University of Crete
School of Sciences and Engineering
Computer Science Department

A Value Network for the Banking Sector: Business Models for the Mortgage Service System

by

MARIA N. KOULENTAKI

Master's Thesis

Heraklion, March 2010

University of Crete
School of Sciences and Engineering
Computer Science Department

A Value Network for the Banking Sector: Business Models for the Mortgage Service System

by

MARIA N. KOULENTAKI

A thesis submitted in partial fulfilment of the
requirements for the degree of
MASTER OF SCIENCE

Author: ______________________________
Maria N. Koulentaki, Computer Science Department

Supervisory Committee: ______________________________
Christos N. Nikolaou, Professor, Supervisor

____
Dimitrios Plexousakis, Professor, Member

____
Konstantinos Panagiotakis, Visiting Professor, Member

Approved by: ______________________________
Panos Trahanias, Professor
Chairman of the Graduate Studies Committee

“A Value Network for the Banking Sector: Business Models for the Mortgage Service System”

Koulentaki Maria

Master of Science Thesis

Computer Science Department
University of Crete

Abstract

The cornerstone for the beginning of the recent economic crisis was the increase of non-performing Mortgage loans of banks in United States. This crisis expanded rapidly in all over the world and had a significant impact on the global economy. This crisis represents both a challenge and an opportunity in a service-oriented economy. In this research, we attempt to apply the Value Network theory in order to model the Mortgage loan service system of the banking sector. This Value Network mainly aims to improve competitiveness and increase the value of services provided through the design, modelling and implementing business processes. We aim to demonstrate the applicability of this value network methodology to the Bank environment in a real, value-delivering situation of a mortgage service.

We propose business models in order to help managers to capture, understand, design, analyze and change the business logic of their company. In particular, we use the Vensim simulation tool, to analyze the Basic model, the Non-Performing loan model, the Price Discrimination model and the Branch Performance Evaluation model. We examine the main structure and some common and useful cases of a bank Mortgage Service system. Taking advantage of the simulation results, a bank may come up to determinant decisions such as to improve customer satisfaction, provide options and analysis models adjusted to its own needs and identify best practice value drivers for profit maximization and cost reduction.

Supervisor Professor: Christos N. Nikolaou
Professor of Computer Science Department
University of Crete

«Ένα Δίκτυο Αξίας στον Τραπεζικό Τομέα. Επιχειρηματικά Μοντέλα για την Υπηρεσία των Στεγαστικών Δανείων»

Κουλεντάκη Μαρία

Μεταπτυχιακή Εργασία

Τμήμα Επιστήμης Υπολογιστών
Πανεπιστήμιο Κρήτης

Περίληψη

Ο ακρογωνιαίος λίθος για την έναρξη της πρόσφατης οικονομικής κρίσης ήταν η αύξηση των μη εξυπηρετούμενων στεγαστικών δανείων των τραπεζών στις Ηνωμένες Πολιτείες. Η κρίση αυτή επεκτάθηκε ραγδαία σε όλο τον κόσμο και είχε σημαντικό αντίκτυπο στην παγκόσμια οικονομία. Η κρίση αυτή αποτελεί συγχρόνως πρόκληση αλλά και ευκαιρία σε μια οικονομία προσανατολισμένη σε υπηρεσίες. Στην παρούσα έρευνα, προσπαθούμε να εφαρμόσουμε την θεωρία των Δικτύων Αξίας, προκειμένου να μοντελοποιήσουμε το σύστημα της υπηρεσίας των στεγαστικών δανείων στον τραπεζικό κλάδο. Αυτό το Δίκτυο Αξίας κυρίως στοχεύει να βελτιώσει την ανταγωνιστικότητα και να αυξήσει την αξία των υπηρεσιών που παρέχονται μέσα από το σχεδιασμό, τη μοντελοποίηση και την υλοποίηση των επιχειρηματικών διαδικασιών.

Προτείνουμε επιχειρηματικά μοντέλα με σκοπό να βοηθήσουμε τους επικεφαλής ως προς τη σύλληψη, την κατανόηση, το σχεδιασμό, την ανάλυση και την αλλαγή της επιχειρησιακής λογικής της εταιρεία τους. Συγκεκριμένα, χρησιμοποιούμε το εργαλείο προσομοίωσης Vensim PLE και αναλύουμε το Βασικό μοντέλο, το μοντέλο των μη Εξυπηρετούμενων δανείων, το μοντέλο της πολιτικής Διάκρισης Τιμών και το μοντέλο Αξιολόγησης της Απόδοσης Υποκαταστήματος. Εξετάζουμε την κύρια δομή και ορισμένες συνήθεις και χρήσιμες περιπτώσεις του συστήματος υπηρεσίας στεγαστικών δανείων. Έχοντας ως πλεονέκτημα τα αποτελέσματα της προσομοίωσης, μια τράπεζα μπορεί να καταλήξει σε αποφάσεις καθοριστικού χαρακτήρα, όπως αποφάσεις για να βελτιώσει την ικανοποίηση των πελατών, να παρέχει επιλογές και μοντέλα ανάλυσης προσαρμοσμένα στις δικές της ανάγκες και τέλος να αναγνωρίσει εντοπίσει τους παράγοντες εκείνους που οδηγούν στις καλύτερες στρατηγικές για την μεγιστοποίηση των κερδών και μείωση του κόστους.

Επόπτης Καθηγητής: Χρήστος Ν. Νικολάου
Καθηγητής τμήματος Επιστήμης Υπολογιστών
Πανεπιστήμιο Κρήτης

Ευχαριστίες

Καταρχήν θέλω να ευχαριστήσω θερμά τον επόπτη καθηγητή μου κ. Νικολάου Χρήστο για την καθοδήγησή του, δίνοντάς μου πολύτιμες συμβουλές ώστε να ολοκληρώσω τις μεταπτυχιακές μου σπουδές.

Επίσης, ευχαριστώ ιδιαιτέρως την καθηγήτρια κα Μπιτσάκη Μαρίνα για τη συνεχή και αποτελεσματική βοήθειά της, καθώς και για την αμέριστη συμπαράστασή της καθ’ όλη τη διάρκεια εκπόνησης της διπλωματικής μου εργασίας.

Θα ήθελα επίσης να ευχαριστήσω τις φίλες μου Πετούση Μαρία, Κοπιδάκη Στέλλα, Μαυράκη Γιάννα, Κολυβάκη Γαρυφαλιά, Μπουράκη Πόπη, Σερδενέ Γιωργία και Καλαϊτζάκη Μαρία για την ενθάρρυνση, την υποστήριξη και την κατανόησή τους όλο αυτό το διάστημα.

Επιπλέον, ένα μεγάλο ευχαριστώ προς τους συναδέλφους μου στην Εθνική Τράπεζα που με την υποστήριξη και την κατανόησή τους με βοήθησαν να ανταποκριθώ στις δύσκολες απαιτήσεις του μεταπτυχιακού αυτού προγράμματος.

Τέλος, θα ήθελα να ευχαριστήσω ολόψυχα τους γονείς μου Νικόλαο και Ευσεβία, τα αδέρφια μου Βασίλη και Αντώνη και τις οικογένειές τους για την αγάπη και την υπομονή τους αλλά και για την αμέριστη συμπαράστασή τους που υπήρξε και εξακολουθεί να υπάρχει σε όλα τα βήματα της ζωής μου.

Σας ευχαριστώ πολύ!

Αφιερωμένο στον αδερφό μου Σταύρο που μπορεί να μην είναι πλέον κοντά μας, αλλά θα είναι πάντα μέσα στην καρδιά μου,

και

στα ανηψάκια μου Σέβη, Ευαγγελία και Νικολιό που με εμπνέουν και με την αγάπη και το χαμόγελό τους μου δίνουν δύναμη...

Table of Contents

List of Figures

List of Graphs

List of Tables

1 Introduction

1.1 Motivation

The subprime mortgage crisis that firstly appeared in 2007 in United States incurred the collapse of the financial industry and generally of the global economy. This crisis in conjunction with the competitive, rapidly changing and increasingly uncertain economic environment makes business decisions more and more complex and difficult. Companies come up with new communication and information technologies, shorter product life cycles, global markets and tougher competition. Due to this hostile and uncertain business environment, firms must achieve in managing multiple channels, complicated supply chains, expensive IT implementations, strategic partnerships and still stay flexible enough to react to market changes and economic fluctuations. Surprisingly, there are still few tools and concepts which can help managers in their strategic business decisions in this difficult period. Therefore, it is obvious the need of creating value network systems, which mainly aim to improve competitiveness and increase the value of services provided through the design, modelling and implementing business processes. Moreover, modelling the mortgage business process would make it easier for business people to understand better its structure and realize new business opportunities. Although most managers have an intuitive understanding of how a company works and how value is created, they are rarely able to manage it systematically without modelling business activities. A business model is an abstract representation of the business logic of a company. This business logic corresponds to an abstract understanding of how the firm makes money, what and to whom it provides and finally how it can accomplish this. Thus, by introducing a business model for mortgage services, managers will be able to understand why mortgages was the reason of bank failures and its domino effect (see Appendix:Subprime mortgage crisis) that later on affected the global economy. In general the purpose of creating a model is to help understand, describe and predict how companies operate in the real world by exploring a simplified representation of a particular entity or phenomenon.

1.2 Literal Review

There has been very little research in the area of value networks. Even though there is an effort in other areas to use Value Networks and create the necessary business models to achieve their goals, there isn't any business model for the mortgage service of a bank or even any other service provided by it in general. One effort has been made in the pharmaceutical industry (Edwards, 2009). Industry was under pressure to reduce costs and increase sales with the existing medicines. Thus, to answer the need for the industry to improve its productivity and regain its innovative edge, Paul J. Edwards applied the NalueNet Works™ methodology (Allee V. , 2008) to the innovation story behind the new use of some medicines. Edwards traces the development path through the identification of participants or roles, tangible and intangible deliverables, and the analysis of their interactions. This research was indented to demonstrate the utility the methodology followed in helping to discovery value inflection points that impact Pharmaceutical innovation and productivity. This has successfully been carried out with the discovery of several such value-drivers for Pharmaceutical research, giving a deeper understanding of value delivery within this network. Additionally, one more research in Value Networks was made in the area of repair service systems (Caswell et al, 2008). It was an empirical case research based on companies that take up with the planning, designing and manufacturing of their products and services. The result of this research showed the value they deliver, how they deliver it, and how value can be discovered and increased in service systems. In general, there have been researches in Value Networks theory in many research areas except for the banking sector.

This research is a first attempt to approach the banking sector and especially the Mortgage Service from the Value Network theory point of view. By creating a business model for the Mortgage loan services, we will be able to investigate and understand the interesting world of Mortgages, which was the source of the recent global crisis. As far as the proposing tutor is concerned no such study is reported in the literature. In this respect, the value of this study is expected to be significant.

1.3 Research Objectives

On the occasion of global economic crisis, there was a need to understand the operation of the mortgage service. By modelling a mortgage service system any bank will be able to observe its value gained from this specific service, according to the parameters that are important to her, as interest rate or other qualitative parameters. It can be applied either to a bank or any financial institution. The main objective is to demonstrate the applicability of the value network methodology to the Bank environment in a real, value-delivering situation of a mortgage service. It is very important to understand how value is delivered among the stakeholders, so as to identify best practice value drivers for profit maximization and cost reduction. In addition, this business model will help managers to capture, understand, communicate, design, analyze and change the logic of their firm (Fensel, 2001). In this thesis, we apply the theory of Value Networks to the Mortgage Service System. Our objectives are:

- ✓ To capture the logic of a business model in the Mortgage service system and provide a comprehensive structure of its components. This formalization of business models helps managers to collaborate with their partners and interact with their customers to their benefit.

- ✓ To determine the value of the various participants in the Value Network. Value estimation helps participants make decisions such as whether it is profitable to participate in that network or in a competitive one.

- ✓ To identify the factors, which affect the value of the participants. It is of significant importance for the bank or any of the participants to be able to manipulate those factors and apply sensitivity analysis in order to determine their effect.

- ✓ To help the keystone players (i.e. bank) to design and implement strategic policies in order to improve their performance and optimize their value.

- ✓ Last but not least, we aim to propose a methodology that it can be easily modified and extended to satisfy participants' needs and expectations.

1.4 Structure of this Thesis

The remainder of this dissertation is organized as follows:

Chapter 2 provides a brief description of Value Networks, the model proposed in the literature and the basic tools used for the modelling and simulation purposes.

Chapter 3 presents the Mortgage loan theory so as to understand the business model logic we are going to follow and also understand the transformation from the Mortgage theory to the Value Network theory and the design of the business models.

Chapter 4 describes the business models used in our research. These are the Basic model, the Non-Performing Loans model, the Price Discrimination model and the Branch Performance Evaluation model.

Chapter 5 performs the evaluation of business models and analyzes the empirical results based on the simulation of different cases in each model.

Chapter 6 presents some conclusions of the whole research work and discusses directions for future work.

2 Value Networks

New forms of entrepreneurship and the development of new technologies have radically changed the traditional ways in which firms manage the functions of design, manufacture and distribution of goods and services. The environment, in which a company evolves, includes complex relationships between competitors and partners and increases the need for mutual development and cooperation. In this context, features like transformation and modelling of business leading to the creation of systems, are organized as value networks. The value networks are complex systems consisting of entities that interact and cooperate to produce economic value. The key objective is to improve competitiveness and increase the value of services provided through the design, modelling and implementing business processes.

Most of us spend a significant part of our day participating in at least one organization. Every organization has a unique pattern of interactions. These often seem at cross-purposes or counterproductive. Different parts of the organization can work against each other, suboptimizing the function of the whole. Organizations are complex systems, frequently frustrating and difficult to work with-and there are simply too many variables to map or to fully understand.

Value network are complex sets of social and technical resources that create business, economic and social value. Value networks are the way people naturally organize around roles and resources to create value. Value is created through tangible and intangible exchanges between roles as people go about their work. Value networks operate in public agencies, civil society, in the enterprise, institutional settings, and all forms of organization. Companies have both internal and external value networks. External facing networks include customers or recipients, intermediaries, stakeholders, open innovation networks and suppliers. Internal value networks focus on key activities, processes and relationships that cut across internal boundaries, such as order fulfilment, innovation, lead processing, or customer support. Local, regional and global value networks advance innovation, wealth, social good and environmental well-being.

Over the past few years, much work on the Value Net-works area has been done by Verna Allee. Her definition for a Value Network is the following: "*A value network is any web relationship that generates both tangible and intangible value through complex dynamic exchanges between two or more individuals, groups, or organizations. People in organizations an enterprise networks engage in many different types of business interactions other than just exchanges of goods, services, and revenue. They also exchange knowledge and other intangibles such as favors and benefits in order to build relationships and ensure that everything runs smoothly*." (Allee V. , 2003). This knowledge and other intangible exchanges are not just activities that support the business model, they are part of the business model. This is very important difference between this approach and traditional business analysis.

Viewing an enterprise as a value network brings greater understanding of the "real" business model than does traditional value chain thinking. Virtually any purposeful organization or group can be understood as a value network, whether private industry, government, or public sector.

An approach by J. Hamilton that refers to Service Value Networks, defines them as 'the flexible, dynamic, delivery of a service, or product, by a business's coordinated value chains (supply chains and demand chains working in harmony), such that a value-adding, specific, service solution is effectively, and efficiently, delivered to the individual customer (Hamilton, 2004). Observe here, that Hamilton in this definition adopts the aforementioned arguments about services and products.

2.1 Major Models for Value Networks

To understand the delivery and exchange of service value is an essential step in analyzing and evaluating Service Value Networks. Since we talk about networks, there is a need that all participants have a common understanding of how service is delivered. Conceiving a conceptual model of Value Networks is an easy way to achieve this task (Gordijn J. , 2003). Various approaches have been proposed to create a modelling language for firm interactions. Our literature survey identifies the following models as interesting attempts to represent inter-organization exchanges: the e3-value modelling framework (Gordijn, Akkermans, & Van Vliet, 2000), the c3-value modelling framework (Weigand, H. et al , 2007) and the Allee's modeling framework (Allee V. , 2003).

2.1.1 The e3-value model

The e3-value modelling approach is a conceptual representation that has its basis in the ARA model view of the industry. The e3-value network (Gordijn, Akkermans, & Van Vliet, 2000) assumes the following core entities. *An Actor* is an economically independent entity representing a company, an organization, or a customer, and not a legal entity. A *Value object* is what is being exchanged between actors with the exchange done through a *Value Port,* which is a connection point between the Actor and the outside word. The value object could be a service, good or money that has an economic value to at least one the Actor. *A value exchanged* connects to a Value port and represents a pipe through which a value object could be potentially traded. *A value interface* is a group of value ports. *A value activity* is performed by an actor motivated by a potential profit. A *Market Segment* is a clustering of actors that assign economic value to object equally, and is typically used to model an group end-consumer with similar interest.

The e3-value model is an efficient modelling framework that has been used in wide array of modelling engagements (Gordijn, Akkermans, & Van Vliet, 2000). The e3-value methodology has been applied to a real world business case and evaluated one-year-and a-half later (Gordijn & Akkermans, 2003). Lessons learned include that the method is lacking a marketing perspective, that business units should be included in the analysis and that it would be helpful to work with evolutionary scenarios. However, Gordijn and Akkermans are positive about their methodology enhancing the common understanding of business ideas, which was not possible by traditional e.g. verbal ways. Furthermore, they believe that a model-based approach to business problems can help assess the consequences of changes in business models.

2.1.2 The c3-value model

The c3-value modelling scheme (Weigand, H. et al , 2007) is an extension of the e3-value model geared toward strategic analysis. Starting from the resource-based view of the firm (RBV), with its claim that sustained competitive advantage is gained by owning strategic resources that are valuable, rare, inimitable, and non-substitutable (VRIN) (Barney, 1991), the c3-value modelling approach proposes analyzing strategy along the following three dimensions: customer, capabilities, and competition, with a particular emphasis on competition as a means to realize the VRIN characteristics. Indeed the c3-model explicitly takes into account the value proposition that is conveyed by the e3- value‘s value objects and proposes a dichotomy of the transferred value: a primary value object that conveys the intended businesses of an actor and the secondary value object that enhances the value delivered by the primary value object.

The c3-value modelling approach is a powerful strategic technique. However, the c3-value framework focuses on the direct competitor and the direct customer thus neglecting the inter-dependencies inherent in the current global economy and the potential given by the network perspective.

2.1.3 The Allee’s model

Allee’s considers a value network as an autopoetic or living system, a system that continually changes and reproduces itself (Allee V. , 2003). As such the network is unmanageable. Allee’s model is constituted by the following entities: *participants, transactions, deliverables, and exchanges*. A participant represents an individual or group of people (organization, business units, communities, etc). Transactions refer to a transfer of a deliverable from one participant to another. In Allee’s model transaction are unidirectional and a bi-directional transaction is called an exchange, which is a transaction that triggers a response from the recipient to the original sender. Exchanges are of primary importance in the model as drivers of value. Deliverables can be tangible such as good, services, and revenue, or intangible such as knowledge and benefit. Analysis within the Allee's framework is mostly visual and consists of detecting *patterns of exchanges* between participants, especially the ones involving intangibles, with the assumption that value is created through exchanges.

Despite all these, Verna's model does not assign a purpose to the network and its focus on exchanges added to its assumption on the unmanageability of the network limits its potential for strategic analysis.

2.2 Tools for Modeling Value Networks

Computer network technologies have been growing explosively and the study in computer networks is being a challenging task. To make this task easy, different users, researchers and companies have developed different network modelling and simulation (MS) tools. These network MS tools can be used in education and research as well as practical purposes. They vary according to their characteristics. System dynamics modelling and simulation is an exciting process that helps the modeller to get an important understanding of the problems involved, but, when the model is built and run, the user does not have so many instruments to tests what that model is really showing. System dynamics attempts to understand the basic structure of a system, and therefore to understand the behavior it can produce. Many of these systems and problems can be built as a computer model. The advantage is that the model on the computer is flexible and can carry out many simulations. Hence, many future development paths can be evaluated. Additionally, System Dynamics diagrams are designed to explain feedback [1] relationships as clearly as possible, and Stella, Vensim and Powesim are considered to be the easiest software packages for system dynamics programming. Other simulation packages, such as the ones used in control engineering, do the same simulations but the graphical languages are different and more obscure, although they have other advantages.

2.2.1 The Model Language

- Stocks are accumulations and hold the current state of the system.
- Flows change. They increase or decrease the stocks. The cloud represents a stock that is outside the system boundary, so we are not concerned to keep

[1] *Feedback* is a process through which an indicator goes through a chain of causal relations to re-affect itself. There are positive and negative feedback loops. On the one hand, a feedback is *positive* if an increase in a variable, after a certain delay, leads to a further increase in the same variable. Positive feedback is found in systems that produce exponential behavior. On the other hand, a feedback is *negative* if an increase in a variable leads to a decrease of the same variable. Negative feedback drives balancing or stabilizing systems that produce asymptotic or oscillatory behavior.

track of it.
Direction of flows are:
- one stock into another (e.g., maturation)
- a stock into a cloud (e.g., deaths)
- a cloud into a stock (e.g., births)

- The converters modify stocks and flows. When you see converters without incoming arrows, you know the converter is specified by the model builder. These are called model inputs sometimes.
- A connector shows the flows inside the model. Connectors enable the creation of FEEDBACK loops.

Then, a system dynamics model involves three different types of variables: stocks, which describe the state of the system, flows, which describe the rate of increasing/decreasing of the stocks, and auxiliary variables, which can be linked to stocks and flows and are used to better describe the system behaviour.

2.2.2 Software

There are three software programs that were designed to facilitate the building and use of System Dynamics models: iThink/Stella, PowerSim and Vensim.

- **iThink/Stella**[2] : originally introduced on the Macintosh in 1984, the Stella software provided a graphically oriented front end for the development of system dynamics models. The stock and flow diagrams, used in the system dynamics literature are directly supported with a series of tools supporting model development. Equation writing is done through dialog boxes accessible from the stock and flow diagrams. IThink is available for Macintosh and Windows computers.iThink guides business team through the creation of models that simulate business processes and scenarios.

- **PowerSim**[3] : in the mid 1980s the Norwegian government sponsored research aimed at improving the quality of high school education using system dynamics models. This project resulted in the development of Mosaic, an object oriented system aimed primarily at the development of simulation based games for education. Powersim was later developed as a Windows based environment for the development of system dynamics models that also facilitates packaging as interactive games or learning environments. Powersim's modeling and simulation tools are used to map formal mental models into models that can be simulated and analyzed on computers.

[2] http://www. iseesystems.com
[3] http://www.powersim.com

- **Vensim**[4] : originally developed in the mid 1980s for use in consulting projects, Vensim was made commercially available in 1992. It is an integrated environment for the development and analysis of system dynamics models. Vensim runs on Windows and Macintosh computers. Vensim is used for developing, analysing, and packaging high quality dynamic feedback models. Models are constructed graphically or in a text editor. Features include dynamic functions, subscripting (arrays), Monte Carlo sensitivity analysis, optimization, data handling, application interfaces, and much more.

2.2.2.1 Comparison of Tools

Similarities

Generally speaking, these programs also provide icon-based methods for numerical simulation of system dynamics models. Stella and Vensim make it easy to define and control the passage of time, but we have to deal with time ourselves in a spreadsheet. The programs start with the stocks and flows, the building blocks of system dynamics modeling. The models may be viewed as a collection of first-order differential equations, with a separate equation for each stock in the model. The equations in realistic models are almost always nonlinear, so it makes sense to solve the equations through numerical simulation. The three programs are icon-based, so they promote the development of models with visual clarity. The programs are visually similar.

These three tools have in common some main capabilities:

- They represent the average behaviour of the participants in the system
- They use a GUI interface to draw the model
- They simulate the same with different values of simulation intervals.
- Their results can be represented either as table or graph.
- They provide sensitivity analysis and comparison of simulation results.

Differences

In spite of the above similarities, there also some additional capabilities each package provides.

Powersim can testify to it is usefulness in dynamic modelling. Powersim is valued for its core features to facilitate system dynamics modelling. It is also valued for the capability to simulate in multiple dimensions, to support hierarchical modelling and for ease of interface design (BWeb). Moreover, Powersim comes with the powerful

[4] http://www.vensim.com

feature of adding user written functions. This can become useful in modelling situations where new concepts (e.g. fuzzy logic) need to be incorporated. The latest version of Powersim can build reusable model components that can be plugged in without much difficulty.

On the other hand, **Stella(iThink)** provides multi-level modeling interface that allows for separating out the user interface, the stock and flow model and the equations into three different levels. The interface level can be used to show an overview of the system, the causal loop diagram and model outputs. The model tracing facility provides an easy way to navigate through the feedback loops and learn about the reasons behind the dynamics. iThink in recent times has been used to build multimedia games meant to give managers an experimental set up for experiential learning.

Lastly, **Vensim** enforces strict rigor in writing model equations. It provides features for tracing feedback loops. In addition, "Causes Tree" and "Uses Tree" diagrams help in debugging the model.

Summarizing, we can say that the additional features make each package suitable for particular modeling situations. However, in for our simulation purposes, we preferred to use Vensim because it has two obvious advantages. It has a free version Vensim PLE for educational purposes and also a forum where you can post questions and generally get answers.

2.2.3 Modelling with Vensim PLE

In this section, we are going to give a brief description of the system and the variables, so as to be able to understand the following description of our business models. In Vensim, a useful representation of relationships comes from a stock-and-flow structure. Stocks are accumulations of material or information. They characterise the state of the system and generate the information upon which decisions and actions are based. Flows (outflows, inflows) are rates at which additions or deletions of stock occur. Whenever these changes are not instantaneous, delays occur in the stock accumulation. These delays can have a major impact on the evolution of the system. This type of graphical description is preferred over the causal loop diagrams because it can be mapped into mathematical equations. These equations form the basis for a model that can be simulated on a computer.

Stock and flow diagrams used in system dynamics to represent the differential equations. A stock represents accumulation. On the other hand, the inflows and outflows represent rates.

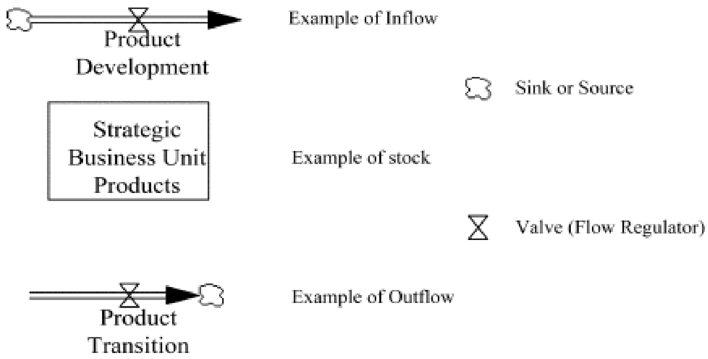


Figure 1. Stock and Flow diagrams in Vensim

2.2.3.1 From causal Loop Diagram to Stock and Flow Diagram

The transition from causal loop diagram to stock and flow diagram has to be performed manually by the user. So far, no such software exists to perform this function for model builders. There are three variable types and two edge-types in Vensim. The variable types are Auxiliary/Constant, stock (also called box or level or state), and the rate variable. The edge types are information (which is represented as a connector edge of the type used in the causal loop diagram) and flow. The variable types are exhibited below.

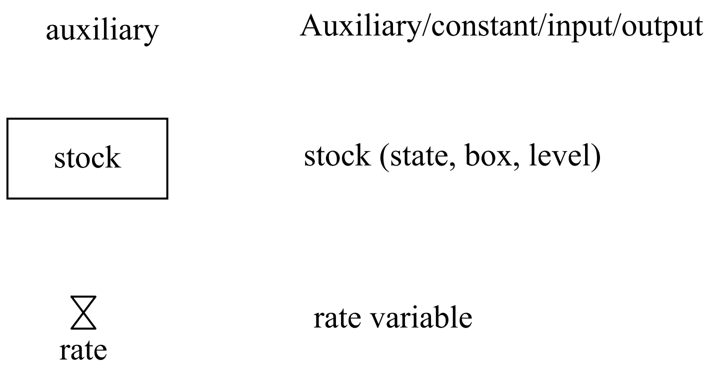


Figure 2. Variable types in Vensim

The variable delineations above don't tell us anything about the character of the variables themselves. For example, a stock variable represents a point where content can accumulate and deplete. The edge types are shown in the following:

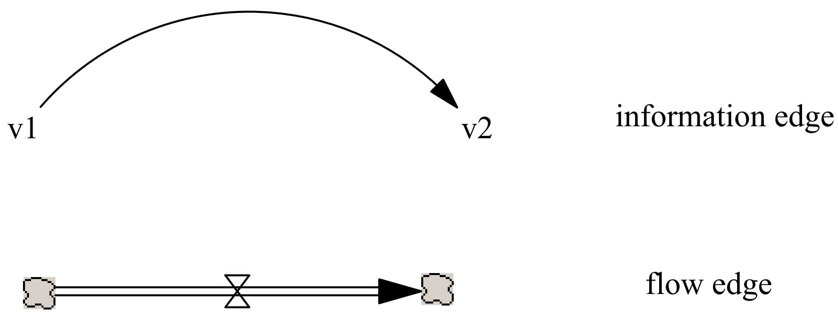


Figure 3. The edge types in Vensim

To translate a causal loop diagram to a stock and flow diagram, we must simply identify all of the variables and edges. However, frequently when we do this we discover that things (variables, edges) are missing and that we must add variables/edges to create a relevant stock and flow diagram.

The reason this is the case is because causal loop diagrams are created for a variety of different reasons, not just to be translated into stock and flow diagrams. Often causal loop diagrams are created to efficiently delineate causal relationships without regard to what structure is necessary to expedite transitions to stock and flow diagrams. When this happens, rate variables are left out, frequently.

3 Mortgage Loans

3.1 A Brief Description

3.1.1 Definition

A **mortgage loan** is a loan secured by real property through the use of a mortgage (a legal instrument)[5]. Anyway, *mortgage* alone, in everyday life, usually refers to *mortgage loan*. One who wants to buy or build a home can take a loan either to purchase or secure against the property from a financial institution, like a bank, either directly or not, through intermediaries. Features of mortgage loans such as the size of the loan, maturity of the loan, interest rate, method of paying off the loan, and other characteristics can vary considerably.

Mortgage operates like a common loan, with the difference that it has a lower interest rate that is considered to reflect the customer's risk. Its amortization time period usually ranges between 10 to 40 years. Depending on the financial institution, there are specific types of real estate assets that can be secured with a mortgage and usually varies according to the purpose of the financing (loan). Mainly, mortgages can be used either to fund improvement works or to purchase property.

3.1.2 Basic Components

Taking a mortgage loan is the commonly used method in many countries, so as one is able to be financed for his private ownership of residential property. Even if the terminology or the precise forms may be different in each country, there are some basic components that tend to be common. These basic components are shown in the following table:

Variable	Meaning
Property	the physical residence being financed. The exact form of ownership will vary from country to country, and may restrict the types of lending that are possible.
Mortgage	the security created on the property by

[5] http://www.wikipedia.org/

	the lender, which will usually include certain restrictions on the use or disposal of the property (such as paying any outstanding debt before selling the property)
Borrower	the person borrowing who either has or is creating an ownership interest in the property
Lender	any lender, but usually a bank or other financial institution
Principal	the original size of the loan, which may or may not include certain other costs. As any principal is repaid, the principal will go down in size
Interest	a financial charge for use of the lender's money
Foreclosure or repossession	the possibility that the lender has to foreclose, repossess or seize the property under certain circumstances is essential to a mortgage loan. Without this aspect, the loan is arguably no different from any other type of loan.

Table 1. Mortgages Basic Components

Generally, mortgage loans are long-term contracts, the periodic payments for which are similar to an annuity and calculated according to the time value of money formulae. As we mentioned before, the most basic arrangement would require a fixed monthly payment over a period of ten to forty years, depending on local conditions. Over this period the principal component of the loan (the original loan) would be slowly paid down through amortization. In practice, many variants are possible and common worldwide and within each country.

Lenders provide funds against property to earn interest income, and generally borrow these funds themselves (for example, by taking deposits or issuing bonds). The price, at which the lenders borrow money, therefore affects the cost of borrowing. Lenders may also, in many countries, sell the mortgage loan to other parties who are interested in receiving the stream of cash payments from the borrower, often in the form of a security (by means of a securitization).

Mortgage lending also includes the apprehensive risk of the mortgage loan, that is, the probability that the funds will be repaid by the borrower (usually it is in correlation with borrower’s creditworthiness), that if they are not repaid, the lender will be able to foreclose and recoup some or all of its original capital and the financial, interest rate risk and time delays that may be involved in certain circumstances[6]. One decision the borrower must face, in cases of housing finance purposes, is to take an adjustable or a fixed rate mortgage. In those mortgage contracts, the prime difference is the distribution of the interest rate risk. While the borrower takes all the interest rate risk (and chance) when she chooses a floating rate mortgage, the lender suffers or profits from interest rate movements when the contract rate is fixed.

Generally, the optimal mortgage contract choice depends on the volatility of the interest rate, the borrower's income and the house market price as well as on the correlation among them. Additionally, the optimal mortgage choice is influenced by the current macroeconomic environment. Fixed rate mortgages may be preferred in terms with historically low interest rates expressing expectations that interest rates is going to rise and the need to ensure the low interest rate for the whole mortgage period, while borrowers may prefer floating rate mortgages when interest rates are expected to fall.

3.2 A Conventional procedure in a Mortgage Value Network System

A brief and skin deep procedure is shown in Figure 4, whereas, we are going to analyze it below.

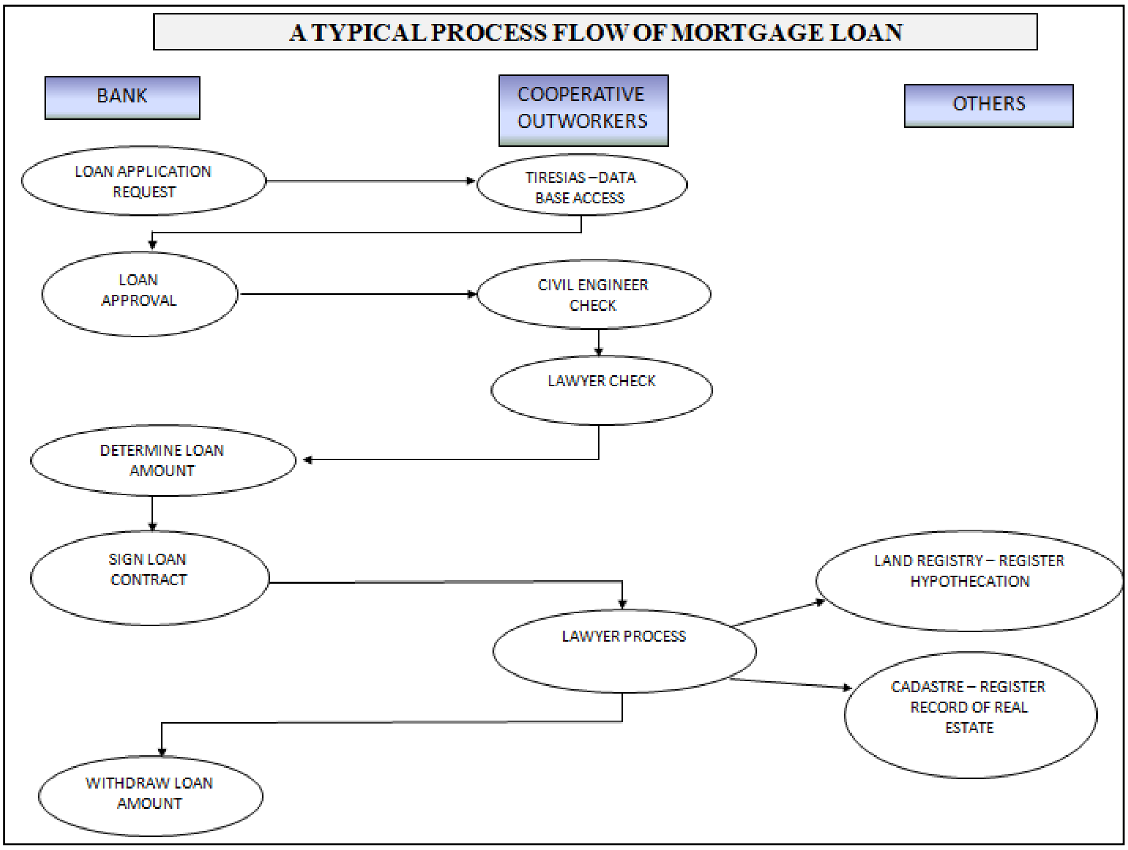


Figure 4. A Typical Process of a Mortgage Loan

[6] http://www.wikipedia.org/

Mortgage loan process includes four main stages:

- application form processing (completing the application form with the help of a loan officer),
- credit risk analysis (Factors are specific to each customer: judgement is made on the basis of past credit history (through credit rating agencies), the borrower gearing (leverage) ratio, wealth of borrower, volatility of the borrowers' income, and whether or not collateral is a part of the loan agreement, length of time as a customer at a bank or at a certain address, employment history, whether a future macroeconomic climate will affect the applicant's ability to repay.),
- surveying (a survey of the proposed property to check for its value, as well as any infringements upon zoning laws or neighbouring properties),
- title checking (to ensure that the title to the property is uncontested and without liens).

Customers arrive for loan at the employee of the bank's branch. The branch takes the documents needed, and applies for the requested loan after checking for the documents to be original. Afterwards, the branch promotes the loan request to the appropriate department. This department makes the appropriate checking as far as the legality of documents is concerned and go ahead the credit risk analysis for the solvency of the customer. They log in the database of the Tiresias system and take the information per participant of the loan, borrowers or guarantors. Tiresias A.U. (see Appendix:TIRESIAS) is an interbank company, which specializes in collecting and placing information on the economic behaviour of enterprises and individuals, information about identities / passports have been stolen or lost, and information on fraudulent use of credit cards. This information will help to protect the institution of faith, to reduce exposures and fight and protection of financial transactions for the benefit of operators and the banking system in general. When the appropriate department make all the checks needed, they send the approval or not of the loan request and the loan conditions. In case of disapproval, they can rearrange the parameters of the mortgage loan and give an approval of a loan with the parameters and conditions they believe that fit the customer. In any other case, they just send their disapproval without an alternative. The next step is the check from the cooperative civil engineer with the bank. His tasks include the check, concurrence of titles and the evaluation of the asset to be mortgaged. Then, it's the lawyer's turn, where he is going to check the titles of the asset. He checks all the contracts and their legality and ask for any additional document it is needed. Furthermore, after all the checks the cooperative civil engineer and lawyer made, the branch is ready to conclude for the final loan amount, depending on the market and object price the asset has.

After all the appropriate checking, the loan officer is ready to prepare the loan contract so as to be signed by all the individuals involved in the loan. After the sign of the loan contract, the lawyer is ready to prepare the appropriate documents for the hypothecation of the land asset. When the decision of hypothecation is ready, the lawyer takes all responsibility to write the hypothecation in the Land Registry and Cadastre. Additionally, he will bring and subedit the certificates of hypothecation registration in the property asset. After all this procedure, which endures about one month, the loan amount can be drawn. Except for the whole procedure needs, there are loan expenses, which must be attributed to the cooperative participants the bank has for the service they provided to it for the completion of the mortgage loan.

3.3 The Transformation of the Mortgage Loan Service from the Bank to the Value Network perspective

After having described the process of a mortgage loan, we have to understand the conversion from the financial into the value networks world. The main participants in our value network are the Bank, the Customers, the cooperative Civil Engineer and Lawyer and lastly the Tiresias, the Land Registry and the Cadastre, as shown in Figure 5.

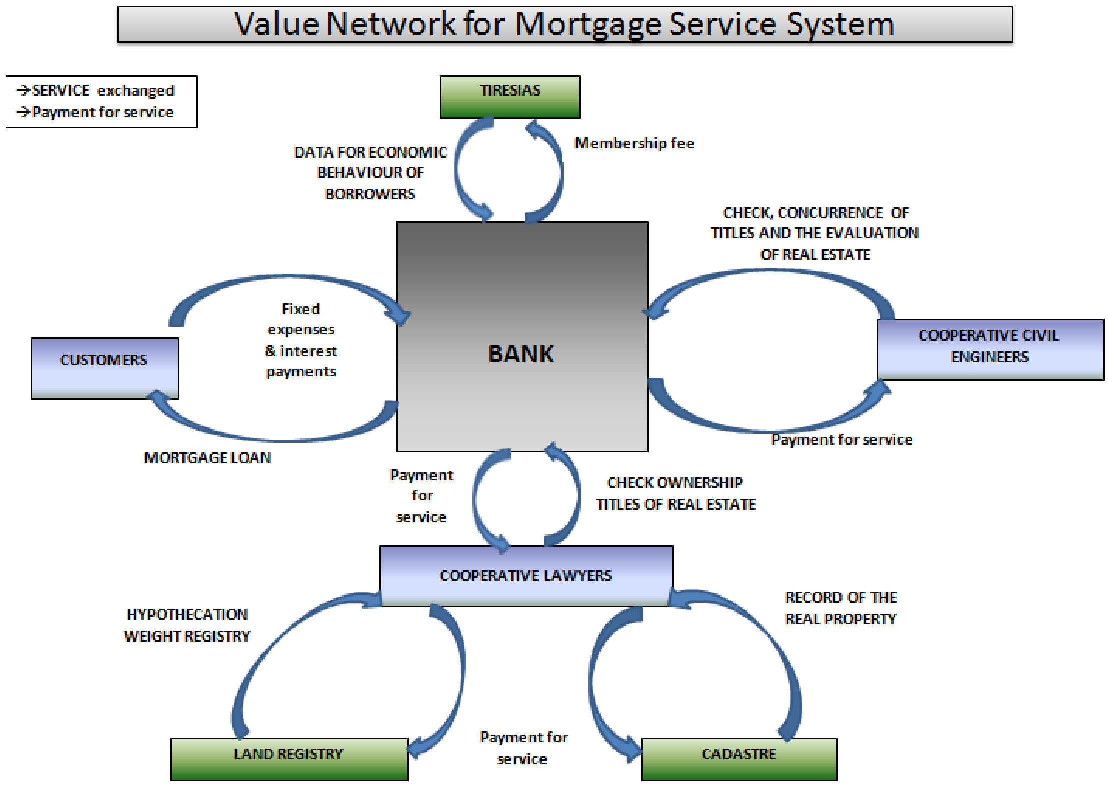


Figure 5. Value Network Of a Mortgage Loan

Bank offers its service to the customer so as to lend him the amount needs for his real estate paying the expenses needed. Afterwards, for every mortgage loan case, the Bank cooperates with Tiresias, so as to get its service as far as the credit evaluation of its borrowers is concerned. In addition, a cooperative civil engineer offers its services to the bank, so as to make a survey of the proposed real estate and check for its value. Moreover, a cooperative lawyer offers its services to the bank by checking the titles of real estate so as to ensure that the title is uncontested and without liens. Lastly, the Cadastre and Land Registry offer their services to the lawyer in order to record the real estate in the Cadastre and also to register the record of weight for the real estate in the Land Registry. All these services are surcharged to the customer.

Except for the typical procedure, every case of providing a mortgage loan is different and it depends on the participants. The good relationship, the good loan service and the amount the customer's requests has been reached; make an important role in borrower's satisfaction index. The customers generate value to the service system through their willingness to pay. It is significant to say that if the accumulation of revenues is smaller than the sum of costs due to its participation in our value network service system. Thus, this participant has a net loss because of its participation, at least up to time T_N. In this case, this participant must examine its future participation in the system and see the overall value.

4 Business Models

4.1 Basic Model

The Mortgage Model was implemented in Vensim PLE. Our model describes the mortgage service provided by a bank to its customers. It describes the value exchanged among the participants in the service value network.

4.1.1 Assumptions of the model

In this section, we determine the model constraints and identify key variables that affect the system's behaviour. A basic assumption is that the bank offers the service of mortgage loans only, so that all revenues and payments are stemmed from this service. In addition, we do not take into consideration the inflation effect. Another crucial assumption is that the bank employs only one lawyer and one civil engineer per branch, who take up with all mortgage loan applications. Moreover, each one of them does not participate in any other external network, so their values are not affected by external factors. Additionally, we suppose that they are partners who cooperate with the bank when needed, and they are not employees working for the bank. We also suppose that there are no non-performing loans or written-off loans, which means that all the mortgage customers pay their instalment without having any difficulty in their repayment. Besides, the expenses the customer pays after the final approval of the loan are fixed and independent of the amount and the customer as individual. The only difference is the expenses of the land registry which is a percentage of the prenotation amount on the basis of which the bank is considered to be safe. Lastly, we have considered that all the initial values of the key parameters of the model are average prices in order to minimize computational complexity.

4.1.2 Formulation of the model

The first thing is to consider all the groups that play key roles in our Mortgage model. The descriptions also reveal the units of the variables. '*Amount of money*' is measured in euro and '*amount spent each month*' is in euro per month. Mapping a Value Network involves diagramming all three value exchanges with each and every member of the business or organizational network. The groups that make the significant role in the system are:

- Bank
- Customer
- Lawyer
- Civil Engineer
- Tiresias
- Land Registry
- Cadastre.

4.1.2.1 Quantitative Approach

Each group cooperates with the others to offer a mortgage loan. We assume that each participant gains value in participating in the service system as if it was either participating in another service system or not. It is of significant importance to be able to have a quantitative estimate of this value and have the changes of this value in relation to the time and to understand any planned or realized changes in the business processes in which a partner participates. Afterwards, we analyze how these quantities can be analyzed and monitored. As far as the value calculation, we followed the methodology according to the research paper of Caswell et all. According to this research, the value of a participant in a service system has the following equation value:

$$\text{Value(t)} \triangleq \sum_{t=0}^{N} [\ \text{Revenues(t)} - \text{Payments(t)} + Satisfaction\ factor * \text{Expected } Revenues(\text{t}+1) \quad (4.1)$$

We made a small change in the model and we added the concept of expected costs/payments. Generally speaking, all the participants which offer a service to the other has a value equation as the following:

$$\text{Value(t)} \triangleq \sum_{t=0}^{N} [\ \text{Revenues(t)} - \text{Payments(t)} + Satisfaction\ factor * (\text{Expected } Revenues(\text{t}+1) - \text{Expected Payments}(\text{t}+1)\ ] \quad (4.2)$$

whereas, the participants which accept the service have an utility function that shows how much useful is the service provided to them and the reason it 's worth using it. Thus, the utility function for those participants, that are customers, depends on the needs of each one separately.

4.1.2.2 Qualitative Approach

Furthermore, it is remarkable to take into consideration the value stemmed from the relationship levels that the participants develop when they sell services to other participants and the customers. This value is created due to intangible assets. All these qualitative values can be quantified by estimating the amount of revenue that a participant expect to generate by selling its service to another participant. We can calculate this expectation by looking more the recent past. Suppose that $\bar{R}(T_N)$ are the revenues that one receives offering his service in the period [T_N, T_{N+1}], then this expectation can be written as:

$$\bar{R}\ (T_N) = w1 \int_{TN-1}^{TN} R(t)\ dt \ \ + w_2\ \bar{R}(T_{N-1}) \quad (4.3)$$

where w_1 and w_2 are the weights that determines the importance of the past data in the estimation of expected revenues, with $w_1 + w_2 = 1$ and $0 < w_1 , w_2 < 1$.

Additionally, supposing_that $\bar{P}(T_N)$ are the payments/costs that one has offering his service in the period [T_N, T_{N+1}], then this expectation can be written as:

$$\bar{P}\ (T_N) = w1 \int_{TN-1}^{TN} P(t)\ dt \ \ + w_2\ \bar{P}(T_{N-1}) \quad (4.4)$$

Additionally, we must take into consideration a satisfaction index in the relationship value, so as to show that an increasing satisfaction index will increase profit expectations and therefore the value of the relationship, whereas a decreasing satisfaction index would have the opposite result. Yi mentioned that customer's satisfaction is influenced by two factors which are experiences and expectations with service performance (Yi, 1990). The satisfaction index has to do with the preference an entity creates related to prices, service or product delivery time, brand names, quality and other parameters. One more assumption we have made, is that we know the satisfaction index of each participant created by its customer, which is also another participant in the network. This satisfaction index information can be created through market research, questionnaires and other ways that are made to mortgage loan holders. Supposing that Sat is the satisfaction created from a customer of one participant, then the following ratio is an estimate of how much the expected profit of the participant change during the time period from T_{N-1} to T_N.

$$\delta \, Sat(T_N) = \frac{Sat(T\_N) - Sat(T\_N-1)}{Sat(T\_N-1)} \quad (4.5)$$

On the other hand, by this way, we can only have temporary changes of satisfaction. Thus, it is better to have an equation to be able to take into consideration longer term trends by using the weighted averages of the satisfaction index as follows:

$$\overline{Sat}(T_N) = w_1 \, Sat(T_N) + w_2 \, \overline{Sat}(T_{N-1}) \quad (4.6)$$

where, $0< w_1 , w_2 <1$ and $w_1 + w_2 = 1$

Furthermore, we can define an equation to calculate the expected value of the interaction between two participants in time period $[T_N, T_{N+1}]$ as follows:

$$\varepsilon(T_N)= \bar{R} (T_N) + \frac{\overline{Sat}(TN) + \overline{Sat}(TN-1)}{\overline{Sat}(TN-1)} \; \bar{R} (T_N) = \frac{\overline{Sat}(TN)}{\overline{Sat}(TN-1)} \bar{R} (T_N) \quad (4.7)$$

According to the above equations, we can compute the total value a participant has in the value network at the end of time period $[T_{N-1}, T_N]$

$V(T_N)$ = profits from interacting with partners in $[T_{N-1}, T_N]$
+ expected value from customer satisfaction in $[T_N, T_{N+1}]$
$=R(T_N) – P(T_N) + \varepsilon(T_N)$

So the value a participant has that offers a service to its customers is given from the equation:

$$V(T) \triangleq \sum_{t=0}^{N} R(t) - \sum_{t=0}^{N} P(t) + \sum_{t=0}^{N} \varepsilon(t) \quad (4.8)$$

Replacing the $\varepsilon(T_N)$ equation we have the final one.

$$V(t) \triangleq \sum_{t=0}^{N} R(t) - \sum_{t=0}^{N} P(t) + \sum_{t=0}^{N} \frac{\overline{Sat}(t)}{\overline{Sat}(t-1)} \, [\bar{R} (t) - \bar{P}(t)] \quad (4.9)$$

It is remarkable to mention an observation occurs from this equation. If the sum of revenues plus the expected value occurs because of customer satisfaction are smaller than the cost of participating in the system, then the future of this service system is inauspicious. The participant will have a net loss because of its participation in the system, up to time it is examined. So, it must examine each time if there is a positive value from its participation in the system and by changing the parameters that affect its cost and revenues, it could see how its value is being changed. Of course, it is important to well define the time horizon when we take an estimate of the value of a service system. Generally speaking, it takes a long time for a service system to recover from a loss and also it takes short time to be able to create new strategies so as to raise the participant's value. Below, we are going to analyze each group's core and analytical diagram in Vensim.

4.1.3 Model Analysis

it is also important to edit the model of the service system. Often, parts of the system are repeated, insignificant, or can be modelled in an easier way. Editing the model makes the model concise by simplification and more useful by removing insignificant parts. For that reason, some stock variables have been simplified by omitting an inflow which is also an outflow in the stock. By this way, the operation value flow in the service system remains the same and the modelling of the system is simpler. This happens with the expenses of mortgage loans, which are the expenses for the lawyer (r_{lawyer}), the expenses for the civil engineer ($r_{civil\ engineer}$), the expenses for the cadastre ($r_{cadastre}$), the expenses for the land registry ($r_{land\ registry}$) and the expenses of the loan application and approval. The customers pay all these expenses to the bank. The bank with its turn pays the lawyer and the civil engineer, whereas the lawyer pays the cadastre and the land registry. Only the loan expenses finally remains to the bank. So, it is more functional and easier to use the first inflow of the expenses and their last outflow in the stocks. So, in our model**,** the customer only pays the loan expenses to the bank and the other are going directly to their end holders, lawyer, civil engineer, cadastre and land registry.

4.1.3.1 Value Calculation of the Bank

Bank is a stock diagram because it is the accumulation of all the revenues the bank takes from its customers per month plus the expected revenues that will have based on the satisfaction of its customers, less the payments that must be made and less the instalment for the money the bank has borrowed. So, the bank has an inflow of 'bank revenues', which represents the revenues the bank has each month. It also has an outflow of 'bank payments', which depicts the payments the bank make each month including the expenses for the sum of the new loans it has and its fixed costs. Lastly, it has an outflow of ‘interest payment’ for the interest the bank pays due to the loans it has from the interbank market. The Figure 6 shows the basic diagram of the bank.

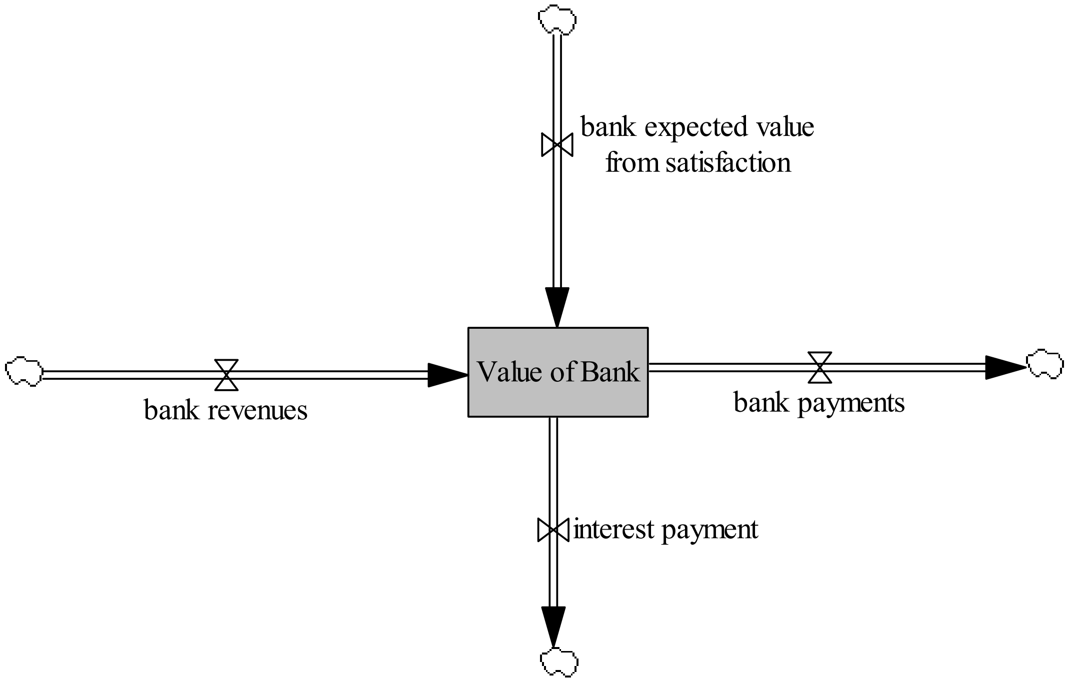


Figure 6. Basic diagram of 'Value of Bank'

The inflow of ‘Bank Revenues’ is the sum of the average instalment the bank receive from the whole loans it has already given plus the total expenses the new loans require in order the mortgage to be completed. The ‘Revenues from satisfaction’ inflow depicts the percentage of expected revenues the bank estimates to have in the next month based on the satisfaction of its customers to whom the bank provides its services. Finally, the outflow of ‘Bank Payments’ is referred to the payments that the bank have to convey to its cooperative participants, lawyer and civil engineer, for their checking and conducting of documents as for the new loans, and also is referred to the fixed costs that each month the bank pays and the costs it may have for every new loan. Lastly, ‘interest payment’ is referred to the interest the bank pays per month for its borrowing money. We suppose that the bank borrows a fraction of what it can lend.

- **Bank Revenues Equation**

The revenues of the Bank are the sum of the payments of the customers ($P_c(t)$) the bank already has $N(t)$ and the total mortgage expenses (r_{all}) charged to the new customers N_{new} (t) the bank gains the current month. The Mortgage Expenses are the total expenses the customer is charged for the completion of the provision of a mortgage loan. This cost involves the expenses of the loan (r_{loan}) needed for the check and examination of the loan application from the suitable department of the bank, the cost of the lawyer (r_{lawyer}) involving the check of the legality of the titles of the real estate being mortgaged, the cost of the civil engineer ($r_{civilengineer}$) for his checking of title matching of the real estate according to the building license, its legality, completeness and its level of building ability so as to be able to carry out an autopsy for evaluation of the real estate. Moreover, there are the land registry expenses ($r_{landRegistry}$) for the registry of the real estate mortgage and finally the cadastre expenses ($r_{cadastre}$) for the registry of the boundaries and location of the real estate.

$$R_B(t) = N(t) * P_c(t) + N_{new}(t) * r_{all} \qquad (4.10)$$

- **Bank Payments Equation**

The payments the bank makes each month include the r_{all} that has in its revenues and must afterwards be delivered to its cooperatives for their service to it, except for the r_{loan}, which are bank expenses. Additionally, the bank pays the Interest (I) for the loans it already has and offered to its old customers, the expenses of the Tiresias monthly membership fee ($r_{tiresias}$), its fixed costs ($r_{Fixed\ Costs}$), which includes the monthly rent, the staff wages, and other fixed costs the bank may have. Finally, the bank pays an average cost for every new customer for its loan preparation and completion procedure (ex. paper material). The last one is expressed as a fraction of the loan expenses the bank receives from its new monthly customers. Whereas the bank receives the revenues we analysed above, most of them are paid to its cooperative partners so as to make the actions that the mortgage procedure demands.

$$P_B(t)= [r_{lawyer} + r_{civil\ engineer} + r_{landRegistry} + r_{cadastre} + a_1*r_{loan}]*N_{new}(t) + r_{tiresias}+ r_{Fixed\ Costs} + I(t) * N(t) \qquad (4.11)$$

where $0<a_1<1$.

As we said in the beginning of this section, there are equations that can be simplified for the simulation because they are added and subtracted. This happens in the case of Bank, where the expenses r_{lawyer}, $r_{civil\ engineer}$, $r_{landRegistry}$, $r_{cadastre}$ are both in revenues and in payments equation all the time periods. Thus the new adjusted equations are as follows:

Revenues equation:

$$R_B(t) = N(t) * P_c(t) + N_{new}(t) * r_{loan} \qquad (4.12)$$

and Payments equation:

$$P_B(t)= a_1*r_{loan} *N_{new}(t) + r_{tiresias}+ r_{Fixed\ Costs} + I(t) * N(t) \qquad (4.13)$$

- **Bank Value Equation**

The most important of all is the value gained from the mortgage loans service the bank provide to its customers.

$$V_B(t) = \sum_{t=1}^{N} [\, R(t) - P(t) + \frac{\overline{Sat}(t)}{\overline{Sat}(t-1)} * [\bar{R}(t) - \bar{P}(t)] \,] \qquad (4.14)$$

Bank Deep Analysis

A more analytical examination of the model will help us to understand better the small but significant details that make it operational and useful. We have considered that bank revenues are a function of 'NUM OF NEW LOANS' times the 'LOAN EXPENSES' because the bank receive the loan expenses for every loan approval, and also of 'TOTAL NUM OF LOANS' times the 'average customer's payments', the average monthly payment of the mortgage loan holders' instalment. On the other hand, the bank pays each month a fraction of loan expenses for the total new loans, its fixed costs, its membership fee for access in Tiresias SA and also the instalment payment for the loans it has borrowed. Additionally, the bank has the expected value, as we analyzed above, based on the satisfaction index created by its customers. All of these inflows and outflows are calculated for all of the branches the bank has. A short tree diagram of 'Value of Bank' with two stages depth is shown in Figure 7.

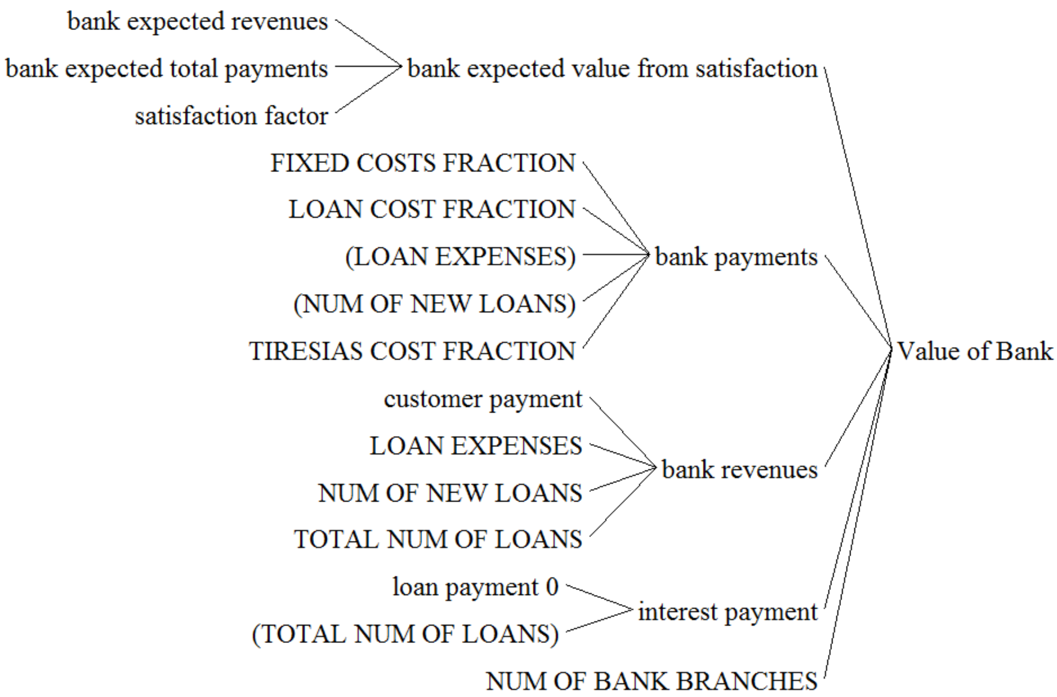


Figure 7. 'Value of Bank' causes tree

In Vensim, the documentation of each node, the calculation unit and some comments that help its comprehension are represented as follows:

bank revenues=
customer payment*TOTAL NUM OF LOANS+LOAN EXPENSES*NUM OF NEW LOANS
Units: euro/Month
the revenues of the bank per month, depends on the average instalment
payment for the existed loans and the mortgage expenses for the
new loans

****

bank payments=
TIRESIAS COST FRACTION+ FIXED COSTS FRACTION+ (LOAN COST FRACTION*LOAN EXPENSES*NUM OF NEW LOANS)
Units: euro/Month
payments are: tiresias membership plus its fixed costs the bank has each month (F7 n) plus the cost for each new loan application

****

interest payment=
loan payment 0*TOTAL NUM OF LOANS
Units: euro/Month
the interest paid for the borrowing money

****
bank expected value from satisfaction=
satisfaction factor * (bank expected revenues - bank expected total payments
)
Units: euro/Month
the percentage of expected bank value(revenues-payments) each
month due to the satisfaction of the customer = ((Sat) ̅(t+1))/((Sat) ̅(t)) * (R ̅BM(t+1) - P ̅BM(t+1))

****
Value of Bank= INTEG (
(bank expected value from satisfaction + bank revenues-bank payments-interest payment)*NUM OF BANK BRANCHES,
0)
Units: euro/Month
Value of the bank consisted of the total revenues – total payments+ expected
value due to customer satisfaction for all of its branches
****

As far as the 'bank expected value from satisfaction' is concerned, it consists of the bank expected value and the 'satisfaction factor'. Bank expected value is the difference between 'bank expected revenues' and 'bank expected total payments'. To calculate bank expected total payments, we need to have 'bank total payments', which equals to the sum of 'bank payments' and 'interest payments'. Whereas, 'bank expected revenues' only needs 'bank revenues' variable. 'Bank expected revenues' at time T_N are estimated as described in the Qualitative Approach in this section. Thus, the 'previous expected bank revenues' depicts the expected revenues at time T_{N-1} and at time 0, they equals to 'bank revenues'. The 'flag revenues' is a temporary variable to help us keep in memory the previous revenues of 'bank expected revenues' with the function DELAY FIXED()[7] that Vensim supports. 'bank expected revenues' is a function of the weighted fractions of 'bank revenues' and 'previous expected bank revenues'. The weights are equal, so as we suppose that they are of the same importance. The same calculation method of 'bank expected revenues' is for 'bank expected total payments'.

previous expected bank revenues=
IF THEN ELSE (flag revenues=0, bank revenues, flag revenues)
Units: euro/Month

****
bank expected revenues=
0.5*bank revenues+0.5*previous expected bank revenues

[7] http://www.vensim.com

Units: euro/Month
bank expected revenues=a*bank revenue + b*previous expected bank
revenues

****

flag revenues=
DELAY FIXED (bank expected revenues, 0, 0)
Units: euro/Month

****

Last but not least, satisfaction factor is of significant importance in the value network because it has to do with the satisfaction created to the bank customers due to the service they have received from the bank at the specified time period. Satisfaction factor is the fraction of next expected satisfaction in time T_N 'bank cur expected sat index' via the expected satisfaction in time T_{N-1} 'bank previous expected satisfaction index'. Again, the logic of the estimation of the satisfaction index is explained in the Qualitative Approach in this section and is modelled the same as the 'bank expected revenues' we previously described. So, each time we need to know 'bank current satisfaction index', whereas the other two variables depend on it. Thus, we have to analyze the 'bank current satisfaction index' so as to be able to have an estimate of the satisfaction factor.

Customer Satisfaction

Another important part of the model is the customer. Measuring the satisfaction for the customer, by measuring the value level of a company's offer, allows a firm to compare itself to its competitors. We suppose that 'bank current satisfaction index' is affected by some qualitative parameters, tangible and intangible assets, and the change in interest rate from the previous and the expected next one. Satisfaction index is affected by the change in interest rates from the side of new loans (N_{new}) and by the qualitative parameters for the total mortgage loans the bank has given. So at first glance, the equation is as follows:

$$\text{'bank current satisfaction index'} = \frac{Nnew}{N+Nnew} * \text{'change in interest rate'} + \frac{N}{N+Nnew} * \text{qualitative parameters} \qquad (4.15)$$

A more analytical diagram that shows all the factors determine the satisfaction index is shown below. The qualitative parameters with its own weights are for the mortgage loan holders and the change in interest rate with its weight is for the new loans only.

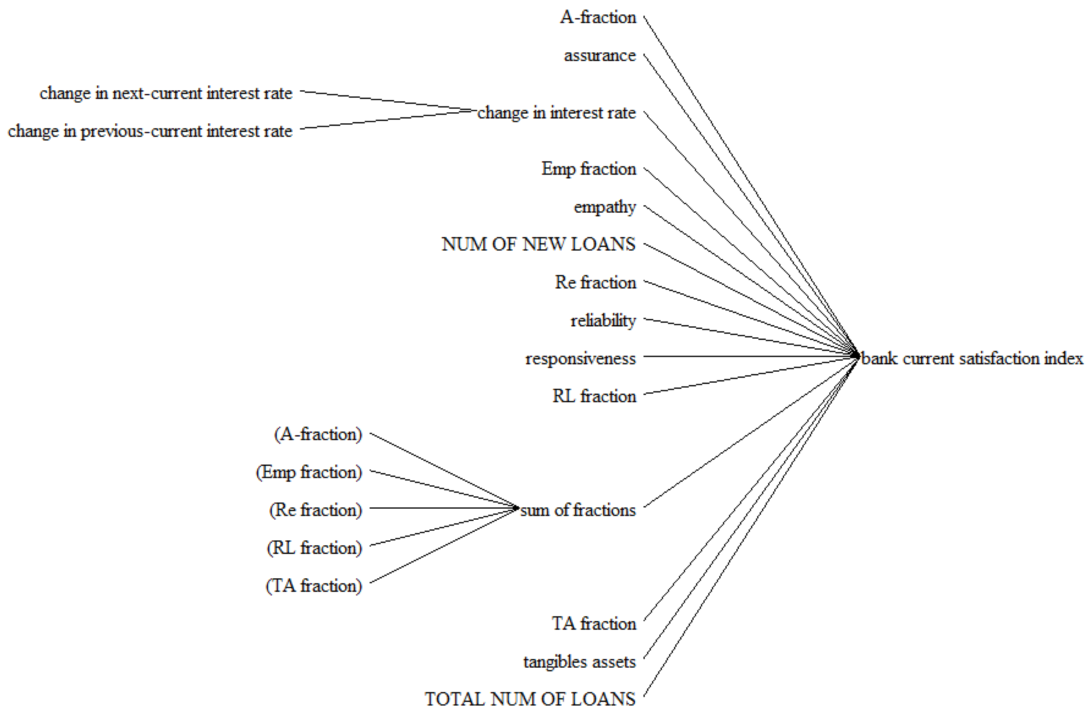


Figure 8. 'Bank current satisfaction index' cause tree diagram

Change in Interest Rate

Interest rate only affects the customers of the new loans. Even if old customers hold a fixed rate mortgage loan or an adjustable rate mortgage loan, their interest rate cannot be changed by the bank itself. The customers have to ask for it, in case of an adjustable loan. The fixed interest rate means that cannot be changed in all the duration of the mortgage loan, whereas the adjustable interest rate can be changed during the maturity of the loan. But the bank cannot intervene in that change. Any adjustable rate consists of three values.

Adjustable Interest Rate= Interest Rate Index + Customer Spread + Law charge (4.16)

Law charge is the charge that the state enforces and is stable for the maturity of the loan. Besides, customer spread is defined by the bank separately for every customer according to the check and evaluation the bank makes depending on some specific criteria that checks as the customer credit ability, solvency, reliability, cooperation with the bank, loan payment history, Tiresias check and moreover, the real estate trade value and the number of mortgages have been on it. So the bank evaluates each customer and gives him the analogous spread, vice versa of how risky the customer is regarded to be. Apart from this procedure that is done at the approval decision, the customer spread remains stable at the end of the mortgage loan. Lastly, the third part of the interest rate, the Interest Rate Index, such as Euribor, Libor or European Central Bank (ECB) Index, is the one which is responsible for any increase or decrease that adjustable interest rates may have. These indexes are not defined by the bank but by a group of Institutions in Europe or the European Central Bank. Thus, the customer satisfaction is independent of the change in interest rates at whole the loan's duration, except for the new loans where the bank decides for the customer spread. At this time only, the customer may be satisfied, less or totally dissatisfied with the spread the bank decided to charge him for the reason that the riskier the customer is regarded, the higher the spread is given to him, thus the higher the final interest rate.

The equation of 'change in interest rate' in Vensim is the following:

$$\text{'change in interest rate'}(t) = \alpha * \text{"change in previous-current interest rate"}(t) + \beta * \text{"change in next-current interest rate"}(t) \quad (4.17)$$

where α and β are the weights that determine the importance of the past and future data in the estimation of the change in interest rate, with $\alpha + \beta = 1$ and $0 < \alpha , \beta < 1$.

We had to find a measure of customer satisfaction based on the interest rate. As we can see, the interest rate is not affected by the bank itself during the maturity of the loan, except for the time of approval where the bank decides for the spread. Thus, mortgage owners' satisfaction is independent of the bank as far as the interest rate is concerned and only the new customers can affect depending on the approved spread in interest rate of ach customer. So, 'change in interest rate' is only a measure of new customers' satisfaction. Generally, we supposed that customer satisfaction as far as its own interest rate is concerned, and especially the spread is charged, is affected by the previous and future expected average interest rates the bank has already given or it is expected to give. For this reason, as for the past interest rates impact, we take into consideration the change in current to previous interest rate, so as to see how much the current average interest rates differ from the average interest rates of previous time period. In Vensim we have the following equation:

"change in previous-current interest rate" = (previous expected interest rate-average interest rate) / previous expected interest rate

The variable "previous expected interest rate-average interest rate" keeps the previous value of current average interest rate by using the function 'DELAY FIXED()'[8] in Vensim through a temporary variable flag, where it intermediates in order the previous variable to be able to check for its initial value.

As for the future expected interest rate impact, we measure the change in expected average interest rate to the current one, so as to see how much the expected average interest rates of next time period differ from the current average interest rates. In Vensim we have the following equation:

[8] http://www.vensim.com

"change in next-current interest rate" = (average expected interest rate-average interest rate)/average interest rate.

In Vensim, the documentation of each node, the calculation unit and some comments that help its comprehension are represented as follows:

change in interest rate=

0.6*"change in previous-current interest rate"+0.4*"change in next-current interest rate"

Units: 1/Month

shows the change in (previous-current interest rate) and in

(change in next-current interest rate)

****

"**change in previous-current interest rate**"=

(previous expected interest rate-average interest rate)/previous expected interest rate

Units: 1/Month

interest rate difference between current and previous

****

"**change in next-current interest rate**"=

(average expected interest rate-average interest rate)/average interest rate

Units: 1/Month

interest rate difference between current and next

****

average interest rate=

INTEGER(RANDOM UNIFORM(0, 1 , 0)*10)/5 +3

Units: 1/Month

random interest rate % from 3 to 5

****

previous expected interest rate=

IF THEN ELSE(flag=0, average interest rate-0.01 ,flag)

Units: 1/Month

****

average expected interest rate=

0.6* average interest rate + 0.4*previous expected interest rate

Units: 1/Month

average expected interest rate=g* INTEREST RATE + d*previous

expected interest rate

****

flag=

DELAY FIXED(average expected interest rate, 0, 0)

Units: 1/Month

****

The graphical representation of this part of the model in Vensim is as follows:

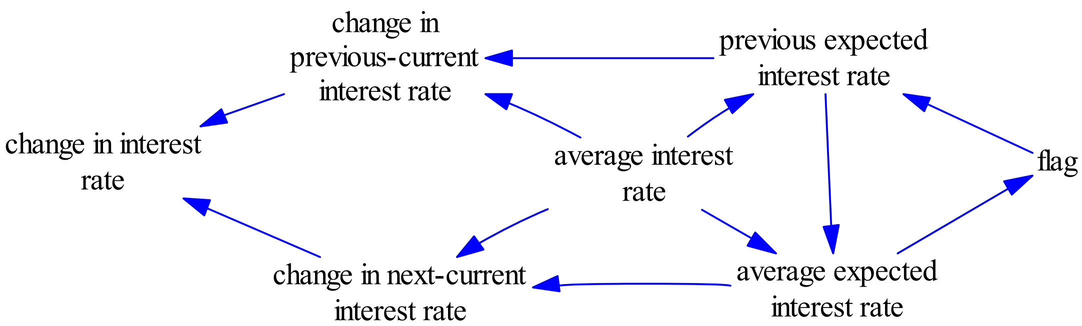


Figure 9. The 'change in interest rate' diagram

Calculation of Interest

Generally, all the loans are charged with an interest rate either fixed or adjustable or a combination of them. In the monthly instalment that the customer pays, both the principal and the interest are included per month. Thus, the monthly instalment calculation is given from the following equation

$$\text{monthly instalment} = \left[\ \text{rate} + \frac{rate}{(1+rate)^n - 1}\ \right] * \text{principal} \qquad (4.18)$$

where rate is the interest rate the loan is charged with, n is the duration left until the end of the loan and principal is the up-to-date balance of the loan principal. In Vensim, the simulation of a instalment payment based on interest rate is shown below

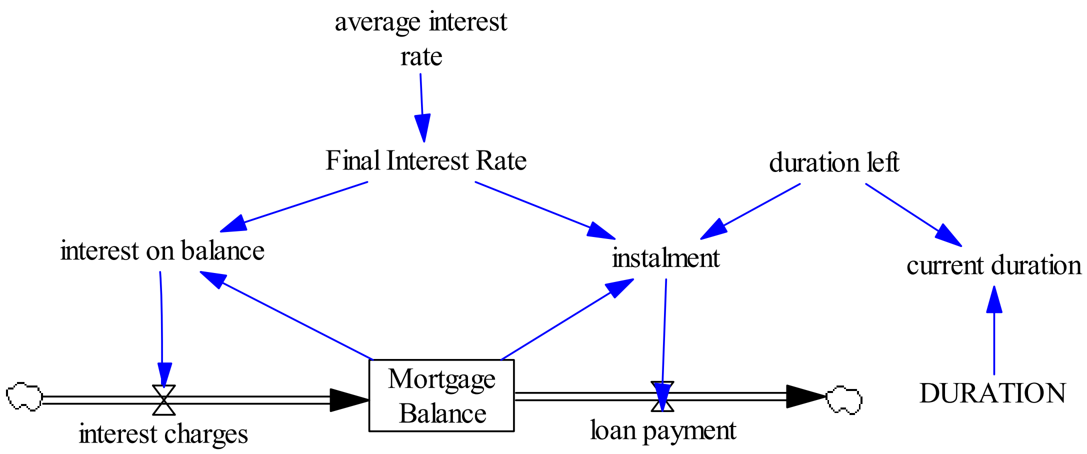


Figure 10. Calculation of interest and instalment of a loan

The 'Mortgage Balance' is a stock variable which has an inflow of 'interest charges' and an outflow of 'loan payment'. Each month, the payment consists of the interest and the principal that must be paid according to the following equation

$$Instalment(t)= Interest(t) + Principal(t) \quad (4.19)$$

The inflow 'interest charges' is an auxiliary variable which equals to the variable 'interest on balance', which in turn calculates the interest corresponds to the mortgage loan balance. So, in any time period the 'Mortgage Balance', which at the beginning is the initial loan amount, is the accumulation of 'interest charges' less the 'loan payment'. The variable 'loan payment' is the monthly 'instalment' that must be paid, depending on the 'duration left' and the interest rate the bank charges, as we showed in the above equation. 'Final Interest Rate' is just the interest rate, adjusted to monthly rate due to the fact that all the interest rates are annual. The documentation of most important of variables is the following:

Mortgage Balance= INTEG (
+interest charges-loan payment,
AVERAGE LOAN PRINCIPAL)
Units: euro/Month
The "Mortgage Balance" is the amount of money the borrower owes
to the bank

****

instalment=
(Final Interest Rate+ (Final Interest Rate/ (EXP(duration left*LN(1+Final Interest Rate
)) -1)))* Mortgage Balance
Units: euro/Month

instalment paid each month for a loan, consists of principal and
interest

****

Final Interest Rate=
(average interest rate/100)/12
Units: 1/Month
The fraction of the "Mortgage Balance" charged as interest per
month

****

interest on balance=
Mortgage Balance *Final Interest Rate
Units: euro/Month
The interest charged on "Mortgage Balance " by the bank

****

It is remarkable to see that in order to represent the function power() in Vensim, where it is not supported, we use a linear estimation of it using logarithm and exponential functions which is:

$$POWER(BASE, X) = EXP(X*LN(BASE)) \tag{4.20}$$

The functions on the right side of this equation are supported by Vensim and so we can calculate the instalment by this way.

Qualitative Parameters

Qualitative parameters are very important in a value network system, which is customer oriented. In our case, we have tangibles and intangibles assets. Tangibles assets are emerged as one variable and depict physical facilities, equipment, and appearance of personnel of the bank. On the other hand, intangibles assets are those related with the behaviour, personality and the service the bank provides to their customers. One major dimension of customer satisfaction is service quality. To assess the service quality, we adopt the service quality dimensions of (Parasuraman A. B., 1991; Parasuraman, Zeithaml, & Berry, 1985), which are Tangibility, Reliability, Responsiveness, Assurance and Empathy. Qualitative parameters with their meanings are shown in the following table.

Qualitative Parameters of Customer Satisfaction	
Tangibility	Physical facilities, equipment, and appearance of personnel
Reliability	Ability to perform the promised service dependably accurately
Responsiveness	Willingness to help customer and provide prompt service
Assurance	Knowledge and courtesy of employees and their ability to inspire trust and confidence
Empathy	Caring, individualized attention the firm provides its customer

Table 2. Qualitative Parameters of Customer Satisfaction

Each tangible or intangible asset has its own weight in the calculation of satisfaction. The equation for satisfaction is:

‘Current Satisfaction index’(t)= (Nnew(t)/(N(t)+Nnew(t)))* ‘change in interest rate’(t)

+(Nnew(t) /(N(t) +Nnew)(t)) * (w1*’tangibles assets’(t) +
+w2*‘assurance’(t) + w3*‘reliability’(t)+ w4*‘responsiveness’(t) + w5*
*‘empathy’(t) (4.21)

where,

w1:‘TA fraction’/ ‘sum of fractions’,weight of tangible assets in customer satisfaction

w2: ‘A-fraction’/ ‘sum of fractions’, weight of assurance in customer satisfaction

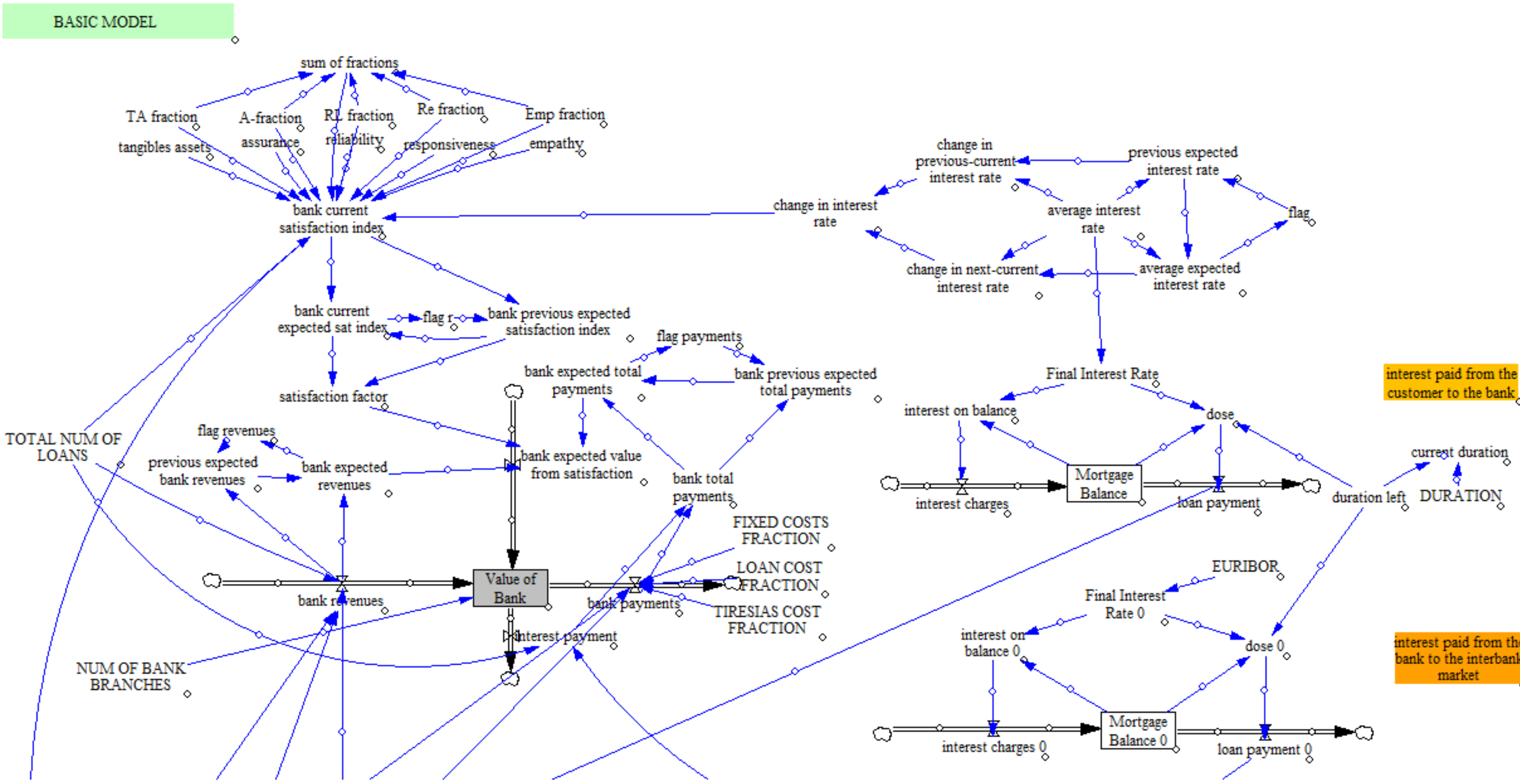
w3: ‘RL fraction’/ ‘sum of fractions’, weight of reliability in customer satisfaction

w4:‘Re fraction’/‘sum of fractions’, weight of responsiveness in customer satisfaction

w5: ‘Emp fraction’/ ‘sum of fractions’, weight of empathy in customer satisfaction

Each one variable has a value which is being generated randomly by the RANDOM UNIFORM() function of Vensim. The same function is for the fraction of any variable. Of course, we can give true values in each coefficient after making research as using questionnaires, run the regression analysis and find the estimates of these values.

Thus, the whole model of Bank that it has partially been analysed is represented below.



Graph 1. Bank representation in Basic Model

4.1.3.2 Value Calculation of the Customer

The Value of customer is a simple Box Variable, which estimates how much utility the mortgage offers to him. The utility reflects the reason that a customer decides to take a mortgage loan in order to gain its own house. Thus, we assume that it is the 'Rent of Real Estate'. We suppose here, that 'Rent of Real Estate' represents the average cost of renting a new house of the same quality as it is the house for which the loan is provided.

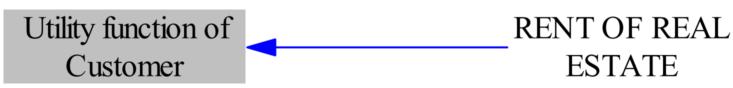


Figure 11. Utility function of Customer

Customer Deep Analysis

On the other hand, special care has to be taken for the customers of the service system, since they do not have, by definition, any downstream relationships. The customers generate value to the service system through their willingness to pay. Here, we have considered that the utility of the loan for the customer depends on an average rent of the real estate is mortgaged. The willingness to pay also depends on customer payment for the loan the customer borrowed an amount based on the average value of the real estate of equal value. Thus, it is very important, the rent of real estate exceeds the monthly instalment of the customer, so as to the utility of the customer to be high and therefore he will feel happy and more willing to pay his small monthly instalment comparatively. As for the bank, it can keep customer's instalment in low levels if it charges low interest rate.

4.1.3.3 Value Calculation of the Lawyer

As far as the lawyer is concerned, it is also a stock variable in the model. It is an accumulation of the lawyer revenues plus the lawyer expected value, based on satisfaction of the bank with which he is cooperated, less the monthly payments he has.

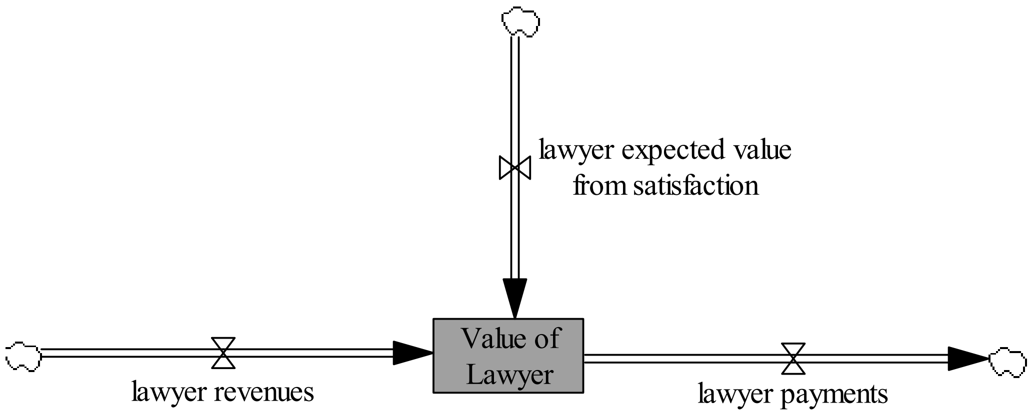


Figure 12. Lawyer basic diagram

The inflow of 'lawyer revenues ' is the sum of all the expenses the lawyer charge so as to complete a case of a mortgage loan and it depends on the number of new loans the bank has each month. The inflow of 'lawyer expected value from satisfaction' is a percentage estimate of the expected value of the lawyer based on the satisfaction of the bank to which the lawyer provides its services. Furthermore, the outflow of 'lawyer payments' evolve all the payments the lawyer must make in a month.

- **Lawyer Revenues Equation**

The revenues of the Lawyer are the sum of the expenses the lawyer takes from the bank (r_{all}) , which are charged to the new customers $N_{new}(t)$ multiplies with the average number on new customers $N_{new}(t)$ the bank has per month. This cost involves the cost of the lawyer (r_{lawyer}) involving the check of the legality of the titles of the real estate being mortgaged, the land registry expenses ($r_{landRegistry}$) for the registry of the real estate mortgage and finally the cadastre expenses ($r_{cadastre}$) for the registry of the boundaries and location of the real estate.

$$R_L(t) = N_{new}(t) * (r_{lawyer} + r_{landRegistry} + r_{cadastre}) \quad (4.22)$$

- **Lawyer Payments Equation**

The payments of the lawyer include the r_{all} that has in its revenues and they must afterwards be delivered to its cooperatives for their service to it, except for the r_{lawyer}, which its own expenses. Additionally, the lawyer pays its fixed costs ($r_{Fixed\ Costs}$), which includes the monthly rent, the staff wages, and other fixed costs the lawyer may have (electricity, water etc.). Finally, the lawyer pays an average cost for every new customer for its loan preparation and completion procedure (ex. paper material). The last one is expressed as a fraction of the lawyer expenses r_{lawyer} , which receives from its new monthly customers. While the lawyer receives the revenues we analysed above, most of them are paid to its cooperative partners so as to make the actions that the mortgage procedure demands.

$$P_L(t)= [\, r_{land\ registry} + r_{cadastre}+ a_1*r_{lawyer} \,] * N_{new}(t) + r_{Fixed\ Costs} \quad (4.23)$$

where $0<a_1<1$.

After the modification of our model for more simplicity, as we said in the beginning of this section, we have the following revenues and payments equations:

Revenues equation:

$$R_L(t) = N_{new}(t) * r_{lawyer} \quad (4.24)$$

and Payments equation:

$$P_L(t)= a_1*r_{lawyer} * N_{new}(t) + r_{Fixed\ Costs} \quad (4.25)$$

- **Value of Lawyer Equation**

The most important of all is the value of the lawyer, which it is gained from the mortgage loans service the bank provides to its customers with the significant cooperation of the lawyer. Thus the value the lawyer has in a time period [0, N] is the following:

$$V_L(t) = \sum_{t=0}^{N} [\, R(t) - P(t) + \frac{\overline{Sat}(t)}{\overline{Sat}(t-1)} * [\bar{R}(t) - \bar{P}(t)\,] \,] \quad (4.26)$$

Lawyer Deep Analysis

Afterwards, we are going to see a more analytical examination of the model, so as to understand better the small but significant details that make it operational and useful. We have considered that lawyer revenues are a function of 'NUM OF NEW LOANS' times the 'LAWYER EXPENSES' because the lawyer receives the lawyer expenses for every new loan. On the other hand, the lawyer pays each month a fraction of lawyer expenses for the total new loans and its fixed costs. Additionally, the lawyer has the expected value, as we have analyzed above, based on the satisfaction index created by its customers, which is the bank in our model. Thus, Value of Lawyer is Stock variable and is an accumulation of current revenues plus the expected value less the payments the lawyer does. A short tree diagram of 'Value of Bank' with two stages depth is shown in Figure 13.

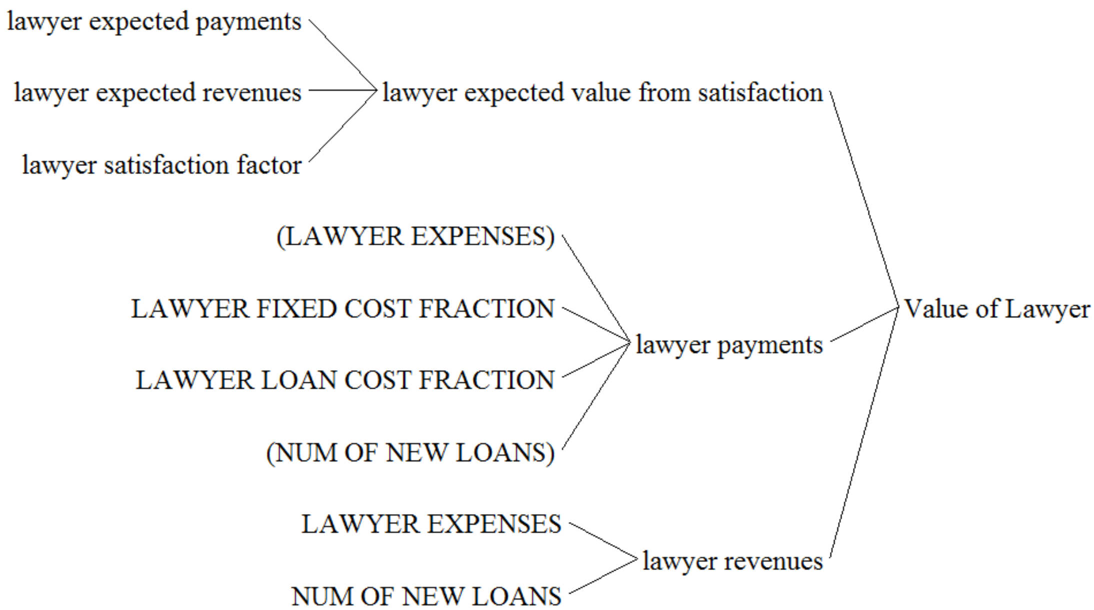


Figure 13. Value of Lawyer: Causes Tree

In Vensim, the documentation of each node, the calculation unit and some comments that help its comprehension are represented as follows:

Value of Lawyer= INTEG (
lawyer revenues-lawyer payments + lawyer expected value from satisfaction,
0)
Units: euro/Month
The value gained from current revenues plus the expected value less the
payments the lawyer has

****

lawyer revenues=

LAWYER EXPENSES*NUM OF NEW LOANS

Units: euro/Month

the monthly lawyer revenues from a loan application

****

lawyer payments=

LAWYER FIXED COST FRACTION + LAWYER LOAN COST FRACTION*LAWYER EXPENSES*NUM OF NEW LOANS

Units: euro/Month

the fixed costs the lawyer pays per month plus the cost for every new loan

****

lawyer expected value from satisfaction=

lawyer satisfaction factor* (lawyer expected revenues -lawyer expected payments

)

Units: euro/Month

shows the percentage of expected value the lawyer will have based on bank satisfaction

****

As far as the 'lawyer expected value from satisfaction' is concerned, it consists of the lawyer expected value and the 'lawyer satisfaction factor'. The lawyer expected value is the difference between 'lawyer expected revenues' and 'lawyer expected payments'. 'Lawyer expected revenues' at time T_N are estimated as described in the Qualitative Approach in this section. Thus, the 'previous expected lawyer revenues' depicts the expected revenues at time T_{N-1} and at time 0, they equals to 'lawyer revenues'. 'flag lawyer' is a temporary variable to help us keep in memory the previous value of 'lawyer expected revenues' with the function DELAY FIXED()[9] that Vensim supports. 'lawyer expected revenues' is a function of the weighted fractions of 'lawyer revenues' and 'previous expected lawyer revenues'. The same calculation logic follows the 'lawyer expected payments'. The documentation of 'lawyer expected revenues from satisfaction' is show below:

lawyer expected value from satisfaction=

lawyer satisfaction factor* (lawyer expected revenues -lawyer expected payments

)

Units: euro/Month

[9] http://www.vensim.com

shows the percentage of expected value the lawyer will have,
based on bank satisfaction
****

lawyer expected revenues=
0.5*lawyer revenues +0.5*previous lawyer expected revenues
Units: euro/Month
lawyer expected revenues=a*lawyer revenues +b*previous lawyer
expected revenues

****

previous lawyer expected revenues=
IF THEN ELSE(flag lawyer=0, lawyer revenues, flag lawyer)
Units: euro/Month
the expected revenues of the previous period

****

flag lawyer=
DELAY FIXED(lawyer expected revenues, 0, 0)
Units: euro/Month

****

Last but not least, we have to determine the parameters that affect the satisfaction factor. It is the satisfaction created to the lawyer customers due to the service they have received from the lawyer at the specified time period. Satisfaction factor is the fraction of next expected satisfaction in time T_N and equals to the 'expected lawyer satisfaction index' via the expected satisfaction in time T_{N-1} 'lawyer previous expected sat index'. Again, the logic of the estimation of the satisfaction index is explained in the Qualitative Approach in this section and is modelled the same as the 'bank expected revenues' or 'bank expected satisfaction index' that we have previously described. So, each time we need to know 'expected lawyer satisfaction index', whereas the other two variables depend on it. Thus, we have to analyze it so as to be able to have an estimate of the 'lawyer satisfaction factor'.

Customer Satisfaction for Lawyer service

It is very important to analyse the satisfaction of the bank in relation to the service the lawyer provides to it. Here, we suppose that 'lawyer current satisfaction index' is affected by some qualitative parameters, tangible and intangible assets, and a quantitative parameter, the number of the attracted from the lawyer customers to the bank. The bank is satisfied with the lawyer, not only with its capabilities and qualifications but also with the customers that the lawyer attracts and offers to the bank as new mortgage loan owners. The more attracted customers the better the satisfaction of the bank as for the lawyer. It is obvious that the bank prefer lawyers to have good qualitative parameters but also to be interested in attracting new customers for the benefit of the bank. So, the ‘lawyer satisfaction index’ depends on the qualitative parameters that are almost the same with those analysed for bank satisfaction index, and the number of customer attracted. Thus, the equation is as follows:

$$\text{‘Lawyer satisfaction index’} = w_1 * \text{‘num of customers lawyer attracts’} + w_2 * \text{ qualitative parameters} \quad (4.27)$$

where w_1 and w_2 are the weights that determine the importance of each variable in the estimation of the satisfaction index, with $w_1 + w_2 = 1$ and $0 < w_1 , w_2 < 1$.

A more analytical diagram that shows all the factors determine the satisfaction index is shown in Figure 14.

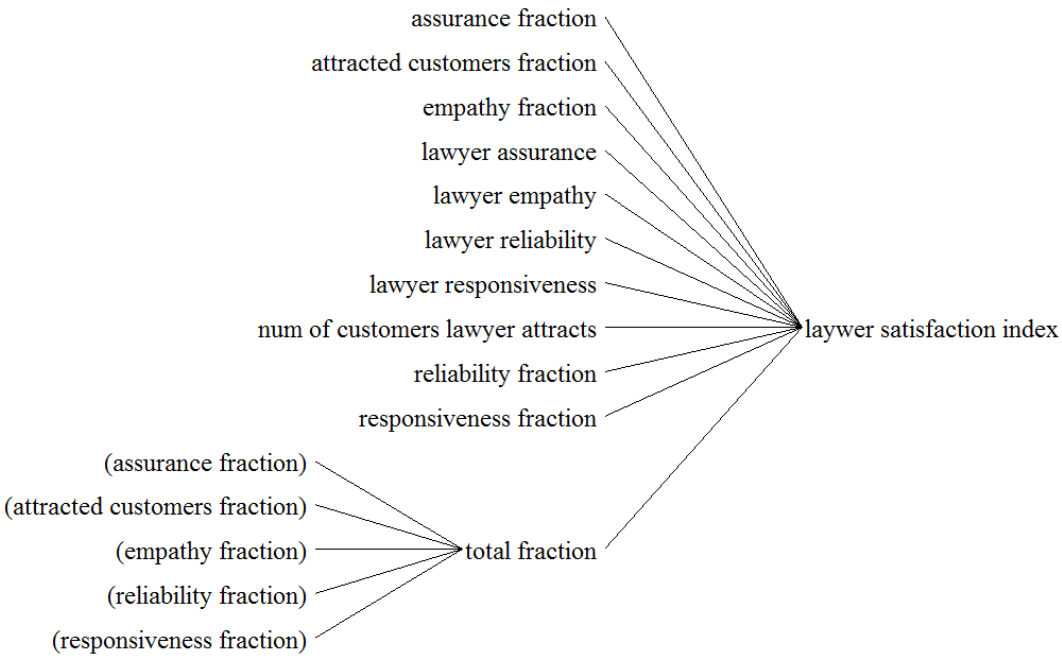


Figure 14. 'Lawyer satisfaction index': Causes Tree diagram

The weight of each parameter is the result of the division of each parameter’s fraction to the total sum of fractions. So, in Vensim the documentation of lawyer satisfaction factor is:

lawyer satisfaction index=

(assurance fraction/total fraction)*lawyer assurance+ (empathy fraction/total fraction)*lawyer empathy + (attracted customers fraction / total fraction)*num of customers lawyer attracts/10 + (reliability fraction /total fraction)*lawyer reliability + (responsiveness fraction/total fraction) *lawyer responsiveness

Units: 1/Month

Depends on the number of new customers the lawyer attracts (ranges from 1 to 10) per month and the quality parameters
****

The only thing that we must explain, is that the 'num of customers lawyer attracts' is divided with 10, so as to be in the range from 0 to 1 as the other qualitative parameters. Consequently, our final result, 'lawyer satisfaction index' will be in the same range, because both weights and parameters will be in that range.

4.1.3.4 Value Calculation of the Civil Engineer

On the other hand, the civil engineer is also a stock variable in the model. It is an accumulation of the civil engineer revenues plus the civil engineer expected revenues, based on satisfaction of the bank with which he is cooperated, less the monthly payments it makes.

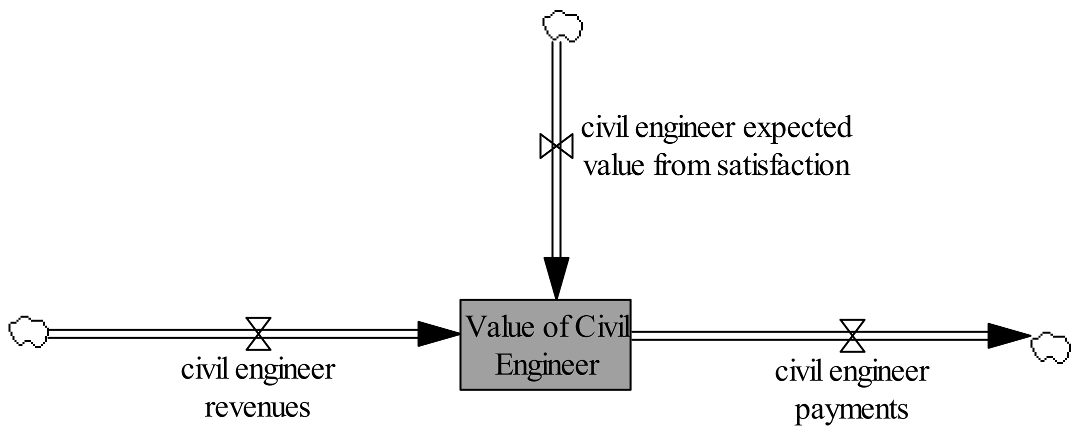


Figure 15. Civil Engineer basic diagram

The inflow of 'civil engineer revenues ' is the sum of all the expenses the civil engineer charges so as to complete a case of a mortgage loan. It depends on the number of new loans the bank has each month. The inflow of 'civil engineer expected value from satisfaction' is a percentage estimate of the expected value (expected revenues – expected payments) of the civil engineer based on the satisfaction of the bank to which the civil engineer provides its services. Furthermore, the outflow of 'civil engineer payments' evolve all the payments the civil engineer must do in a month.

Civil Engineer modelling idea is the same as lawyer one. Its equations are also the following:

Revenues:

$$R_{CE} = (r_{civil\ engineer}) * N_{new}(t) \qquad (4.28)$$

Payments:

$$P_{CE}(t) = r_{fixed\ costs} + (a_{1} * r_{civil\ engineer}) * N_{new}(t) \qquad (4.29)$$

Value :

$$V_{CE}(t) = \sum_{t=0}^{N} [\, R(t) - P(t) + \frac{\overline{Sat}(t)}{\overline{Sat}(t-1)} * [\bar{R}(t) - \bar{P}(t)\,] \;\;] \qquad (4.30)$$

4.1.3.5 The Other Participants

All the other groups are of no importance to examine their value because it is influenced by other networks, as other financial institutions, and thus, their value cannot be calculated. They participate in more value networks and as a result, we cannot remotely calculate their revenues and estimate their value because we will take wrong results. We have them in the model, just because the groups that we study their value interact with them. So it is needed to exist in the value network. Those groups are Tiresias, Cadastre and Land Registry.

TIRESIAS

Tiresias (see Appendix: TIRESIAS) is also a stock with inflows and outflows to change its value. Its inflows are the revenues it has from the monthly membership fee the financial institution pays for and the expected value it hopes to take. Its outflow of 'tiresias payments' is referred to its fixed costs per month.

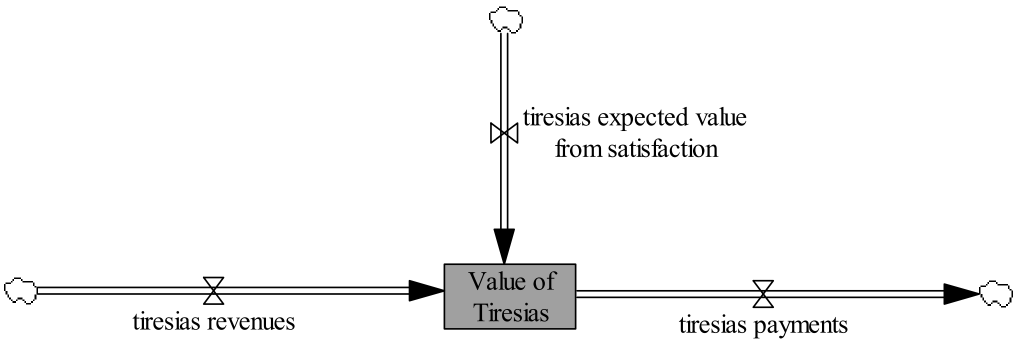


Figure 16. Tiresias basic diagram

The bank pays to Tiresias the monthly fee so as to be member and as a consequence to have access to Tiresias' database for the economic behaviour of its customers. Apart from the bank we examine, there are also other banks and generally other financial institutions that are members to Tiresias and pay a monthly membership fee. Thus, Tiresias revenues depend on many other entities and not only our bank payment. Due to the participation in many other value networks, we cannot calculate its value depending only on our own one, because we will end up to wrong results and therefore to wrong conclusions.

LAND REGISTRY and CADASTRE

The core diagram of Land Registry consists of a stock having inflows and outflows. The inflow 'Land Registry' is the monthly revenues it has due to the prenotations made for the new loans of the bank. Whereas, the other inflow of 'land registry expected value' is the expected value and the outflow of 'land registry payments' is the fixed costs it pays monthly. Similar to the Land Registry, Cadastre is a stock having inflows and an outflow.

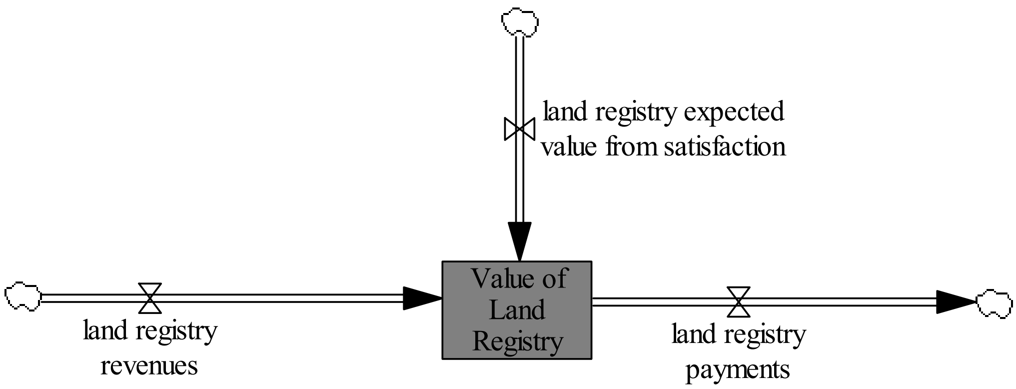


Figure 17. Land Registry basic diagram

Cadastre also follows the same logic with the Land Registry. Thus, its representation is the following:

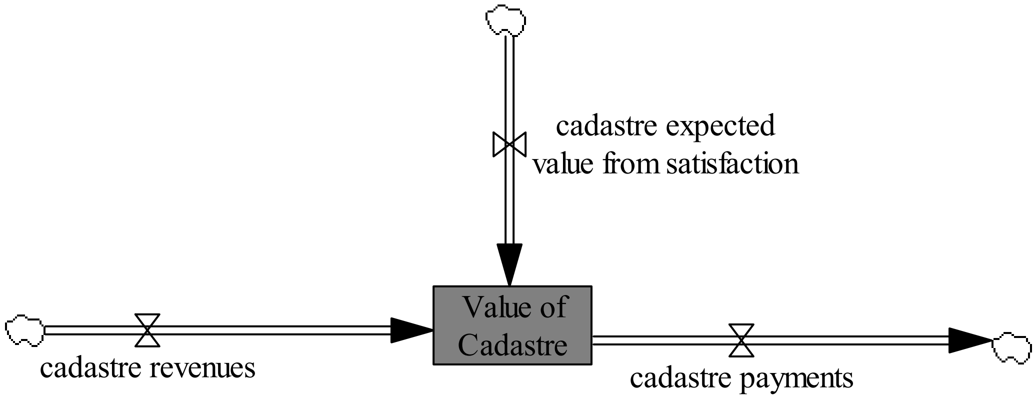
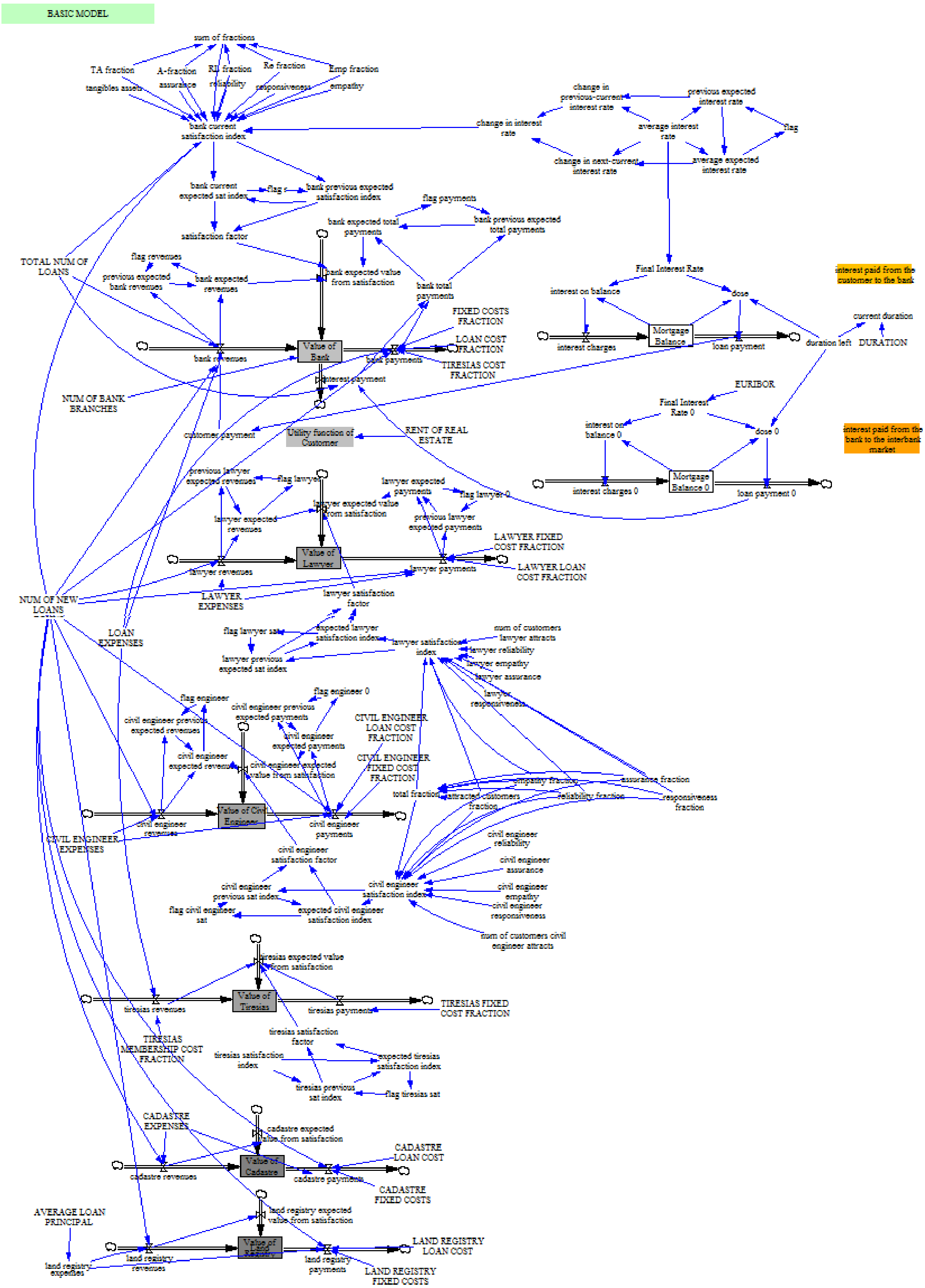


Figure 18. Cadastre basic diagram

We have already completed the analysis for the basic model and the components it consists of. Thus, the whole graphical representation of our basic model is shown below.



Graph 2. Basic Model

4.2 Non-Performing Loans model

The financial crisis of 2007–2010 (see Appendix:Subprime mortgage crisis) has been called by leading economists the worst financial crisis since the Great Depression of the 1930s. It contributed to the failure of key businesses, declines in consumer wealth estimated in the trillions of U.S. dollars, substantial financial commitments incurred by governments, and a significant decline in economic activity. Many causes have been proposed, with varying weight assigned by experts. Both market-based and regulatory solutions have been implemented or are under consideration, while significant risks remain for the world economy over the 2010–2011 periods. Although this economic period has at times been referred to as "the Great Recession," this same phrase has been used to refer to every recession of the several preceding decades[10].

The collapse of a global housing bubble, which peaked in the U.S. in 2006, caused the values of securities tied to real estate pricing to plummet thereafter, damaging financial institutions globally. Questions regarding bank solvency, declines in credit availability, and damaged investor confidence had impact on global stock markets, where securities suffered large losses during late 2008 and early 2009. Economies worldwide slowed during this period as credit tightened and international trade declined. Critics argued that credit rating agencies and investors failed to accurately price the risk involved with mortgage-related financial products, and that governments did not adjust their regulatory practices to address 21st century financial markets. Governments and central banks responded with unprecedented fiscal stimulus, monetary policy expansion, and institutional bailouts.

The model of non-performing loans tries to represent this crisis and simulate it using the basic model with some small changes. The important thing to know, so as to understand the changes made, is that the crisis started from the collapse of global housing prices. However, in times of economic trouble, the price of collateral can become very volatile and banks may have to raise either the loan price or the amount of collateral required. If collateral values fall dramatically, there can be a banking sector collapse- as was the case in the Japanese banking system crises that occurred in 1997 – 1998. Obviously, if the value of the collaterals linked to the ability of the borrower to repay, a decrease in the value of the collateral will increase the probability of default. Another reason that had a direct impact on customer is its income. According to the central bank of Greece, the annual instalment payment of the mortgage loan, including any other loan liabilities, must not exceed the 40% of its annual income. Respectively, the monthly loan payment must not exceed the 40% of customer's monthly salary. Obviously, the rest of 60% allow the customer to live a relatively comfortable life. Unfortunately, many banks overlook these instructions and as a result people become more and more indebted. Thus, either the reduction of real estate market prices, or the reduction of the disposable monthly income are reasons

[10] http://www.wikipedia.org

for a loan to default. Consequently, the mortgage loan owners either start to pay less or not to pay at all their monthly instalment and they just abandon their loan obligations and their real estate too. This situation had a significant impact on the financial institutions because their revenues from the monthly payments of their customers reduced. So, we are going to show how the fall in property prices or income results in loan losses and negative equity.

As far as the Utility of the customer is concerned, we have already said in the basic model that equals to the average rent of the real estate which is hypothecated of equal value. Because of the fact that we add the market value of the real estate in this model, we can modify the Utility of the customer indirectly by changing the rent of real estate by using the *comparable sales method*[11], a technique allowed by the courts to estimate the fair rental value of a real estate. This technique requires the determination of two amounts: the fair market value of the subject property and the rate of return on investment that an unrelated lessor of comparable property would require. The two numbers are multiplied to determine the fair rental value amount. The first amount, fair market value, should be readily available from real estate sales records. The second figure, the required rate of return, is more subjective but it can easily be found.

4.2.1 Model Analysis

In non-performing loans model, some more variables were added. Some of them affect the payment of the customer and some others affect the Utility function of the customer.

4.2.1.1 The Customer Payments

The first one has to do with the customer. We added one more Box variable 'customer real payment' so as to calculate the real payment the customer does. We supposed that the customer is reliable to its payments as long as the monthly payment instalment does not exceed the limit of its monthly income and also the limit of market value of equal value of real estate, for which the customer has borrowed, is bigger than the loan principal. By the time the value of real estate is becoming lower and lower and the loan principal is still high, the customer reduces its payment more and more up and pays an equal instalment as the low market value is the remained loan principal and still not more than the corresponding rent. Whereas, if the monthly income becomes lower and lower, the customer pays the limit of this income as the maximum payment he can afford. From the customer point of view, there is no reason to give a

[11] http://www.home.co.uk/guides/property_valuation/comparable_sales_method.htm

instalment bigger than the respective value of its real estate for which this obligation has occurred or if he cannot live a normal life with the essentials due to low income. Thus, there saw the need to add the constant variables 'MARKET VALUE OF REAL ESTATE' and 'AVERAGE MONTHLY INCOME', their fractions 'real estate fraction' and 'income fraction' and the limits occurs from them, the box variables 'limit of real estate value' and 'limit of income' respectively. Moreover, we use the box variable 'criteria for default' so as to determine the final payment of the customer in case of default. Default occurs if the mortgage loan payment exceeds the 'limit of income' or if the initial 'AVERAGE LOAN PRINCIPAL' exceeds the 'limit of real estate value' and the rest of mortgage loan 'Mortgage Balance' is higher than the 'limit of real estate value'. In these cases, the customer will pay the limit of his income or he will pay a instalment that corresponds to the 'limit of real estate value' as mortgage balance but no more than the corresponding rent respectively. Thus, we consider that the customer will really pay the minimum of these alternatives. The new changed documentation for these variable which affects the customer's payment is the following:

AVERAGE MONTHLY INCOME=
2000
Units: euro/Month
the average monthly income for a house

****

income fraction=
40/100
Units: 1/Month
the percentage of income up to which the customer can afford borrowing

****

limit of income=
AVERAGE MONTHLY INCOME*income fraction
Units: euro/Month
shows the percentage that is considered the limit for the income

****

MARKET VALUE OF REAL ESTATE=
140000
Units: euro/Month
the total commercial value of the real estate

****

real estate fraction=
75/100
Units: 1/Month

the percentage of real estate value that limits the mortgage loan the customer can afford borrowing

****

limit of real estate value=
MARKET VALUE OF REAL ESTATE*real estate fraction
Units: euro/Month
shows the percentage that is considered the limit for the real estate market value

****

In order to calculate the instalment for the second scenario of default, we used the box variable 'instalment due to default in real estate value'. This variable uses the instalment payment formula of a loan with the same interest rate and same maturity of the customer's real loan, so as to calculate the monthly payment by just replacing the 'Mortgage Balance' as the 'limit of real estate value'. The documentation of this variable is shown below:

instalment due to default in real estate value=
(Final Interest Rate+ (Final Interest Rate/ (EXP(duration left*LN(1+Final Interest Rate
)) -1)))* limit of real estate value
Units: euro/Month
calculates the monthly instalment replacing the limit of market value (75% of market value) with the mortgage balance

****
The variable which determines for the 'customer real payment' is the 'criteria for default'. This variable keeps the minimum of the three possible payments, loan payment, payment in case of income reduction, payment in case of real estate market value reduction. Additionally, by creating this new variable, we actually add a condition by using MIN() and IF THEN ELSE() functions of Vensim. The documentation is shown below:

criteria for default=
MIN((IF THEN ELSE(loan payment >limit of income ,limit of income ,
loan payment
)), (IF THEN ELSE((AVERAGE LOAN PRINCIPAL>limit of real estate value
:AND: Mortgage Balance>limit of real estate value) , MIN(instalment due to default in real estate value, RENT OF REAL ESTATE)
, loan payment)   )   )
Units: euro/Month

shows the minimum payment of the customer depending on the case of default. Default occurs either due to reduce of the limit of income or in market price of real estate.
****

customer real payment=

criteria for default

Units: euro/Month

the payment the customer will decide depending on the case of default

****

For the needs of our model, we changed the 'MARKET VALUE OF REAL ESTATE' or 'AVERAGE MONTHLY INCOME' box variables by using the function STEP(x,y)[12] of Vensim, which changes the value of the variable by 'x' at time step 'y'. With this function, we can reduce the value of each variable step by step so as to examine the behavior of the customer according the changes. In case of default, the loans will not well-performed and the bank revenues will start reducing.

The last variable we added in our model is the 'non-performing loan balance', which keeps the non-performing loan balance the customer not pays. So, it is the difference of 'customer normal payment' with the 'customer real payment'. This difference is then added to the mortgage balance of the customer and the interest is capitalized and the balance of the unpaid instalment remains to the mortgage principal. In Vensim, it is represented as an inflow of the stock variable 'Mortgage Balance'. Thus, the documentation of 'non-performing loan balance' and the 'Mortgage Balance' are as follows:

"**non-performing loan balance**"=

customer normal payment-customer real payment

Units: euro/Month

the non performing loan balance that the customer not pay

****

Mortgage Balance= INTEG (

interest charges-loan payment+"non-performing loan balance",

AVERAGE LOAN PRINCIPAL)

Units: euro/Month

The "Mortgage Balance" is the amount of money the borrower owes

to the bank, -((Final Interest Rate+ (Final Interest Rate/ (

EXP(duration left*LN(1+Final Interest Rate)) -1)))*LOAN

PRINCIPAL)+LOAN PRINCIPAL*Final Interest Rate

****

[12] http:www.vensim.com

Now, the 'Mortgage Balance' is the accumulation of 'interest charges' plus the 'non-performing loan balance' less the 'loan payment'. The more the customer do not pay, the more the mortgage balance will increase, because the principal increase, thus the interest will increase, thus the monthly instalment will eventually increase and it will be hard for the customer to be able to respond to the more increasing monthly instalment.

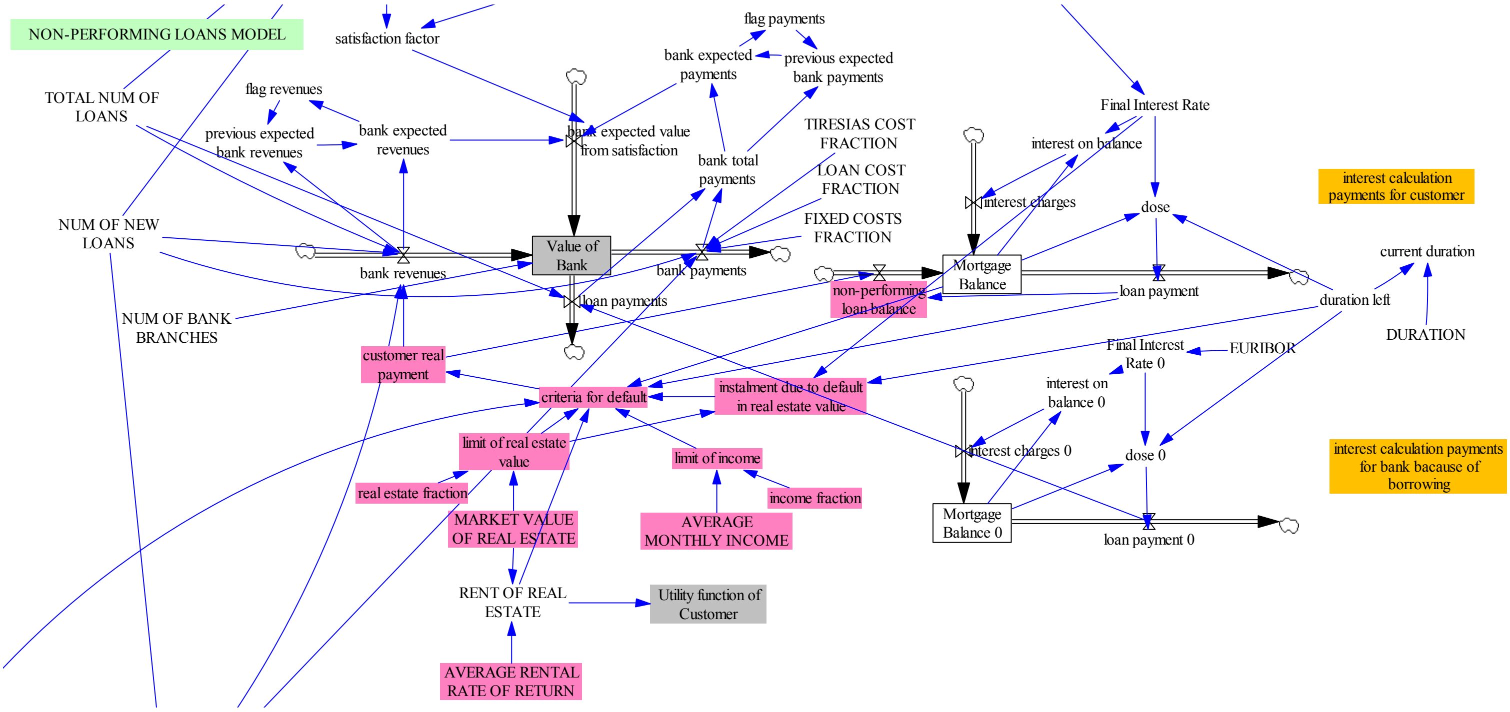
4.2.1.2 Utility function of the Customer

The effects on private consumption of households by housing market developments, and especially on housing prices and the market value of assets (wealth) of households are estimated to be limited. For that reason, it is expected that the impact of recent developments in the rate of change of GDP will be marginal. To the extent that house prices affect the rent (although this has not been demonstrated clearly in Greece), the housing market could affect the evolution of consumer price index. However, according to data extracted from the annual report 2008 of the President of Bank of Greece, it is noted that in the last five years the average annual growth rate of rents were significantly higher than the corresponding rate of increase in the general price level. Surfing the internet, we can find the average rental rate of return of our country or anywhere else we want. Thus, we added the constant variable 'AVERAGE RENTAL RATE OF RETURN' which we set the value we want and the documentation of the variable 'RENT OF REAL ESTATE' has changed as below:

RENT OF REAL ESTATE=
MARKET VALUE OF REAL ESTATE * (AVERAGE RENTAL RATE OF RETURN / 12)
Units: euro/Month
the rent the real estate deserves, fair rental value = market
value * average rental rate of return

****

In Vensim, the graphical representation of the non-performing loans model is shown below:



Graph 3. Non-Performing Loans model – changes from the Basic model

4.3 Price Discrimination model

Arguably, price discrimination is one of the most widely practised forms of pricing. At its most basic, price discrimination is present whenever the same product or service is sold to different customers or consumers at different prices. For a firm to engage in price discrimination, three conditions are necessary. Firstly, the firm must have sufficient market power to exercise some control over the price at which it sells its product. Secondly, it must be possible to separate customers or consumers into separate groups according to their price sensitivity. Finally, the firm must be able to prevent those customers or consumers who are sold the product at a lower price, reselling to customers and consumers who are being charged a higher price (Perman & Scouller, 1999).

Price discrimination is an important strategy in pursuit of maximizing profits. The essence of price discrimination is to charge customers the price they are willing to pay. Whenever a service is provided where p > MC (price > Marginal Cost), there is an incentive to engage in price discrimination, because there are buyers who are willing to pay more than it costs to provide the service. Charging a uniform price means lowering the price to those customers who are prepared to pay a higher price and, hence, the bank is foregoing higher revenue without any change in unit costs. Price discrimination is a practice widely promoted by the marketing literature. By definition, a firm can only be maximizing its profits when the difference between total revenue and total costs is maximized. As will be demonstrated below, profits can be increased if those customers that are less price sensitive are charged a higher price and those that are more price sensitive are charged a lower price. The charging of non-uniform prices does not, however, always reflect price discrimination.

Price discrimination comes in a number of forms and the traditional classification of the forms of price discrimination is due to Pigou (Pigou, 1920). He distinguished three types of price discrimination, the economics of which are dealt with in the following sections:

- First-degree price discrimination - where a supplier with sufficient market power sells each unit of output at a different price to individual customers equivalent to each individual's reservation price.

- Second-degree price discrimination - where a supplier with sufficient market power divides output into successive tranches and charges customers successively lower prices for each tranche consumed.

- Third-degree price discrimination - where a supplier with sufficient market power divides customers into distinct groups and charges each group a different profit-maximizing price.

Our price discrimination model tries to demonstrate that the third degree price discrimination can be simulated in our model and gives results about bank profitability. In our model, we divided customers into two distinct segment-groups and charge each segment a different price. The third degree price discrimination is exercised in markets where customer's segmentation is based on objective attributes, e.g. racial discrimination, wealthy customers. Thus, we divided new customers into two segment-groups and charge them different interest rates. In the group of special customers, we charge lower interest rates, according to the evaluation of the bank, and the range of this group varies from 2.5% to 3.4%. The range of higher interest rates for the other group of common customers is from 3.5% to 4.4%. Whereas, the average interest rate of the non-price discrimination model ranged from 2.5% to 4.5%. Thus, we make the simulation and compare the results of the two models, so as to show which one model is the best for the bank profitability. By changing the ranges of interest rate, the bank can make a sensitivity analysis and finally follow the policy is to its advantage.

4.3.1 Model Analysis

In price discrimination model, there were added some more variables in order to differentiate it from the basic model. As the definition of price discrimination says, the important thing to remember is that the bank changes its pricing policy in some groups of customers, which are two in our model. So, in our model, we change the part of the model that has to do with the interest rate the customers are charged. Thus, we create two segment-groups, the special customers and the common customers. We assume that the 'special customers' are the 30%, as the 'special customers fraction' is initialized, of the new customers Nnew the bank has per month and the rest 70% is the 'common customers', as the 'common customers fraction'. So, the distinction of customers affects only the new customers and not the total customers the bank has, who are already mortgage holders. Additionally, we use two more box variables to represent the distinct interest rates, the 'special interest rate' and the 'common interest rate' for each distinct group respectively. Afterwards, we calculate the differences of the current average interest rate of each category with the previous and the next expected ones. So as to find the customer satisfaction created by interest rate, we take into consideration the previous interest rate the bank has given to a group. So we have a box variable 'change in previous-current interest rate' to keep this change. If the previous interest rate was smaller, then the difference will be negative, which depicts negative satisfaction due to the fact that the current customer has been charged a bigger interest rate than the previous periods. The negative difference depicts to a positive satisfaction. We also use the box variable 'change in next-current interest rate', so as to keep the change of current interest rate and that of the next expected period interest rate. If the difference between the next expected and current interest rate is positive, the satisfaction will be positive because it is expected that the next given interest rates will be larger than the one given in current period. So the average satisfaction of the customers is positive because they know that they have charged smaller interest rates. By saying that they have charged an interest rate, we mean that if it is for fixed interest rate, they have achieved a small one, whereas if it is for adjustable interest rate, they have achieved a small spread. More risky loans may be priced higher than the less risky loans. Generally, the judgement is made on the basis of past credit history (through credit rating agencies), the borrower gearing (leverage) ratio, wealth of borrower, volatility of the borrowers' income, whether or not collateral is a part of the loan agreement, length of time as a customer at a bank or at a certain address, employment history, and whether a future macroeconomic climate will affect the applicant's ability to repay. As far as the fixed rate is concerned, the satisfaction of customer remain unchanged in case of fixed interest rate, because it remains the same during the previous, current and next periods and thus, the differences are zero and consequently, the interest rate does not affect customer satisfaction. Thus, the interest rate can be a factor that affects customer satisfaction only in case it is adjustable during the periods. The documentation of these changes in interest rates of the different groups of customers, special and common, is the following:

change in interest rate special=
0.5*"change in previous-current interest rate"+0.5*"change in next-current interest rate"
Units: 1/Month
shows the change in (previous-current interest rate) and in
(change in next-current interest rate)

****

"**change in previous-current interest rate**"=
(previous expected interest rate-special interest rate)/previous expected interest rate
Units: 1/Month
interest rate difference between current and previous for
customers with special interest rate

****

"**change in next-current interest rate**"=
(average expected interest rate-special interest rate)/special interest rate
Units: 1/Month
interest rate difference between current and next for customers
with special interest rate

****

special interest rate=
RANDOM UNIFORM(0, 1 , 0) +2.5

Units: 1/Month
random interest rate % from 2.5 to 3.4 for special customers

****

previous expected interest rate=
IF THEN ELSE(flag=0, special interest rate ,flag)
Units: 1/Month
****

average expected interest rate=
0.5* special interest rate + 0.5*previous expected interest rate
Units: 1/Month
average expected interest rate=g* INTEREST RATE + d*previous expected interest rate

****

flag=
DELAY FIXED(average expected interest rate, 0, 0)
Units: 1/Month

****

The same documentation is for the other group of customers, the common customers. After having the changes in interest rates for both the two groups of our model, we calculate the average change in interest rates, with each change to have a weight according to the number of customers each group has to the total number of customers. Lastly, the 'average change in interest rates' is a box variable, which depicts the impact of changes of interest rates in customer satisfaction. So, the documentation for this box variable is the following:

average change in interest rates=
(special customers/(special customers + common customers))*change in interest rate special
+ (common customers/(special customers + common customers))*change in interest rate common
Units: 1/Month
the average change in interest rates of two categories of customers

****

Moreover, the whole causes tree representation of 'average change in interest rates' in price discrimination model with two depth precision is shown below:

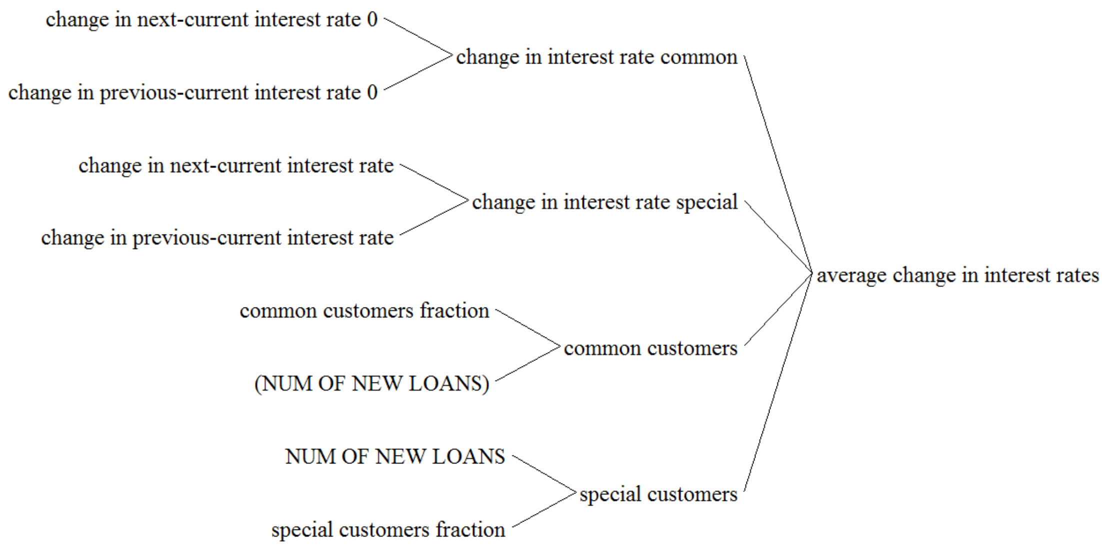


Figure 19. Causes Tree:'average change in interest rates' in Price Discrimination model

Therefore, we use the average interest rate for special customers and the average interest rate for common customers so as to calculate the average interest rate the bank has provided during a time period. So, we use a box variable 'average interest rate' that is the weighted average of 'special interest rate' and 'common interest rate'. The weights used, depend on the number of special customers to the total new customers and the number of common customers to the total new customers for the special and common interest rate respectively. The equation of this variable is:

'**average interest rate**'=('special customers'/ ('special customers'+

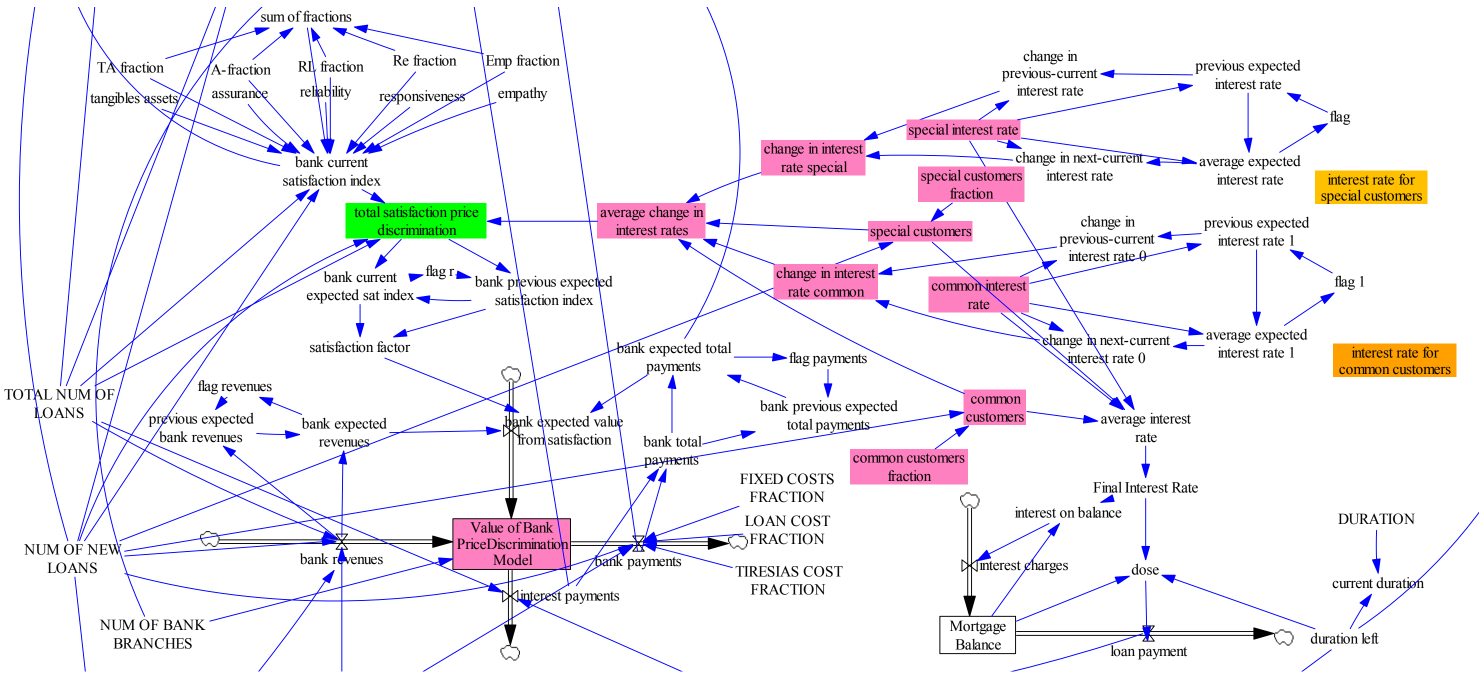
+ 'common customers')) * 'special interest rate' +

+ ('common customers'/('special customers'+

+ 'common customers')) *'common interest rate' (4.31)

With this average interest rate, we then calculate the average payment of a loan mortgage, so as to calculate the total revenues of the bank.

The graphical representation of the variables added in the basic model so as to create the price discrimination model is shown below:



Graph 4. Price Discrimination model- changes from the Basic model

4.4 Branch Performance Evaluation Model

Recognition of the importance of relationships in recent years has inspired marketers to focus on the maintenance of exchange relationships rather than on the accumulation of transient transactions. Tumbull and Wilson (1989) contend that managing buyer-seller relationships is central to achieving strategic advantage in the marketplace, while Reichheld (1994) argues that managing for loyalty (customers and employees) is the only way to achieve sustainably superior profits. Webster (1994) convincingly argues for a new marketing concept in which delivering value to loyal customers is very important. He states “customer loyalty has meaning only within the context of relationship marketing”. Nevertheless, only when both parties obtain benefits which outweigh the costs, relationships are likely to persist. For the company and sales associate, benefits include higher sales, more positive word-of-mouth, lower costs per transaction, and most importantly, customer loyalty and retention.

Customer satisfaction represents a modern approach for quality in enterprises and organisations and serves the development of a truly customer-focused management and culture. Measuring customer satisfaction offers an immediate, meaningful and objective feedback about clients’ preferences and expectations.

The branch occupies the key position in the bank's organisation. In recent years considerable resources have been spent helping branch staff to develop a greater marketing orientation, stressing particularly the importance of research and market planning. This has presented top management with the need to help branch managers by providing assessments of potential at branch level and thereafter by objectively evaluating the results of the business development effort.

In branch evaluation performance model, we are going to examine the behaviour of the branch performance due to customer satisfaction. As we have already mentioned, customer satisfaction is defined by 5 parameters, reliability, responsiveness, empathy, assurance, tangibles and change in interest rate. Thus, we are going to observe the changes in total Value of a Bank Branch according to the changes in customers’ satisfaction parameters, which in turn affects the sales of the branch, meaning the number of new loans it has per month either the total number of loans the bank or branch has in its assets and succeed to sustain them.

4.4.1 Model Analysis

4.4.1.1 Total Bank Value

In Branch Performance Evaluation model we added some more variables in order to meet our simulation and modeling needs. Firstly, we separated the value of one branch and the value of the all rest branches the bank has. Thus, we have 'Value of Bank Branch', the 'Value of Other Bank Branches' and the 'TOTAL VALUE OF BANK'. The first two stock variables are calculated in the same way as in the basic model with the difference that the 'Value of Bank Branch' is only for one branch, whereas the 'Value of Other Bank Branches' has each one of inflows and outflows multiplied with the 'NUM OF BRANCHES'. Finally, 'TOTAL VALUE OF BANK' is the sum of the two values, and represents the total value of the bank. One change is that we add separate variable to represent the number of total and new loans for each value either branch or bank. So, we added the box variables 'AVERAGE NUM OF TOTAL LOANS' and 'AVERAGE NUM OF NEW LOANS', which they can either be constant as defined or produce random numbers. Afterwards, in order to calculate 'Value of Other Bank Branches', we multiplied those variables with the 'NUM OF BRANCHES' variable.

TOTAL NUM OF LOANS=
AVERAGE NUM OF TOTAL LOANS*NUM OF BRANCHES
Units: 1/Month

****

NUM OF NEW LOANS=
AVERAGE NUM OF NEW LOANS*NUM OF BRANCHES
Units: 1/Month
the new loans provided per month

****

The dependent variables of 'Value of Other Bank Branches' are shown in Figure 20:

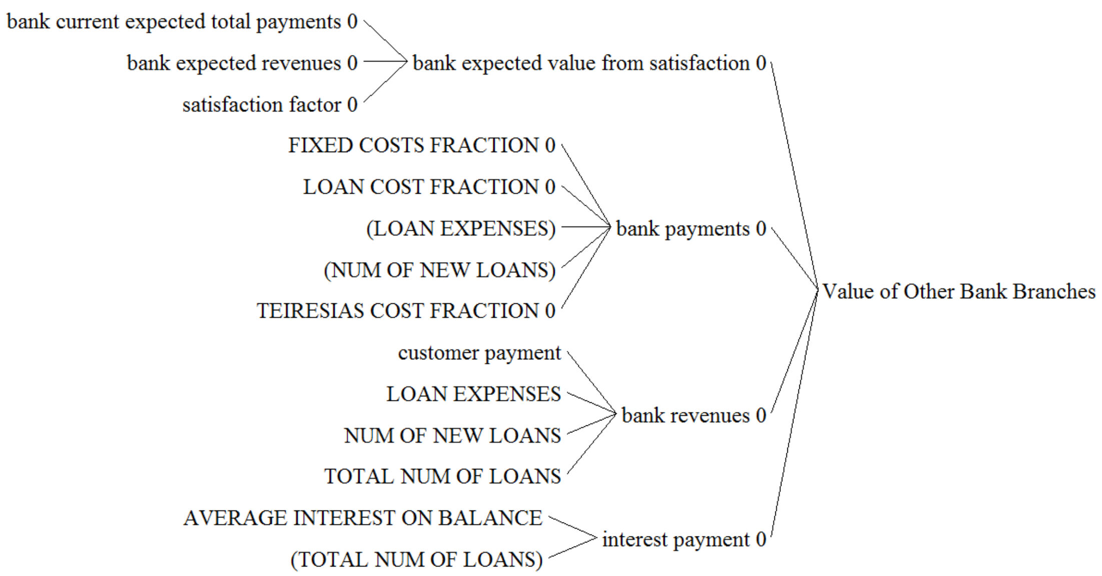


Figure 20. Value of Other Bank Branches: Causes Tree

4.4.1.2 Bank Branch Value

This distinction made due to the fact that the branch number of total and new loans may change during the time, depending on the customer satisfaction index, as we have already referred in the beginning. For this reason, we added a new box variable 'satisfaction impact on customers' for the branch, which checks each month the satisfaction index occurs as shown below. We have made some conditions when the variable changes and affects the number of loans.

satisfaction impact on customers=
IF THEN ELSE(((branch current satisfaction index<0.5) :AND: (branch current satisfaction index
>0.4)), 1/2 , IF THEN ELSE(branch current satisfaction index<=0.4 :AND:
branch current satisfaction index>0.3 , 1/4
,IF THEN ELSE(branch current satisfaction index <=0.3 :AND: branch current satisfaction index
>0, 1/5 , 1)))
Units: 1/Month
the percentage of customers satisfaction impact on new and old customers

****

Thus, this variable is a factor multiplied with the 'AVERAGE NUM OF TOTAL LOANS' and 'AVERAGE NUM OF NEW LOANS' variables and as results we take the 'changed TOTAL NUM OF LOANS' and 'changed NUM OF NEW LOANS' new variables for the calculation of the branch value. The number of loans is affected only when the satisfaction index falls down the 0.5, which means that the customers are not well satisfied with the overall service the branch offers. If it falls in the range <0.4 , 0.5> then both variables concerning the loans are reduced by ½, whereas if it is in the range <0.4 , 0.3> the reduce is by ¼ and lastly if the range is <0.3 , 0> the reduce is by 1/5. So, if the branch achieves o maintain the satisfaction index of its customers more than 0.5, then the number of total and new loans will not be affected. We make the assumption that both variables, 'changed TOTAL NUM OF LOANS' and 'changed NUM OF NEW LOANS' are affected because either the bank loose new customers because of the bad reputation of the branch, either the existed customers dislike the service the branch offers and desire to transfer their loan to other bank.

changed TOTAL NUM OF LOANS=
IF THEN ELSE(operation index=0, 0 ,INTEGER(AVERAGE NUM OF TOTAL LOANS*satisfaction impact on customers
))
Units: 1/Month
changes according to the satisfaction impact on customers of the service offered

****

changed NUM OF NEW LOANS=

IF THEN ELSE(operation index=0, 0, INTEGER(AVERAGE NUM OF NEW LOANS *satisfaction impact on customers
))

Units: 1/Month

changes according to the satisfaction impact on customers of the service offered

****

The variable 'operation index' defines the operation of the bank branch. We use this variable in order to be able to set the operation of the branch by the bank. In cases of bad branch performance, the bank should take the necessary measures to detect losses or even reduce them. Under this assumption, we consider that he bank will intervene either if the value of the branch becomes negative for the first time and continue to be negative for at least 48 months, or if the branch value becomes negative for a second time and remain in the same position for at least 36 months. By this way, the bank helps the branch and gives it a chance to recover within a time period, but if a second time the branch value becomes negative then the bank will be patient for a smaller period of time. Thus, the variable 'operation index' determines the operation of the branch and it is zero(0) if the branch must stop its operation or it is set to one (1) if it continues operating.

operation index=

IF THEN ELSE((flag operation>1 :AND: counter of negative branch value>36)
:OR: (flag operation>0 :AND: counter of negative branch value>48) , 0 , 1
)

Units: 1/Month

determines the operation of the bank branch, 0:stop operation, 1: continue operation

****

Moreover, we needed to include the constant variable 'LIMIT' so as to define the limit the bank sets for the operation of the branch. This Limit is set to zero in our model, which means that the bank starts monitoring the branch more strictly after its value falls down the limit. Additionally, we use one more box variable 'flag operation', which is a counter of how many times the value of the branch has become under the LIMIT that the bank sets. We also used the variable 'previous operation', so as to keep the previous value of bank branch and compare it with the LIMIT. By this way, we achieve to know how many times the branch fell down the LIMIT, where the previous month was not. Afterwards, the 'value of under the LIMIT branch value' is of significant importance because it counts the duration that the branch value remains under the limit each time it falls. By checking this variable, the bank is able to know the duration of the bad behavior of the branch and respectively to decide for the policy to follow.

flag operation= INTEG (
IF THEN ELSE(Value of Bank Branch<LIMIT :AND: previous operation>LIMIT, +1
, 0), 0)
Units: 1/Month
counts how many times the bank has low operation value, under the LIMIT

****

previous branch value=
DELAY FIXED(Value of Bank Branch, 0 , 0)
Units: 1/Month
keeps the previous value of bank branch

****

counter of under the LIMIT branch value= INTEG (
IF THEN ELSE(Value of Bank Branch<=LIMIT , +1 , -counter of under the LIMIT branch value
), 0)
Units: 1/Month
counter of how many continuing months the value of bank branch is down the LIMIT

****

Under all these assumption and all these variables added in our model, the bank can control the operation of the bank with the variable 'Stop Branch Operation'. This variable abstract the remaining value of the branch value and makes it equal to zero. This is done when the 'operation index' is set to zero, which means that the branch must stop its operation according to the bank criteria.

Stop Branch Operation=
IF THEN ELSE(operation index=0, -Value of Bank Branch, 0)
Units: euro/Month
make zero the bank branch value when the operation index=0, which means that branch must stop its operation

****

The overall causes tree diagram of 'Stop Branch Operation' variable and all its dependent variables is shown in Figure 21 below:

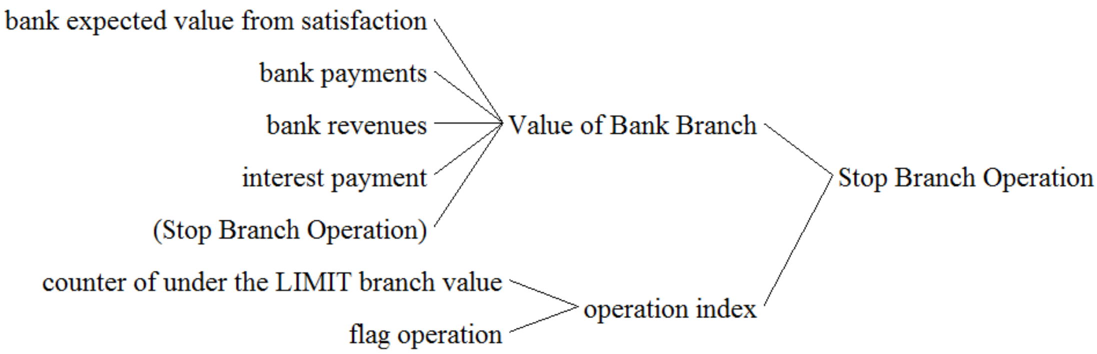
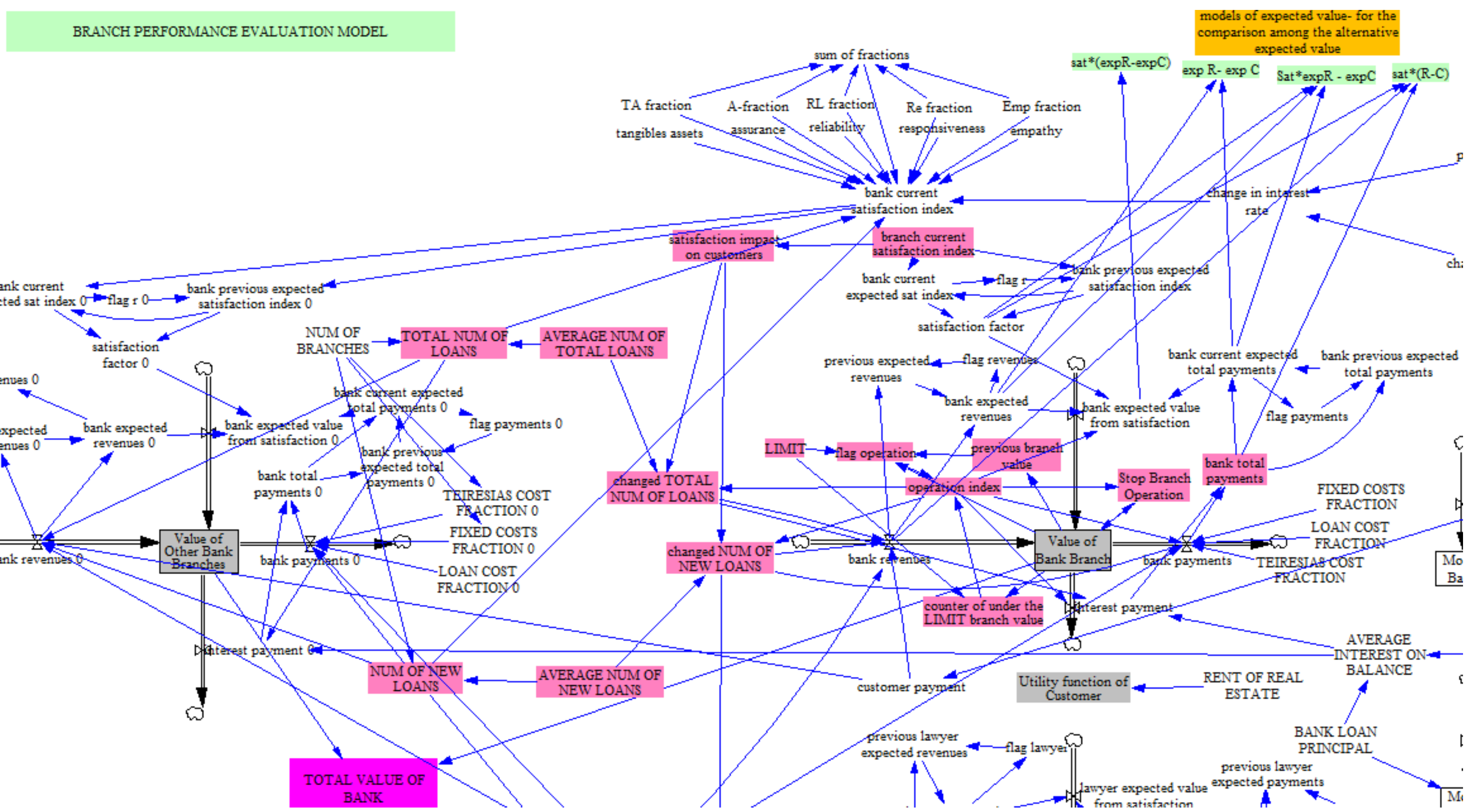


Figure 21. Stop Branch Operation: Causes Tree

Last but not least, the graphical representation of the variables added in the basic model so as to create the branch performance evaluation model is shown in Graph 5 below.



Graph 5. Branch Performance Evaluation Model- changes from the basic model

Whereas, the causes tree for the value of the bank branch with all its dependent variables is the following.

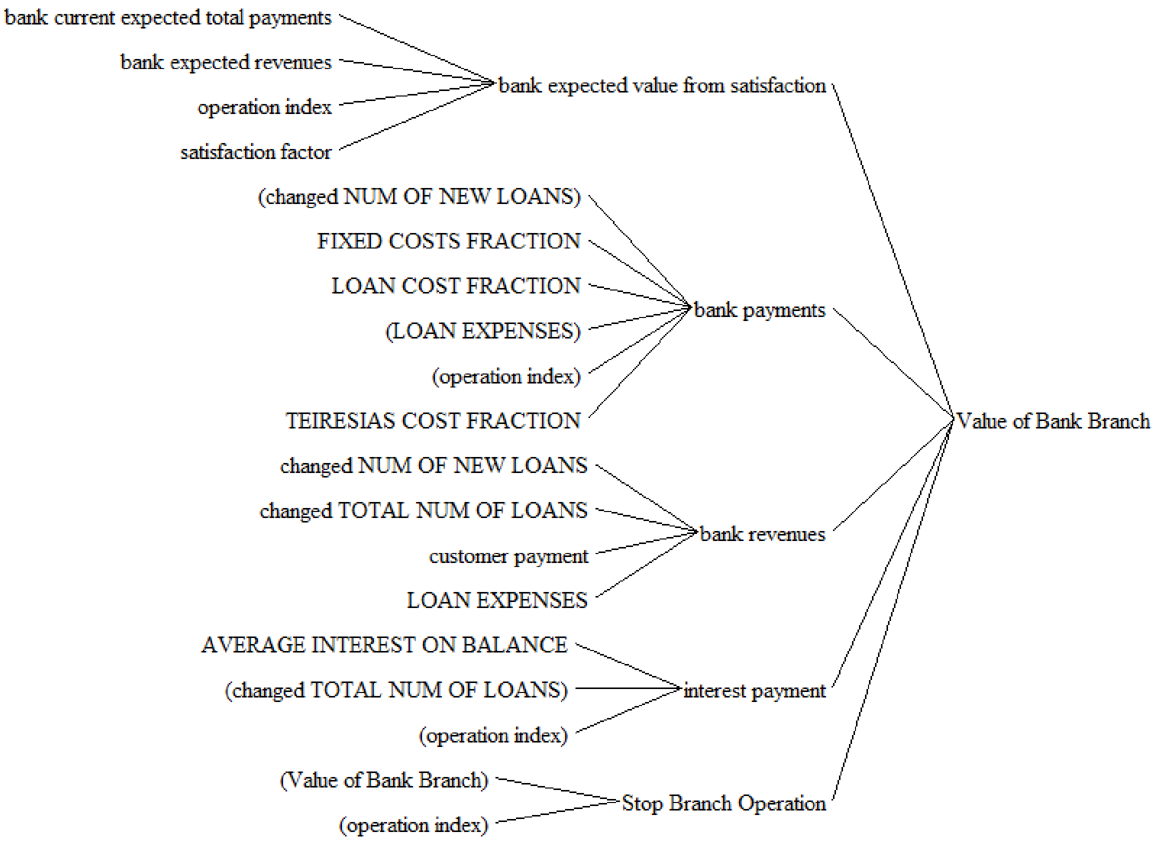


Figure 22. Value of Bank Branch: Causes Tree

5 Empirical Results & Discussion

In this section, we apply the previous business models using reasonable values and present the results.

5.1 Basic Model

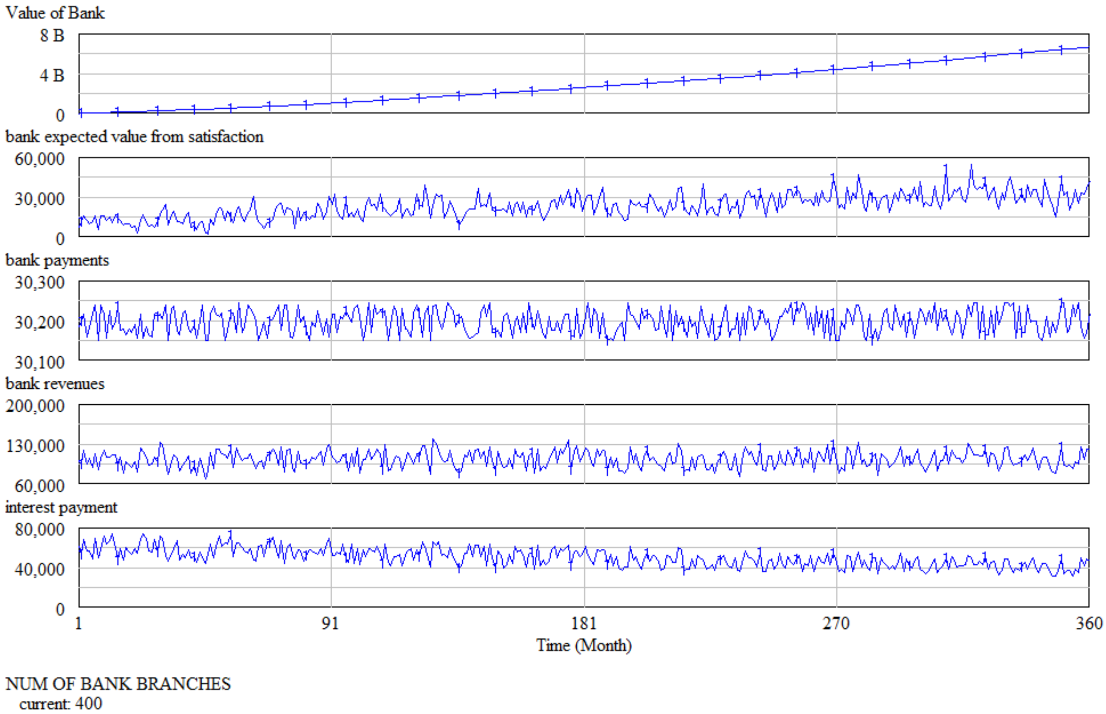
For the simulation needs of the basic model, we use the values shown in Table 3. We use a random function in some variables (instead of a constant value) so as to see how the value of the bank and other important variables is affected by the fluctuations of the independent variables.

Box Variable	Value
AVERAGE LOAN PRINCIPAL	100000
TOTAL NUM OF LOANS	INTEGER(RANDOM UNIFORM(0, 1 , 0)*100 + 150)
NUM OF NEW LOANS	INTEGER(RANDOM UNIFORM(0, 1 , 0)*10*2 +10)
NUM OF BANK BRANCHES	400
FIXED COSTS FRACTION	30000
LOAN COST FRACTION	0.01
TIRESIAS COST FRACTION	100
LOAN EXPENSES	500
EURIBOR	0.7
DURATION	360
tangibles assets	RANDOM UNIFORM(0, 1 , 0)
Assurance	RANDOM UNIFORM(0, 1 , 0)
Reliability	RANDOM UNIFORM(0, 1 , 0)
Responsiveness	RANDOM UNIFORM(0, 1 , 0)
Empathy	RANDOM UNIFORM(0, 1 , 0)
possibility of renegotiation	RANDOM UNIFORM(0, 1 , 0)
staff turnover	RANDOM UNIFORM(0, 1 , 0)
time of approval	RANDOM UNIFORM(0, 1 , 0)
average change in interest rates	IF THEN ELSE("change in previous-current interest rate"=0, 0, 0.5) + (0.6*"change in previous-current interest rate"+0.4*"change in next-current interest rate")

average interest rate	INTEGER(RANDOM UNIFORM(0, 1 , 0)*10)/5 +3
RENT OF REAL ESTATE	1500
LAWYER FIXED COST FRACTION	1000
LAWYER LOAN COST FRACTION	0.01
LAWYER EXPENSES	240
CIVIL ENGINEER FIXED COST FRACTION	1000
CIVIL ENGINEER LOAN COST FRACTION	0.01
CIVIL ENGINEER EXPENSES	120
TIRESIAS FIXED COST FRACTION	100000
TIRESIAS MEMBERSHIP COST FRACTION	0.1
CADASTRE EXPENSES	50
CADASTRE LOAN COST	0.01
CADASTRE FIXED COSTS	10000
land registry expenses	AVERAGE LOAN PRINCIPAL*120/100*0.775/100
LAND REGISTRY LOAN COST	0.01
LAND REGISTRY FIXED COSTS	10000

Table 3. Values for calculation for the basic model

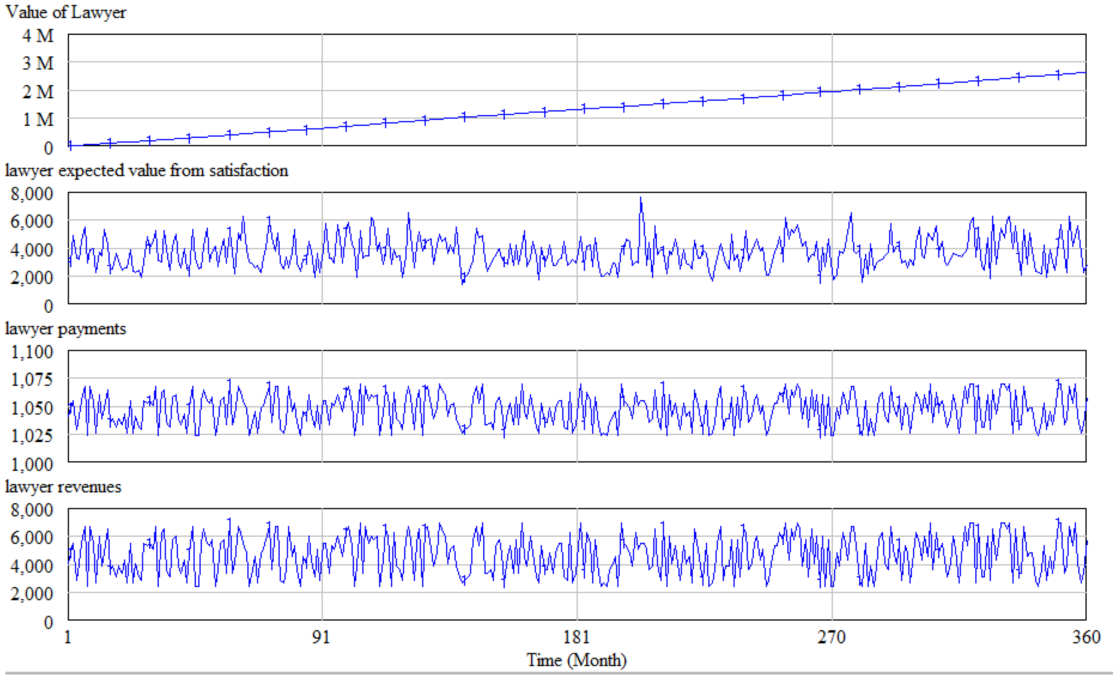
We observe that the 'bank value' is increasing during the specified period. Additionally, the 'bank payments' have fluctuations, which occur due to the different number of new customers the bank has each month. The minimum limit is the amount of €30,000.00 which is considered to be the fixed costs the bank has each month. Moreover, 'bank revenues' have also fluctuations because of the variable number of the total customers who pay their monthly instalment and also the loan application form expenses from the new customers. The minimum and maximum limit exists due to the assumption that the 'total num of loans' are between the range of 150 to 240 customers. An average monthly instalment of €400 (average loan of €100,000.00) gives a minimum limit of €60,000.00 and a maximum of €96,000.00 without the revenues gained from the new loans per month. Furthermore, the 'interest payments' are the monthly instalment the bank pays each month for the money it has borrowed for its ‘total num of loans’. We have considered the bank has borrowed money so as to be able to offer mortgage loans in a flexible way. But, its payments are less than those of its customers due to the fact that the bank borrows with a reduced interest rate from the interbank market, which we suppose that is the EURIBOR which is now 0.7%. Afterwards, the ‘bank expected value from satisfaction’ of the bank is the sum of expected revenues less the expected payments, which are around the bank’s total revenues less total payments respectively, multiplied by the satisfaction factor. We observe that, this variable has an ascending line because the total payments remain almost stable, whereas the total revenues have a descending line in the specified period.



Graph 6. Value of Bank: Causes Strip

As far as the lawyer is concerned (Graph 7), we can observe that its value is ascending during the specified period. The ‘lawyer revenues’ has fluctuations depending on the random number of new customers the bank has per month, from where the lawyer gains €240 per new loan. Thus, supposing that the least number of new customers are 10 and the maximum is 28, we conclude that the minimum and maximum value of this variable is €2,400.00 and €6,720.00 respectively. On the other hand, the ‘lawyer payments’ is the fixed costs with the amount of €1,000.00 the lawyer pays each month, and a fraction of the expenses he gains from every new loan so as to complete each loan check. Thus, this variable varies in the range of €1,024.00 and €1,067.20 during the whole period. Lastly, the expected value is the sum of expected revenues less the expected payments, which are around the lawyer’s total revenues less total payments respectively, multiplied with the satisfaction factor**.** Thus, this variable has an ascending line because the total payments remain almost stable, whereas the total revenues have a descending line in the specified period.

Thus, we know that the total value of the lawyer is the accumulation of 'lawyer revenues' plus the 'lawyer expected value from satisfaction' less the 'lawyer payments' and so we can see the reason that the bank value is ascending.



Graph 7. Value of Lawyer: Causes Strip in basic model

The value of civil engineer can be described the same as that of lawyer. Whereas, as we have already said, we are not interested in calculating the value of Tiresias, Cadastre and Loan Registry, because we consider that they participate in more than one value networks and therefore we will end up to wrong conclusions. While we take into consideration their costs and revenues that are created due to their participation in our value network, we are not interesting in calculating their value because of their participation in many value networks.

5.2 Non- Performing Loans Model

In this model, we try to simulate the case of non-performing loans due to the changing needs occur. We model the case of the economic crisis which started in 2007 and still exists. This economic crisis affected the market values of the real estates and these in turn, affected the consumer's behaviour, owners of a loan that their real estate had been mortgaged. Consequently, this crisis mainly affected the mortgage loans. As the market value of the mortgage loans decrease, the more the customers were not willing to pay the monthly instalment of their loan or pay less. The change in market value affects the rent of real estate and this in turn affects the Utility function of the customer as we mentioned in the description of the model. One more factor that affects the payments of the customer is its monthly income. Thus, the Table 4 shows the changes made is some box variables for the simulation needs.

Box Variable	Value
average change in interest rates	IF THEN ELSE("change in previous-current interest rate"=0, 0, 0.5) + (0.6*"change in previous-current interest rate"+0.4*"change in next-current interest rate")
average interest rate	INTEGER(RANDOM UNIFORM(0, 1 , 0)*10)/5 +3
AVERAGE RENTAL RATE OF RETURN	4%
MARKET VALUE OF REAL ESTATE	140000
real estate fraction	75%
AVERAGE MONTHLY INCOME	2000
income fraction	40%

Table 4. Changes in variables values for calculations in non-performing model

We have three simulation scenarios.

Scenario 1:

Only the 'MARKET VALUE OF REAL ESTATE' changes during the time as follows:

STEP(-20000, 12) + STEP(-12000, 24) + STEP(-4000, 36)

Scenario 2:

Only the 'AVERAGE MONTHLY INCOME' changes during the time as follows:

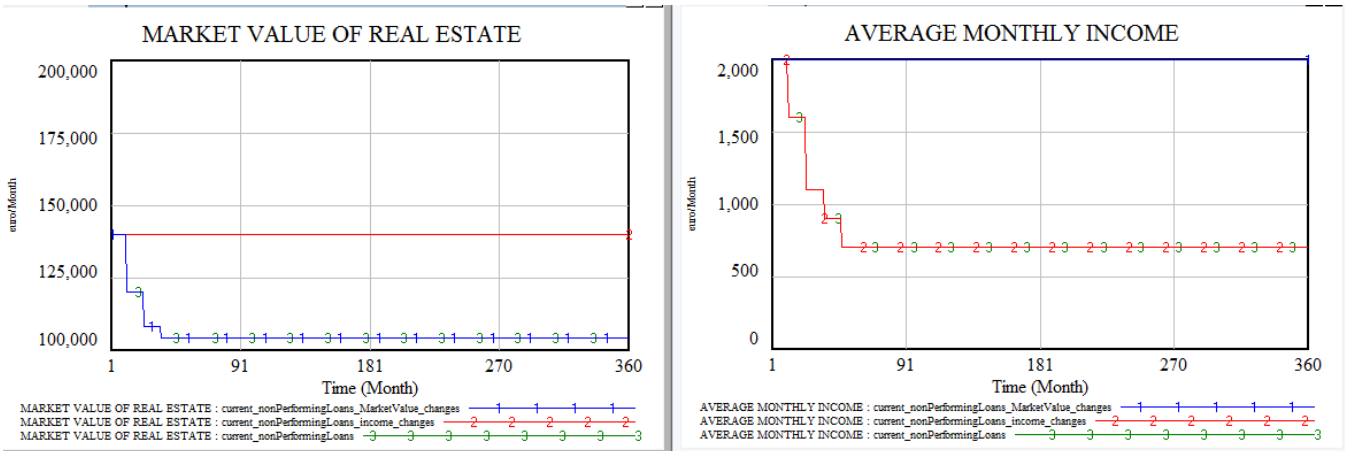
STEP(-400, 12) + STEP(-500, 24) + STEP(-200, 36) + STEP(-200, 48)

Scenario 3:

Both variables have the previous changes simultaneously.

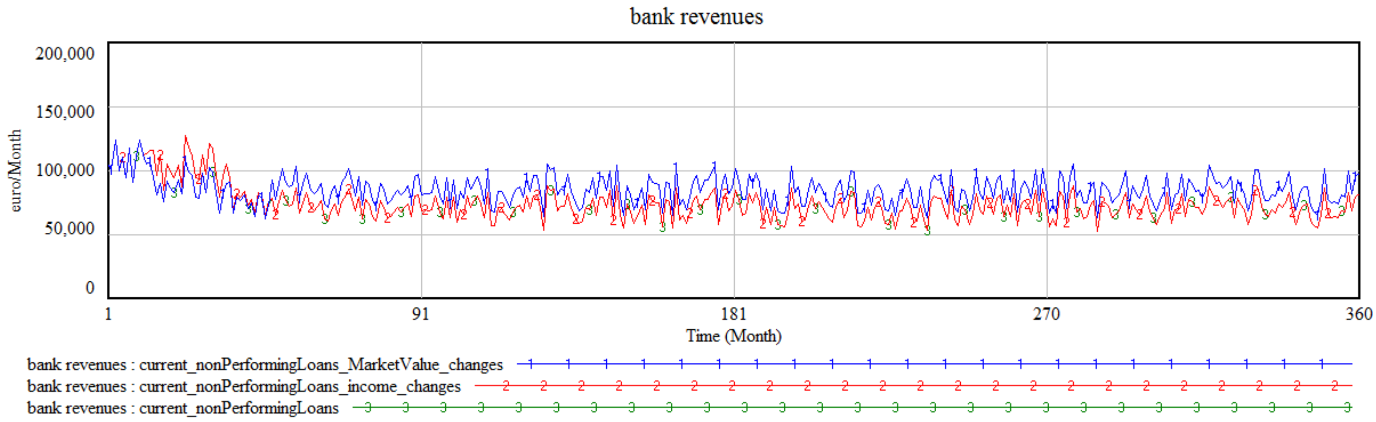
The function STEP(x,y) changes the value by x at time period y. So, in the first scenario we consider that real estates' market values decrease starting after 12 months up to 36 months in our paradigm. It means that the real estate rent value starts at €140000, then it falls by €20000 in 12 months, by €12000 in 24 months and by €4000 in 36 months. In addition, in the second scenario we consider that average monthly income of customers decrease starting after 12 months up to 48 months in our paradigm. It means that the income value starts at €2000, then it falls by €400 in 12 months, by €500 in 24 months, by €200 in 36 months and by €200 in 48 months. Lastly, in the last scenario we consider that both real estates' market values and average monthly income decrease. In all these scenarios, the customers start changing their behaviour according to the circumstances.

The average monthly instalment in our model is about €400-€500 per month. Thus, by the time the market value of real estate or income become smaller than the average monthly instalment of the customer, the customer starts changing his payment behaviour towards the bank. The customer finally pays the minimum among 'loan payment', 'instalment due to default in real estate value', 'RENT OF REAL ESTATE' and 'limit of income' and as a result, when the 'customer real payment' becomes smaller than the monthly instalment, then the rest of the unpaid instalment will be added in the loan principal. The revenues of the bank will be decreased than the expected ones and as a result the overall value of the bank will be descending unless the overall situation is changed. Consequently, there will be the time that the bank will start having negative value due to non-performing loans. On the other hand, the situation becomes worse because of the fact that the rest of the unpaid monthly instalment is added in the mortgage principal and as a result the interest increases and therefore the next monthly instalments increases too. The changes of the key variables in these scenarios are shown in the following Graph 8.

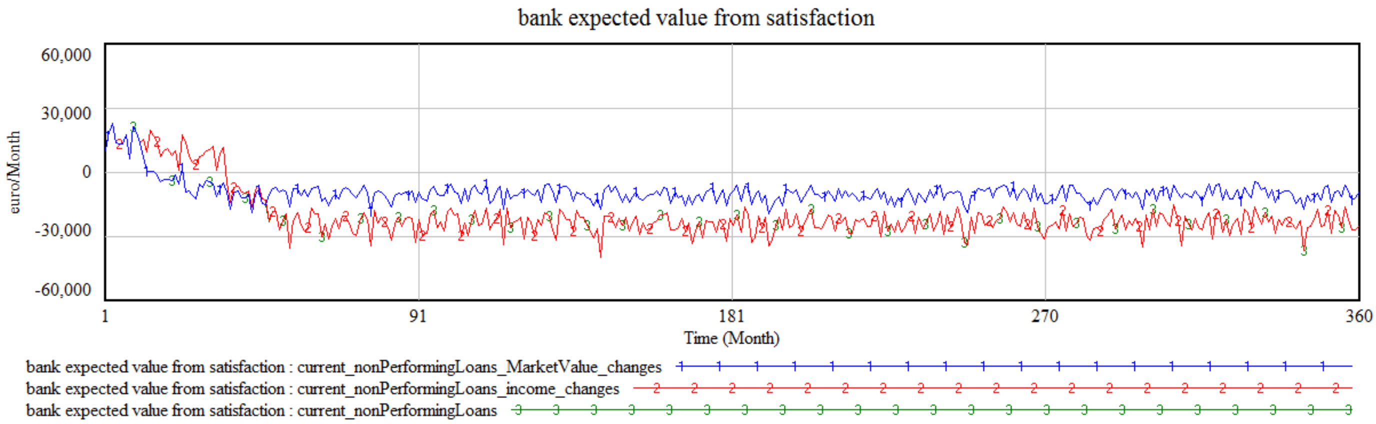


Graph 8. 'Market Value of Real Estate' & 'AVERAGE MONTHLY INCOME' graphs

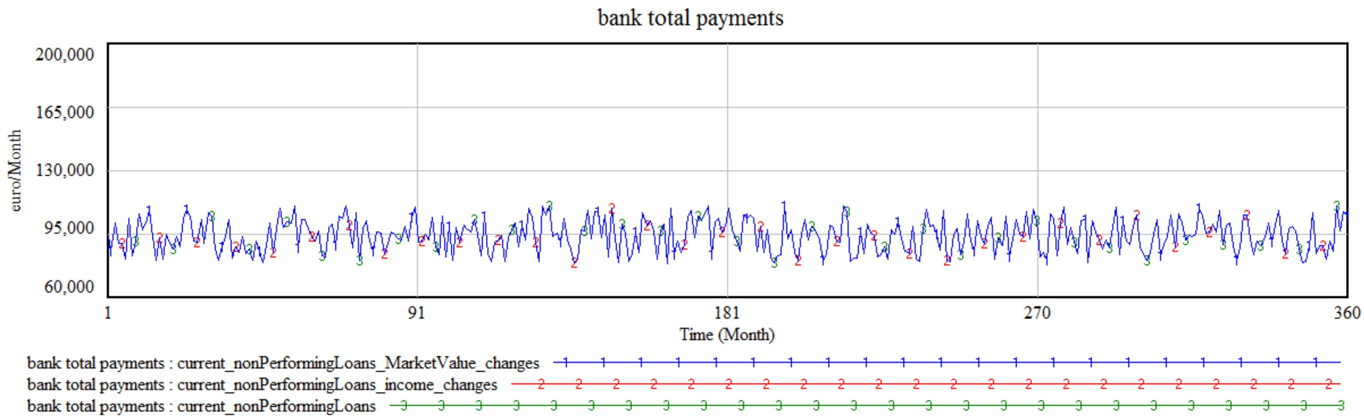
In the following graphs (Graph 9, Graph 10,Graph 11), we observe that the total 'bank revenues' starts to decline when these values become smaller and smaller and therefore they affect the average monthly instalment. Revenues' value is almost around the amount of €100,000.00 but after the declines in real estates and income, it starts to decline almost around in €60,000.00. Thus, the expected revenues will follow the declining line of revenues. However, the 'bank total payments' remains stable over the estimated period and are almost €85,000.00 and therefore the expected value starts at about €20,000.00. Afterwards, 'bank revenues' and also 'bank expected value' that are mainly affected by the changes in our key variables will start declining in value and become negative, whereas 'bank total payments' remains almost stable over the period because it is independent of these changing variables.



Graph 9. Comparison of 'bank revenues' in 3 scenarios



Graph 10. Comparison of 'bank expected value from satisfaction' in 3 scenarios

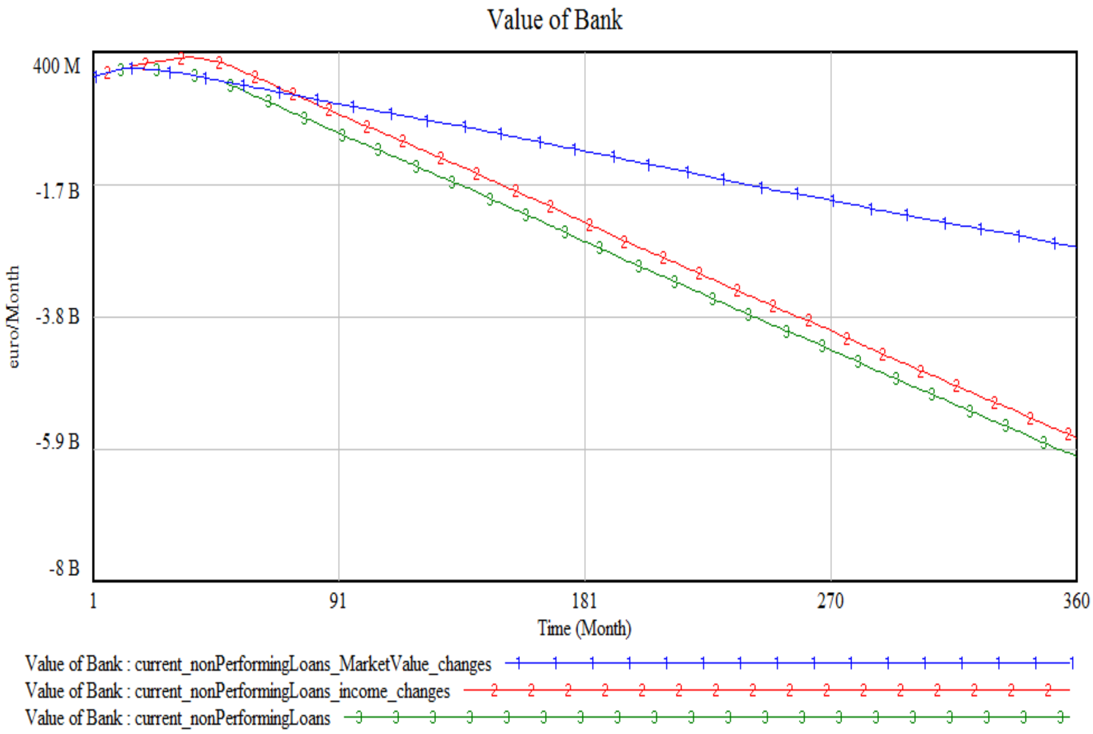


Graph 11. Comparison of 'bank total payments' in 3 scenarios

Furthermore, we observe (Graph 12) that the mortgage balance declines at the beginning. In this case, the loans are performing well because the customers pay their monthly instalment. However, it starts the ascending line when the changes in the key variables are made and thus, the customer monthly real payment is smaller. So, the mortgage balance exceeds the initial mortgage principal of €100,000.00 and is increasing because both interests and principal are increasing. In the first scenario, despite the continuous decreases in the market value, the customer pays at least a instalment that is enough to decrease the mortgage principal but not to reduce it to zero.

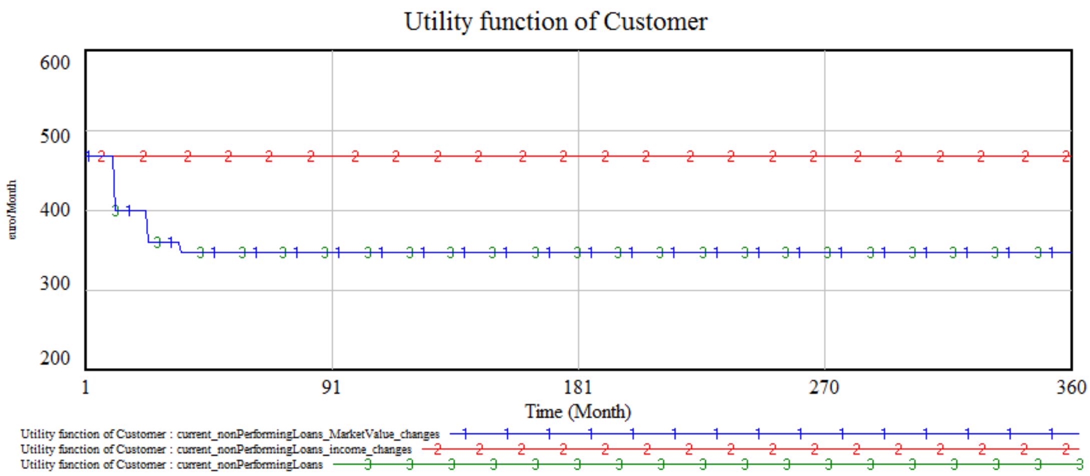
Graph 12. Mortgage Balance graph

The following Graph 13 shows the value of the bank in these three scenarios. The third one includes the changes in both variables that made in the previous two scenarios simultaneously. The most important to understand this graph is to remember that the customer finally pays the minimum among 'loan payment', 'instalment due to default in real estate value', 'RENT OF REAL ESTATE' and 'limit of income'. As we can see, at the beginning, in the third scenario the value line is the same as that of the first scenario, in which the market value was changing because the variable with the smaller value is ‘instalment due to default in real estate value’. Thus, in these scenarios the value of the bank has an equal line. Nevertheless, when the income continue decreasing, the ‘limit of income’ becomes the variable with the smaller value and thus the value of the bank in the third scenario changes its line and follows the values line of the second scenario which was ascending at the beginning. Anyway, the value of the bank in the last scenario has the most descending line because it includes the scenario of the combination of the two previous and assumes that the customer make the worst payment each time.



Graph 13.Bank Value in non-performing loans model:Comparison of 3 scenarios

Lastly, in Graph 14 we can see that the Utility function of the Customer remains unchanged in the second scenario whereas it is changing in the other two because of the changes in the market value of real estate with a direct effect in the rent of real estate, which in turn affects the Utility of the customer.



Graph 14. Utility function of Customer in non-performing loans model

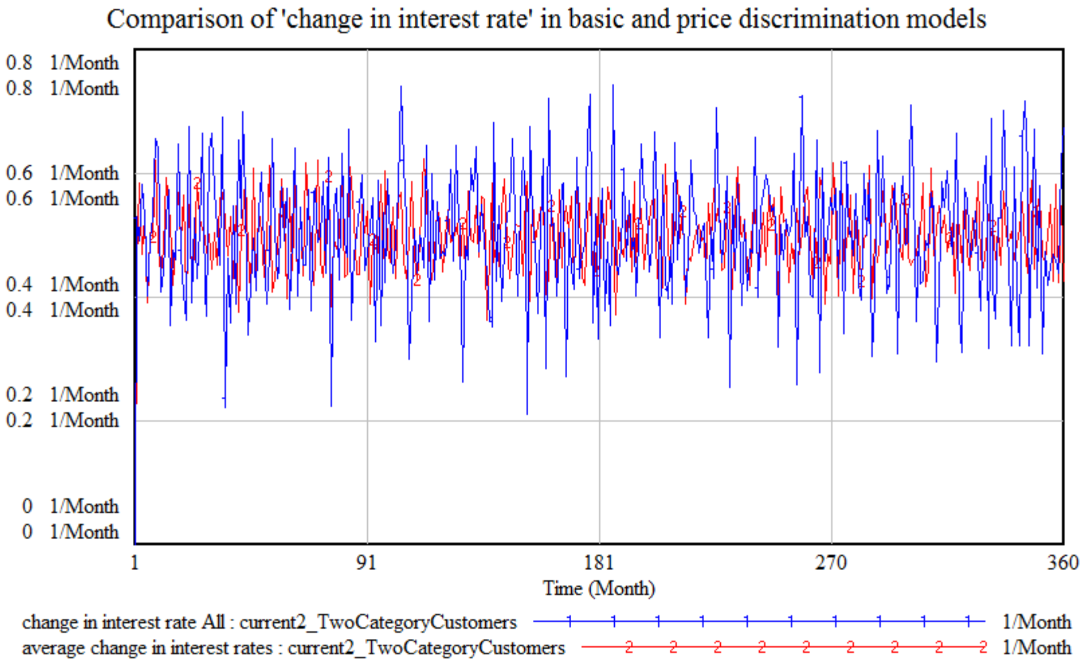
5.3 Price Discrimination Model

This model is an attempt to distinguish a group of people that are considered to be special to the bank and have a better treatment than the other group of common people. The aim of creating this model is to examine if our model is good enough and gives us right results. According to the economic theory, price discrimination is a pricing strategy that can increase welfare by more accurately targeting prices at consumers' demands and lowering the costs of search. Price discrimination can take a number of forms, but they share in common a need to identify - either by research, experience or self-selection - individual or group demands. Providing these individuals or groups have varying reservation prices and/or price sensitivities, price discrimination will yield higher revenues without additional costs for the bank.

Box Variable	Value
common customers	common customers fraction * NUM OF NEW LOANS
common customers fraction	0.7
common interest rate	RANDOM UNIFORM(0, 1 , 0) +3.5
special customers	special customers fraction * NUM OF NEW LOANS
special customers fraction	0.3
special interest rate	RANDOM UNIFORM(0, 1 , 0) +2.5

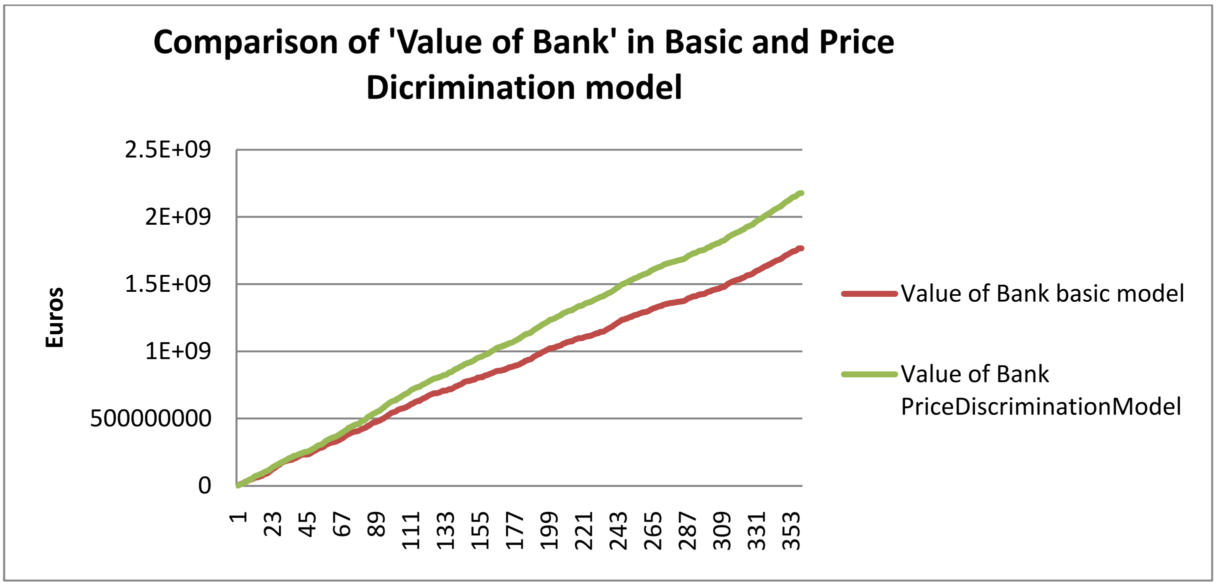
Table 5. New & changed variables for calculations in the non-performing model

In the above Table 5, we can see the important variables added and their values for the simulation needs. We assume that 'special customers' represent the 30% of total new customers, whereas the 'common customers' represent the 70%. Additionally, the interest rate range for special customers is between 2.5% and 3.5%, low pricing policy, whereas the range for common customers is between 3.5% and 4.5%, higher pricing policy. Whereas, in the basic model, the average interest rate for all the customers ranges from 2.5% to 4.5%. By running the simulation, we observe the difference in the variable 'change in interest rate' between basic and price discrimination models, which is one quantitative factor that affects the satisfaction of customers and which on turn affects the total satisfaction factor, which is multiplied with the expected value of the bank per month and gives us the final accumulative value. The graph of this variable in both models is shown below (Graph 15).



Graph 15. Comparison of 'change in interest rate' in Basic & Price Discrimination models

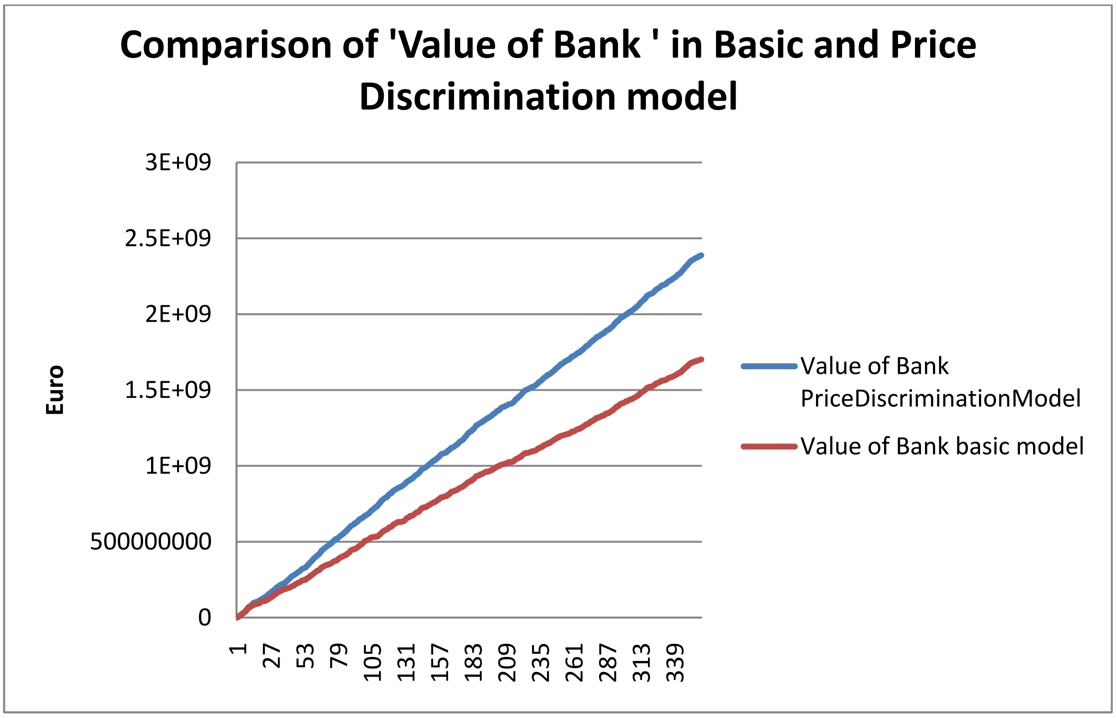
As we already said, the change in interest rates from one time period to the other is a factor that affects the satisfaction of customers and therefore the value of bank, which is the variable that we are finally interested in. Thus, we must compare the 'Value of Bank' in both models so as to make our conclusions. The comparison graph of 'Value of Bank' in both models is the following (Graph 16).



Graph 16. Case 1: Comparison of 'Value of Bank' in both models

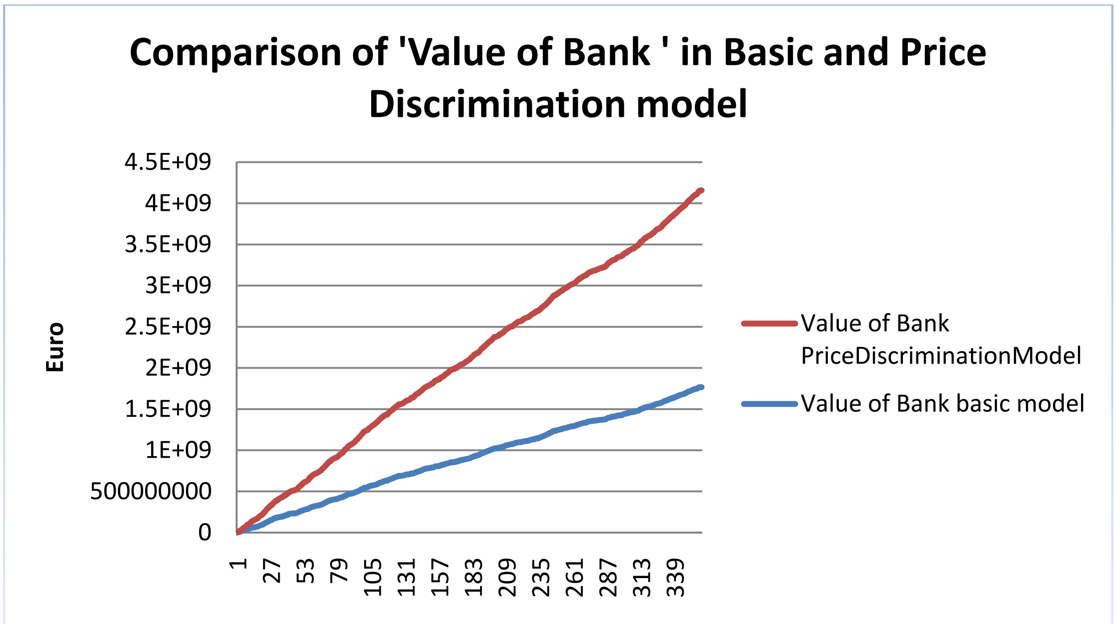
According to the results we can infer that it is better for the bank to apply the price discrimination policy because the simulation showed that bank total value is more than that without the policy not only at the end of the specified period but almost at whole the duration.

By changing just the range of interest rates so as to overlap, we observe a big difference in bank's value. For average interest rate of special customers to range between 2.8% and 3.8% and that of common customers to range between 3.5% and 4.5%, we have better results. So, we conclude that when the interest rate ranges of the two categories of customers are overlapped, the difference in bank value is significantly bigger between price discrimination and basic model as shown below (Graph 17):



Graph 17. Case 2: Comparison of 'Value of Bank' in both models

Lastly, if we change the values of interest rates and fraction of special and common customers the difference in bank value in two models is spectacular. By changing the range of interest rates of special customers from 2.7% to 3.2% and the their fraction to be 20% of new customers and respectively the range in interest rate for common customers to be from 3.5% to 4.5% and their fraction to be 80% we have the following graph (Graph 18). We observe again that price discrimination policy leads.



Graph 18. Case 3: Comparison of 'Value of Bank' in both models

To conclude, we infer that the bank can make a sensitivity analysis by taking decisions concerning the ranges of interest rates or the fraction of special and common customers and follow the policy that match its own interests and profits.

5.4 Branch Performance Evaluation Model

It is very important for a bank to have the control and manipulation of its branches. In this model, we are going to simulate a branch operation and the operation of the overall bank separately, in order to observe the branch value line in the different cases of customer satisfaction and the effective measures the bank must take in order to keep positive and ascending line of the total value of the bank. Otherwise, it must monitor the branch and take the necessary decisions about its operation, to continue or stop. The following Table 6 represents some of the new variables of the model and their values for our simulation.

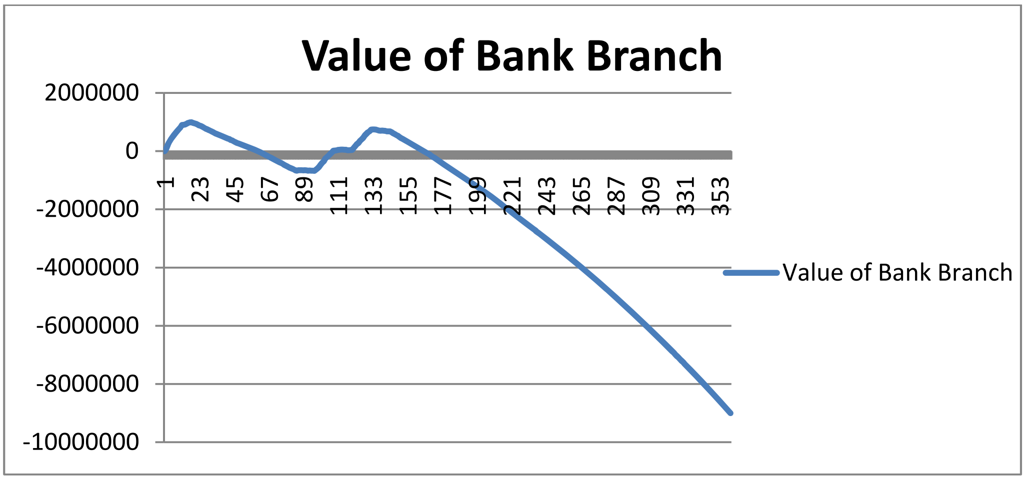
Box Variable	Value
AVERAGE LOAN PRINCIPAL	120000
AVERAGE NUM OF TOTAL LOANS	170
AVERAGE NUM OF NEW LOANS	20
tangibles assets	0.6
Assurance	0.74

Reliability	0.83
Responsiveness	0.7
Empathy	0.65
average change in interest rates	IF THEN ELSE("change in previous-current interest rate"=0, 0, 0.5) + (0.6*"change in previous-current interest rate"+0.4*"change in next-current interest rate")
average interest rate	INTEGER(RANDOM UNIFORM(0, 1 , 0)*10)/5 +3
LIMIT	0
bank current satisfaction index	0.62+STEP(-0.2, 12) +STEP(-0.1, 18) + STEP(0.1, 84) +STEP(0.1, 96)+ STEP(-0.1, 108) + STEP(0.2, 120)+STEP(-0.2, 132) +STEP(-0.1, 144)

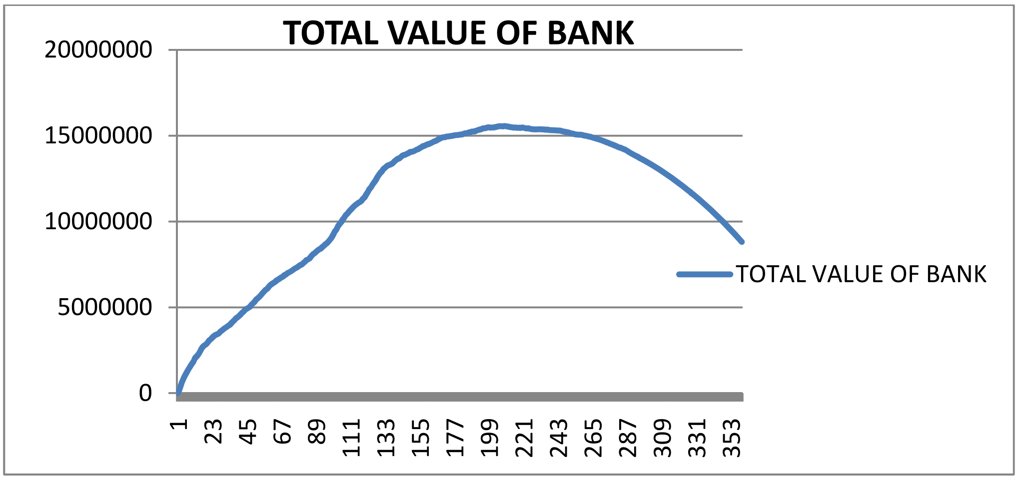
Table 6. Additional & changed variables for calculations in the branch evaluation model

We suppose that the bank monitors the branch and defines its limits. If the branch gets down of this 'LIMIT', the bank will stop its operation. The bank estimates that it is not affordable to continue branch operation. In our model, branch behaviour depends on customer satisfaction factors, reliability, responsiveness, empathy, tangibles, assurance and lastly change in interest rates. According to a scenario, the factors of customer satisfaction are changed in some way that 'bank current satisfaction index' is changed proportionately. This variable starts from 0.62, then falls by 0.2 at 12 months, falls by 0.1 at 18 months, increases by 0.1 at 84 months, increases by 0.1 at 96 months, falls by 0.1 at 108 months, increases by 0.2 at 120 months, falls again by 0.2 at 132 months and also by 0.1 at 144 months. Afterwards, the 'bank current satisfaction index' affects the number of total customers and the number of new customers according to the 'satisfaction impact on customers' variable's condition. Generally, the bank's value depends on its customers and thus the same does each branch separately. So, when the branch lose its customers (total and new), then its value becomes decreasing and possibly ends up to be negative. By the time the branch's value becomes negative, the bank will proceed into closing it by either stopping its operation or merging with other neighbour branch.

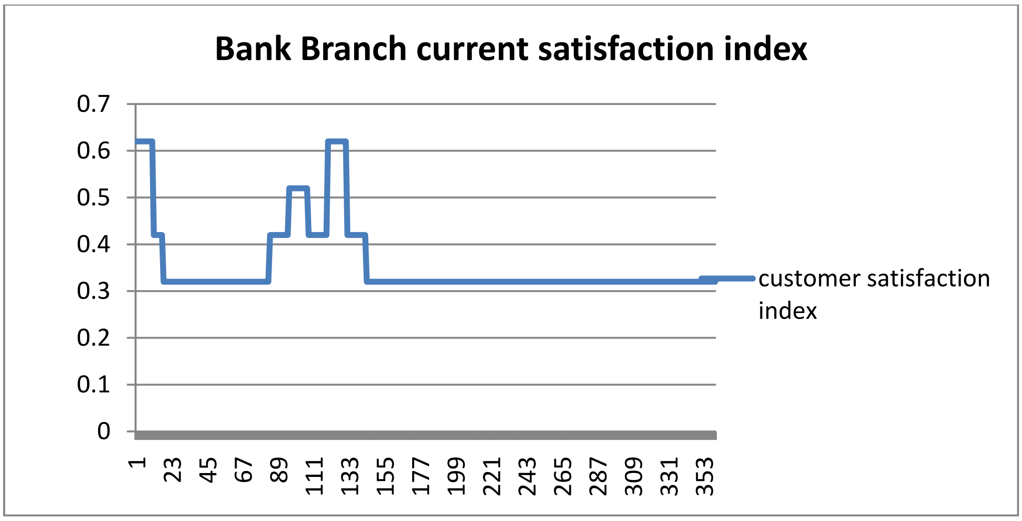
According to the results of the simulation (Graph 19, Graph 20, Graph 21, Graph 22), we observe that the bank and branch value was arising until the first downfall of 'customer satisfaction index'. Afterwards, this variable falls to 0.42 in 12 month and the branch value starts falling due to the decrease in number of customers, whereas the impact is not clear in the bank yet. After the next decrease in 'customer satisfaction index' at 18th month by 0.1, we can see that the number of loans fell dramatically and as a result, the value of branch became negative after a few months and thus the total value of bank is still increasing but with a smaller rate. However, after the increase of 'customer satisfaction index' in 0.42 at 84 month and also in 0.52 at 96 month, the number of loans was increased spectacularly and the branch value started to increase slowly. Lastly, after the final decreases after the 132 month the number of loans fell again after a few months and the value of branch starts decreasing again with a constant rate until the end. The most significant here is the fact that after the last decreases, the total value of the bank started to decrease and after some years it will also be more obvious. This bad situation was caused by the total bad behaviour of one branch. Thus, we infer that the bank must someway do something to be protected by the bad customer satisfaction in that specific branch, which has impact on its value.



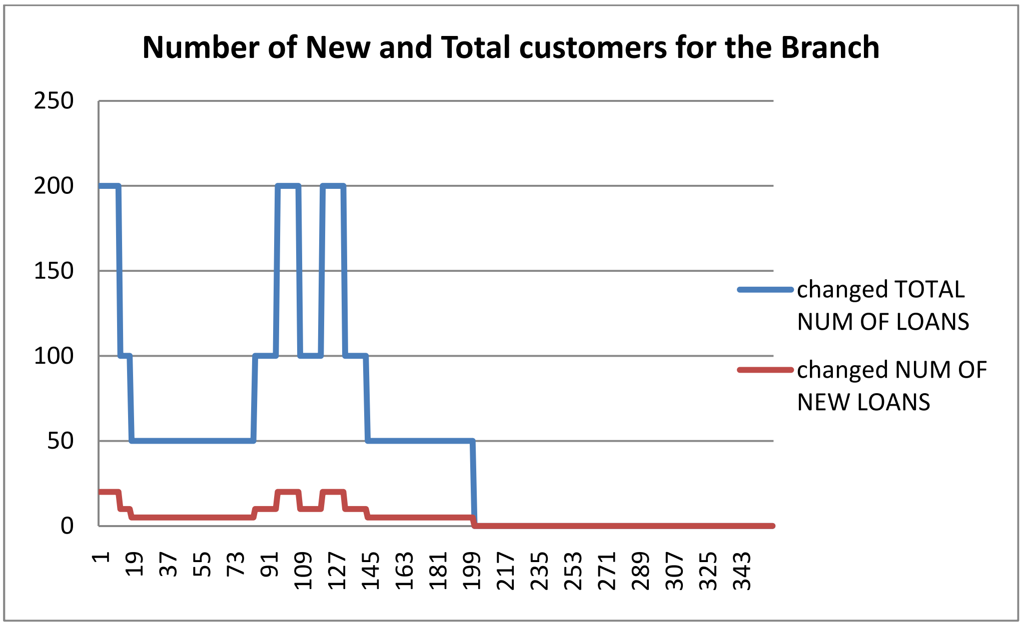
Graph 19. Value of Bank Branch



Graph 20. Total Value of Bank

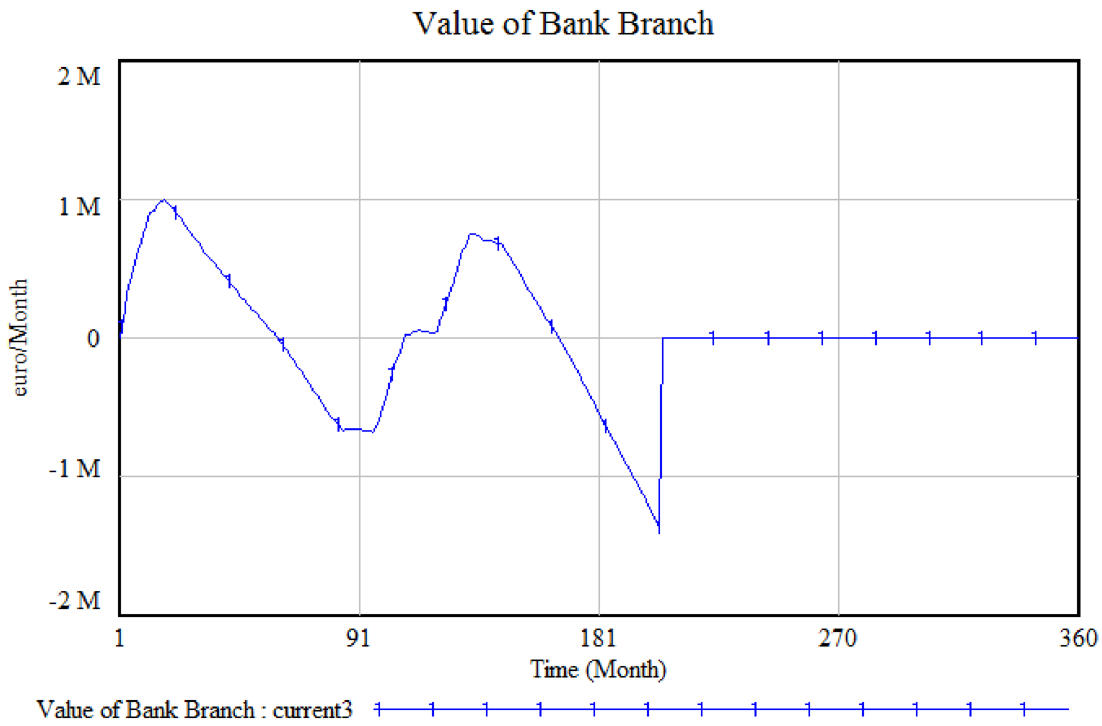


Graph 21. Branch 'customer satisfaction index':Branch Performance Evaluation

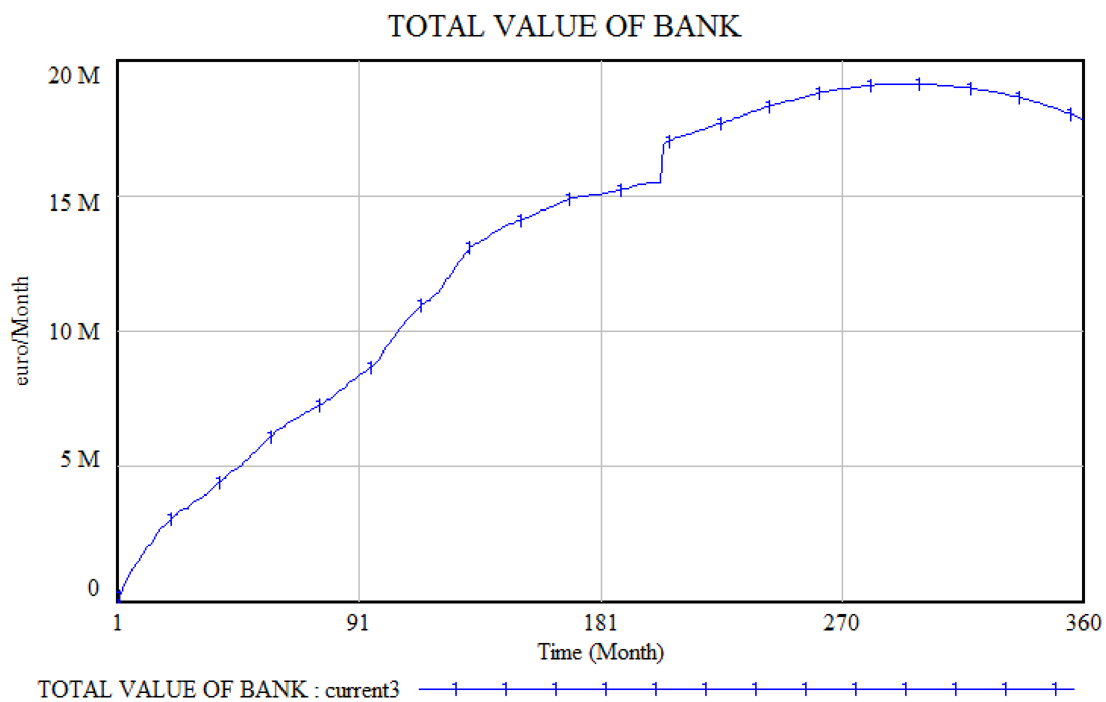


Graph 22. Num of New and Total customers of Branch

So, by taking some measures, the bank can deter this bad situation at least at the point its value starts to decrease. So, we add a condition in the 'operation index', which checks the 'value of Bank Branch' and if it is negative then se suppose that the bank will try to help this branch and monitor its performance for a while until its value becomes positive and starts operating efficiently. But, if the branch value falls again, then the bank will give it a second chance to recover within three years. If it finally continues the same descending route, the Bank will intervene and stop the operation of this specific branch so as to stop affecting the bank's overall value. The results of this simulation are shown in the Graph 23 and Graph 24. We observe that the bank gave to its branch a chance to recover once but the second time that the branch became negative, the bank stopped its operation after 36 months. By this policy, the bank value changed and continued its ascending route as before.

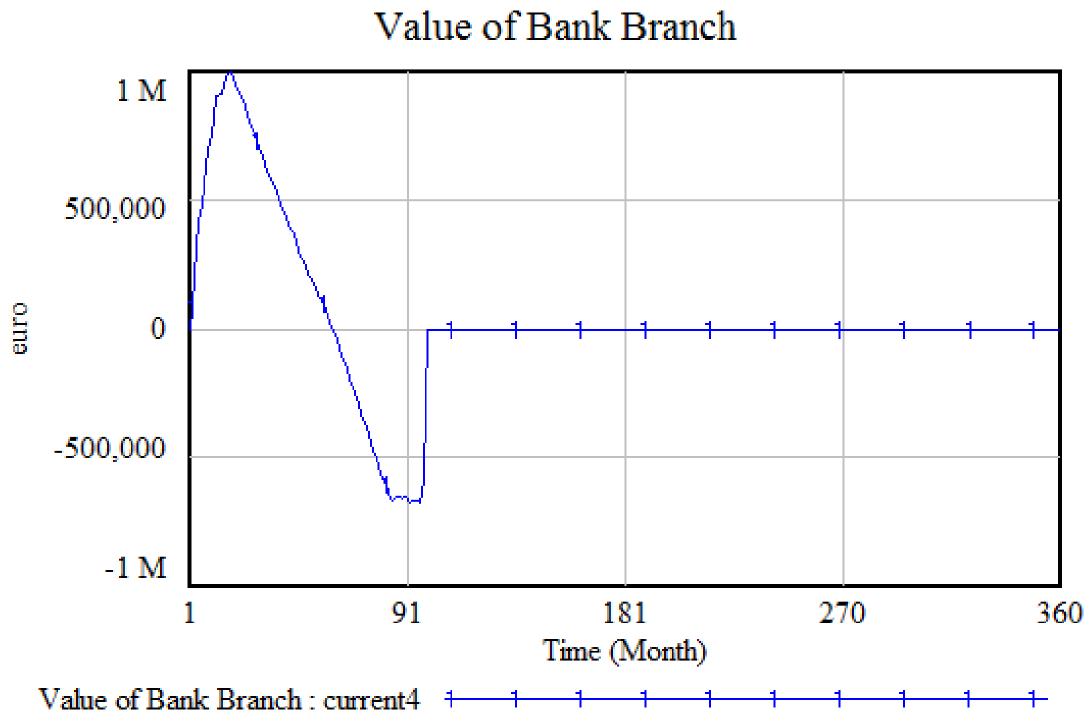


Graph 23. Value of Bank Branch



Graph 24. Value of Bank

On the other hand, the bank's effort to detect the bad branch behaviour if it is not able to recover the first time, is an alternative policy. Thus, the bank sets a limit of 36 months so that the bank will not let the branch continue its operation if the negative value remains up to 36 months the first time. Then the graphical representation of the branch value will be the following (Graph 25):



Graph 25. Value of Bank Branch

Thus, branch operation depends on the policy the bank is going to follow in case its value becomes negative due to reduced number of total and new loans which are affected by the low customer satisfaction of the branch.

5.4.1 General Observations

1) In this model, we can see that the results are strongly correlated with the number of total loans the bank or branch has. This happens due to the fact that the number of loans affects the total revenues of the branch or bank and thus their overall value. In case of the branch evaluation, the bigger the number of total loans the more time needed for the branch to be affected by the bad customer satisfaction and thus the more slowly the branch value will become negative.

2) Additionally, the branch value is also significantly affected by the mortgage loan principal. We assume that the mortgage loan principal is €100,000.00 in our simulations. If we change it to €150,000.00 then we observe that the bank branch value will delay to be negative. Of course it will also start to decline when the customer satisfaction is becoming worse and worse. On the other hand, the value

of the branch will have already been high and it will need much more time to reach a negative value. Thus, the bad situation due to the low customer satisfaction index will persist more until the bank decides to stop its branch operation due to the bad performance.

3) Generally speaking, we can infer that the earlier the ‘customer satisfaction index’ falls, the quicker the Value of Branch becomes negative. Therefore, the bank will be able to take the necessary measures so as to be protected.

4) Last but not least, it is of significance importance to mention our empirical conclusions about the model we choose to express the expected value of a participant offering its service. The general model for the bank value that we have already used in the previous models is the following:

$$V_B(t) = \sum_{t=0}^{N} [\, R(t) - P(t) + \frac{\overline{Sat}(t)}{\overline{Sat}(t-1)} * [\bar{R}(t) - \bar{P}(t)] \,]$$

where $\frac{\overline{Sat}(t)}{\overline{Sat}(t-1)} * [\bar{R}(t) - \bar{P}(t)]$ represents the model for the expected value.

In this model, there were four candidate models for the bank branch expected value, which are the following:

a) Expected value= satisfaction factor *(expected Revenues –expected Costs) (5.1)

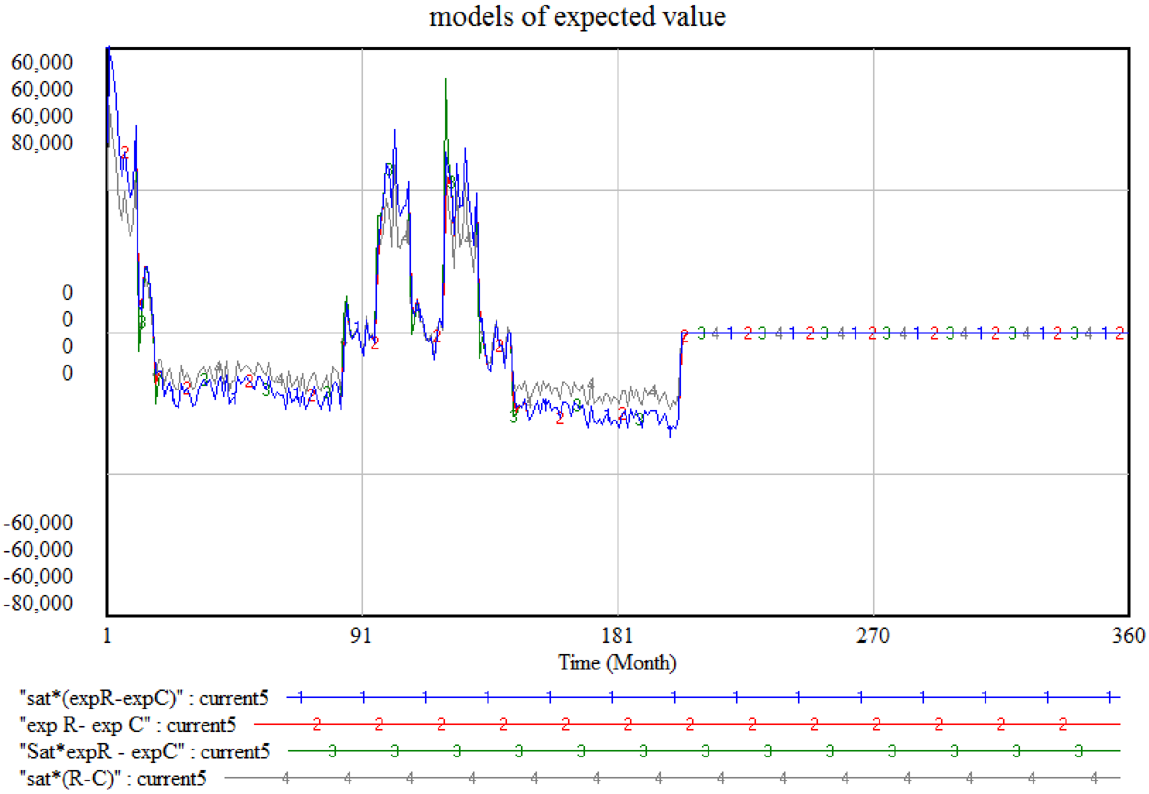
b) Expected value= expected Revenues – expected Costs (5.2)

c) Expected value= satisfaction factor * expected Revenues – expected Costs (5.3)

d) Expected value= satisfaction factor * (Revenues – Costs) (5.4)

The first model is the model we already have used and we have already explained in the basic model. The second model is a variant of the first one with the difference that the satisfaction factor is not included. This thought made due to the fact that expectation already exists in expected values of Revenues and Costs. So the satisfaction factor, which expresses expectation for the future, does not need to exist. Moreover, in the third model we have the satisfaction factor to affect only expected Revenues due to the fact that satisfaction factor expresses the customer satisfaction and thus it has a straight effect on expected revenues of the bank. Whereas, costs are not affected by the customer satisfaction which in turn affects the satisfaction factor, because they are remain almost constant during the period. Lastly, the fourth model has only the satisfaction factor that includes the expectation and calculates the real value from total Revenues and total Costs.

These are four different alternative models to express the expected value and their results are shown in the following graph. We created four variables each one representing one of these models. Afterwards, we created a graph including all these variables in order to compare their values during the period of time. The examination of those models was made only in the Branch Performance Evaluation Model and then we generalized the conclusion to the other models.



Graph 26. Four Alternative Models for Expected Value in Branch Performance Evaluation model

According to the above Graph 26, we conclude that all these models behave the same except for the last one that deviates from the others a little. We observe that the last model has the smallest variance in comparison with the other models. Thus, any model we may choose, the results will be almost the same in our calculations. Consequently, we remained in our first solution and we made our calculations and conclusions according to the first model.

6 Conclusion and Future Work

Generally, the business model concept and related computer-based tools have potential to be further explored. Above all, the ability to create a transparent big picture of a business and to externalize the relationships and dependencies of business elements seem to interest executives and consultants. Furthermore, business models were perceived as a tool to create a commonly understood language to improve communication and understanding of the fundamental questions of a business. By more fully understanding the tangible and intangible exchanges that create value, people can more easily see where to make needed changes without wreaking havoc on the whole system.

In this dissertation, we used the theory of Value Networks and demonstrated a business model that represents the Mortgage service system of a financial institution. The aim was to study the value delivered among its participants, to evaluate their participation in this value network, to focus on the variables that affect their value and perform sensitivity analysis to determine the effect and finally recognize the costs occurred. Using Vensim simulation tool, we proposed and analyzed some specific models in order to help the bank, as the milestone of the network, to evaluate its performance and design its strategies according to different possible cases. In case of Non-Performing loans model, we demonstrated the recent economic crisis. The Non-Performing loans model showed that it can help the bank to simulate or even predict some difficult circumstances such as reductions in real estate market values or in average monthly income of customers that they result in low solvency. In addition, the Price discrimination model approved that a bank should adopt this policy and adjust its interest rates or the percentage of the customers in each category according to its needs. The results showed that this policy has positive effects on banks profitability. Last but not least, the Branch Performance Evaluation model showed that a bank should monitor its branches that are self-governed and control their performances by improving customer satisfaction. Customer satisfaction, in turn, affects the bank's total value. The bank can take strategic decisions about a branch operation depending on its overall performance.

To conclude, the bank, based on the basic model, can modify and/or extend it so as to meet its own expectations and make the right decisions. The next step in this research would be to find a methodology so as to determine the right prices and quantities that optimize the value of a participant. An additional future extension of this analysis that occurs from the general observations of the Branch Performance Evaluation model is the use of one of the alternative models of the expected value. The use of a different model may have better simulation results in other models.

There is no doubt that any business modeling approach has its limitations. After all, "*the map is not the territory*" as Alfred Korzybski said. But in today's complex business environment where competitive advantage often comes from innovations and relationships, the value network perspective can be useful for helping people address complex systemic issues in organizations, business webs, and economic webs. With a value network perspective, not only can people manage their own organizations more effectively, but also they can build robust, expanding value networks that serve both private enterprise and the public sector. Indeed, the very terms for-profit and not-for-profit will become obsolete as people appreciate the economy itself as one value creating system providing tangible and intangible value through a rich interwoven fabric of value networks.

Bibliography

Allee, V. (2000). "Reconfiguring the Value Network". *Journal of Business Strategy , 21* (4), pp. 36-39.

Allee, V. (2008). "Value Network Analysis and value conversion of tangible and intangible assets". *Journal of Intellectual Capital , 9* (1), pp. 5.

Allee, V. (2003). *The future of knowledge: Increasing prosperity through value networks.* Boston: Butterworth-Heinemann.

Allee, V. (1997). *The knowledge evolution: Expanding organizational intelligence.* Boston: Butterworth-Heinemann.

Allen, P. M. (2001). "A complex systems approach to learning in adaptive networks". *International Journal of Innovation Management , 5* (2), pp. 149-180.

Barney, J. (1991). "Firm Resources and Sustained Competitive Advantage". *Journal of Management , 17* (1), pp. 99--120.

Black, H., Boehm, T., & DeGennaro, R. (2003). "Is there discrimination in mortgage pricing? The case of overages". *Journal of Banking and Finance , 27* (6), pp. 1139-1165.

Borenstein, S. (1985). "Price discrimination in free-entry markets". *The Rand Journal of Economics , 16* (3), pp. 380-397.

Bork, R. (1993). *The Antitrust Paradox* (2nd εκδ.). New York: The Free Press.

Caswell et al. (2008). "Estimating value in service systems: A case study of a repair service system". *IBM Systems Journal , 47* (1), pp. 87-100.

Currie, W. (2004). *Value creation from e-business models.* Butterworth-Heinemann.

Dai, Q., & Kauffman, R. J. (2002). "Business Models for Internet-based B2B Electronic Markets". *International Journal of Electronic Commerce , 6* (4), pp. 41-72.

Edwards, P. (2009). "Value networks identify innovation in 21st century pharmaceutical research". *Drug discovery today , 14* (1-2), pp. 68-77.

Fensel, D. (2001). *Ontologies: Silver Bullet for Knowledge Management and Electronic Commerce.* Heidelberg: Springer-Verlag.

Gordijn, J. (2003). Why visualization of e-business models matters. *Business models & the mobile industry: Concepts, Metrics, Visualization and Cases.* Proceedings of 16th Bled conference.

Gordijn, J., & Akkermans, J. M. (2001). "Designing and evaluating e-Business models". *IEEE Intelligent Systems - Intelligent e-Business, , 16* (4), pp. 11-17.

Gordijn, J., & Akkermans, J. M. (2003). Does e-business modeling really help. *36th Hawaii International Conference On System Sciences.* Hawaii.

Gordijn, J., Akkermans, H., & Van Vliet, H. (2000). "Business modelling is not process modelling". *Conceptual Modeling for E-Business and the Web , LNCS 1921*, pp. 40-51.

Hamilton, J. (2004). "Service Value Networks: value, performance and strategy for the services industry". *Journal of Systems Science and Systems Engineering , 13* (4), pp. 469-489.

Ihlanfeldt, K., & Mayock, T. (2009). "Price discrimination in the housing market". *Journal of Urban Economics , 66* (2), pp. 125-140.

Lee, C. (2001). "Modeling the business value of information technology". *Information & Management , 39* (3), pp. 191-210.

Levesque, T. and McDougall, G.H.G. (1996). "Determinants of customer satisfaction in retail banking". *International Journal of Bank Marketing , 14* (7), pp. 12-20.

Magretta, J. (2002). "Why Business Models Matter". *Harvard Business Review , 80* (5), pp. 86-92.

Myers, C. (2004). "Discrimination and neighborhood effects: Understanding racial differentials in US housing prices". *Journal of urban economics , 56* (2), pp. 279-302.

Parasuraman, A. B. (1991). "Refinement and reassessment of the SERVQUAL scale". *Journal of retailing , 67* (4), pp. 420-50.

Parasuraman, A., Zeithaml, V., & Berry, L. (1985). "A conceptual model of service quality and its implications for future research". *The Journal of Marketing , 49* (4), pp. 41-50.

Pateli, A., & Giaglis, G. (2003). A Framework For Understanding and Analysing e-Business. *Proceedings of the Bled Electronic Commerce Conference.*

Perman, R., & Scouller, J. (1999). *Business economics.* Oxford: Oxford University Press.

Phlips, L. (1983). *The economics of price discrimination.* Cambridge Univ Pr.

Pigou, A. (1920). "The economics of welfare". *Macmillan , 72*, pp. 480--697.

Polanyi, M. (1958). *Personal Knowledge: Towards a Post-Critical Philosophy.* Chicago: University of Chicago Press.

Reichheld, F. (1994). "Loyalty and the renaissance of marketing". *Marketing Management , 2* (4), pp. 10-21.

Turnbull, P., & Wilson, D. (1989). "Developing and protecting profitable customer relationships". *Industrial Marketing Management , 18* (3), pp. 23-38.

Webster, F. (1994). "Defining the new marketing concept". *Marketing Management , 2* (4), pp. 22-31.

Weigand, H. et al . (2007). Strategic Analysis using Value Modelling--a c3 approach. *Prooceedings of the 40th Hawaii InternationaI Conference on System Sciences.*

Yee, R. W. Y., Yeung, A. C. L. & Cheng, T. C. E. (2008). "The impact of employee satisfaction on quality and profitability in high-contact service industries". *Journal of Operations Management , 26* (5), pp. 651-668.

Yi, Y. (1990). "A critical review of consumer satisfaction". *Review of Marketing , IL*, pp. 68-123.

APPENDIX

Tiresias

Tiresias is an inter banking company which processes data that reflect the economic behaviour of individuals and companies as well as data that contribute to the prevention of fraud in financial transactions. The distributed data contribute to the protection of credit, the reduction of credit risk and the improvement of financial transactions, to the benefit of individuals and the banking system in general[13].

Tiresias' early beginning took place in 1972 as a service of the Hellenic Bank Union but since 1993 it has been working as a non-profit company. In 1997, Tiresias established, as a SA company, from banks which actually activate in Greece, with one aim; to gather, edit, manage and provide data of the economic behavior to the financial institutions. Tiresias' main objective is to contribute to the protection of banking system, the improvement of financial transactions and afterwards the support to the development of Greek economy. For this reason, systems were developed to provide data, which shows the economic behavior of individuals and companies, so as to help its members to evaluate the solvency and credit ability of their customers. Today, 150 people work in Tiresias, whereas it simultaneously cooperates with approximately 140 lawyers. The information data provided comes from Financial and Credit Agents, Courts, Land Registries and the Ministry of Economy. Data registry is done after quality checking and archiving procedures and is presented to its members through information (on-line) systems, which are created according to all the needed measures for the highest, as possible, protection of collecting, editing, transferring and access on its file systems. Moreover, all the predictable measures of secureness of the maximum safety of the system of fieldwork, editing, messaging and accessing to its archives have been taken. Tiresias operates with certificated procedures by ISO 9001:2000 and consists of rules that absolutely respect the citizens rights, according to law 2472/97 about the protection of individuals from processing their personal data. Data integrity and validation and also the protection of data files are two of the most basic roles and objectives of Tiresias. The access on its data base can only be done by specially trained and authorized users of its members, whereas any access and search in its data base is recorded in Tiresias' electronic file. Until now, Tiresias' operation has contributed gradually to the information improvement of financial institutions, having benefits both to their operation and also to citizens protection. It is obvious that the improvement of the parameters and elements that participate in the evaluation of dangers reduces the cost and increases the possibilities of safe financing with obvious economic benefits for the financial institutions and the public. The support of Tiresias to the banks has a lot of benefits which are included in the following table.

[13] http://www.tiresias.gr

Contribution of Tiresias' Operation	
Financial Institutions	Citizens
• Lower risk of non-performing loans • Reduction of operation and money cost • Secure transactions • Reduction of the procedure/time for approvals • Increase of loans, with the improvement of repayment ability estimation	• Reduction of loan interest rate • Protection from fraud in financial transactions (deceit) against them • Protection from over borrowing • Reduction of the procedure/time for approvals • Ability of more quick loan procedures and more propitious contract conditions for the consistent transactors

Table 7. Contribution of Tiresias Operation

Subprime Mortgage Crisis

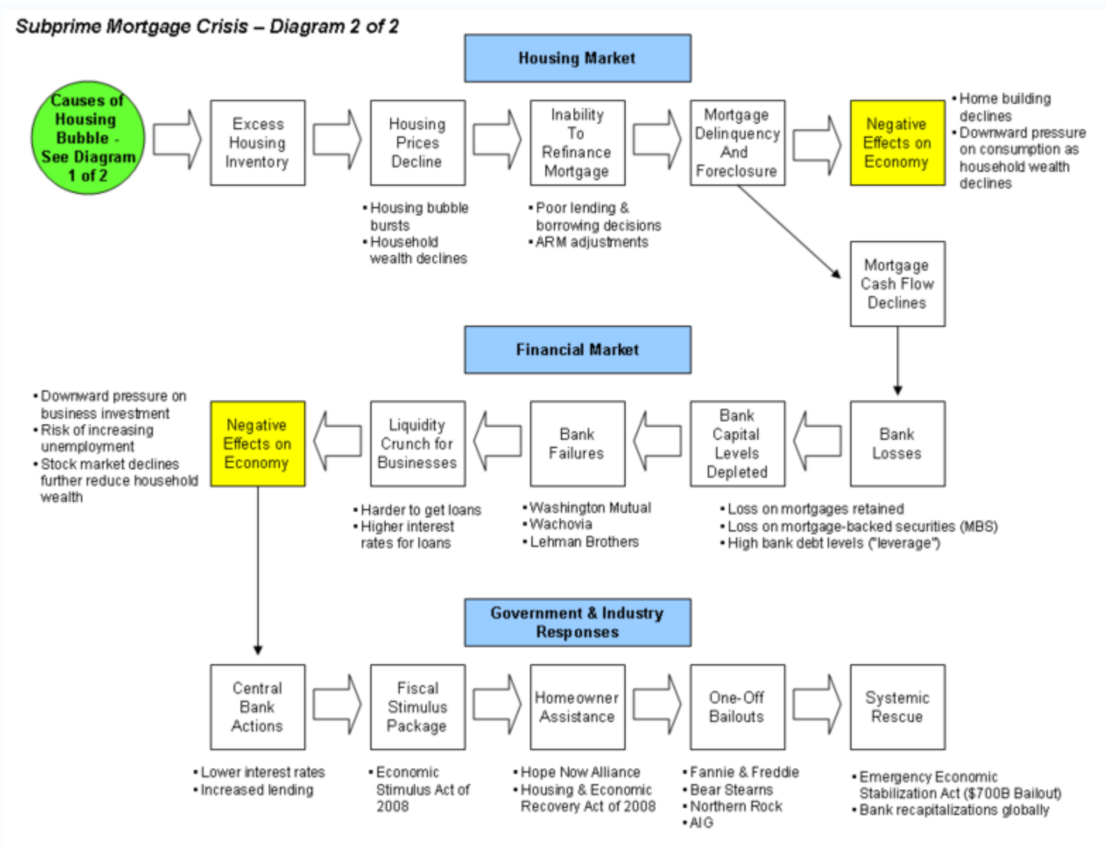


Figure 23. Domino effect as housing prices declined[14]

[14] http://www.wikipedia.org

Glossary of Terms

Mortgages[15]

Amortization or **amortisation** is the process of decreasing or accounting for, an amount over a period of time.

Cadastre (also spelled **cadaster**) is a comprehensive register of the real property of a country, and commonly includes details of the ownership, the tenure, the precise location, the dimensions (and area) and the value of individual parcels of land.

Collateral, in lending agreements**,** is a borrower's pledge of specific property to a lender, to secure repayment of a loan.

Encumbrance is a legal term of art for anything that affects or limits the title of a property, such as mortgages, leases, easements, liens, or restrictions. Also, those considered as potentially making the title defeasible are also encumbrances.

Land registration is a system by which the ownership of estates in land, is recorded and registered, usually by government, in order to provide evidence of title and to facilitate dealing.

Pledge (also **pawn**) is a bailment or deposit of personal property to a creditor to secure repayment for some debt or engagement. The term is also used to denote the property which constitutes the security.

Title is a legal document showing a person's right to or ownership of a property.

Value Networks[16]

Business Model refers to a set of "rules," interactions, and relationships that define how a business generates value.

Exchange in a Value Network refers to two or more transactions between two roles or participants, and it evokes a quality of reciprocity (e.g., an exchange of money for service).

HoloMapping is a non-linear systems mapping technique that shows the key transactions and deliverables between roles and participants in a network or

[15] http://www.wikipedia.org
[16] http://www.valuenetworks.com

organizational system. It was developed by Verna Allee in 1993, and is used in *ValueNet Works* Analysis.

Intangible knowledge and information exchange flow around and support the core product and service value chain, but are not contractually paid for. These include strategic information, planning knowledge, process knowledge, technical know-how collaborative design work, joint planning activities, and policy development.

Perceived Value, a key focus in VNA, is how valuable you as well as other roles and participants perceive your deliverable to be.

Stakeholders have an interest in, provide resources for, or are affected by an activity, change, or decision.

Tangible exchange involve goods, services, or revenue, including all transaction involving contracts and invoices, return receipts of orders, requests for proposals, confirmations, or payments.

Value Network is any set of roles and relationships that generates social or economic good through complex dynamic exchanges of tangible and intangible value between two or more individuals, groups, or organizations. Any organization, group of organizations, or purposeful network in which people are engaged in creating social or economic good, can be visualized and analyzed as a value network, whether it is in private industry, government, or the public sector.

Value Network Analysis (VNA) is a whole-system mapping and network analysis approach to understanding tangible and intangible value creation among roles and participants in any purposeful activity, whether small work groups, organizations, business webs, or civil society networks.

Value chain is another term for a core business process consisting of tangible transactions involving goods, services, and revenue.