployed capital input is always sufficient to produce the good. Effectively, each firm possesses a simple *Leontief* technology, $q_i = N_i$,where q_i , N_i , respectively denote the firm's *i*'s output and number of employees, and is (for simplicity) assumed that the productivity of labour equals one.

The representative consumer's preferences for products q_i, q_j, z – with z denoting a composite *numeraire* (e.g., $P_z \equiv 1$), are given by a simple variant of Dixit's (1979) quasi-linear specification:

$$u(q_i, q_j, z) = (q_i + q_j) - (q_i^2 + q_j^2 + 2\gamma q_i q_j)/2 + z \quad (1)$$

Therefore, each firm *i ≠j=1,2*, faces an inverse demand function of the form:

$$P_i(q_i, q_j) = 1 - q_i - \gamma q_j \quad (2)$$

Where, $\gamma \in (0,1)$ is a measure of the degree of substitutability between the firms' products:

As $\gamma \to 0$ product differentiation among firms increases while as $\gamma \to 1$ the firms' products become more close substitutes.

Inverting (2) we subsequently obtain product demand for each firm *i* as a function of its own and its rival (*j*) firm's price:

$$q_i(P_i, P_j) = \frac{(1-\gamma) - P_i - \gamma P_j}{1-\gamma^2} \quad (3)$$

Hence, the profit maximant of each firm *i* can be alternatively expressed like in (4a) and (4b) below.

$$\Pi_i = P_i(q_i, q_j)q_i - w_i q_i \quad (4a)$$

$$\Pi_i = P_i q_i(P_i, P_j) - w_i q_i(P_i, P_j) \quad (4b)$$

The sectoral labour market is unionized and union structure as well as collective bargaining is decentralized at the firm-level. Assuming utilitarian behavior on the part of unions − endowed with risk-neutral members, the union's *i* 's maximant is a variant of the Oswald's (1982) familiar rent formula:

$$U_i = (w_i - w_0) q_i \quad (5)$$

Where w_0 stands for the exogenous reservation wage. The latter is typically considered to be a weighted average, of the unemployment benefit and the wage which can obtain any union member employed outside the reference sector.

In the above context our postulated sequence of events is as follows. At stage one, firms and unions, simultaneously and independently in each firm/union pair *i ≠j=1*, *2*, collectively decide about the agenda (scope) of negotiations − to take place among them at the subsequent stage of the game, and an agreement over efficient bargains is reached whenever both the firm and the union would raise no veto against the pair's unilateral switch from the right-to-manage bargaining (*R*) agenda to the efficient bargains (*E*) agenda.[36] At stage two, given that the outcome of stage one in any firm/union pair *i* is also observable by the rival pair *j*, firm-union collective negotiations about only wages (*R*), or about both wages and employment (*E*), are simultaneously and independently conducted in each firm/union pair. At stage three, given the quantity −or price, mode of competition in the product market, if the *R* agenda is everywhere sustained then the firms *i ≠j=1*, *2*, simultaneously and independently adjust their own quantities −or their own prices.[37] Otherwise e.g., if the *E* agenda has been chosen by one or both firm/union pair(s) then: In the first instance, the firm conducting right-to-manage bargaining unilaterally adjusts its own quantity − or price, at stage three, whilst the rival firm/union pair by conducting

[36] Otherwise, i.e., whenever the firm, or the union, or both the union and the firm, object the pair's switch to the *E* agenda, then the pair will stick to the *R* agenda: Given that the institutional set-up in the majority of the unionized labour markets (especially in Europe) formally addresses bargaining about wages only, it is reasonable to consider *R* to be the "benchmark" firm-union bargaining agenda [see, e.g., Hartog and Theeuwes (1992), Petrakis and Vlassis (2000)].

[37] In what follows apart from taking the mode of product market competition to be exogenous we do not consider the asymmetric instance of product market rivalry, where one firm adjusts its own quantity while its rival firm adjusts its own price. Such a configuration extends the scope of the present paper and is left for future research.

efficient bargains has already collectively chosen the firm's own quantity − or price, at stage two. In the second instance, wages, quantities and prices, in any firm/union pair, are via efficient bargaining chosen at stage two. Hence, stage three is meaningless.[38]

3.4. Equilibrium Analysis

3.4.1. Quantity (*Q*) Competition in the product market

Given that the mode of product market competition common for both firms is quantity (*Q*) competition, and that any firm/union pair may independently from the other pair materialize any of the alternative bargaining agendas {*R* or *E*}, four different (sub)games arise at stage one of the game.

3.4.2. Universal Right-to-Manage Bargaining (QRR)

Assuming that (at stage one) both firm/union pairs have collectively chosen the right-to-manage bargaining (*R*) agenda, at stage three both firms $i \neq j = 1,2$, independently and simultaneously adjust their own outputs so that to maximize their own profits. Thus, from the *f.o.cs* of (4a), *w.r.t.* q_i, q_j, a standard system of best-response functions is derived:

$$q_i \equiv RF_i(q_j) = \frac{1 - \gamma q_j - w_i}{2} \tag{6}$$

Solving (6) for $q_{i \neq j=1,2}$ the firms' optimal output/employment rules are then defined by the following system.

$$q_i(w_i, w_j) = \frac{(2 - \gamma) - 2w_i + \gamma w_j}{4 - \gamma^2} \tag{7}$$

[38] Note that the choice/announcement of own price on the part of each firm also implies each firm's quantity sold, and vice-versa. Yet, since firm-specific prices (firm-specific quantities) are strategic complements (strategic substitutes), as it becomes evident later on the product and labour market outcomes under those alternative modes of product market competition would be quite different.

At stage two, since the bargaining agendas of both firm/union pairs contain only wages, $w_{i\neq j=1,2}$ bargains are independently struck in each firm/union pair so as to maximize the following Nash Bargaining product.

$$B_i = [U_i(q_i, w_i)]^b [\Pi_i(q_i, q_j, w_i)]^{(1-b)}; i \neq j = 1,2 \quad (8)$$

Where, (1-*b*) and 0<*b*<1, respectively stand for the firm's and the union's bargaining power over the bargained argument(s) −here about the wage, and are assumed to be symmetric across firm/union pairs.

Substituting q_i, from (7) into (8), and solving the system of *f.o.cs* of (8), *w.r.t.* w_i, w_j, we subsequently get the following (symmetric) wage outcomes:[39]

$$w_i^{QRR} = w_j^{QRR} = \frac{b(2-\gamma) + 2(2-b)w_0}{4-b\gamma} \quad (9)$$

Consequently substituting (9) into (7), and then both (9) and (7) into (4a) and (5), the following output/ employment, profits, and union rents (symmetric) outcomes are derived in the (*QRR*) candidate equilibrium.

$$q_i^{QRR} = q_j^{QRR} = \frac{2(2-b)(1-w_0)}{(2+\gamma)(4-b\gamma)} \quad (10)$$

$$\Pi_i^{QRR} = \Pi_j^{QRR} = (q_i^{QRR})^2 = \frac{4[(2-b)(1-w_0)]^2}{[(2+\gamma)(4-b\gamma)]^2} \quad (11)$$

$$U_i^{QRR} = U_j^{QRR} = \frac{2b(2-b)(2-\gamma)(1-w_0)^2}{(2+\gamma)(4-b\gamma)^2} \quad (12)$$

3.4.3. Efficient Bargains and Right-to-Manage (QER)

This game effectively addresses Stackelberg competition in quantities as follows. W.l.o.g. let at stage two the firm/union pair *i* (the firm/union pair *j*) bargain about the wage (about both wage and employment) leaving discretion to firm *i* to later on, e.g., at stage three, choose its employment/output level.

To elaborate backward, recall that at stage three the firm's *i*'s best response function is:

[39] Since, given the concavity of the firms' revenue functions, a unique (candidate) equilibrium in the space of outputs exists, and optimal wages depend only on optimal outputs, a unique vector of bargained wages emerges in the candidate equilibrium.

$$q_i \equiv RF_i(q_j) = \frac{1 - \gamma q_j - w_i}{2} \tag{13}$$

At stage two, therefore, the agents of firm/union pair *j* bargain over w_j, q_j so that – given (13) – maximize:

$$B_j = [U_j(q_j, w_j, w_i)]^b [\Pi_j(q_j, w_j, w_i)]^{(1-b)} \tag{14}$$

While, at the same time, the agents of firm/union pair *i* bargain over w_i so as to maximize:

$$B_i = [U_i(q_i, w_i)]^b [\Pi_i(q_i, q_j, w_i)]^{(1-b)} \tag{15}$$

Solving the system of *f.o.cs* of (14) and (15) *w.r.t.* w_j, q_j, and w_i, and like in 3.1.1 doing the proper substitutions, we obtain the following wage, output/employment, profits, and union rents (asymmetric) outcomes in the (*QER*) candidate equilibrium.

$$w_i^{QER} = \frac{b\{4 - \gamma(2+\gamma) + 2[(2-\gamma)(1+\gamma) - (1-b)(2-\gamma(\gamma+1)]w_0\}}{[8 - \gamma^2(4-b)]} \tag{16}$$

$$w_j^{QER} = \frac{b\{[\gamma(1+b) - 4][\gamma^2 - 2] + [8 + (1-b)(8-6\gamma^2) - (1-b)^2\gamma(2-\gamma^2) + \gamma(2 - \gamma(2+\gamma))]w_0\}}{[16 - 2\gamma^2(4-b)]} \tag{17}$$

$$q_i^{QER} = \frac{(2-b)[4 - \gamma(2+\gamma)](1 - w_0)}{16 - 2(4-b)\gamma^2} \tag{18}$$

$$q_j^{QER} = \frac{[4 - \gamma(2-b)](1 - w_0)}{8 - (4-b)\gamma^2} \tag{19}$$

$$\Pi_i^{QER} = (q_i^{QER})^2 \tag{20}$$

$$\Pi_j^{QER} = \frac{(1-b)(2-\gamma^2)(q_j^{QER})^2}{2} \tag{21}$$

$$U_i^{QER} = \frac{2b}{(2-b)}(q_i^{QER})^2 \tag{22}$$

$$U_j^{QER} = \frac{(2-\gamma^2)b}{2}(q_j^{QER})^2 \tag{23}$$

3.4.4. Universal Efficient Bargaining (QEE)

Suppose that the bargaining agenda selected at stage one from any firm/union pair is efficient (*E*) bargains. Then, at stage two (stage three is here meaningless) each firm/union pair *i*, independently from and simultaneously with the rival pair *j*, conducts bargaining over both wage and employment so as to maximize:

$$B_i^{QEE} = [U_i(q_i, w_i)]^b [\Pi_i(q_i, q_j, w_i)]^{(1-b)} \quad (24)$$

Solving the system of *f.o.cs* of (24) *w.r.t.* w_i, q_i ; *i≠ j=1, 2*, we subsequently obtain the following wage, output/employment, profits, and union rents (symmetric) outcomes in the (*QEE*) candidate equilibrium.

$$w_i^{QEE} = w_j^{QEE} = \frac{1-(1-b)(1-w_0)+(1+\gamma)w_0}{2+\gamma} \quad (25)$$

$$q_i^{QEE} = q_j^{QEE} = \frac{1-w_0}{2+\gamma} \quad (26)$$

$$\Pi_i^{QEE} = \Pi_j^{QEE} = \frac{(1-b)(1-w_0)^2}{(2+\gamma)^2} \quad (27)$$

$$U_i^{QEE} = U_j^{QEE} = \frac{b(1-w_0)^2}{(2+\gamma)^2} \quad (28)$$

3.4.5. Nash Equilibrium

Moving backward to stage one− let us now search for the firm/union pairs' bargaining agendas in the Nash equilibrium. Recall that for *R* to be sustained as the firm/union pair's *i's ≠j*=1, 2, bargaining agenda −given that the rival firm/union pair *j* has selected *B* or *R* as its own agenda, at least one of the agents in pair *i* must have no incentive for the pair to unilaterally switch from the *R* to the *E* agenda. Otherwise, i.e., if both profits and union rents in pair *i* strictly increase under the *E* agenda, no one of the agents in pair *i* will "vote" (e.g., raise a *veto*) against the considered deviation. In order to check for the Nash equilibrium it is then sufficient to examine the following deviations: *QRR→ QER*; *QER→ QEE*. Our relevant findings are summarized in Proposition 1.

Proposition 1:

For any $0 < w_0 < 1$[40] *there exists a function* $b(\gamma)$, *with* $\frac{\vartheta b(\gamma)}{\vartheta \gamma} > 0$; $\gamma \in (0,1)$; $b(\gamma) \in (0, 0.425]$, *such that, under quantity (Q) competition in the product market:*

(i) *If* $0 < b < b(\gamma)$ *then the firm and the union in one firm/union pair would*

[40] Given our product demand specification − note that, for the sectoral market to exist, the (maximum) price should be less than one. It follows that the unions' reservation wage (w_0), i.e., the firms' (minimum) unit cost, should be also less than one.

collectively decide to bargain about both wage and employment, while in its rival pair the firm and the union would decide to bargain only about the wage. Therefore the unique Nash equilibrium is QER.

(ii) *If* $1 > b > b(\gamma)$ *then no firm would agree with its union to bargain about both wage and employment, despite that both unions are willing to do so. Therefore the unique Nash equilibrium is QRR.*

The above findings reassure the Petrakis and Vlassis (2000) central suggestion that, if union power is low enough (less than 0.5), then efficient bargains may emerge in at least one firm/union pair (the other pairs conducting right-to-manage bargaining) in equilibrium. In our context of analysis the intuition behind this result is as follows. By agreeing with its own union on pair-specific efficient bargaining the firm effectively becomes a Stackelberg leader in the product market and, hence, enjoys a higher market share relative to the case it had stuck to right-to-manage bargaining. On the other hand, however, by paying a higher wage bill the firm may have to transfer to its union a disproportionate share of the emerging profits differential. The latter effect can of course be sufficiently strong to make the *E* agenda less profitable for the firm compared to the *R* agenda. Therefore, an upper limit in union's power (*b*) exists so as by keeping the wage contract low enough to make the *E* agenda to the firm's best interest. The union, on the other hand, since it gains higher employment would always opt for efficient bargains.[41] Nonetheless, the *b* upper value for the firm to consent to the *E* agenda increases with the degree of product substitutability among firms (*γ*), e.g., the *b*-constraint relaxes for the firm as *γ* increases. This is reasonable since business-stealing ensuing from Stackelberg leadership becomes higher as the firms' products become more close substitutes. Therefore, a higher γ compensates the firm for a higher wage –ensuing as *b* increases. Last but not least, the *E* agenda can never be chosen by both firm/union pairs in the equilibrium. The reason is that total output and employment would then become prohibitively high to sustain oligopoly profits, despite this would be on the

[41] As it can be easily checked, the wage contract in the deviant pair under *QER* is lower than under *QRR*. Since, however, union members are risk averse or (like in our specification) neutral, the wage effect (of a switch to *QER*) on union's rents is of a second order while the respective employment effect is of a first order.

best interest of both unions. Such an instance is in fact similar to a well known from standard oligopoly theory situation of *Stackelberg warfare* in which no one firm is willing to engage.

3.5. Price (*P*) Competition in the product market

Let us next unfold the four sets of candidate equilibria arising at the first stage of the game under price competition in the product market[42].

3.5.1. Universal Right-to-Manage Bargaining (PRR)

From the *f.o.cs* of (4b), *w.r.t.* $P_{i\neq j=1,2}$ the following system of best response functions is derived.

$$P_i \equiv RF_i(P_j) = \frac{(1-\gamma)+\gamma P_j + w_i}{(3-\gamma^2)}; i \neq j = 1,2 \tag{29}$$

Solving (29) for P_i, the firms' optimal pricing rules at stage three are then defined by the following system.

$$P_i(w_i, w_j) = \frac{2(1+w_i)-\gamma[(1+\gamma)-w_j]}{(4-\gamma^2)}; i \neq j = 1,2 \tag{30}$$

Substituting for P_i, from (30) into (3), to get q_i as functions of wages, and solving the system of *f.o.cs* [of the derived version of (8)] *w.r.t.* $w_{i\neq j=1,2}$ we subsequently obtain a unique vector of bargained wages in the *PRR* candidate equilibrium:

$$w_i^{PRR} = w_j^{PRR} = \frac{b(2-\gamma(1+\gamma))-(2-b)(2-\gamma^2)w_0}{4-\gamma(b+2\gamma)} \tag{31}$$

Using (31), and reversely substituting, the following output/ employment, profits, and union rents (symmetric) outcomes are derived in the candidate equilibrium.

$$q_i^{PRR} = q_j^{PRR} = \frac{(2-b)(2-\gamma^2)(1-w_0)}{(1+\gamma)(2-\gamma)[4-\gamma(b+2\gamma)]} \tag{32}$$

$$\Pi_i^{PRR} = \Pi_j^{PRR} = \frac{(1-\gamma)[(2-b)(2-\gamma^2)(1-w_0)]^2}{(1+\gamma)\{(2-\gamma)[4-\gamma(b+2\gamma)]\}^2} \tag{33}$$

[42] The notation of the various candidate equilibria is similar to that of the *Q* competition case. Simply substitute *P* for *Q* in the relevant superscripts.

$$U_i^{PRR} = R_j^{PRR} = \frac{b(2-b)(1-\gamma)(2+\gamma)(2-\gamma^2)(1-w_0)^2}{(2-\gamma)(1+\gamma)[4-\gamma(b+2\gamma)]^2} \quad (34)$$

3.5.2. Right-to-Manage and Efficient Bargains (PRE)

The symmetric *PRE* and *PER* games effectively address price competition in the product market in a sequential fashion: W.l.o.g working in terms of *PRE*, at stage two the firm/union pair *i* conducts wage bargains –leaving discretion to firm *i* to later on (e.g., at stage three) announce its price, while at the same time the firm/union pair *j* conducts wage and price bargains; hence, apart from the wage the firm's *j*'s price is announced at stage two. Accordingly, the candidate equilibrium is derived as follows.

The firm's *i*'s best response function, at stage three, is known to be:

$$P_i \equiv RF_i(P_j) = \frac{(1-\gamma)+\gamma P_j + w_i}{(3-\gamma^2)} \quad (35)$$

Considering (35), the firm and the union in pair *j* at stage two bargain over P_j, w_j so that to maximize:

$$B_j = [U_j(P_j, w_j, w_i)]^b [\Pi_j(P_j, w_j, w_i)]^{(1-b)} \quad (36)$$

While at the same time the firm *i* and union *i* bargain over w_i so that to maximize:

$$B_i = [U_i(P_i, P_j, w_i)]^b [\Pi_i(P_i, P_j, w_i)]^{(1-b)} \quad (37)$$

Solving the system of *f.o.cs* of (36) and (37) *w.r.t.* w_j , P_j, and w_i, and doing the proper substitutions, the following wage, output/employment, profits, and union rents (asymmetric) outcomes are obtained in the *PRE* candidate equilibrium.

$$w_i^{PRE} = \frac{b(1-\gamma)[4+\gamma(2-\gamma)] + [4+b(2-\gamma)(2-\gamma^2)]w_0}{[8-\gamma^2(4+b)]} \quad (38)$$

$$w_i^{PRE} = \frac{b\{4-\gamma[2(1+\gamma)-b(1-\gamma)]\}}{8-\gamma^2(4+b)} + [\frac{b\{4+\gamma[(2-b)-2\gamma]\}}{8-\gamma^2(4+b)} + (1-b)]w_0 \quad (39)$$

$$q_i^{PRE} = \frac{(2-b)[4+\gamma(2-\gamma)](1-w_0)}{2(1+\gamma)[8-(4+b)\gamma^2]} \quad (40)$$

$$q_j^{PRE} = \frac{[4+\gamma(2+b)](2-\gamma^2)(1-w_0)}{2(1+\gamma)[8-(4+b)\gamma^2]} \quad (41)$$

$$\Pi_i^{PRE} = \frac{(2-b)^2(1-\gamma)[4+\gamma(2-\gamma)]^2(1-w_0)^2}{4(1+\gamma)[8-(4+b)\gamma^2]^2} \quad (42)$$

$$\Pi_j^{PRE} = \frac{(1-b)(1-\gamma)(2-\gamma^2)[4+\gamma(2+b)]^2(1-w_0)^2}{2(1+\gamma)[8-(4+b)\gamma^2]^2} \quad (43)$$

$$U_i^{PRE} = \frac{b(2-b)(1-\gamma)[4+\gamma(2-\gamma)]^2(1-w_0)^2}{2(1+\gamma)[8-(4+b)\gamma^2]^2} \quad (44)$$

$$U_j^{PRE} = \frac{b(1-\gamma)(2-\gamma^2)[4+\gamma(2+b)]^2(1-w_0)^2}{2(1+\gamma)[8-(4+b)\gamma^2]^2} \quad (45)$$

3.5.3. Universal Efficient bargaining (PEE)

The *PEE* game is the price competition counterpart of the *QEE* game: Using (3) and (4b) in order to express profits and rents as functions of prices and wages, and given that the bargaining agenda in both firm/union pairs is *EB*, at stage two each pair $i \neq j = 1,2$, independently from and simultaneously with the rival pair *j*, conducts bargains over both the firm-specific price and wage so that to maximize:

$$B_i = [U_i(P_i, P_j, w_i)]^b [\Pi_i(P_i, P_j, w_i)]^{(1-b)} \quad (46)$$

Solving the system of *f.o.cs* of (46) *w.r.t* w_i, P_i, we then easily obtain the following wage, output/employment, profits, and union rents (symmetric) outcomes in the candidate equilibrium.

$$w_i^{PEE} = w_j^{PEE} = \frac{b[(1-\gamma)+w_0]}{(2-\gamma)} + (1-b)w_0 \quad (47)$$

$$q_i^{PEE} = q_j^{PEE} = \frac{1-w_0}{(2-\gamma)(1+\gamma)} \quad (48)$$

$$\Pi_i^{PEE} = \Pi_j^{PEE} = \frac{(1-b)(1-\gamma)(1-w_0)^2}{(1+\gamma)(2-\gamma)^2} \quad (49)$$

$$U_i^{PEE} = U_j^{PEE} = \frac{b(1-\gamma)(1-w_0)^2}{(1+\gamma)(2-\gamma)^2} \quad (50)$$

3.5.4. Nash Equilibrium

Along the lines of reasoning in 3.5.4, in order to check for the equilibrium bargaining agendas under price competition, is sufficient to examine the effects on firms' profits and unions' rents ensuing from the following switches in the firm/union

pairs' bargaining agendas: *PRR→ PRE*; *PRE→ PEE*. Our findings are summarized in Proposition 2.

Proposition 2:

For any $0 < w_0 < 1$, *there exist functions* $b_x(\gamma); x = f, ur, ue$, *with* $\frac{\vartheta b_x(\gamma)}{\vartheta \gamma} > 0$; γ $\in (0,1)$; $b_f(\gamma) \in (0, 0.25] < b_{ur}(\gamma) \in (0, 0.6] \; \forall \; 0 < \gamma < 1$; $b_{ue}(\gamma) \in (0, 1)$, *such that:*

(i) *If* $0 < b < b_f(\gamma)$, *then the profits of firm j (the rents of union j) strictly increase (decrease) under PRR→ PRE.*

(ii) *If* $1 > b > b_{ur}(\gamma) > b_f(\gamma)$, *then the rents of union j (the profits of firm j) strictly increase (decrease) under PRR→ PRE*.

(iii) *If* $1 > b > b_{ue}(\gamma)$, *then the rents of union i strictly increase under PRE→ PEE. However, the profits of firm i always (e.g., for any b, γ) strictly decrease under PRE→ PEE.*

Therefore, the unique Nash Equilibrium is PRR.

Proposition 2 suggests that under price competition in the product market a conflict of interest always arises between the firm and the union, in any firm/union pair, regarding the pair's unilateral deviation from the (benchmark) *R* agenda to the *E* agenda. Therefore, right-to-manage bargaining is sustained in both firm/union pairs in equilibrium. The reasoning is as follows. Given that the rival firm *i* agrees with its own union to stick to the *R* agenda [see *(i)* and *(ii)*], the firm *j* −by switching its bargaining agenda from *R* to *E*− would become a price leader in the product market. The firm *j* and union *j* must then consider the following ensuing effects: First, due to price leadership on the part of firm *j*, its rival firm's (*i's*) price would always be lower in the (*PRE*) candidate equilibrium −compared to the benchmark (*PRR*) equilibrium. Second, due to the strategic complementarity that exists amongst the firms' prices, both prices will be lower in the candidate equilibrium in comparison to the *PRR* equilibrium. The firm *j* (the union *j*) would therefore anticipate that a deviation from *PRR* to *PRE* would be to the firm's (to the union's) best interest so long as the firm

(the union) will on its own part gain more than loose by enjoying *a smaller portion of a larger pie* .[43] It proves that regarding the firm (the union) this happens if union power− *b* is sufficiently low (high). This is so because the firm (the union) will gain more than loose from the pair's unilateral switch from the *R* to the *E* agenda insofar as the wage would be kept low (high) enough to make the − as above ensuing− reallocation of market shares and employment among firm/union pairs to the firm's (to the union's) *j*'s best interest. Yet, the upper critical bound of *b* −for the firm to consent to the *E* agenda is always lower than the lower critical bound of *b* −for the union to act similarly. The firm and/or the union in any firm/union pair will therefore always "vote" against the pair's unilateral deviation from the benchmark *R* agenda, hence, the *PRE* configuration can never emerge in equilibrium. On the other hand regarding the pair's *i*'s deviation from the *R* to the *E* agenda − given that the rival pair *j* conducts efficient bargains [see *(iii)*], the firm *i* would never have such an interest. The reason is that, by thus fiercing price competition, the firm's *i*'s (as well as the firm's *j*'s) profits would be driven lower. The firm's *i*'s union would however opt for a deviation to the *E* agenda if its bargaining power was high enough, since in such an instance the union would extract higher rents (in terms of higher employment) at the cost of both firms' profits.

3.6. Welfare analysis

In order to proceed to an evaluation of our findings, in social welfare terms, let us first define the following.

- Consumer Surplus: $CS_S = (\frac{1+\gamma}{4})(q_{iS} + q_{jS})^2$
- Firms' (total) Profits: $T\Pi_S = \Pi_{iS} + \Pi_{jS}$
- Unions' (total) Rents: $TU_S = U_{iS} + U_{jS}$

[43] Regarding the size and the portion of the *pie*, e.g., the anticipated firm/union pair's *j*'s welfare gain in the *PRE* equilibrium -compared to the *PRR* equilibrium- note that: First, the *pie* will be *larger* since, due to the universal decline in prices, sectoral output would be higher. Second, the *portion* of the pie which the firm *j* and union *j* will jointly enjoy will be *smaller* because the firm's *j*'s price would be higher than its rival firm's *i*'s price.

Social Welfare, at the sector's level, is then typically defined as:

- $SW_S = CS_S + T\Pi_S + TU_S$

Noting that the subscript s allows for all possible product and labour market equilibrium configurations, e.g., $s = \{QRE\ or\ QER\}, [PRR]$, the required figures can be respectively calculated, by means of {(18)-(23)} and [(32)-(34)]. Proposition 3 summarizes the findings of the subsequently made welfare comparisons.

Proposition 3:

(a) *For any* $0 < w_0 < 1$ *there exist functions* $\gamma_z(b); z = sw, cs, t\pi$, *with* $\frac{\vartheta \gamma_z(b)}{\vartheta b} > 0$; $b \in (0,0.425)$, *and* $\gamma_{sw}(b) \in (0.25, 0.5)$; $\gamma_{cs}(b) \in (0.25, 0.5)$; $\gamma_{t\pi}(b) \in (0.3, 0.65)$, *such that:*

(i) *If* $0 < \gamma < \gamma_{sw}(b)$, *then Social Welfare under QRE (or QER) is higher than under PRR.*

(ii) *If* $0 < \gamma < \gamma_{cs}(b)$, *then Consumer Surplus under QRE (or QER) is higher than under PRR.*

(iii) *If* $0 < \gamma < \gamma_{t\pi}(b)$, *then the total Profits under QRE (or QER) are lower than under PRR.*

(в) *For any* $0 < w_0 < 1$, *if* $0.125 < b < 0.425$; $\gamma \in (0,1)$, *or* $b \in (0,0.425)$ *and* $\gamma \in (0, 0.35)$, *or* $b \in (0,0.425)$ *and* $\gamma \in (0.5, 1)$, *then total Union Rents under QRE (or QER) are higher than under PRR.*

[The proof appears in the Appendix 3]

Proposition 3 suggests that whenever union power is sufficiently low so as to induce efficient bargains in the labour market − under quantity competition in the product market, if the degree of substitutability among the firms' products is also low enough, then the quantity mode of competition entails higher consumer surplus and social welfare than the price mode −which always sustains right-to-manage bargaining. To grasp the intuition behind this finding recall that *ceteris paribus* the lower is the degree of product substitutability the lower becomes the output differential in favor of price competition relative to quantity competition. Thus,

efficient bargaining − which is partially emerging under quantity competition, may ultimately reverse that output differential if γ is sufficiently low. In the latter instance the firms' profits are nonetheless lower, whilst (with the exception of a very narrow b and/or γ configuration) the unions' rents are higher, this resulting from the profits-to-rents redistribution brought by efficient bargains. Quite remarkably, therefore, if product market competition was to switch from the price mode to the quantity mode the possibility of efficient bargaining −which then arises if union power is sufficiently low, might render higher efficiency to the sectoral market and also entail welfare redistribution from firms to consumers and (quite probably) to unions[44].

3.7. Conclusions - Epilogue

In this paper we have developed a decentralized union-oligopoly bargaining framework allowing us to: First, examine whether the firm-union bargaining agendas may apart from wages also regard employment in equilibrium, and find out whether this possibility is contingent on the mode of product market competition. Second, compare on efficiency grounds the properties of the bargaining agendas/mode of competition configurations which may emerge in equilibrium.

Under quite regular assumptions about firm and union behavior we have shown that under price competition in the product market the equilibrium bargaining agenda in any firm/union pair would, for all possible parameter configurations, regard only the wage. Under quantity competition, nonetheless, and provided that union bargaining power is low enough, the bargaining agenda of one (some) firm/union union pair (s) may apart from the wage regard employment.[45] These findings further suggest that, in contrast to conventional wisdom, quantity competition may imply higher consumer surplus and social welfare than price competition −the role of unions in that being critical: The less militant unions are the more probable is, by enabling efficient bargains, apart from serving their best interest to enhance efficiency. On the other hand militant enough unions may, by

[44] As one referee has pointed out, when γ is low enough the driving force for higher social welfare under Q than under P competition is the (low) bargaining power of unions.
[45] Our analysis can be extended to an n-unionized oligopoly still retaining all of its qualitative features and findings.

deterring efficient bargains, apart from lowering social welfare themselves enjoy lower rents.

A straightforward, yet quite promising, extension of our present analysis is to investigate whether firms, by strategically choosing their mode of competition before entering into negotiations with their unions, may induce the bargaining agenda which best serves their interest − in an holistic mode of competition/bargaining agenda equilibrium. We leave this piece of work for later on.

3.8. Appendix

3.8.1. Proof of Proposition 1:

(A). To check for the Nash equilibrium in the bargaining agendas of firm/union pairs $i \neq j = 1,2$, we must first examine the signs of the differentials in firm's *i*'s profits and union's *i*'s rents emerging from the pair's *i*'s unilateral deviation from the right-to-manage (*R*) agenda to the efficient bargains (*E*) agenda, given that the firm/union pair *j* sticks to the (benchmark) *R* agenda (e.g., *QRR*→ *QER*). Subtracting (12) from (23), the union rents differential emerging under the considered deviation [e.g., $DU_i = U_i^{QER} - U_i^{QRR}$] proves to be:

$$DU_i \propto \{\frac{(2-\gamma^2)[4-(2-b)\gamma]^2}{[8-(4-b)\gamma^2]^2} - \frac{4(2-b)(2-\gamma)}{(2+\gamma)(4-b\gamma)^2}\} > 0 \; \forall \; \gamma, b \in (0,1).$$

As however regards the similarly emerging profits differential [e.g., $D\Pi_i = \Pi_i^{QER} - \Pi_i^{QRR}$], by subtracting (11) from (21) an analytically tractable formula cannot be obtained. Nonetheless, we can still check for the sign of $D\Pi_i$ by contour-plotting the [(21)-(11)] difference[46] over a fine grid of our critical *γ* and *b* parameters. By inspecting this plot (reported in *Figure 1* below) it can be checked that if $b < b(\gamma)$; $b(\gamma) \in (0,0.425]$ then $D\Pi_i > 0$. Therefore, under the latter parameter configuration both the firm and the union in firm/union pair *i* have an incentive to switch their bargaining agenda (from *R* to *E*).

(B). To complete the proof we must further check whether the firm and/or the union in pair *j* have an incentive for the pair to deviate from the *R* to the *E* agenda, given that the rival pair *i* is going to bargain according to the *E* agenda (e.g., *QER*→ *QEE*). The following critical differentials for firm *j* and union *j* respectively arise, their signs suggesting that the firm *j* will always raise a veto against the considered deviation.

$$D\Pi_j \{= (27) - (21)\} = \Pi_j^{QEE} - \Pi_j^{QER} \propto -\left\{\frac{4(1-b)}{(2+\gamma)^2} + \frac{(2-b^2)[4-(2+\gamma)\gamma]^2}{[8-(4-b)\gamma^2]^2}\right\} < 0$$

[46] This perplexed difference, as well as all analogous formulae which are delivered later on, are available by the authors upon request.

$DU_j\{= (28) - (22)\} = U_j^{QEE} - U_j^{QER} \propto \frac{2}{(2+\gamma)^2} - \frac{(2-b)[4-(2+\gamma)\gamma]^2}{[8-(4-b)\gamma^2]^2} > 0$

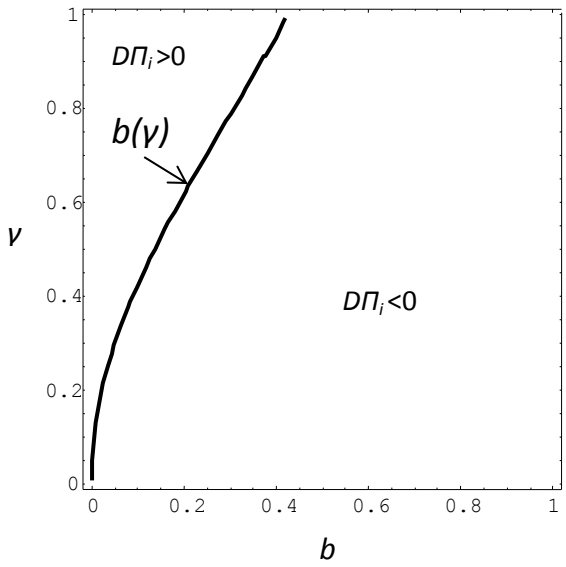

Figure 1

3.8.2. Proof of Proposition 2:

(A). Like the proof of Proposition1, we must first check the signs of the differentials in firm's *j*'s profits and union's *j*'s rents emerging from the pair's *j*'s unilateral deviation from the right-to-manage (*R*) agenda to the efficient bargains (*E*) agenda, given that the firm/union pair *i* sticks to the (benchmark) *R* agenda (e.g., *PRR*→ *PRE*). Yet, by subtracting (33) from (43) – to get $\{D\Pi_j = \Pi_j^{PRE} - \Pi_j^{PRR}\}$, and (34) from (45) – to get $\{DU_j = U_j^{PRE} - U_j^{PRR}\}$, we cannot obtain analytically tractable expressions, in both instances. Once again, therefore, we have to check the signs of $D\Pi_j$ and DU_j by respectively plotting the [(43)-(33)] and [(45)-(34)] differences over a fine grid of our critical *γ* and *b* parameters. These contour-plots are reported in *Figure 2* and *Figure 3*, below. By inspecting these plots it can be checked that: ***(i)*** If $0 < b < b_f(\gamma)$ then the profits of firm *j* (the rents of union *j*) strictly increase (decrease) under *PRR*→ *PRE*. ***(ii)*** If $1 > b > b_{ur}(\gamma) > b_f(\gamma)$ then the rents of union *j* (the profits of firm *j*) strictly increase (decrease) under *PRR*→ *PRE*. Therefore, as it is clearly depicted in *Figure 4* where the two critical *b*(*γ*) schedules are confronted, since $b_f(\gamma) \in$

$(0, 0.25] < b_{ur}(\gamma) \in (0, 0.6] \; \forall \; 0 < \gamma < 1$, a conflict of interest always arises between the firm and the union in firm/union pair *j* regarding a switch of their bargaining agenda (from *R* to *E*).

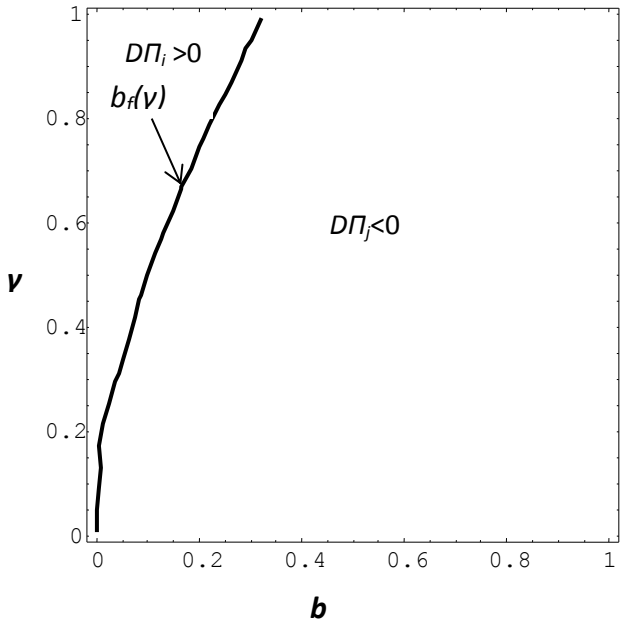

Figure 2

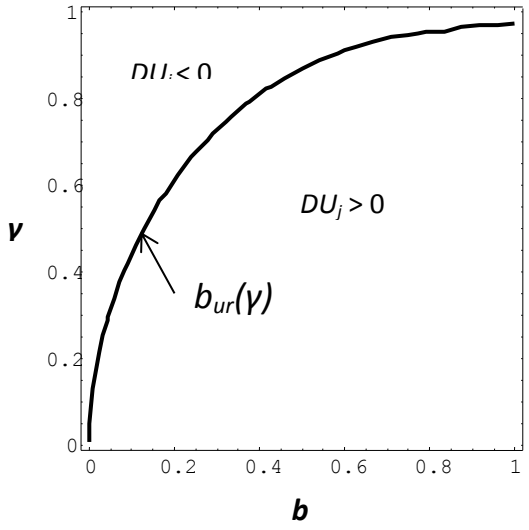

Figure 3

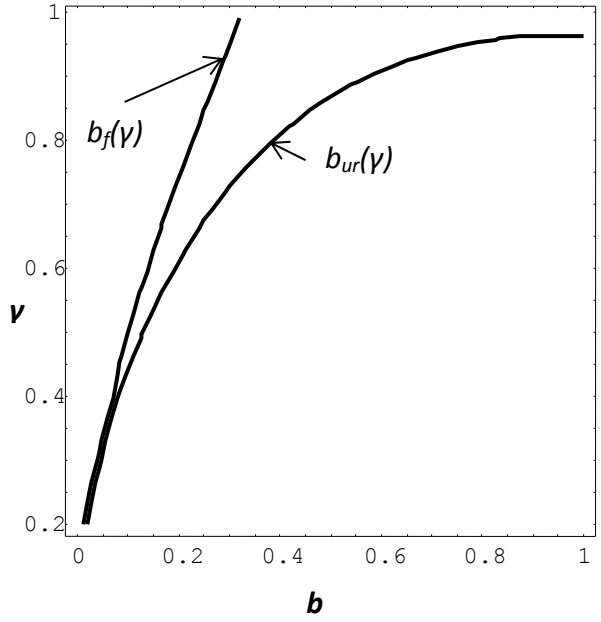

Figure 4

(B).To complete the proof we must check whether the firm and/or the union in pair *i* have an incentive for the pair *i* to unilaterally deviate from the *R* to the *E* agenda, given that the rival pair *j* is going to bargain according to the *E* agenda (e.g., *PRE*→ *PEE*). Regarding the firm *i*, by subtracting (42) from (49) the emerging profits differential turns to be always negative:

$D\Pi_i = \Pi_i^{PEE} - \Pi_i^{PRE} \propto \left\{ \frac{4(1-b)}{(2-\gamma)^2} - \frac{(2-b)^2[4+(2-\gamma)\gamma]^2}{[8-(4+b)\gamma^2]^2} \right\} < 0$.

On the other hand regarding the union's *i*'s rents differential, $DU_i = U_i^{PEE} - R_i^{PRE}$, we must again rely on the contour-plot of the {(50) − (44)} difference over a fine grid of our critical *γ* and *b* parameters (see *Figure 5* below). Inspecting this plot it is clearly seen that [***(iii)***] if $1 > b > b_{ue}(\gamma)$ then union *i* would be willing to switch the pair's bargaining agenda (from *R* to *E*). Since however (as shown above) this is in contrast to the firm's *i*'s best interest, the firm/union pair *i* will stick to the benchmark (*R*) bargaining agenda.

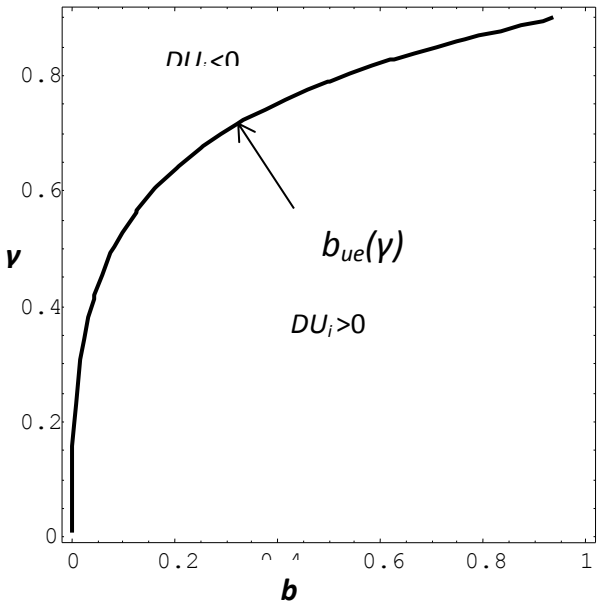

Figure 5

3.8.3. Proof of Proposition 3:

Recall the following definitions, and w.l.o.g note that, $s = \{QRE\}, \{PRR\}$.

- Consumer Surplus: $CS_S = (\frac{1+\gamma}{4})(q_{iS} + q_{jS})^2$
- Firms' (total) Profits: $T\Pi_S = \Pi_{iS} + \Pi_{jS}$
- Unions' (total) Rents: $TU_S = U_{iS} + U_{jS}$
- $SW_S = CS_S + T\Pi_S + TU_S$

The welfare comparisons which are reported in *Figures 6-9* are made according to the above definitions, by using {(18)-(23)} and [(32)-(34)] to respectively calculate the $(D = \{.\} - [.])$ differences and subsequently contour- plot these differences over a fine grid of our critical *γ* and *b* parameters.[47]

(a.i). $DSW = \{SW_{QRE}\} - [SW_{PRR}]$

[47] Note that in these plots $b \in (0,0.425]$ in order to fulfill the condition for *QER* to be an equilibrium configuration.

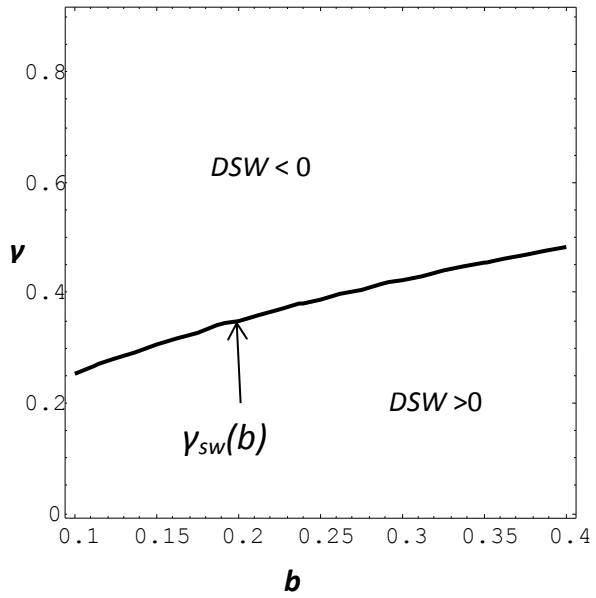

Figure 6

(a.ii). $DCS = \{CS_{QRE}\} - [CS_{PRR}]$

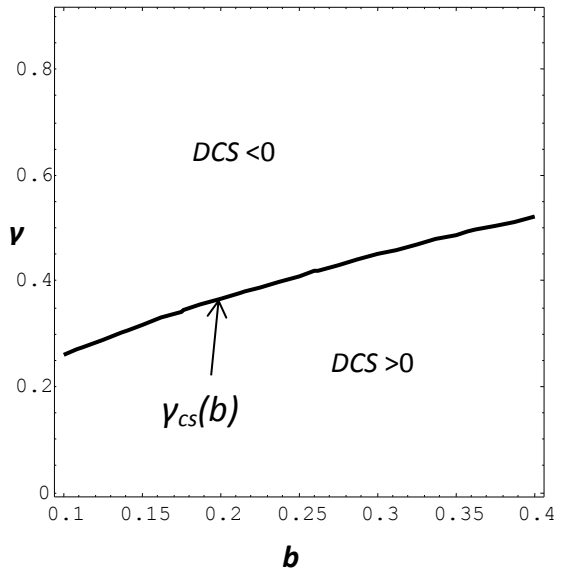

Figure 7

(a.iii). $DT\Pi = \{T\Pi_{QRE}\} - [T\Pi S_{PRR}]$

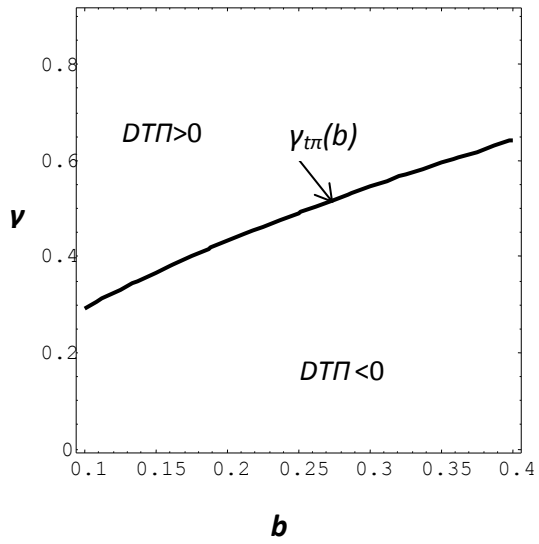

Figure 8

(в). $DTU = \{TU_{QRE}\} - [TU_{PRR}]$

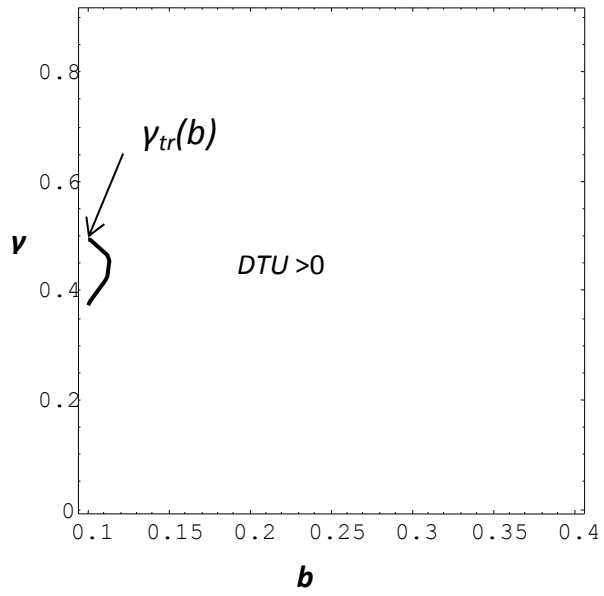

Figure 9

3.9. References

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ΠΕΡΙΛΗΨΗ

Της Διδακτορικής Διατριβής του

Στέφανου Μαμάκη

με τίτλο:

«Οι Αντικειμενικοί Στόχοι των Εργατικών Ενώσεων και των Επιχειρήσεων σε ένα Στρατηγικό Πλαίσιο»

η οποία υποβάλλεται στο

Τμήμα Οικονομικών Επιστημών του Πανεπιστημίου Κρήτης

Ρέθυμνο, Ιανουάριος 2015

Περιεχόμενα

Εισαγωγή

Η παρούσα διατριβή εντάσσεται στο θεωρητικό πλαίσιο των Οικονομικών της Εργασίας, χρησιμοποιώντας αναλυτικά εργαλεία από την Βιομηχανική Οργάνωση και την Θεωρία Παιγνίων.

Ένα από τα σημαντικότερα ερευνητικά επιτεύγματα των τελευταίων 20 ετών είναι η ανάπτυξη ενός θεωρητικού πλαισίου ανάλυσης της αγοράς εργασίας με τεχνικές διαπραγματεύσεων (bargaining). Η ανάπτυξη αυτού του πλαισίου ξεκίνησε στις αρχές της δεκαετίας του '80 με συνεισφορές από τον Peter A. Diamond, Dale Mortensen T και άλλων. Αργότερα, το πλαίσιο αυτό προσαρμόστηκε κατάλληλα στην αγορά εργασίας. Τα πεδία της έρευνας σε αυτόν τον τομέα της οικονομικής είναι πράγματι απεριόριστα, και παρά την υπάρχουσα βιβλιογραφία, υπάρχουν ακόμα ανεξερεύνητες περιοχές. Δεδομένου των νέων στρατηγικών που σχηματίζονται στην πραγματική οικονομία, αλλάζοντας τη δομή της αγοράς εργασίας, η εμβάθυνση σε αυτές τις ανεξερεύνητες περιοχές καθίσταται όλο και περισσότερο κρίσιμη.

Σε αυτό το πλαίσιο, κινείται η παρούσα διατριβή, η οποία ερευνά τους στόχους των εργατικών ενώσεων και των επιχειρήσεων σε ένα στρατηγικό πλαίσιο. Ειδικότερα, η έρευνα εστιάζεται σε τρία κρίσιμα και ενδιαφέροντα θέματα:

- Διαπραγματεύσεις σε Συνδικαλισμένο Ολιγοπώλιο και Άμεσες Ξένες Επενδύσεις (ΑΞΕ)
- Διαπραγματεύσεις σε Συνδικαλισμένο Ολιγοπώλιο και το φαινόμενο της Αδήλωτης Εργασίας
- Αποδοτικότητα του Ανταγωνισμού ως προς τις Τιμές (ala Bertrand) σε σύγκριση με τον Ανταγωνισμό ως προς τις Ποσότητες (ala Cournot) σε Συνδικαλισμένο Ολιγοπώλιο.

Κεφάλαιο 1ο: Union-Oligopoly Bargaining and Foreign Direct Investments (F.D.I.)

Η έρευνα στο 1ο κεφάλαιο εξετάζει τις δομές οργάνωσης των εργατικών ενώσεων σε ένα ολιγοπωλιακό κλάδο ως στρατηγικό εργαλείο, όταν ο κλάδος αυτός (δυνητικά) δέχεται άμεσες ξένες επενδύσεις (inward FDI).

Εισαγωγή:

Οι ΑΞΕ και ο συνδικαλισμός στην αγορά εργασίας αποτελούν, ξεχωριστά το κάθε ένα, από ένα πολυδιάστατο πεδίο έρευνας των οικονομικών. Η αλληλεπίδραση μεταξύ τους καθίσταται ακόμα περισσότερο περίπλοκη, ωστόσο η ανάλυσή της φέρεται ως πολλά υποσχόμενη, προκειμένου να αναδειχθούν ενδιαφέροντες εφαρμογές κοινωνικής πολιτικής.

Στη διεθνή βιβλιογραφία για την οικονομική ανάλυση των ΑΞΕ, απαντώνται τρεις διαφορετικοί τύποι υποδειγματοποίησης, που χρησιμοποιούνται ώστε να εξηγήσουν την φύση και τις επιπτώσεις των ΑΞΕ:

(a) real capital arbitrage models

(b) market power / industrial organization models and

(c) firm-theoretic models[48].

Ο Hymer (1960) ήταν ο πρώτος που υποστήριξε ότι τα υποδείγματα real capital arbitrage είχαν σοβαρές ανεπάρκειες και ότι μία πολυεθνική εταιρία προκειμένου να πραγματοποιήσει ΑΞΕ έπρεπε να διαθέτει ένα συγκριτικό πλεονέκτημα έναντι των εγχώριων επιχειρήσεων.

Αναφορικά με τη δομή της αγοράς, οι παλιότερες έρευνες επικεντρώνονταν κυρίως σε μονοπωλιστικές αγορές. Ωστόσο, σύγχρονοι ερευνητές χρησιμοποιούν όλο και περισσότερο ολιγοπωλιακές αγορές στην ανάλυσή τους. Όλη αυτή η σχετική έρευνα, ιδίως με τη συνδρομή των εργασιών των Coase (1937), Arrow (1964) και

[48] Θεωρούμε ότι η απόδοση των συγκεκριμένων όρων στα ελληνικά θα οδηγήσει μάλλον σε παρερμηνείες, καθώς αφορούν διεθνή ορολογία.

Williamson (1975) αλλά και με την επενέργεια ιδεών ενδογενούς ανάλυσης, κατέληξε στη διαμόρφωση ενός θεωρητικού υποδείγματος ανάλυσης της πολυεθνικής επιχείρησης.

Το ανωτέρω θεωρητικό υπόδειγμα εμπλουτίστηκε με τις επιπτώσεις των ΑΞΕ στην αγορά εργασίας και αντίστροφα. Ένα από τα πιο ενδιαφέροντα θέματα είναι και η χρησιμοποίηση της θεσμικής οργάνωσης της αγοράς εργασίας σε εργατικές ενώσεις ως εργαλείο πολιτικής, προκειμένου να προσελκύσει ή να αποτρέψει ΑΞΕ. Σε αυτό το θεωρητικό πλαίσιο ανάλυσης εμπίπτει και η έρευνα του πρώτου κεφαλαίου.

Το Υπόδειγμα:

Υποθέτουμε δυοπώλιο με ανταγωνισμό a la Cournot, όπου η τοπική επιχείρηση παράγει και διαθέτει το προϊόν της αποκλειστικά στην εγχώρια αγορά, ενώ η ξένη επιχείρηση (πολυεθνική) έχει τη δυνατότητα

- είτε να παράγει στο εξωτερικό και να πουλάει στην εγχώρια αγορά μέσω διεθνούς εμπορίου (εξαγωγές)
- είτε να παράγει και να πουλάει στην εγχώρια αγορά υλοποιώντας ΑΞΕ στην χώρα υποδοχής.

Η παραγωγή χαρακτηρίζεται από σταθερές αποδόσεις κλίμακας και απαιτεί μόνο εργασία για να παραχθεί το αγαθό. Η συνάρτηση παραγωγής ενσωματώνει τεχνολογία Leontief, διασφαλίζοντας ότι το κεφάλαιο είναι πάντοτε επαρκές για την παραγωγή του αγαθού. Πρόσθετα, θεωρούμε ότι η πολυεθνική επιχείρηση διαθέτει ανταγωνιστικό πλεονέκτημα έναντι της εγχώριας επιχείρησης (ακολουθώντας σχετική εργασία του Hymer), οπότε υποθέτουμε τεχνολογικό πλεονέκτημα της πολυεθνικής επιχείρησης που οδηγεί σε παραγωγικότητα $k > 1$.

Η αγορά εργασίας, και εγχώρια και στο εξωτερικό, είναι οργανωμένη σε εργατικές ενώσεις. Μελετώνται δύο διαφορετικοί τύποι συλλογικής οργάνωσης των εργατικών σωματείων και, επομένως, των συλλογικών διαπραγματεύσεων, βάσει των οποίων προσδιορίζεται κάθε φορά το επίπεδο των μισθών του κλάδου (και συνεπώς η απασχόληση):

– Αποκεντρωμένη δομή εργατικών ενώσεων / αποκεντρωμένες συλλογικές διαπραγματεύσεις. Σε αυτή τη περίπτωση, κάθε εργατικό σωματείο ξεχωριστά διαπραγματεύεται με την επιχείρηση τους μισθούς των μελών του, με σκοπό την μεγιστοποίηση της χρησιμότητάς του.

– Συντονισμός των εργατικών ενώσεων / κεντρικές συλλογικές διαπραγματεύσεις. Σε αυτή τη περίπτωση, η οποία προφανώς έχει νόημα μόνο αν η εγχώρια αγορά γίνει υποδοχέας ΑΞΕ, οι δύο εργατικές ενώσεις συντονίζονται μεταξύ τους και διαπραγματεύονται με κάθε μία επιχείρηση από κοινού τους μισθούς των μελών τους. Σκοπός των ενώσεων είναι η μεγιστοποίηση της συνολικής τους χρησιμότητας, ενώ κατά τις διαπραγματεύσεις λαμβάνουν υπόψη ότι στην περίπτωση που αυτές αποτύχουν με τη μία επιχείρηση, τότε οι διαπραγματεύσεις θα γίνουν μόνο με την άλλη, η οποία θα καταστεί μονοπωλητής. Αναγκαία προϋπόθεση για να συντονιστούν τα εργατικά σωματεία μεταξύ τους είναι οι χρησιμότητες και των δύο να αυξάνονται.

Σε ένα παίγνιο 5 σταδίων αναλύουμε τις στρατηγικές όλων των μερών και τις πιθανές ισορροπίες που θα προκύψουν:

- Στάδιο 1^{ο}: Απόφαση του κοινωνικού σχεδιαστή

(παρέμβαση ή μη στην αγορά εργασίας, θεσμοθετώντας συγκεκριμένο πλαίσιο συλλογικών διαπραγματεύσεων)

- Στάδιο 2^{ο}: Απόφαση της πολυεθνικής επιχείρησης

(ανταγωνισμός μέσω διεθνούς εμπορίου ή υλοποίηση ΑΞΕ)

- Στάδιο 3^{ο}: Απόφαση των εργατικών ενώσεων

(αποκεντρωμένη οργάνωση των εργατικών ενώσεων ή συντονισμός μεταξύ τους και κεντρικές διαπραγματεύσεις)

- Στάδιο 4^{ο}: Προσδιορισμός μισθού μέσω συλλογικών διαπραγματεύσεων
- Στάδιο 5ο: Ανταγωνισμός επιχειρήσεων a la Cournot.

Αποτελέσματα Έρευνας:

Τα αποτελέσματα της έρευνας αποκαλύπτουν ότι το θεσμικό πλαίσιο οργάνωσης των εργατικών ενώσεων κατά τις συλλογικές διαπραγματεύσεις μπορεί ενίοτε – και κάτω από συγκεκριμένες προϋποθέσεις – να λειτουργήσει ως εργαλείο πολιτικής,

προσελκύοντας ή αποτρέποντας ΑΞΕ. Γενικότερα, μπορούμε να διακρίνουμε τρεις διαφορετικές περιπτώσεις:

1. Όταν τα κέρδη της πολυεθνικής στην περίπτωση του διεθνούς εμπορίου είναι μεγαλύτερα από τα κέρδη που θα αποκομίσει στην περίπτωση των ΑΞΕ (είτε σε αποκεντρωμένη, είτε σε κεντρική δομή οργάνωσης). Σε αυτή την περίπτωση, η δομή των εργατικών ενώσεων δεν μπορεί να αποτελέσει ένα αποτελεσματικό εργαλείο πολιτικής προσέλκυσης ΑΞΕ. Το αποτέλεσμα της τελικής ισορροπίας θα είναι ανταγωνισμός μέσω διεθνούς εμπορίου (εξαγωγές).

2. Όταν τα κέρδη της πολυεθνικής σε κάθε περίπτωση των ΑΞΕ είναι μεγαλύτερα από τα αντίστοιχα κέρδη στην περίπτωση του διεθνούς εμπορίου. Στην περίπτωση αυτή, αφενός οι ΑΞΕ θα υλοποιηθούν στην τελική ισορροπία, αφετέρου η δομή των εργατικών ενώσεων δεν μπορεί να αποτελέσει ένα αποτελεσματικό εργαλείο πολιτικής αποτροπής ΑΞΕ. Οι εργατικές ενώσεις και ο κεντρικός σχεδιαστής θα προσαρμόσουν τις τακτικές τους εντός του πλαισίου των ΑΞΕ.

3. Τέλος, όταν τα κέρδη της πολυεθνικής στην μία περίπτωση των ΑΞΕ (είτε σε κεντρική είτε σε αποκεντρωμένη δομή) είναι μεγαλύτερα από τα αντίστοιχα κέρδη στην περίπτωση του διεθνούς εμπορίου ενώ ταυτόχρονα τα κέρδη στην άλλη περίπτωση των ΑΞΕ είναι μικρότερα από τα κέρδη που θα αποκομίσει στο διεθνές εμπόριο, το τελικό αποτέλεσμα δεν είναι εκ των προτέρων γνωστό και επηρεάζεται από τις στρατηγικές επιλογές των μερών. Σε αυτή την τελευταία περίπτωση, η δομή οργάνωσης της αγοράς εργασίας μπορεί να αποτελέσει ένα αποτελεσματικό εργαλείο πολιτικής προσέλκυσης ΑΞΕ.

Για την διερεύνηση των ανωτέρω, το κεφάλαιο δομείται ως εξής: Στην ενότητα 1.2. καταρτίζεται ένα γενικό δομικό μοντέλο ανάλυσης και αναλύονται οι βέλτιστες στρατηγικές όλων των μερών. Στην ενότητα 1.3. μετασχηματίζουμε κατάλληλα το υπόδειγμα προκειμένου να διερευνήσουμε τον ρόλο του μοναδιαίου κόστους

παραγωγής κατά το διεθνές εμπόριο και κατά την υλοποίηση των ΑΞΕ στην τελική ισορροπία, ενώ στην ενότητα 1.4. γίνεται αντίστοιχη ανάλυση για τον μισθό επιφύλαξης (reservation wage) της εγχώριας αγοράς και της αντίστοιχης στο εξωτερικό.

Η διερεύνηση των ανωτέρω υποδειγμάτων, κατέληξε στα εξής ειδικότερα:

Α. Από την ανάλυση του γενικού υποδείγματος, διερευνήθηκαν οι βέλτιστες πρακτικές και οι τελικές ισορροπίες που μπορούν να προκύψουν. Δεδομένης της πολυπλοκότητας του υποδείγματος, το οποίο πρέπει να επιλυθεί υπολογιστικά για να εξαχθούν αναλυτικά συμπεράσματα, αναδείχθηκε ότι οι διάφορες εφαρμοζόμενες πολιτικές του κοινωνικού σχεδιαστή μπορεί να έρχονται σε αντίθεση με τα συμφέροντα των επιμέρους οικονομικών μονάδων της οικονομίας (εργατικά σωματεία, επιχειρήσεις, καταναλωτές). Ακόμα, συμπέρασμα της ανάλυσης είναι και το ότι οι θεσμικές ρυθμίσεις οργάνωσης της αγοράς εργασίας μπορούν υπό προϋποθέσεις να προσελκύσουν ή να αποτρέψουν τις ΑΞΕ, ενώ υπάρχουν περιπτώσεις όπου η οργάνωση της αγοράς εργασίας αποδεικνύεται αναποτελεσματική ώστε να επηρεάσει τις πρακτικές των πολυεθνικών επιχειρήσεων. Σε αυτές τις περιπτώσεις, ο κοινωνικός σχεδιαστής πρέπει να αναζητήσει άλλες στρατηγικές προσέλκυσης ή αποτροπής των ΑΞΕ.

Β. Η ειδικότερη ανάλυση του υποδείγματος ως προς το μοναδιαίο κόστος παραγωγής, απέδειξε ότι αν το μοναδιαίο κόστος παραγωγής στην περίπτωση των εξαγωγών είναι χαμηλότερο από το αντίστοιχο στην περίπτωση των ΑΞΕ, τότε η δομή της αγοράς εργασίας είναι άσχετη με τις τελικές αποφάσεις για την πραγματοποίηση ή μη των ΑΞΕ. Ακόμα, αν το μοναδιαίο κόστος στην περίπτωση των ΑΞΕ είναι αρκετά υψηλό αλλά χαμηλότερο από το αντίστοιχο της περίπτωσης των εξαγωγών, τότε οι ΑΞΕ θα αποτραπούν ως βέλτιστη κοινωνική επιλογή, αφήνοντας την αγορά εργασίας να αυτό-ρυθμιστεί σε κεντρική βάση (centralized union structure). Αν τέλος, το μοναδιαίο κόστος στην περίπτωση των ΑΞΕ είναι αρκετά χαμηλό, τότε ο κεντρικός σχεδιαστής θα επιβάλλει αποκεντρωμένη δομή στην αγορά εργασίας (decentralized union structure), προσελκύοντας ΑΞΕ ως βέλτιστη κοινωνική επιλογή, ερχόμενος σε σύγκρουση με τα συμφέροντα των εργατικών σωματείων.

Γ. Τέλος, η διερεύνηση του υποδείγματος εστιάζοντας στον μισθό επιφύλαξης ανέδειξε ότι αν ο μισθός επιφύλαξης στην χώρα υποδοχής είναι υψηλότερος από τον αντίστοιχο στην ξένη αγορά, τότε η θεσμοθέτηση συγκεκριμένης δομής στην αγορά εργασίας δεν θα προσελκύσει ΑΞΕ. Από την άλλη, αν ο μισθός επιφύλαξης στη χώρα υποδοχής είναι αρκετά χαμηλός, τότε θα υλοποιηθούν οι ΑΞΕ ανεξάρτητα της δομής της αγοράς εργασίας. Σε αυτή τη περίπτωση, ο κεντρικός σχεδιαστής μπορεί να επιλέξει τη δομή αυτή που θα αποφέρει μεγαλύτερη κοινωνική ευημερία, πάντα στα πλαίσια των ΑΞΕ. Και σε αυτή τη περίπτωση αναδείχτηκε ότι είναι πιθανές οι αντιθέσεις μεταξύ του κοινωνικού σχεδιαστή και των λοιπών οικονομικών μονάδων στην οικονομία, καθώς έχουν διαφορετικούς στόχους, οι οποίοι δεν συμπίπτουν υποχρεωτικά.

Καινοτόμα τεχνικά στοιχεία της παρούσας έρευνας αποτελούν:

1. Η ενσωμάτωση στην ανάλυση της επιλογής των εργατικών ενώσεων για κεντρικές ή αποκεντρωμένες συλλογικές διαπραγματεύσεις ως στρατηγικό εργαλείο αποτροπής ή προσέλκυσης των ΑΞΕ σύμφωνα με το συμφέρον των εργατικών ενώσεων.
2. Η ενσωμάτωση στη συνάρτηση χρησιμότητας των εργατικών σωματείων της χρησιμότητας επιφύλαξης σε περίπτωση αποτυχίας των συλλογικών διαπραγματεύσεων, οπότε και οι διαπραγματεύσεις στη συνέχεια θα πραγματοποιηθούν μόνο με την άλλη επιχείρηση, η οποία θα λειτουργεί ως μονοπωλητής.

Η ανάλυση του παρόντος κεφαλαίου και τα ευρήματά της συμβάλλουν στην επέκταση της ήδη υπάρχουσας βιβλιογραφίας αναφορικά με την αλληλεπίδραση της οργανωμένης αγοράς εργασίας σε ενώσεις και των ΑΞΕ.

Κεφάλαιο 2ο: Union Oligopoly Bargaining and Undeclared Labour

Η έρευνα που διεξάγεται σε αυτό το κεφάλαιο εξετάζει τη φύση της αδήλωτης εργασίας και τις επιπτώσεις της στην αγορά εργασίας, στην αγορά του προϊόντος και την κοινωνική ευημερία.

Εισαγωγή:

Με τον όρο «αδήλωτη εργασία» περιγράφονται οι αμειβόμενες δραστηριότητες που είναι νόμιμες ως προς τη φύση τους, αλλά δεν δηλώνονται στις δημόσιες αρχές με συνέπεια την αποφυγή της φορολογίας και των αντίστοιχων εισφορών κοινωνικής ασφάλισης.

Οι επιπτώσεις της αδήλωτης εργασίας ποικίλλουν και εκτείνονται σε μάκρο-οικονομικό αλλά και σε μίκρο-οικονομικό επίπεδο: μειώνει τα έσοδα από τη φορολόγηση, υπονομεύει τη χρηματοδότηση των ασφαλιστικών ταμείων κοινωνικής ασφάλισης, είναι πηγή και ενισχύει το κοινωνικό ντάμπινγκ [49], εμπεριέχει το στοιχείο της κοινωνικής απάτης στην περίπτωση που η αδήλωτη εργασία επιδοτείται με κοινωνικά επιδόματα, δημιουργεί συνθήκες αθέμιτου ανταγωνισμού και προκαλεί παραγωγικές αναποτελεσματικότητες.

Είναι μια διαδικασία που εμπλέκονται και οι εργοδότες και οι εργαζόμενοι λόγω των πιθανών οικονομικών ωφελειών που θα αποκομίσουν από την μη καταβολή φόρων και εισφορών κοινωνικής ασφάλισης.

Λαμβάνοντας υπόψη την πολυπλοκότητα και την ετερογένεια της αδήλωτης εργασίας, είναι περισσότερο από προφανές ότι δεν υπάρχει κάποια απλή λύση για την αντιμετώπιση αυτού του φαινομένου. Εντούτοις, ένας από τους στόχους του Συμβουλίου της Ε.Ε. (ψήφισμα Συμβουλίου 2003) για την μετατροπή της αδήλωτης εργασίας σε κανονική απασχόληση, είναι να περιοριστεί η οικονομική ελκυστικότητα της αδήλωτης εργασίας. Για να επιτευχθεί ο στόχος αυτός, οι πολιτικές που προτείνονται, επικεντρώνονται στη φορολογία της υπερωριών, την

[49] Εκμετάλλευση του χαμηλότερου κόστους εργασίας σε μια χώρα (λόγω μειωμένων εισφορών κοινωνικής ασφάλισης), με σκοπό την προσέλκυση σε αυτήν επιχειρηματικών δραστηριοτήτων εις βάρος άλλων χωρών.

άρση των φορολογικών στρεβλώσεων μεταξύ των μισθοδοτούμενων εργαζομένων και των ελεύθερων επαγγελματιών και τη μείωση της φορολογίας των δραστηριοτήτων χαμηλής παραγωγικότητας.

Μέχρι τώρα, το συγκεκριμένο φαινόμενο δεν είχε αναλυθεί με εργαλεία βιομηχανικής οργάνωσης και θεωρίας παιγνίων. Αντίθετα, υπάρχει αφθονία άρθρων, που παρουσιάζουν την τρέχουσα κατάσταση, αναλύοντας και μετρώντας με στατιστικά εργαλεία και ερωτηματολόγια τις συνέπειες και την τάση αυτού του φαινομένου. Και παρά το γεγονός ότι η αδήλωτη εργασία περιγράφεται αρκετά καλά από τη σχετική αρθρογραφία (καθορισμός έννοιας, μέτρηση, καθορισμός πολιτικών για να σταματήσουν τη διάδοσή της κ.λ.π.), τα συμπεράσματα δεν στηρίζονται σε οποιοδήποτε θεωρητικό υπόδειγμα, το οποίο θα μπορούσε να δώσει αξιόπιστα αποτελέσματα και εφαρμογές πολιτικής.

Η παρούσα έρευνα αποτελεί την πρώτη (από όσο γνωρίζουμε) προσπάθεια δημιουργίας ενός θεωρητικού πλαισίου ανάλυσης με τα εργαλεία της Βιομηχανικής Οργάνωσης και της Θεωρίας Παιγνίων. Στοχεύει στην καλύτερη κατανόηση του φαινομένου της αδήλωτης εργασίας και του τρόπου λειτουργίας του, στην αποτύπωση των επιπτώσεων που έχει στις αγορές και στην κοινωνική ευημερία και στην παροχή νέων εργαλείων πολιτικής για την ελαχιστοποίηση (αν χρειάζεται) αυτού του φαινόμενου. Ακόμα, διερευνά την πιθανότητα ενδογενούς συμμόρφωση των επιχειρήσεων και των εργαζομένων βάσει ορθολογικών αποφάσεων.

Η όλη ιδέα στηρίζεται στο κόστος ευκαιρίας που υπάρχει από το γεγονός ότι εάν μια επιχείρηση δεν ασφαλίσει το προσωπικό της, θα προκύψει μεγαλύτερος φόρος κερδών. Οπότε, οι επιχειρήσεις έχουν την επιλογή

- είτε να ασφαλίσουν το προσωπικό τους – καταβάλλοντας μειωμένο φόρο / αυξημένες εισφορές κοινωνικής ασφάλισης,
- είτε να μην ασφαλίσουν το προσωπικό τους – καταβάλλοντας αυξημένο φόρο / μειωμένες εισφορές κοινωνικής ασφάλισης.

Σε όλη αυτή την υπόθεση εργασίας, συνεκτιμώνται ανάλογα οι επιλογές των εργατικών σωματείων καθώς και η ακολουθούμενη πολιτική του κεντρικού σχεδιαστή.

Τα Υποδείγματα - Αποτελέσματα:

Για την διερεύνηση του φαινομένου, χρησιμοποιήθηκαν τρία διαφορετικά υποδείγματα σε αντίστοιχες ενότητες:

Α. Το πρώτο υπόδειγμα εξετάζει το φαινόμενο της αδήλωτης εργασίας σε ένα δυοπώλιο Cournot με εξωγενώς καθορισμένους μισθούς, όπου η πρώτη επιχείρηση ασφαλίζει το προσωπικό της ενώ η δεύτερη εφαρμόζει αδήλωτη εργασία. Το αρχικό αυτό υπόδειγμα χρησιμοποιείται για να αναδείξει με απλό τρόπο το δημιουργούμενο κόστος ευκαιρίας μεταξύ φορολόγησης και εισφορών κοινωνικής ασφάλισης και ουσιαστικά χρησιμοποιήθηκε ως διερευνητικό υπόδειγμα για τα υπόλοιπα μοντέλα. Για την κατασκευή του υποδείγματος χρησιμοποιήθηκε αναλογικός φορολογικός συντελεστής για τις επιχειρήσεις, ενσωματώθηκαν οι φόροι και οι εισφορές κοινωνικής ασφάλισης στις συναρτήσεις κερδών, ενώ δεν λήφθηκαν υπόψη οποιεσδήποτε συλλογικές διαπραγματεύσεις και οι προτιμήσεις των εργατικών σωματείων.

Τα αποτελέσματα της ανάλυσης επιβεβαίωσαν την στενή αλληλεπίδραση που υπάρχει μεταξύ της φορολόγησης και των εισφορών κοινωνικής ασφάλισης ως προς τη διαμόρφωση των τελικών κερδών των επιχειρήσεων. Προσδιορίστηκε η κριτική τιμή του φορολογικού συντελεστή (συναρτήσει του συντελεστή εισφορών κοινωνικής ασφάλισης), πάνω από την οποία οι επιχειρήσεις απολαμβάνουν μεγαλύτερα κέρδη δηλώνοντας και ασφαλίζοντας το προσωπικό τους (οπότε απαλείφονται τα όποια κίνητρα για αδήλωτη εργασία από πλευράς επιχειρήσεων).

Β. Το δεύτερο υπόδειγμα αφορά επίσης ένα δυοπώλιο Cournot σε παίγνιο 2 σταδίων. Ωστόσο, στο υπόδειγμα αυτό εμβαθύνουμε ακόμα περισσότερο σε ανάλυση, ενδογενοποιώντας το – βέλτιστο – ποσοστό αδήλωτης εργασίας που θα επιλέξει η κάθε επιχείρηση και χρησιμοποιώντας τεχνικές συλλογικών αποκεντρωμένων διαπραγματεύσεων για τον προσδιορισμό του μισθού (και συνεπώς της απασχόλησης). Ακόμα, ενδογενοποιείται ο τρόπος που μοιράζονται τα οφέλη από την αποφυγή καταβολής ασφαλιστικών εισφορών μεταξύ επιχειρήσεων

και εργαζομένων, χρησιμοποιείται προοδευτικός φορολογικός συντελεστής για τις επιχειρήσεις και αναλογικός για τους εργαζομένους, ενώ ενσωματώνονται στις συναρτήσεις χρησιμότητας των εργατικών σωματείων το όφελος από την ασφάλιση (παροχή σε είδος) και ο φόρος που καταβάλλουν οι εργαζόμενοι. Τέλος, κατασκευάστηκε ένα αντίστοιχο υπόδειγμα χωρίς αδήλωτη εργασία, το οποίο χρησιμοποιήθηκε ως σημείο αναφοράς και μέτρο σύγκρισης.

Από την ανάλυση προέκυψε ότι υπάρχει τέτοια κριτική τιμή του συντελεστή φορολόγησης (συναρτήσει και του ποσοστού κοινωνικής ασφάλισης), κάτω από την οποία το βέλτιστο για τις επιχειρήσεις ποσοστό αδήλωτης εργασίας θα αποδώσει μεγαλύτερους μισθούς, μεγαλύτερη ποσότητα στην αγορά (και συνεπώς απασχόληση), μεγαλύτερο πλεόνασμα καταναλωτή και χαμηλότερη τιμή. Ακόμα, αποδείχτηκε διαγραμματικά ότι - κάτω από προϋποθέσεις - η αδήλωτη εργασία μπορεί να αποδώσει μεγαλύτερα κέρδη στις επιχειρήσεις, μεγαλύτερη χρησιμότητα στα εργατικά σωματεία και πρόσθετα μπορεί να αυξήσει τα κρατικά έσοδα και την κοινωνική ευημερία. Τέλος, προτάθηκε ως μέτρο πολιτικής συγκεκριμένος φορολογικός συντελεστής (συναρτήσει του ποσοστού εισφορών κοινωνικής ασφάλισης), ο οποίος λειτουργεί ως βέλτιστος κατά Pareto στην περίπτωση της αδήλωτης εργασίας. Ειδικότερα, αποδείχθηκε ότι εφόσον χρησιμοποιηθεί ο προτεινόμενος φορολογικός συντελεστής, η εφαρμογή του βέλτιστου ποσοστού αδήλωτης εργασίας από τη μεριά των επιχειρήσεων, θα αποφέρει τουλάχιστον ίδιους ή και μεγαλύτερους μισθούς, ποσότητες και συνεπώς απασχόληση, κέρδη, χρησιμότητα των εργατικών σωματείων, πλεόνασμα καταναλωτή και κοινωνική ευημερία σε σύγκριση με την αντίστοιχη αγορά χωρίς αδήλωτη εργασία. Ωστόσο η πολιτική αυτή απαιτεί εναλλακτικούς τρόπους χρηματοδότησης, καθώς αποφέρει μειωμένα κρατικά έσοδα.

Γ. Στο τρίτο υπόδειγμα αναπτύσσεται ένα matrix game σε αμιγείς στρατηγικές (pure strategies), στο οποίο οι επιχειρήσεις εναλλακτικά είτε ασφαλίζουν όλο το προσωπικό τους είτε όχι. Για την κατασκευή του υποδείγματος χρησιμοποιήθηκε αναλογική άμεση φορολόγηση σε επιχειρήσεις και εργαζόμενους και έμμεσος φορολογικός συντελεστής, εφαρμοζόμενος στα έσοδα των επιχειρήσεων.

Στρατηγικά, για την εκδήλωση του φαινομένου της αδήλωτης εργασίας καθορίστηκε η συμπαιγνία μεταξύ επιχειρήσεων και εργατικών σωματείων ως αναγκαία προϋπόθεση.

Εξετάστηκαν τρεις διαφορετικές περιπτώσεις πιθανής ισορροπίας (και οι δύο επιχειρήσεις ασφαλίζουν, καμία δεν ασφαλίζει, η μία ασφαλίζει ενώ η άλλη όχι), διερευνήθηκαν οι πιθανότητες μονομερούς απόκλισης (unilateral deviations) των εργατικών σωματείων και των επιχειρήσεων από τις αρχικές τους επιλογές και εν τέλει αναζητήθηκε ισορροπία του υποδείγματος κατά Nash.

Η έρευνα κατέληξε στο συμπέρασμα ότι και οι τρεις περιπτώσεις μπορούν υπό προϋποθέσεις να αποτελέσουν ισορροπίες κατά Nash, ενώ προσδιορίστηκαν και οι κριτικές τιμές των παραμέτρων για να μην υπάρχουν κίνητρα για μονομερείς αποκλίσεις.

Κεφάλαιο 3ο: Efficiency of Price Competition Versus Quantity Competition in Unionized Oligopoly

Στο τρίτο κεφάλαιο αναπτύχθηκε ένα υπόδειγμα δυοπωλίου με αποκεντρωμένες διαπραγματεύσεις μισθών, προκειμένου να διερευνηθεί εάν είναι εφικτό η ατζέντα των συλλογικών διαπραγματεύσεων να περιλαμβάνει - εκτός των μισθών - και την απασχόληση και κατά πόσο επηρεάζεται από τον τύπο του ανταγωνισμού (ως προς τις τιμές ή ως προς τις ποσότητες). Ακόμα, αντικείμενο έρευνας αποτέλεσε και η ανάδειξη της περισσότερο αποτελεσματικής – σε κοινωνικούς όρους – ατζέντας συλλογικών διαπραγματεύσεων ανά τύπο ανταγωνισμού.

Εισαγωγή:

Θεμελιώδη στοιχεία στην σύγχρονη ολιγοπωλιακή θεωρία αποτελούν τα υποδείγματα Cournot-Nash, όπου οι επιχειρήσεις ανταγωνίζονται προσαρμόζοντας η κάθε μία τις ποσότητες που θα προσφέρει στην αγορά, και τα υποδείγματα Bertrand-Nash, όπου οι επιχειρήσεις ανταγωνίζονται στις τιμές. Τα υποδείγματα αυτά απαντώνται και στην πραγματική οικονομία [Tremblay and Tremblay (2011), Tremblay et al. (2013)], ενώ παρέχουν σημαντικές εφαρμογές στη θεωρία και την πρακτική της Βιομηχανικής Οργάνωσης [Vives (2001)].

Αναφορικά με την αγορά εργασίας, η οργάνωσή της σε εργατικές ενώσεις αποτελεί ένα συχνό φαινόμενο, ιδίως στην Ευρώπη [βλ. π.χ. Hartog and Theeuwes (1992)]. Μπορούμε να διακρίνουμε δύο βασικούς τύπους διαπραγματεύσεων των εργατικών ενώσεων με τις επιχειρήσεις:

1. “Right-to-Manage”, όπου αφορά τη διαπραγμάτευση μόνο των μισθών [βλ. π.χ. Nickell and Andrews (1983)]
2. “Efficient Bargains”, όπου αφορά τη διαπραγμάτευση από κοινού των μισθών και της απασχόλησης [βλ. McDonald and Solow (1981), MacCurdy and Pencavel (1986), Alogoskoufis and Manning (1991), Petrakis and Vlassis (2000)].

Η παρούσα σχετική βιβλιογραφία φαίνεται να τείνει στο συμπέρασμα ότι συγκριτικά με τον ανταγωνισμό στις ποσότητες και τη διαπραγμάτευση μόνο για τους μισθούς (right-to-manage), ο ανταγωνισμός ως προς τις τιμές και οι

διαπραγματεύσεις από κοινού των μισθών και της απασχόλησης (efficient bargaining) αποδίδουν μεγαλύτερη παραγωγή, απασχόληση και πλεόνασμα καταναλωτή. Ωστόσο, η μέχρι τώρα βιβλιογραφία δεν έχει εξετάσει ακόμα εάν οι διαπραγματεύσεις μόνο των μισθών ή/και οι διαπραγματεύσεις από κοινού μισθών και απασχόλησης μπορούν να υφίστανται σε ανταγωνισμό ως προς τις τιμές.

Έρευνες σε ένα μη συνδικαλισμένο θεωρητικό πλαίσιο δυοπωλίου έχουν αποδείξει ότι ο ανταγωνισμός ως προς τις τιμές υποκατάστατων αγαθών είναι περισσότερο αποτελεσματικός (ως προς τις ποσότητες και το πλεόνασμα καταναλωτή) στην ισορροπία σε σχέση με τον ανταγωνισμό ως προς τις ποσότητες [βλ. π.χ. Singh and Vives (1984)]. Ωστόσο, το αποτέλεσμα αυτό καθίσταται ανίσχυρο καθώς η βιομηχανία επεκτείνεται σε μεγαλύτερο αριθμό επιχειρήσεων [βλ. π.χ. Hackner (2000)].

Ακόμα, σε μια ολιγοπωλιακή αγορά ν επιχειρήσεων που ανταγωνίζονται ως προς τις ποσότητες και με αγορά εργασίας οργανωμένη σε εργατικά σωματεία, που συλλογικά διαπραγματεύονται την ατζέντα εργασιακών θεμάτων, οι Πετράκης και Βλάσσης (2000) απέδειξαν ότι σε ανταγωνισμό ως προς τις ποσότητες, οι διαπραγματεύσεις από κοινού για μισθούς και απασχόληση θα αποδώσουν στην ισορροπία μεγαλύτερη αποτελεσματικότητα, σε σύγκριση με τις διαπραγματεύσεις ως προς τους μισθούς μόνο.

Στο τρίτο κεφάλαιο διερευνούμε όλους τους πιθανούς συνδυασμούς (Cournot/Bertrand competition, Right-to-Manage/Efficient Bargaining) ενώ παράλληλα αποτιμώνται σε όρους αποτελεσματικότητας στην τελική ισορροπία.

Το Υπόδειγμα:

Στο κεφάλαιο αυτό αναπτύσσονται υποδείγματα συνδικαλισμένων δυοπωλίων διαφοροποιημένων προϊόντων με αποκεντρωμένες συλλογικές διαπραγματεύσεις [βλ. Petrakis and Vlassis (2000)]. Υποθέτουμε ότι πριν τον τελικό ανταγωνισμό ως προς τις ποσότητες ή ως προς τις τιμές και πριν τις συλλογικές διαπραγματεύσεις ως προς τους μισθούς ή ως προς τους μισθούς και την απασχόληση, ξεχωριστά το κάθε ζεύγος επιχείρησης – εργατικού σωματείου από κοινού αποφασίζει για τα θέματα της ατζέντας διαπραγματεύσεων. Κάθε προσδιοριζόμενη ατζέντα διαπραγματεύσεων θεωρούμε ότι είναι παρατηρήσιμη από το άλλο ζευγάρι

επιχείρησης – εργατικού σωματείου πριν τις διαπραγματεύσεις. Επίσης, εξετάζονται ενδογενώς και οι δύο τρόποι ανταγωνισμού στην τελική ισορροπία, και ως προς τις ποσότητες, και ως προς τις τιμές.

Συνεπώς, διαμορφώνεται ένα παίγνιο 3 σταδίων ως εξής:

- Στάδιο $1^{ο}$: Οι επιχειρήσεις και οι εργατικές ενώσεις αποφασίζουν για την ατζέντα των διαπραγματεύσεων.
- Στάδιο $2^{ο}$: Διαδικασία διαπραγματεύσεων επί των θεμάτων της ατζέντας.
- Στάδιο $3^{ο}$: Ανταγωνισμός ως προς τις τιμές ή ως προς τις ποσότητες, εφόσον έχει επιλεγεί ως ατζέντα διαπραγματεύσεων μόνο οι μισθοί από όλα τα μέρη.

Συμπεράσματα:

Τα συμπεράσματα της έρευνας δείχνουν ότι όταν οι επιχειρήσεις ανταγωνίζονται στις τιμές, η ατζέντα διαπραγματεύσεων για κάθε ζεύγος επιχείρησης και εργατικής ένωσης στην τελική ισορροπία θα αφορά μόνο τους μισθούς. Στην περίπτωση που οι επιχειρήσεις ανταγωνίζονται στις ποσότητες, και με την προϋπόθεση ότι η διαπραγματευτική δύναμη των εργατικών ενώσεων είναι αρκετά χαμηλή, τότε προκύπτει ότι η ατζέντα διαπραγματεύσεων στην ισορροπία θα περιλαμβάνει εκτός από τον μισθό και την απασχόληση για τουλάχιστον ένα ζεύγος επιχείρησης και εργατικής ένωσης.

Τα ευρήματα αυτά υποδεικνύουν ότι ο ανταγωνισμός στις ποσότητες μπορεί να αποδειχθεί πιο αποτελεσματικός από αυτόν στις τιμές, καθώς μπορεί να αποφέρει μεγαλύτερο πλεόνασμα καταναλωτή και μεγαλύτερη κοινωνική ευημερία. Σε αυτό το συμπέρασμα συμβάλλουν οι εργατικές ενώσεις με καταλυτικό τρόπο: όσο λιγότερο αγωνιστική είναι η εργατική ένωση, τόσο πιο πιθανό είναι να προκύψει ατζέντα διαπραγματεύσεων με αντικείμενα και τον μισθό και την απασχόληση (efficient bargaining) και συνεπώς να αυξήσουν την αποτελεσματικότητα σε κοινωνικούς όρους. Αντίθετα, όταν οι εργατικές ενώσεις είναι αρκετά αγωνιστικές, τότε μπορούν να αποτρέψουν τις αποτελεσματικές διαπραγματεύσεις με αποτέλεσμα την μείωση της κοινωνικής ευημερίας και εν τέλει των μισθών τους.