

**A DYNAMIC SIMULATOR
FOR STRATEGIC MANAGEMENT
IN SERVICE SECTOR**

82879

by

Korkut ırak

B.S. in Ind. Eng., Istanbul Technical University, 1994

82879

Submitted to the Institute for Graduate Studies in
Science and Engineering in partial fulfillment of
the requirements for the degree of
Master of Science
in
Industrial Engineering

T.C. YÜKSEKÖĞRETİM BAKANLIĞI
DOKÜMANİZASYON MERKEZİ

Boğaziçi University

1999

**A DYNAMIC SIMULATOR
FOR STRATEGIC MANAGEMENT
IN SERVICE SECTOR**

APPROVED BY

Prof. Yaman BARLAS
(Thesis Supervisor)



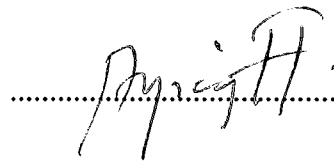
.....

Assist. Prof. Taner BİLGİÇ



.....

Assist. Prof. Ayşegül TOKER
(B.U. BA Dept.)



.....

DATE OF APPROVAL

02.03.1999
.....

ACKNOWLEDGMENTS

I would like to express my deepest gratitude to Prof. Yaman BARLAS, my thesis supervisor, for his invaluable guidance, support and advisory throughout all phases of this research, and for his patience and flexibility.

I would like to thank Assist. Prof. Taner BİLGİÇ and Assist. Prof. Ayşegül TOKER, the members of my thesis committee, for spending their valuable time for my thesis.

I also would like to thank Prof. Süleyman ÖZEKİCİ, the graduate program advisor, for his support and patience.

I wish to express my deepest gratitude to my parents, Aynur and Recai ÇIRAK and to my sister Nihan ÇIRAK, for supporting me during all phases of my education.

I finally wish to express my deepest gratitude to my wife, Serap ÇIRAK, for her invaluable support, patience, help and kindness in all aspects of my life.

ABSTRACT

The main objective of this research is to construct an interactive dynamic simulation model on which the strategic management of an insurance company, concerning the interactions between the technical departments of the company, those between the company and the market and the related strategic decisions can be analyzed and certain policies for sustaining growth can be tested. More specifically, the model focuses on long-term, strategic management problems that are naturally dynamic and persistent. The model generates many performance measures concerning the financial, technical and market aspects. In order to construct such a simulation game, a system dynamics model of the strategic management aspects of an insurance company is built. The model is validated and verified by standard tests. Next, the necessary changes are made on the model to construct the interactive gaming version of it. After the validation of the game, it is played by different players with academic and business backgrounds. Finally the game results of these players are analyzed and compared. The outputs provided by the players show different difficulties involved in managing the growth of an insurance company successfully. In conclusion, the simulation game provides a research platform for the theory of strategic decision making as well as a learning laboratory for the practice of scientific management education.

ÖZET

Bu araştırmanın ana amacı, bir sigorta şirketinin teknik bölümleri arasında ve pazar ile şirket arasında etkileşimlerin ve bunlarla ilişkili stratejik kararların incelenebileceği ve kalıcı bir büyüme için politikaların denenebileceği bir katılımlı dinamik benzetim modelinin kurulmasıdır. Model, özellikle dinamik ve süreklilik gösteren, uzun vadeli stratejik yönetim sorunlarına odaklanmıştır. Model, bir sigorta şirketinin stratejik yönetiminin mali, teknik ve pazar yönleri ile ilgili olarak bir dizi performans ölçütü hesaplamaktadır. Böyle bir benzetim oyunu kurabilmek için, öncelikle bir sigorta şirketinin stratejik yönetim cephesinin bir sistem dinamiği modeli kurulmuştur. Kurulan modelin geçerliliği bir dizi standart test ile sınanmıştır. Daha sonra, modelin etkileşimli oyun versiyonunun kurulabilmesi için, model üzerinde gerekli değişiklikler yapılmıştır. Oyun, geçerliliği sılandıktan sonra, akademisyenlerden ve iş dünyasından gelen profesyonellerden oluşan bir grup oyuncu tarafından oynanmıştır. Son olarak, bu oyuncuların neticeleri incelenmiş ve karşılaştırılmıştır. Oyuncuların sonuçları, bir sigorta şirketinin başarılı büyüme yönetiminin çeşitli zorluklar içerdiğini göstermektedir. Sonuç olarak, benzetim oyunu hem stratejik karar verme teorisi için bir araştırma ortamı hem de bilimsel yönetim eğitiminin uygulaması için bir öğrenme laboratuvarı sağlamaktadır.

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS	III
ABSTRACT.....	IV
ÖZET	V
TABLE OF CONTENTS.....	VI
LIST OF FIGURES	IX
LIST OF TABLES.....	XVI
LIST OF ABBREVIATIONS.....	XVII
1. INTRODUCTION	1
2. PROBLEM DEFINITION.....	4
3. METHODOLOGY	6
3.1. System Dynamics	6
3.2. Interactive Simulators	9
4. SIMULATION MODEL	11
4.1. Introduction.....	11
4.2. The Basic Dynamics of The Company	13
4.3. The Main Assumptions of The Model	16
4.4. The Major Characteristics of The Model.....	16
4.5. Sector Descriptions	17
4.5.1. The Policy Department Sector.....	17
4.5.2. The Claims Department Sector.....	23
4.5.3. The Agency Sector.....	28
4.5.4. The Marketing Sector	35

4.5.5. The Finance Sector	40
5. MODEL VERIFICATION AND VALIDATION	46
5.1. Overview.....	46
5.2. Data Collection and Parameter Estimation.....	46
5.3. Verification of the Model.....	48
5.4. Extreme Condition Tests	50
5.4.1. No Work Force	51
5.4.2. No Agency	51
5.4.3. No Auto Sales	51
5.4.4. Strong Competitors.....	52
5.4.5. Weak Competitors	52
5.4.6. Raising the Policy Price.....	53
5.4.7. Reducing the Policy Price.....	53
5.5. Base Run of the Model	54
5.6. Behavior Validation of the Model	57
6. THE INTERACTIVE SIMULATION GAME DESIGN	58
6.1. Introduction.....	58
6.2. Game Description	61
6.2.1. Game / Control Panel Screen.....	62
6.2.2. Model Overview Screen	64
6.2.3. Varying the Scenario Screen.....	65
6.2.4. General Information About the Model Screen.....	65
6.2.5. Preview the Controls Screen.....	72
6.2.6. Exit From Game Screens	72
6.3. More About the Game	72
6.4. Scenario Analysis	73
6.5. Verification and Validation of the Game.....	75
6.6. Game Results	75
6.6.1. The Performance of Player 1	76
6.6.2. The Performance of Player 2	76

6.6.3. The Performance of Player 3	77
6.6.4. The Performance of Player 4	78
6.6.5. The Performance of Player 5	79
6.6.6. The Performance of Player 6	79
7. SUMMARY OBSERVATIONS	81
8. CONCLUSION.....	83
APPENDIX A MODEL EQUATIONS OF THE INTERACTIVE GAME.....	85
APPENDIX B FIGURES OF MODEL BEHAVIOR IN VALIDATION TESTS.....	93
APPENDIX C FIGURES OF GAME RESULTS	110
APPENDIX D DATA SETS USED IN PARAMETER ESTIMATION	140
APPENDIX E GAME INSTRUCTIONS.....	157
REFERENCES	165
REFERENCES NOT CITED	168

LIST OF FIGURES

	Page
FIGURE 4.2.1. Premiums [US\$ mio, in 1989 constant prices]	13
FIGURE 4.2.2. Number of Active (In Force) Policies	14
FIGURE 4.2.3. Number of Underwritten (Created) Policies	14
FIGURE 4.2.4. Number of Claims	15
FIGURE 4.2.5. Yearly Average Market Share	15
FIGURE 4.5.1.1. The Price Effect On Renewals	18
FIGURE 4.5.1.2. The Policy Agency Effect on the policy work intensity	19
FIGURE 4.5.1.3. The Policy Department Sector	20
FIGURE 4.5.1.4. The Policy Quality Effect on the number of claim files	21
FIGURE 4.5.1.5. The Policy Work Intensity Effect on the quitting fraction of the policy work force	22
FIGURE 4.5.1.6. The Salary Effect on the quitting fraction of the policy work force	23
FIGURE 4.5.2.1. The Claims Work Intensity Effect on Settlement Time	25
FIGURE 4.5.2.2. The Claims Agency Effect on the claims work intensity	26
FIGURE 4.5.2.3. The Claims Work Intensity Effect on the quitting fraction of the claims work force	26
FIGURE 4.5.2.4. The Claims Department Sector	27
FIGURE 4.5.3.1. Commission Effect on applying agencies	29
FIGURE 4.5.3.2. The Agency Sector	30
FIGURE 4.5.3.3. Market Share Effect on applying agencies	31
FIGURE 4.5.3.4. Efficiency Effect on agency opening & closing decision	31
FIGURE 4.5.3.5. Market Share Effect on quitting agencies	33
FIGURE 4.5.3.6. Agency Relations Effect on quitting agencies	35
FIGURE 4.5.4.1. Indicated Marketing Effect on underwriting productivity	36
FIGURE 4.5.4.2. Settlement Time Effect on underwriting productivity	37
FIGURE 4.5.4.3. The Marketing Sector	38
FIGURE 4.5.4.4. Market Saturation Effect on underwriting productivity	39
FIGURE 4.5.4.5. Price Effect on New Policies	40

FIGURE 4.5.5.1.	The Finance Sector	42
FIGURE 5.3.1.	The Behaviors of Technical Measures during the isolated run of the Claims Department	48
FIGURE 5.3.2.	The Behaviors of Work Intensity Measures during the isolated run of the Claims Department	49
FIGURE 5.5.1.	The Dynamic Behavior of Financial Measures in the Base Run	54
FIGURE 5.5.2.	The Dynamic Behavior of Technical (Policy) Measures in the Base Run	55
FIGURE 5.5.3.	The Dynamic Behavior of Market Measures in the Base Run	55
FIGURE 5.5.4.	The Dynamic Behavior of Technical (Claims) Measures in the Base Run	56
FIGURE 5.5.5.	The Dynamic Behavior of Work Intensity Measures in the Base Run	56
FIGURE 6.1.1.	The Average Number of Competing Companies in Sector	59
FIGURE 6.1.2.	The Cash Index Effect	60
FIGURE 6.2.1.1.	Game / Control Panel Screen	66
FIGURE 6.2.1.2.	More Variables Screen	67
FIGURE 6.2.2.1.	Model Overview Screen	68
FIGURE 6.2.3.1.	Varying the Scenario Screen	69
FIGURE 6.2.4.1.	General Information About the Model Screen	70
FIGURE 6.2.5.1.	Preview the Controls Screen	71
FIGURE B.1.1.1.	The Behaviors of Financial Measures in Case of No Work Force	94
FIGURE B.1.1.2.	The Behaviors of Market Measures in Case of No Work Force	94
FIGURE B.1.1.3.	The Behaviors of Technical Measures in Case of No Work Force	95
FIGURE B.1.2.1.	The Behaviors of Financial Measures in Case of No Agency	95
FIGURE B.1.2.2.	The Behaviors of Technical Measures in Case of No Agency	96
FIGURE B.1.2.3.	The Behaviors of Market Measures in Case of No Agency	96
FIGURE B.1.3.1.	The Behaviors of Financial Measures in Case of No Auto Sales	97
FIGURE B.1.3.2.	The Behaviors of Technical Measures in Case of No Auto Sales	97
FIGURE B.1.4.1.	The Behaviors of Financial Measures in Case of Strong Competitors	98
FIGURE B.1.4.2.	The Behaviors of Market Measures in Case of Strong Competitors	98

FIGURE B.1.4.3.	The Behaviors of Technical Measures in Case of Strong Competitors	99
FIGURE B.1.5.1.	The Behaviors of Financial Measures in Case of Weak Competitors	99
FIGURE B.1.5.2.	The Behaviors of Market Measures in Case of Weak Competitors	100
FIGURE B.1.5.3.	The Behaviors of Technical Measures in Case of Weak Competitors	100
FIGURE B.1.6.1.	The Behavior of Technical Measures in Case of Raising the Policy Price	101
FIGURE B.1.6.2.	The Behavior of further Technical Measures in Case of Raising the Policy Price	101
FIGURE B.1.6.3.	The Behavior of Market Measures in Case of Raising the Policy Price	102
FIGURE B.1.6.4.	The Behavior of Financial Measures in Case of Raising the Policy Price	102
FIGURE B.1.7.1.	The Behavior of Technical Measures in Case of Reducing the Policy Price	103
FIGURE B.1.7.2.	The Behavior of further Technical Measures in Case of Reducing the Policy Price	103
FIGURE B.1.7.3.	The Behavior of Market Measures in Case of Reducing the Policy Price	104
FIGURE B.1.7.4.	The Behavior of Financial Measures in Case of Reducing the Policy Price	104
FIGURE B.2.1.1.	Real Behavior of Premiums [US\$ mio, in 1989 constant prices]	105
FIGURE B.2.1.2.	Model Behavior of Premiums [US\$ mio, in 1989 constant prices]	105
FIGURE B.2.2.1.	Real Behavior of Active (In Force) Policies	106
FIGURE B.2.2.2.	Model Behavior of Active (In Force) Policies	106
FIGURE B.2.3.1.	Real Behavior of Underwritten (Created) Policies	107
FIGURE B.2.3.2.	Model Behavior of Underwritten (Created) Policies	107
FIGURE B.2.4.1.	Real Behavior of Claims	108
FIGURE B.2.4.2.	Model Behavior of Claims	108
FIGURE B.2.5.1.	Real Behavior of Loss Ratio	109
FIGURE B.2.5.2.	Model Behavior of Loss Ratio	109

FIGURE C.1.1.1.	Policy Price Decision of Player 1	110
FIGURE C.1.1.2.	Agency Opening Closing Decision of Player 1	110
FIGURE C.1.1.3.	Policy Work Force Hiring Firing Decision of Player 1	110
FIGURE C.1.1.4.	Claims Work Force Hiring Firing Decision of Player 1	110
FIGURE C.1.1.5.	Marketing Expenditures Ratio Decision of Player 1	110
FIGURE C.1.2.1.	Cash Position of Player 1	111
FIGURE C.1.2.2.	Premiums and Claim Payments of Player 1	111
FIGURE C.1.2.3.	Profits of Player 1	111
FIGURE C.1.2.4.	Market Share of Player 1	112
FIGURE C.1.2.5.	Loss Ratio of Player 1	112
FIGURE C.1.2.6.	Active Policies of Player 1	112
FIGURE C.1.2.7.	Productivity Measures of Agencies of Player 1	113
FIGURE C.1.2.8.	Work Intensities of Player 1	113
FIGURE C.1.2.9.	Agency / Workforce Ratio of Player 1	113
FIGURE C.1.2.10.	Agencies of Player 1	114
FIGURE C.1.2.11.	Technical Work Force of Player 1	114
FIGURE C.1.2.12.	Claims of Player 1	114
FIGURE C.2.1.1.	Policy Price Decision of Player 2	115
FIGURE C.2.1.2.	Agency Opening Closing Decision of Player 2	115
FIGURE C.2.1.3.	Policy Work Force Hiring Firing Decision of Player 2	115
FIGURE C.2.1.4.	Claims Work Force Hiring Firing Decision of Player 2	115
FIGURE C.2.1.5.	Marketing Expenditures Ratio Decision of Player 2	115
FIGURE C.2.2.1.	Cash Position of Player 2	116
FIGURE C.2.2.2.	Premiums and Claim Payments of Player 2	116
FIGURE C.2.2.3.	Profits of Player 2	116
FIGURE C.2.2.4.	Market Share of Player 2	117
FIGURE C.2.2.5.	Loss Ratio of Player 2	117
FIGURE C.2.2.6.	Active Policies of Player 2	117
FIGURE C.2.2.7.	Productivity Measures of Agencies of Player 2	118
FIGURE C.2.2.8.	Work Intensities of Player 2	118
FIGURE C.2.2.9.	Agency / Workforce Ratio of Player 2	118
FIGURE C.2.2.10.	Agencies of Player 2	119

FIGURE C.2.2.11.	Technical Work Force of Player 2	119
FIGURE C.2.2.12.	Claims of Player 2	119
FIGURE C.3.1.1.	Policy Price Decision of Player 3	120
FIGURE C.3.1.2.	Agency Opening Closing Decision of Player 3	120
FIGURE C.3.1.3.	Policy Work Force Hiring Firing Decision of Player 3	120
FIGURE C.3.1.4.	Claims Work Force Hiring Firing Decision of Player 3	120
FIGURE C.3.1.5.	Marketing Expenditures Ratio Decision of Player 3	120
FIGURE C.3.2.1.	Cash Position of Player 3	121
FIGURE C.3.2.2.	Premiums and Claim Payments of Player 3	121
FIGURE C.3.2.3.	Profits of Player 3	121
FIGURE C.3.2.4.	Market Share of Player 3	122
FIGURE C.3.2.5.	Loss Ratio of Player 3	122
FIGURE C.3.2.6.	Active Policies of Player 3	122
FIGURE C.3.2.7.	Productivity Measures of Agencies of Player 3	123
FIGURE C.3.2.8.	Work Intensities of Player 3	123
FIGURE C.3.2.9.	Agency / Workforce Ratio of Player 3	123
FIGURE C.3.2.10.	Agencies of Player 3	124
FIGURE C.3.2.11.	Technical Work Force of Player 3	124
FIGURE C.3.2.12.	Claims of Player 3	124
FIGURE C.4.1.1.	Policy Price Decision of Player 4	125
FIGURE C.4.1.2.	Agency Opening Closing Decision of Player 4	125
FIGURE C.4.1.3.	Policy Work Force Hiring Firing Decision of Player 4	125
FIGURE C.4.1.4.	Claims Work Force Hiring Firing Decision of Player 4	125
FIGURE C.4.1.5.	Marketing Expenditures Ratio Decision of Player 4	125
FIGURE C.4.2.1.	Cash Position of Player 4	126
FIGURE C.4.2.2.	Premiums and Claim Payments of Player 4	126
FIGURE C.4.2.3.	Profits of Player 4	126
FIGURE C.4.2.4.	Market Share of Player 4	127
FIGURE C.4.2.5.	Loss Ratio of Player 4	127
FIGURE C.4.2.6.	Active Policies of Player 4	127
FIGURE C.4.2.7.	Productivity Measures of Agencies of Player 4	128
FIGURE C.4.2.8.	Work Intensities of Player 4	128

FIGURE C.4.2.9.	Agency / Workforce Ratio of Player 4	128
FIGURE C.4.2.10.	Agencies of Player 4	129
FIGURE C.4.2.11.	Technical Work Force of Player 4	129
FIGURE C.4.2.12.	Claims of Player 4	129
FIGURE C.5.1.1.	Policy Price Decision of Player 5	130
FIGURE C.5.1.2.	Agency Opening Closing Decision of Player 5	130
FIGURE C.5.1.3.	Policy Work Force Hiring Firing Decision of Player 5	130
FIGURE C.5.1.4.	Claims Work Force Hiring Firing Decision of Player 5	130
FIGURE C.5.1.5.	Marketing Expenditures Ratio Decision of Player 5	130
FIGURE C.5.2.1.	Cash Position of Player 5	131
FIGURE C.5.2.2.	Premiums and Claim Payments of Player 5	131
FIGURE C.5.2.3.	Profits of Player 5	131
FIGURE C.5.2.4.	Market Share of Player 5	132
FIGURE C.5.2.5.	Loss Ratio of Player 5	132
FIGURE C.5.2.6.	Active Policies of Player 5	132
FIGURE C.5.2.7.	Productivity Measures of Agencies of Player 5	133
FIGURE C.5.2.8.	Work Intensities of Player 5	133
FIGURE C.5.2.9.	Agency / Workforce Ratio of Player 5	133
FIGURE C.5.2.10.	Agencies of Player 5	134
FIGURE C.5.2.11.	Technical Work Force of Player 5	134
FIGURE C.5.2.12.	Claims of Player 5	134
FIGURE C.6.1.1.	Policy Price Decision of Player 6	135
FIGURE C.6.1.2.	Agency Opening Closing Decision of Player 6	135
FIGURE C.6.1.3.	Policy Work Force Hiring Firing Decision of Player 6	135
FIGURE C.6.1.4.	Claims Work Force Hiring Firing Decision of Player 6	135
FIGURE C.6.1.5.	Marketing Expenditures Ratio Decision of Player 6	135
FIGURE C.6.2.1.	Cash Position of Player 6	136
FIGURE C.6.2.2.	Premiums and Claim Payments of Player 6	136
FIGURE C.6.2.3.	Profits of Player 6	136
FIGURE C.6.2.4.	Market Share of Player 6	137
FIGURE C.6.2.5.	Loss Ratio of Player 6	137
FIGURE C.6.2.6.	Active Policies of Player 6	137

FIGURE C.6.2.7.	Productivity Measures of Agencies of Player 6	138
FIGURE C.6.2.8.	Work Intensities of Player 6	138
FIGURE C.6.2.9.	Agency / Workforce Ratio of Player 6	138
FIGURE C.6.2.10.	Agencies of Player 6	139
FIGURE C.6.2.11.	Technical Work Force of Player 6	139
FIGURE C.6.2.12.	Claims of Player 6	139
FIGURE E.1.	Main Game Screen	160



LIST OF TABLES

	Page
TABLE D.1. Underwritten Policies (Renewals included, regional details)	141
TABLE D.2. Total Underwritten Policies (Renewals included)	142
TABLE D.3. Premiums (nominal, TL mio)	142
TABLE D.4. Total Work Force	142
TABLE D.5. Technical Work Force	143
TABLE D.6. Agencies	143
TABLE D.7. Claim Payments (nominal, TL mio)	144
TABLE D.8. Claim Payments (nominal, TL mio, regional details)	144
TABLE D.9. Central Claim Payments (nominal, TL mio)	144
TABLE D.10. Total Claim Files	144
TABLE D.11. Claim Files (details)	145
TABLE D.12. Active Policies (yearly)	152
TABLE D.13. Active Policies (monthly)	152
TABLE D.14. Monetary Values of the Turkish Insurance Sector (nominal, TL mio)	156

LIST OF ABBREVIATIONS

Acc.-Motor	The Accident Insurance Policy for Motor Vehicles
CTPL-Mot.	The Compulsory Third Party Liability Insurance Policy for Motor Vehicles
CWIEffectOnSettTime	The claims work intensity effect on settlement time
CWNormIntensityForSettTime	The claims norm work intensity for settlement time
MeanCcP	The long term average number of claims per active policy
Mio	Million



1. INTRODUCTION

Strategic decision making is not the exclusive domain of large companies. It is an important activity in all types of organizations - large and small, for profit and not for profit, private and public. Companies of all sizes and all purposes must learn to direct the strategic management process by engaging in strategic decision making. When a grocery store, bank, or insurance agency decides to offer a new product line or service, it is making a strategic decision. When a hospital or public service agency decides to serve a new clientele, it is making a strategic decision. In short, whenever organizations significantly alter their activities, the strategic management process is at work.

The term *strategic management* is used to refer to the entire scope of strategic decision making activity in an organization. It may be defined as the set of managerial decisions that relates the organization to its environment, guides internal activities, and determines the long term performance of the organization (Stahl and Grigsby, 1991). And Greenley defines the *strategic management* as the management of the overall organization in total, being particularly concerned with future direction (Greenley, 1989). Consequently, it also provides a framework for operational management.

Managers, like all other human beings, live in a complex, dynamic reality of natural and social systems. Most systems are not in equilibrium and their states change continuously. In order to understand, adapt to, and control this reality, methods must be developed to capture it in formal models. The mental models of decision-makers cannot process the variety and complexity of most of the systems experiencing problems. With the use of computers, however, it is possible to explicitly represent, combine, and formalize these models, and communicate their assumptions to laymen, colleagues, and policy designers who will subject them to constructive criticism. Simulation models, in particular, can be used to investigate the intimate relationship that exists between the structure and behavior of dynamic systems. That is how problematic behavior arises from the underlying structure of a system and how this structure can be modified to alleviate system's problems.

Interactive dynamic management simulators provide a platform on which managers can experiment with different strategies and observe the consequences. Such simulators have been built for public and private corporations in a variety of sectors, such as insurance, education and airline service. A number of learning laboratories and management microworlds have been developed during the insurance crisis in the US in the 80's and 90's. One of them is developed for a leading American property and liability insurance company to address the runaway costs that threaten the entire liability insurance industry (Senge and Sterman, 1992). To support the strategic planning of Athabasca University, a fast growing open university, a microworld is developed (Mahmoud and Genta, 1993). A microworld is developed for the Venezuela's international airline Viasa, which provides passenger and cargo air service on international routes out of Venezuela, to support the strategic management laboratory at Viasa (Carrero et al., 1992). For economic development planning, a user-friendly learning laboratory is developed which makes it possible to experiment with ideas without incurring the costs and risks of real actions (Saeed, 1989). The Quahog oil production simulator is a simple, highly dynamic and descriptive model of a US oil company developed for rapid training and corporate culture change. The model is introduced into an already established new employee training program in that organization (Kreutzer et al., 1992).

In the early 1980s the AT&T operating companies were converting their highly profitable base of electromechanical telephone switching systems (known as PBXs) to new PBXs, in an increasingly competitive market. A key issue facing senior managers was how to retain a high share of the installed base of PBX systems while customers migrated from the old to new technology. A System Dynamics simulation model is developed in order to help them design the migration strategy (Graham et al., 1992).

Software industry is one of the most rapidly growing business in our age. Yet, this growth has not been a well-balanced one. Management of software systems has been plagued by overruns, late deliveries, and users' dissatisfaction. In the area of software project management, an interactive simulation game is constructed that can be used by managers as a participatory learning laboratory (Barlas and Bayraktutar, 1992).

An interactive dynamic simulation game for university management system is constructed as a platform, on which a range of problems concerning a university administration system can be analyzed and certain policies for overcoming these problems can be tested and compared (Diker, 1995).

The People Express Management Flight Simulator is one of the most popular interactive simulation games based on a system dynamics model of the firm (Graham et al., 1992). People Express Airlines went from startup in 1981 to the fifth-largest US airline by 1986. People Express' spectacular early success was matched by equally spectacular failure. In the first nine months of 1986 the firm lost \$ 245 million, and, in September 1986, the firm was purchased by Texas Air. The People Express case is widely used to examine a broad range of issues in growth management, industry deregulation, human resources, and organizational structure. The model constructed by Sterman integrates the operations, human resources, organizational structure, and philosophy of People Express with the structure of the US air-travel market and competitive environment of the early 1980s (Graham et al., 1989).

The purpose of this research is to build an interactive dynamic simulator for strategic insurance management. The simulation model will be constructed using System Dynamics methodology and will be converted into a simulation game, by a suitable player interface for interactive decision variables.

2. PROBLEM DEFINITION

Increased competition and explosive technological, political and environmental changes constitute major threats to the traditional management practices of companies in the service sector (e.g. insurance companies, banks, etc.).

Organizational decision making is highly complex and managerial choices are far from trivial. The fact that people have a hard time learning from real-life experiences compounds the problem, especially when the decisions and their consequences are separated in time and space. Not only, it is difficult to learn causal relations in one decision environment, but also decision-makers do not easily draw appropriate lessons from failures (Baken et al., 1992).

Decision making in strategic management in service sector will be under scientific investigation in this project. How are decisions made in a complex, dynamic environment? What information is taken into consideration? How is that information transformed into a decision, and how are decisions being implemented? What circumstances affect this process? Which system properties pose the major challenges to the decision-maker? These types of questions must be answered in the process of building management simulation models for the service sector. The above questions are not very easy to answer and they do not have a fixed and single solution. The outcome always depends on the interactions of several strategic variables. *System Dynamics* methodology provides a useful framework to tackle these questions (Forrester, 1978). It is a tool which combines small parts to identify the structure of the overall system - be it in engineering, management, economics, psychology or the nature itself (Forrester, 1978). Therefore, it is argued here that providing potential managers or manager trainees with a model of a typical company and letting them interact with it so that they can take decisions and simulate the behavior in a laboratory experiment will be at least as much useful -if not more- as giving them pages of case studies full of financial statements and expecting them to take an action (Graham et al., 1992). Parallely, a dynamic feedback simulation model of a company selected from the

service sector will be constructed according to the system dynamics principles in this thesis. The model will then be converted into an *Interactive Dynamic Simulator*, which is explained below so that it can serve the managers as a decision support system for strategic management problems.

Interactive Dynamic Simulation is the name given to the technique described above. It is an educational computer game designed to let the user to interact with a close-to-reality environment and come up with alternative solutions that change over time. More comprehensive and extended versions of interactive games are called *Learning Laboratories* (Kim, 1989). They are based on real case studies and often involve enhanced video or audio input interface.

The main objective of the study is to approach certain management problems of a selected company from the service sector (Halk Sigorta Insurance Company) by dynamic simulation analysis. The company that provides the data for the model is an insurance company, which is one of the leading firms in the Turkish insurance sector with its five regional centers and about 500 agencies spread in the country. The company underwrites accident, fire, marine, engineering and agriculture policies. With an \$ 88 million premium income occupying 6.5 per cent of the market, the company took the sixth place in the market in 1995.

The company exhibited a strong growth between 1989 and 1992-93, followed by stagnation, even a slight decline (in terms of premium revenues, market share, number of underwritten policies, number of active policies). The number of claims and the claim payments increased slightly after the stagnation though the decline in other variables.

In this research, the dynamics behind the strategic problems of the company will be analyzed by building a management simulation model of the company. Through an analysis of the structures of the basic departments of the company and the interdependencies among them, a dynamic simulation model will be built to generate an understanding of how the problems are created. The designed model will be a management decision support system. It can function as an experimental laboratory for future scenarios.

3. METHODOLOGY

In this study, an interactive dynamic simulation model, which is intended to represent the strategic managerial aspects of an insurance company, is built. The tool used to analyze the system and build the model is System Dynamics methodology.

3.1. System Dynamics

System dynamics methodology was introduced in 1960's by a group of scientists at Sloan School of Management at MIT. At the beginning, it was applied to industrial systems. During 1970' and 1980's it has become extremely popular and has been applied to a wide range of systems, including ecological, economic, sociological and even psychological systems.

System Dynamics methodology performs satisfactorily in analyzing and modeling complex, large scale, non-linear, partially qualitative social systems. The main assumption of System Dynamics approach is that the world, with all its physical, ecological, sociological, economic aspects, is a whole and is composed of innumerable sub-systems. Other important assumptions of System Dynamics are direct causal relationships between variables and interdependence of causal factors through feedback loops.

A feedback loop implies the circular cause and effect relationship between variables; that is, the loop will always start and end at a particular variable. There are two types of feedback loops: positive and negative. In case of a positive feedback loop, an initial increase in a variable returns back to the same variable through the feedback loop as an increasing effect; and an initial decrease in the variable returns to itself as a decreasing effect. Thus, positive feedback loops reinforces the initial change over time. On the other hand, an increase in a variable returns to itself as decreasing effect through a negative

feedback loop, whereas a decrease returns as an increasing effect. Thus, negative feedback loops seek to bring its variables to a balance. It is the interactions of positive and negative feedback loops within a system which produce the behavior patterns (like oscillations, growth or decline) of the system.

An important distinction of System Dynamics methodology is that it is used to analyze dynamic systems, in which the fundamental variables tend to change through time. This means difference equations are the main mathematical structures. The variables are grouped into three according to their mathematical characteristics (Barlas, 1995):

(A) Stock (or level) variables represent values that accumulate or decay through time. The value of a stock variable, at a given time, depends on its previous values and the sum of inflows and outflows in the previous time interval (Diker, 1995).

(B) Flow (or rate) variables represent the changes in stock variables through time. So, they are connected directly to stocks that they change. Stock-flow relationships correspond to differential equations whereby the flows represent the derivatives of stock variables (Diker, 1995).

(C) Converters (or auxiliaries) represent quantities which are determined at every time increment only by the variables that effect them and not by their previous values. Thus, they simply represent how a certain variable depends on other variables at a point in time (Diker, 1995).

The models may be represented by causal loop diagrams, which show the causal relationships between variables without making any distinctions between stocks, flows and converters. Structure diagrams, on the other hand, which show both causal relationships and the mathematical characteristics of the variables. Naturally, a set of mathematical equations, which demonstrate the algebraic relationships among the variables, accompany these diagrams. When expressing it mathematically, that is, with equations, the model can be reduced to equations that represent only the stock variables.

Briefly, *Dynamic Systems* thinking is a paradigm concerned with *systems*, which are sets of interrelated elements. It has a set of assumptions which condition what you see and how you make meaning out of what you see (Barlas, 1995): *Causal thinking, closed*

loop thinking which states that the behavior is a result of internal dynamics rather than external forces and tries to find out the causes of the dynamics, and *dynamic thinking* which involves focusing on patterns of behavior over time rather than concentrating on events.

System dynamics is a method, which uses the direct relationships between several variables to arrive to the desired behavior over time, as explained before. As mentioned, it is a tool, which combines small parts to identify the structure of the overall system - be it in engineering, management, economics, psychology or the nature itself.

System dynamics methodology consist of six main steps (Barlas, 1995).

(A) Problem Identification: A clear and precise statement of what dynamic problem needs to be understood and solved is given.

(B) Model Conceptualization: A list of all relevant variables is formed and a causal-loop diagram of the potential variables within the boundary of the system is constructed.

(C) Model Construction: The causal-loop diagram is translated into a more structural framework, a stock-flow diagram. The mathematical relationships between variables are written down. Coefficients and initial values are estimated and specified.

(D) Simulation and Validity Testing: The simulations are run and tested for validity.

(a) Structural Validity: The model is tested for any fundamental flaws in the logic of the relationships between variables.

(b) Behavior Validity: The model behavior is tested for its closeness to real life behavior.

(E) Simulation Experiments and Model Analysis: Simulation runs are done with certain selected values of parameters and functions in order to reach conclusions as to what strategies are more effective with respect to the problem under study.

(F) Implementation of Results: Implementing the recommendations of the model on the actual system, if one does exist. (This happens very rarely.)

The model that is represented in this study is used to drive an Interactive Dynamic Simulation Environment. In recent years, Interactive Dynamic Simulation Environments have been one of the main areas of interest in the field of System Dynamics. Such simulation environments are developed to provide a realistic micro model of a given system, which lets the users test their decisions interactively without interfering the real system.

3.2. Interactive Simulators

Interactive simulators are modified simulation models where certain decisions are made interactively by a player in the course of a simulation.

Interactive simulators provide considerable benefits, both as a teaching / learning tool and as a research tool. Their main benefit is that they encourage active learning which relies mostly on the participation of the user, letting him to learn about the system that was modeled, as if he were interacting with the real system. Another benefit is that this method enhances communication between the individual learners who form a group within an organization, since it requires discussions in small project teams. The main benefit provided by interactive simulators as a research tool is that using these tools it is possible to test the validity and robustness of a model, by having a wide variety of participants play the game making all kinds of different decisions. Interactive simulators also have the potential of a research tool for analyzing the various aspects of dynamic decision making theory (Barlas and Bayraktutar, 1992).

More comprehensive and extended versions of interactive games are called Learning Laboratories (Andersen et al., 1990). They are based on real case studies and often involve enhanced video or audio input interface.

The learning laboratory refers to a personal computer based arena in which managers are free to learn using their own style, at their own pace, and in a sequence that

they determine (Peterson, 1990). One or more simulation models provide the “engine” for learning within the environment (Mahmoud and Genta, 1993). The learning laboratory is a managerial ‘practice field’ where one can test out new strategies and policies, reflect on the outcomes, and discuss pertinent issues with others in the group (Kim, 1989).

Interactive simulators can be used in situations where real-life experimentation is infeasible because of cost considerations, time involvement, or both. They can be regarded as framing tool for dynamic issues, often referred to as transitional objects (Baken et al., 1992).

There are a number of computer packages which can be used to construct an interactive dynamic simulation model / learning laboratory. Among these are special tools such as Stella, i-think, Dynamo, Vensim, Powersim, Microworld Creator, and languages such as C, Visual Basic, and Turbo Pascal. This can even be accomplished using spreadsheet software like MS Excel, or database management software like MS Access.

4. SIMULATION MODEL

4.1. Introduction

The model presented in this study focuses on the strategic management aspects of an insurance company. The main concerns while modeling the system were the strategic managerial decisions of the company, the interactions between the technical departments of the company, the interactions between the company and the market and the effects of the strategic managerial decisions on these interactions. The basic time step used in the simulation is a month.

The basic structure of the model is derived from a model built in a project done for an insurance company by the System Dynamics Team of the Boğaziçi University (Barlas et al., 1997). Several modifications, additions and cancellations are made in this thesis.

The model is constructed on sector basis. The main sectors are determined according to the interactions of the company with the market.

The main goal of the developed simulation model is to understand the interactions that exist between policy department, claims department, agencies, market (competitors) and financial information so as to achieve growth of market shares in terms of revenue. The model consists of six sectors accordingly: Policy department, claims department, agency, marketing, finance sector. The basic structure of the model is based on the general operations of an insurance company, which are explained in the following passages.

Underwriting is defined as the process of hazard recognition and evaluation, selection of insured, pricing and determination of policy terms and conditions. In Turkey,

the agencies are the major sources of underwriting activities. The main function of the agencies is to find potential insureds. The agencies have the right to bind the insurance contracts. But there are certain agency limits for the underwriting of policies. In the cases of limit exceeding, the agencies send the potential policy proposals to the general directorate or center where the possibility of the proposals to be underwritten is evaluated.

The premiums are collected as a consequence of the underwritten policies. Twenty five per cent of the total premium is collected as prepayment. The remaining amount is divided into five equal payments and collected monthly. The duration of the insurance contract is one year. The insured prefers either renewal or the cancellation of its policy at the end of the year.

The claims function is critical in properly performing the contractual promise to indemnify the insured for a covered loss. Proper claim handling is one of the products purchased by the insured. The manner in which an insurer administers the claim function strongly influences the reputation of that insurer. The claims are handled by the claims department. Phone calls and fax messages are used to inform the company about the claims. These claims are called pending claims since they require a careful investigation procedure by surveyors and the other personnel. After the investigation, pending claims are settled either by a payment decision or a refusal of the payment.

The vast majority of the policy operations are done at the center. Underwriting and renewal of the expired policies, modifications on the policies, cancellation operations constitute the workload of the personnel in the policy department. Agencies, on the other hand, create an important amount of workload by requesting answers to their questions either generated by telephone or an individual visit to company center.

The agencies department determines the opening and closing of the agencies and accomplishes the required necessities.

Marketing and underwriting are cooperative activities that depend heavily on each other regardless of market conditions. The marketing department communicates the major

advantages of the company compared with the competitive firms to the potential and actual customers. On the other hand, this department makes the underwriters of the policy department aware of the needs of the customers. Furthermore, marketing expenditures are decided by the marketing department in coordination of the top management.

The finance department is responsible for collecting the incurred premiums and some other related activities.

4.2. The Basic Dynamics of The Company

The basic dynamics of Halk Sigorta Insurance Company from 1989 is a rapid growth till the years 1992-93, and a stagnation in these years, even a slight decline. The behavior patterns of main indicators are examined one by one in the following passages.

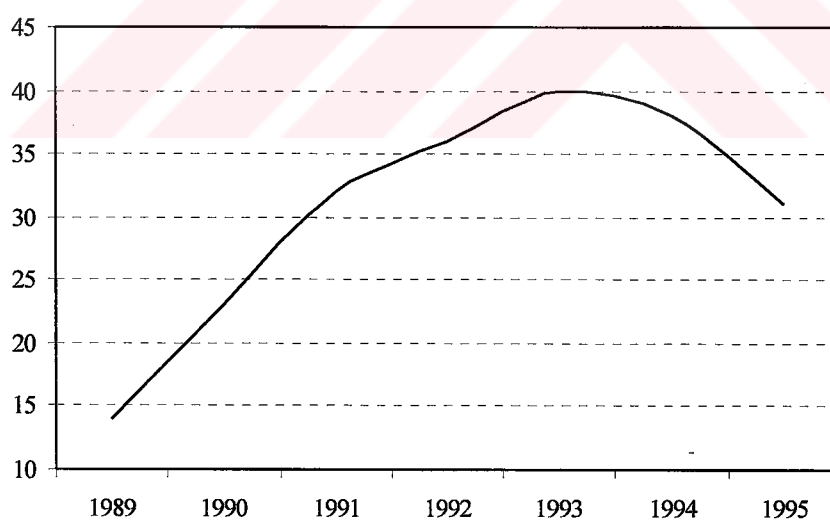


FIGURE 4.2.1. Premiums [US\$ mio, in 1989 constant prices]

The premiums increase till 1993 rapidly. Thereafter they stagnate in 1993 and start to decrease then (Figure 4.2.1).

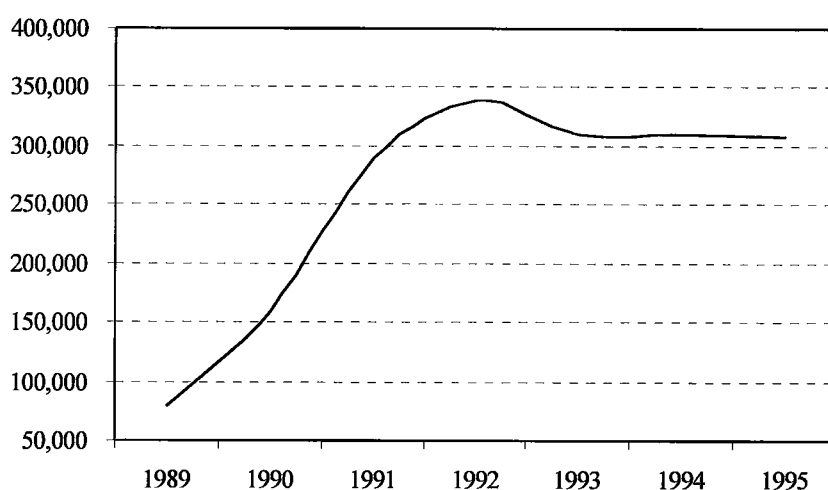


FIGURE 4.2.2. Number of Active (In Force) Policies

The number of active policies exhibits a boom-then-stagnation behavior (Figure 4.2.2).

The number of underwritten policies exhibits a rapid growth till 1991. It stagnates and declines between 1991 and 1993. In 1994 it increases slightly, but thereafter it starts to decrease fast (Figure 4.2.3).

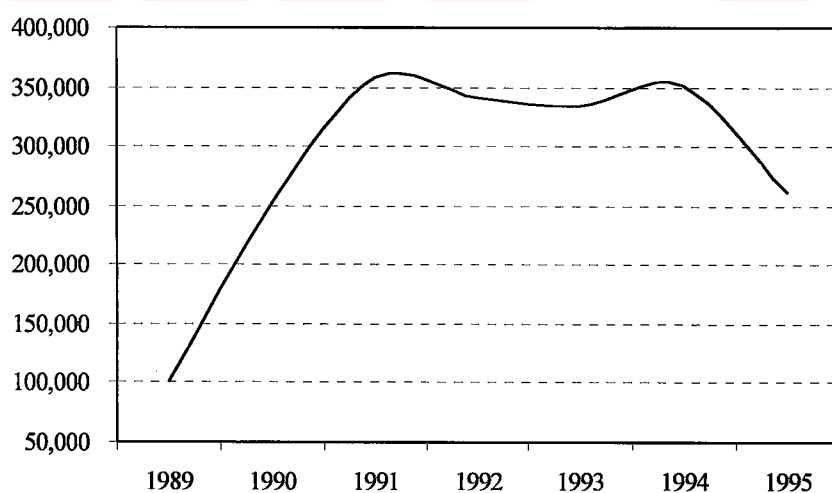


FIGURE 4.2.3. Number of Underwritten (Created) Policies

Contrary to the stagnation in other measures, the number of claims increases with a decreasing rate after the rapid growth which lasts in 1992 (Figure 4.2.4).

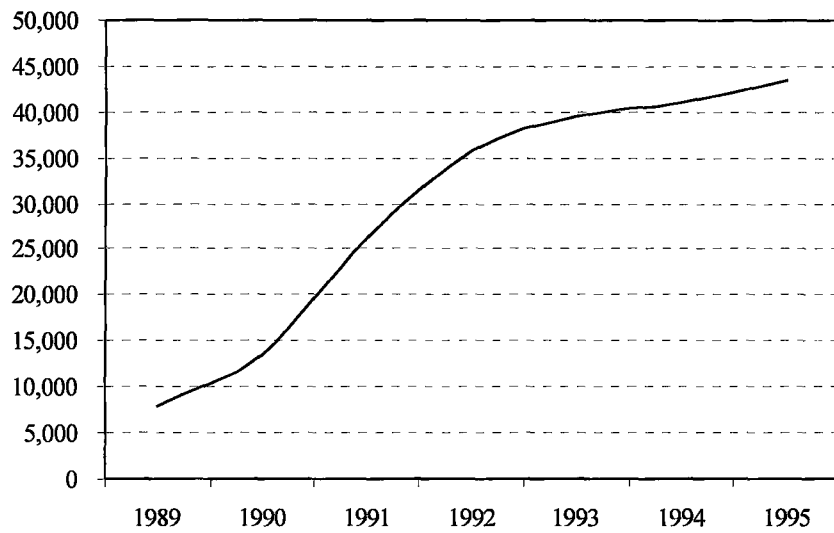


FIGURE 4.2.4. Number of Claims

The market share exhibits the typical boom-then-bust behavior. It increases rapidly till 1991. Thereafter it decreases rapidly, too (Figure 4.2.5).

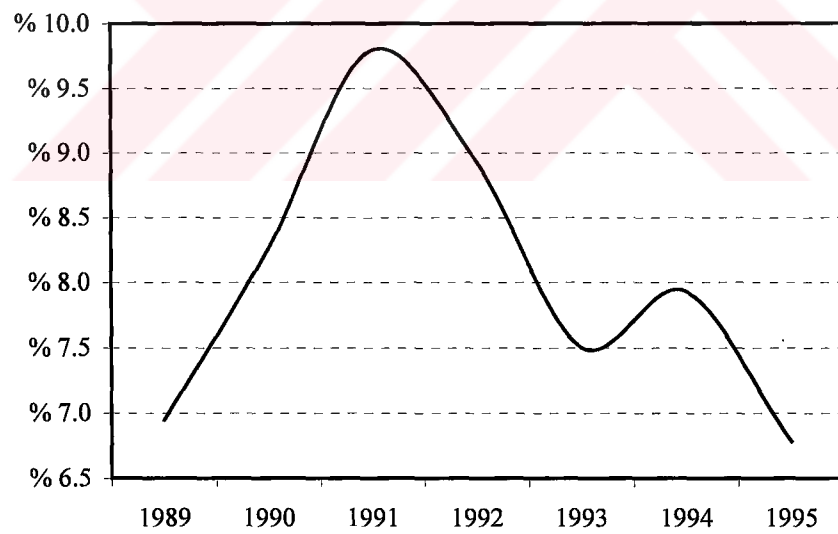


FIGURE 4.2.5. Yearly Average Market Share

4.3. The Main Assumptions of The Model

The main assumptions of the model are as follows:

- (A) The company underwrites only one type of policy, i.e. the accident policies.
- (B) The renewal fraction is effected only by the relative price (company's price relative to competitors' price).
- (C) The underwriting productivity of the sales force is assumed to be fixed and is not effected by the total market effect or the policy work intensity effect.
- (D) The support personnel per technical work force is assumed to be fixed. By hiring and firing of the technical workforce, the related support personnel is hired and fired simultaneously by the model.
- (E) The company is assumed to take credit whenever it is operating at a negative cash level so that it pays interest at the debt interest rate, and earns interest at the income interest rate whenever it is operating at a positive cash level.
- (F) The retiring fraction of the workforce, the commission rate in market, the average settlement time in market, the commission rate of reinsurance companies are all assumed to be fixed.

4.4. The Major Characteristics of The Model

The major characteristics of the model is as follows:

- (A) The underwriting productivity of the agencies is effected by five factors: market growth, relative price, marketing, relative settlement time and market saturation.
- (B) The marketing expenditures are calculated as a fraction of the total premium income in the game version.
- (C) The number of the claims amounts a to constant fraction of the active policies.
- (D) The policy work intensity effects the quality of the policy underwriting process. Policies underwritten with inadequate quality cause to increase of the average claim per policy.

(E) The increasing claims work intensity increases the average time to settlement of a claim file.

(F) The quitting fraction of the technical work force depends on the relative salary and the related work intensity ratios.

(G) The applying of agencies to the company depends on the relative commission rate and the average market share.

(H) The quitting fraction of the agencies depends on the average market share and the agency relations of the firm, i.e. the number of agencies divided by work force ratio.

(I) "Other expenses" are calculated as a fraction of the personnel expenses.

4.5. Sector Descriptions

4.5.1. The Policy Department Sector

The basic structure of this sector is the collection and storage of policies (Figure 4.5.1.3). Policies are either underwritten directly by the department or agencies, or they are renewed after the expiration. Three conveyors (policy01, policy16, policy612) are used for storing the active policies. The transit times are determined by considering the payments. The premium prepayments are collected in the first month, and the equal monthly payments are collected in the next five months. Therefore the transit time for the first two conveyors are one and five respectively. The last conveyor represents the accumulation of the policies after the payments till the expiration. Thus, the transit time for the last conveyor is six months. The expired policies are renewed automatically for one month, allowing a decision time for the insureds. A percentage of these expired policies continues to stay in the company, while the rest leaves the company. The renewal fraction depends on the company's relative prices in the market (Equation 4.1). This relative price is modeled as an effect of the current policy price on the policy renewal rate which is a graphical function of the ratio of the policy price and the average policy price in market (Figure

4.5.1.1). By examining the figure in question, we conclude that it has no effect when the price is equal to the average price in market. If the price is say twenty per cent more than the average market price, the renewals are reduced to about thirty per cent of their normal value. And if the price is less than the average market price, normal renewals are multiplied by a value greater than one, as seen in Figure 4.5.1.1.

$$\begin{aligned} \text{RenewalFraction} &= \text{NormalRenewalFraction} * \text{PriceEffectOnRenewals} \\ &[1/\text{month}] \quad (4.1) \\ \text{NormalRenewalFraction} &= 0.63 [1/\text{month}] \end{aligned}$$

The “normal” renewal fraction which equals 0.63 has been estimated from company’s renewal data (Appendix D), under “normal” operating conditions. From the data it is concluded that the operating range is within 20-25 per cent around the normal value. The shape of the effect graph (Figure 4.5.1.1) is adapted according to the assumed causality behind the renewal process and the price relation. Many experiments were done with different slopes and the ranges of the effect graph in order to “fine tune” the model. The slopes and the ranges which provide the most realistic and the closest pattern resemblance between the model behavior and the real behavior were chosen. This is valid for all of following effect graphs in this study, if the contrary is not stated.

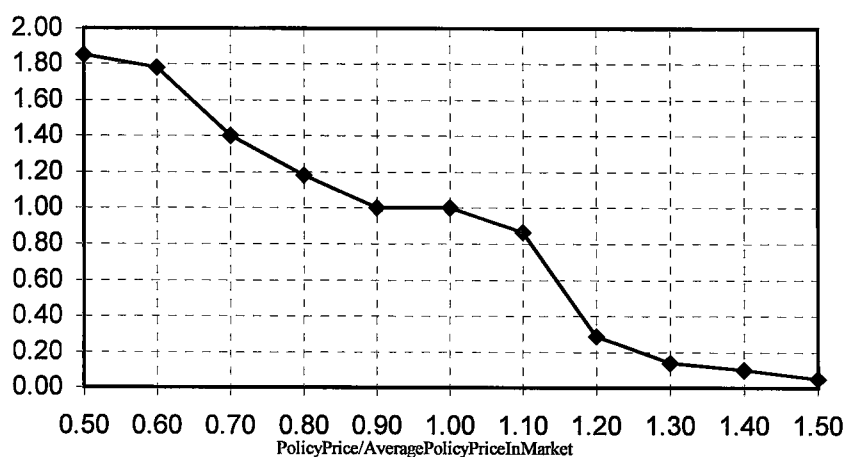


FIGURE 4.5.1.1. The Price Effect On Renewals

There is also another cancellation in the first conveyor. However this cancellation is relatively small, since the insured occasionally cancels its contract after the prepayment. This attitude of the insured is modeled by a relative small constant, i.e. the canceling fraction.

The total number of active (in force) policies and the agency disturbances constitute the work intensity of the policy department (Equation 4.2). The active policy per employee ratio is the main measure of the work intensity. The increasing agency disturbance has an increasing effect on the work intensity, which is called as policy agency effect and depends on the agency per work force ratio (the agency per work force ratio will be explained in the chapter 4.5.3. Agency Sector). The policy agency effect is modeled as a graphical lookup function (Figure 4.5.1.2) of the technical work force per agency ratio and is a multiplier of the policy work intensity.

$$\text{PolicyWorkIntensity} = \text{PolicyAgencyEffect} * \text{InForcePolicy} / \text{PolicyWorkforce} \quad (4.2)$$

[policy/man]

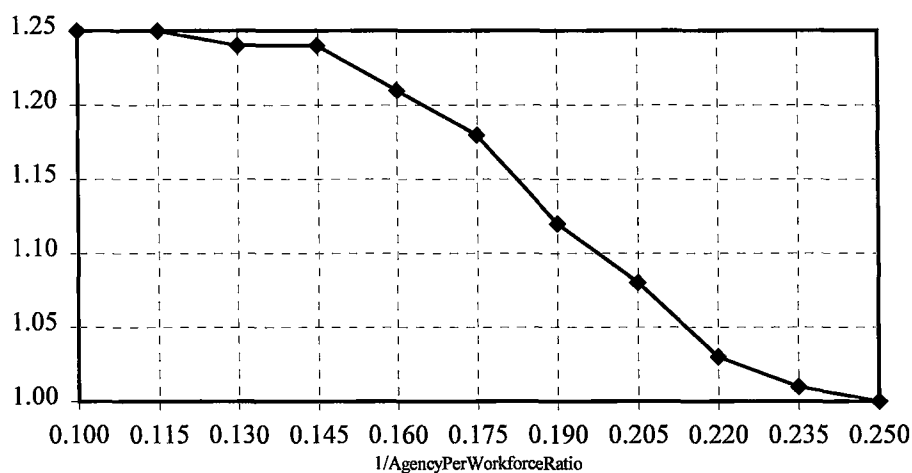


FIGURE 4.5.1.2. The Policy Agency Effect on the policy work intensity

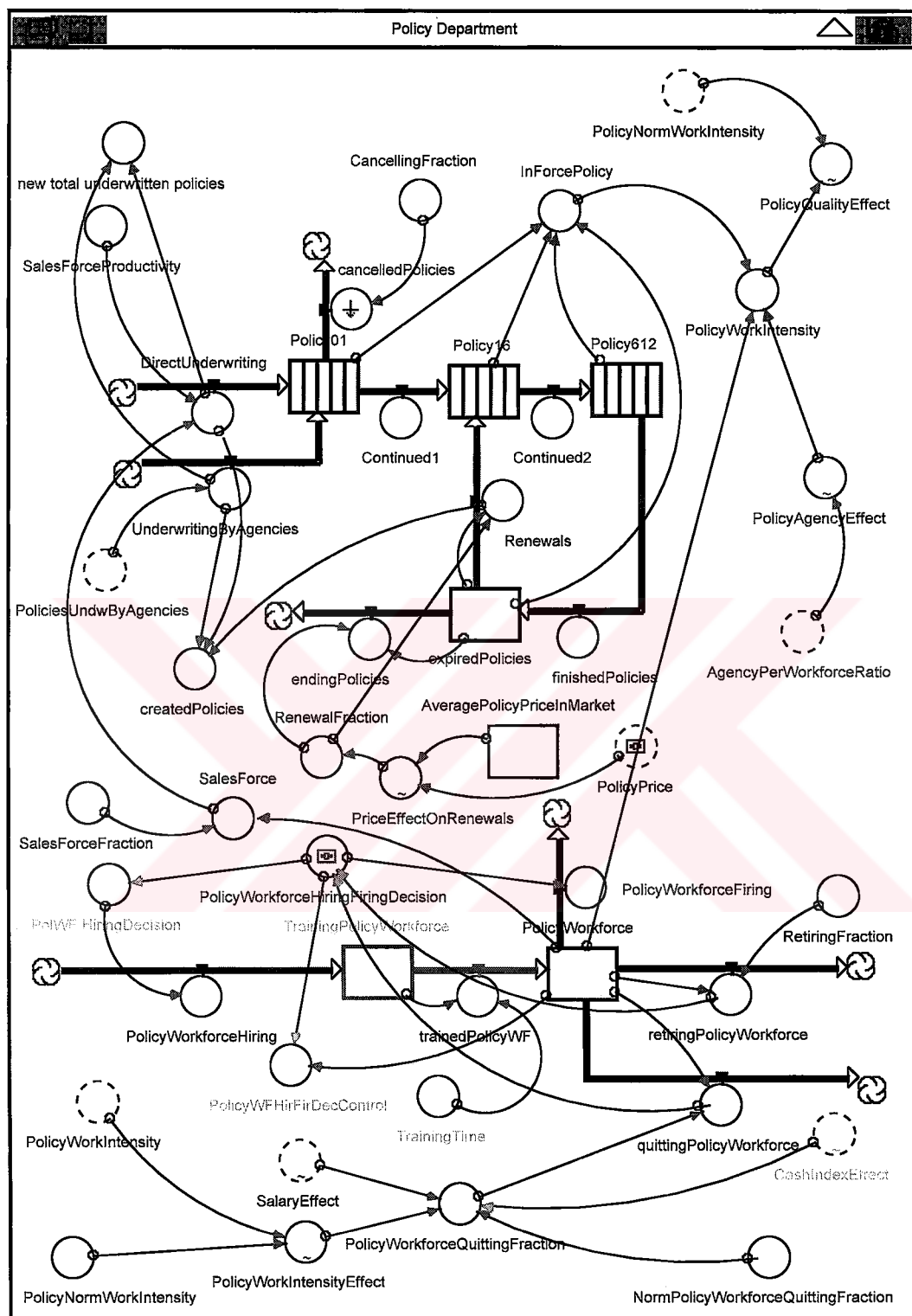


FIGURE 4.5.1.3. The Policy Department Sector

The policy work intensity affects the quality of the underwritten policies which affects the number of claim files positively. The policy quality effect is activated after the policy work intensity exceeds the policy norm work intensity which states the norm value of the work intensity for the comparison of the actual work intensity values. The policy quality effect is modeled as a graphical function of the ratio of the policy work intensity and policy norm work intensity (Figure 4.5.1.4).

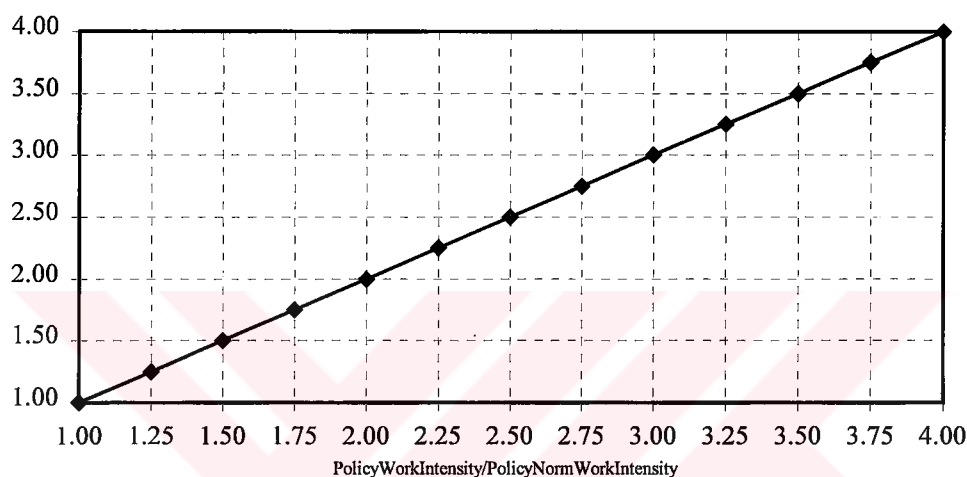


FIGURE 4.5.1.4. The Policy Quality Effect on the number of claim files

The employees in this department are accumulated in the stock 'policy work force'. While the policy work force hiring decision increases the policy work force, the policy work force firing decision, retiring policy work force and quitting policy work force decrease the policy work force. The number of the retiring employees is a constant percentage of the total work force, i.e. the retiring fraction. The number of the quitting personnel depends on the work intensity as well as the salary. The increasing policy work intensity causes to increase of the policy work force quitting fraction (Equation 4.3). This is modeled as policy work intensity effect, which is a graphical function of the ratio of the policy work intensity and policy norm work intensity (Figure 4.5.1.5).

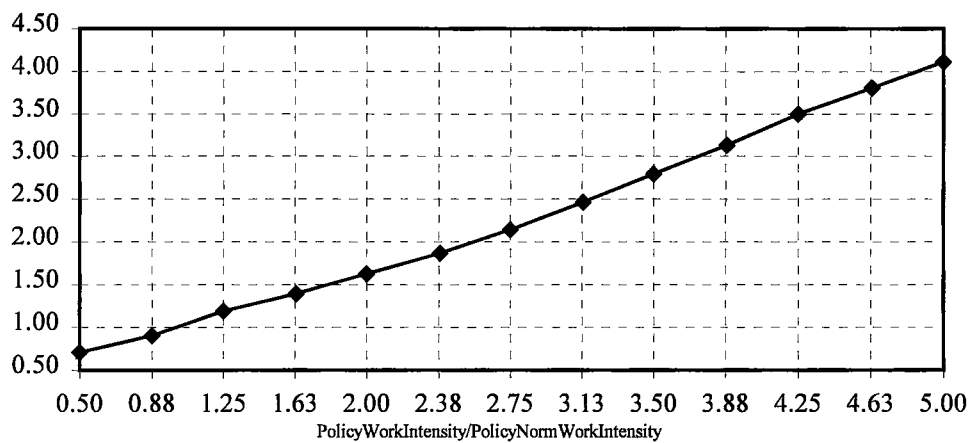


FIGURE 4.5.1.5. The Policy Work Intensity Effect on the quitting fraction of the policy work force

$$\text{PolicyWorkforceQuittingFraction} = \text{NormPolicyWorkforceQuittingFraction} * \text{SalaryEffect} * \text{PolicyWorkIntensityEffect} \quad (4.3)$$

[1/month]

The “normal” policy work force quitting fraction which equals 0.012 has been estimated from company’s work force data (Appendix D), under “normal” operating conditions. The shape of the effect graph (Figure 4.5.1.5) is adapted according to the assumed causality behind the quitting behavior of the policy department employees and the work intensity relation. Many experiments were done with different slopes and the ranges of the effect graph in order to “fine tune” the model. The slopes and the ranges which provide the most realistic and the closest pattern resemblance between the model behavior and the real behavior were chosen. This is valid also for the salary effect graph which is explained in the following passages.

The increasing salary relative to the average salary in the market results in the decreasing of the quitting fraction (Equation 4.3). This is modeled as salary effect, which is a graphical function of the ratio of the average salary in the market and the salary in the company (Figure 4.5.1.6). The salary is a condition variable and will be explained in the chapter 4.5.5 Finance Sector.

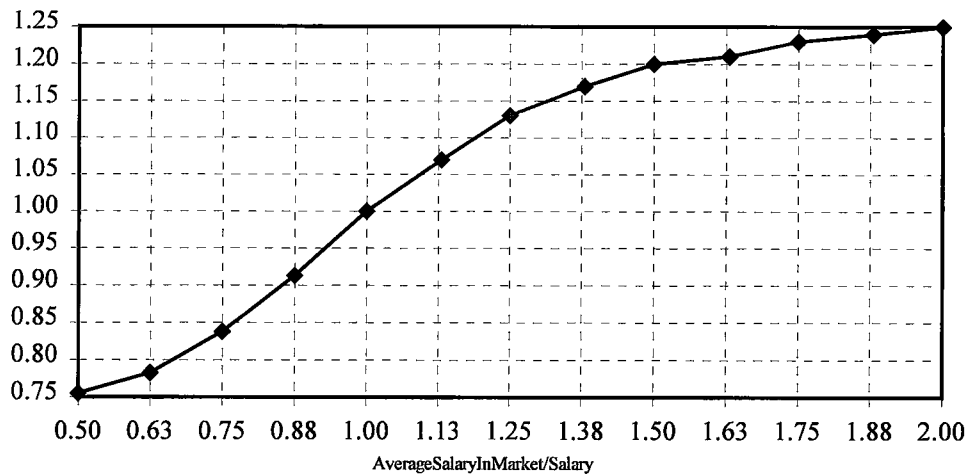


FIGURE 4.5.1.6. The Salary Effect on the quitting fraction of the policy work force

A small percentage (sales force fraction) of the policy work force who are called direct 'sales force' is in charge of selling policies. The sales force sells policies with the sales force productivity which is mentioned as 'direct underwriting' at the beginning of this chapter (Equation 4.4).

$$\text{DirectUnderwriting} = \text{SalesForce} * \text{SalesForceProductivity} [\text{policy/month}] \quad (4.4)$$

See Appendix A for the other equations in this sector.

4.5.2. The Claims Department Sector

If a loss which is covered under the policy wordings occurs, the policyholder submits his claim to the insurer in order to indemnify his loss. In this sector claims are accumulated in the pending claims stock (Figure 4.5.2.4). The number of claims is a variable percentage of the total number of active policies which is called "average claim per policy". The average number of claims per policy depends on a long term norm average (MeanCpP) and the quality of the written policies which is defined in the policy

department according to the work intensity (See Figure 4.5.1.4 and Equation 4.5). Increasing work intensity causes to increase of the average number of claims per policy.

$$\text{AverageClaimPerPolicy} = \text{MeanCpP} * \text{PolicyQualityEffect} [\text{claim/policy}] \quad (4.5)$$

Settlements decrease the amount of pending claims. The average time to settlement of a claim depends on the work intensity of the claims department (claims work intensity). The increasing claims work intensity causes to increase of the average time to settlement (Equation 4.6). This is modeled as claims work intensity effect on settlement time (CWIEffectOnSettTime), which is a graphical function of the claims work intensity ratio for settlement time (Figure 4.5.2.1).

$$\begin{aligned} \text{AverageTimeToSettlement} &= \text{NormalTimeToSettlement} * \\ &\quad \text{CWIEffectOnSettTime} [\text{months/claim file}] \\ \text{NormalTimeToSettlement} &= 1.3 [\text{months/claim file}] \end{aligned} \quad (4.6)$$

The “normal” time to settlement which equals 1.3 has been estimated from company’s claims data (Appendix D), under “normal” operating conditions. The shape of the effect graph (Figure 4.5.2.1) is adapted according to the assumed causality behind the claims handling process and the work intensity relation. Many experiments were done with different slopes and the ranges of the effect graph in order to “fine tune” the model. The slopes and the ranges which provide the most realistic and the closest pattern resemblance between the model behavior and the real behavior were chosen.

The claims work intensity ratio for settlement time (CWNormIntensityForSettTime) is the ratio of the claims work intensity and claims norm work intensity for settlement time (Equation 4.7). Thus, the claims work intensity effect on settlement time is activated after the claims work intensity exceeds the claims norm work intensity for settlement time.

$$\text{ClaimsWorkIntensityRatioForSettTime} = \frac{\text{ClaimsWorkIntensity}}{\text{CWNormIntensityForSettTime}} \quad (4.7)$$

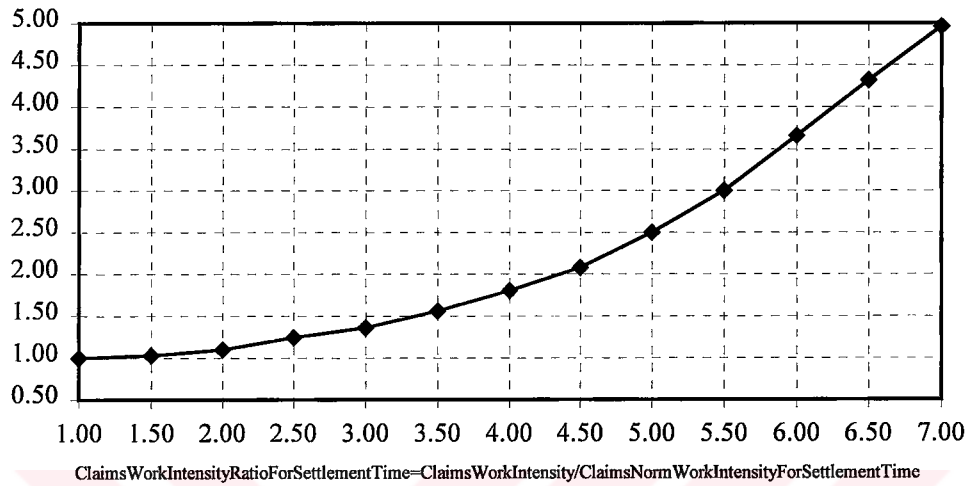


FIGURE 4.5.2.1. The Claims Work Intensity Effect on Settlement Time

The claims work intensity is similar to the policy work intensity. The number of pending claim files and the agency disturbances constitute the work intensity of the claims department (Equation 4.8). The pending claim file per employee ratio is the main measure of the work intensity. The increasing agency disturbance has an increasing effect on the work intensity, which is called as claims agency effect and depends on the agency per work force ratio (the agency per work force ratio will be explained in the chapter 4.5.3. Agency Sector). The claims agency effect is modeled as a graphical function (Figure 4.5.2.2) of the technical work force per agency ratio and is a multiplier of the claims work intensity.

$$\text{ClaimsWorkIntensity} = \text{ClaimsAgencyEffect} * \text{PendingClaims} / \text{ClaimsWorkforce} [\text{claim files/man}] \quad (4.8)$$

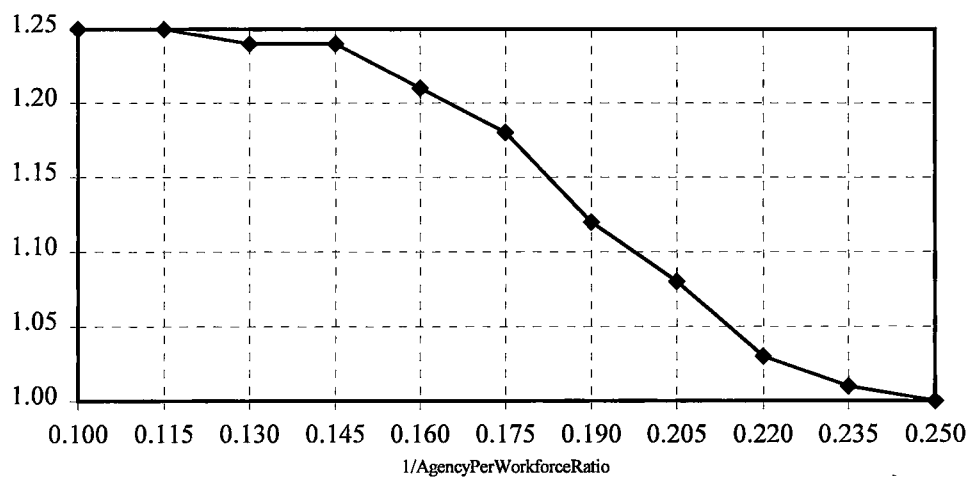


FIGURE 4.5.2.2. The Claims Agency Effect on the claims work intensity

The work force structure of the claims department is similar to the work force structure of the policy department. The employees in this department are accumulated in the stock 'claims work force'. While the claims work force hiring decision increases the claims work force, the claims work force firing decision, retiring claims work force and quitting claims work force decrease the claims work force. The number of the retiring employees is a constant percentage of the total work force, i.e. the retiring fraction. The number of the quitting personnel depends on the work intensity as well as the salary. The increasing claims work intensity causes the increase of the claims work force quitting

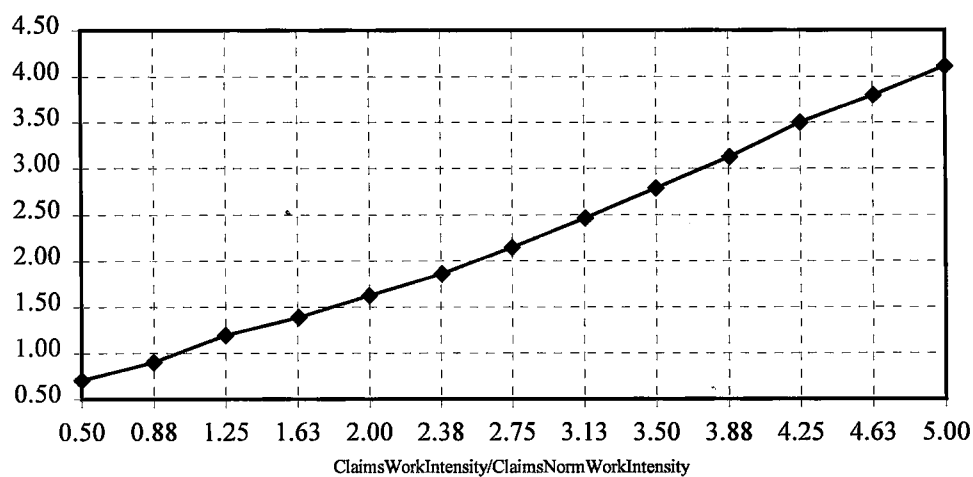


FIGURE 4.5.2.3. The Claims Work Intensity Effect on the quitting fraction of the claims work force

fraction. This is modeled as claims work intensity effect, which is a graphical function of the ratio of the claims work intensity and claims norm work intensity (Figure 4.5.2.3).

The increasing salary relative to the average salary in the market results in the decreasing of the quitting fraction. This is modeled as salary effect, which is a graphical function of the ratio of the average salary in the market and the salary in the company (Figure 4.5.1.6). The salary is a condition variable and will be explained in the chapter 4.5.5 Finance Sector.

See Appendix A for the other equations in this sector.

4.5.3. The Agency Sector

Policies are sold by the agencies. In this sector the agencies are accumulated in the agencies stock. While the agency opening decision increases the number of agencies, the agency closing decision and the agency quitting decrease the number of agencies (Figure 4.5.3.2).

All agencies of all insurance companies in Turkey are modeled as the global agency pool which exhibits an s-shaped growth dynamic. Agencies subtracted from the global agency pool define the potential agency pool. Agencies in the potential agency pool don't work with the company indeed, but a certain percentage of them apply to be an agency of the company according to the market share and the commissions paid. The upper limit of the applying percentage is the 'max applying fraction' (Equation 4.9).

$$\text{MaxApplyingAgencyPool} = \text{PotentialAgencyPool} * \text{CommissionEffect} * \text{MarketShareEffectOnApplying} * \text{MaxApplyingFraction} [\text{agency/month}] \quad (4.9)$$

The agency gets commission when she underwrites a policy. The commission amounts a certain percentage of written premium which is called 'commission rate'. The insurance companies apply different commission rates. If the commission rate is higher than the average commission rate in the sector (AverageCommRateInMarket), the company will be more attractive than the other companies for the agencies in the potential agency pool. An increase of commission rate results in a decrease of premium revenues simultaneously. There is a delicate balance to seek. The commission effect on applying agencies is modeled as a graphical function of the commissions ratio (Equation 4.10) which is defined by the commission rate and average commission rate in the sector (Figure 4.5.3.1).

$$\text{CommissionsRatio} = \text{CommissionRate} / \text{AverageCommRateInMarket} \quad (4.10)$$

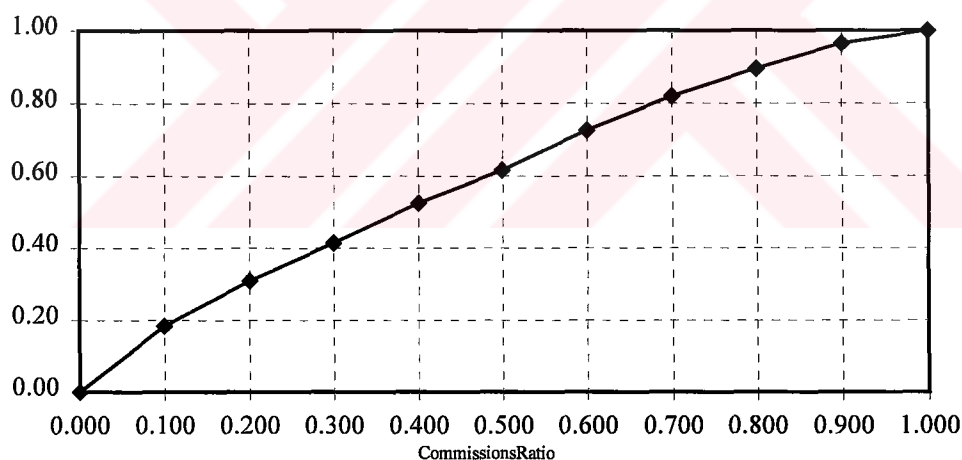


FIGURE 4.5.3.1. Commission Effect on applying agencies

From the agency's point of view, high market share means high written premium and high commissions. Therefore, high market shares increase the attractiveness of the company for the agencies in the potential agency pool, too. In other words, more agencies are willing to work with the company if the company's market share is high. The market share effect on applying is modeled as a graphical function of the yearly average market share (Figure 4.5.3.3).

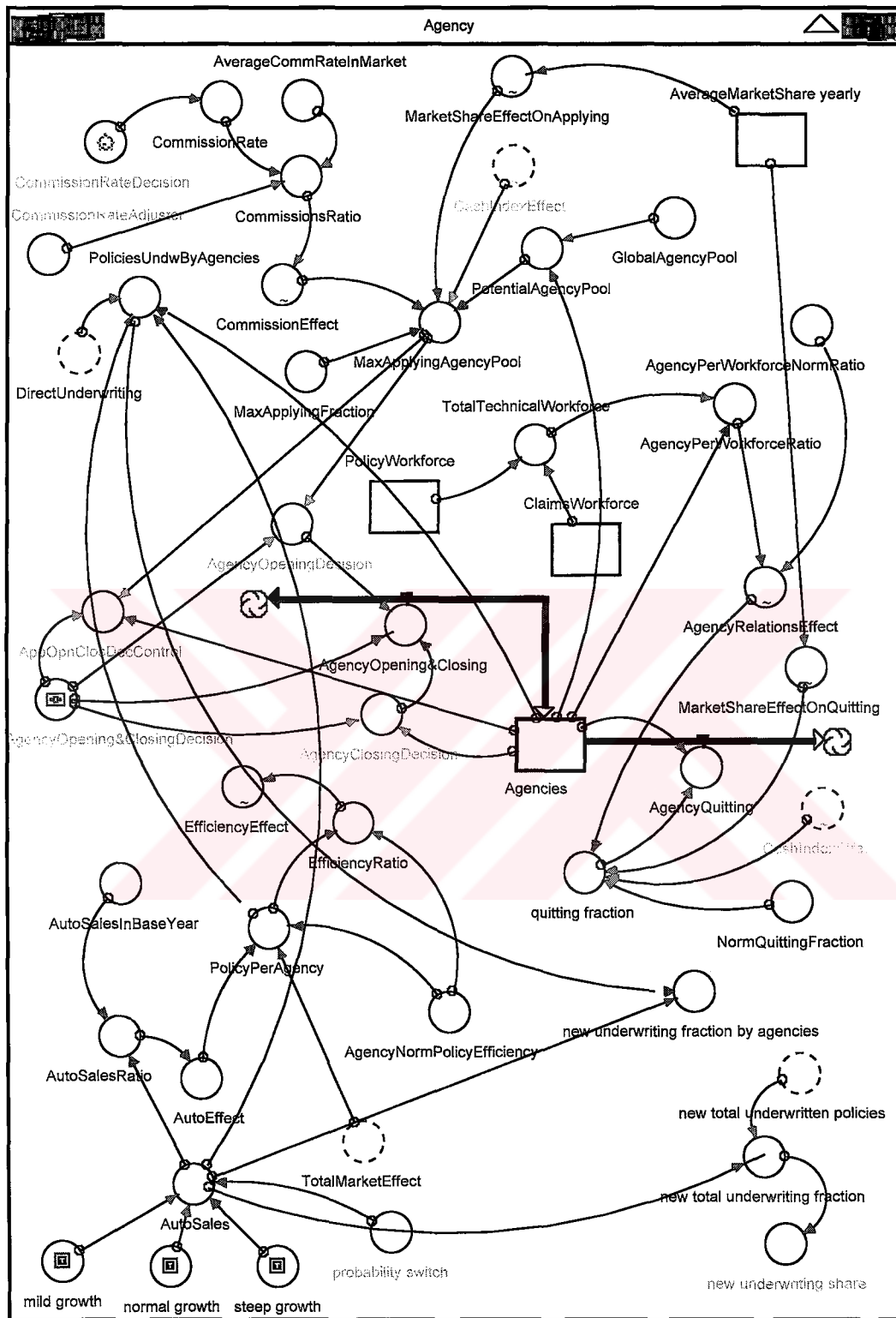


FIGURE 4.5.3.2. The Agency Sector

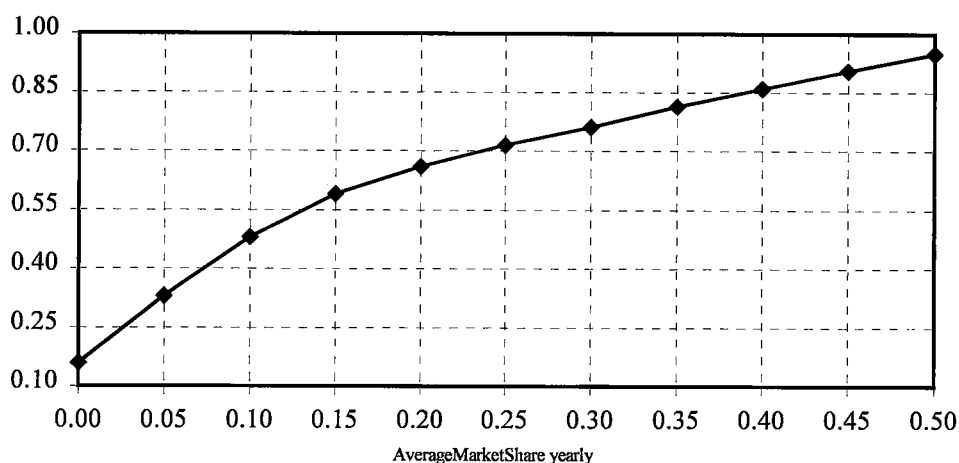


FIGURE 4.5.3.3. Market Share Effect on applying agencies

The efficiency of the agencies is the determinant factor on the agency opening & closing decision. The efficiency effect is modeled as a graphical function of the efficiency ratio (Figure 4.5.3.4). The efficiency ratio compares the average monthly policy underwriting productivity of the agencies (policy per agency) with the expected normal policy underwriting efficiency of the agencies (agency norm policy efficiency). If the agencies underwrite more policies than expected, that is, the efficiency ratio exceeds one, the company is willing to hire more agencies. The company can open at most so many agencies at a time as the agencies in the maximum applying agency pool.

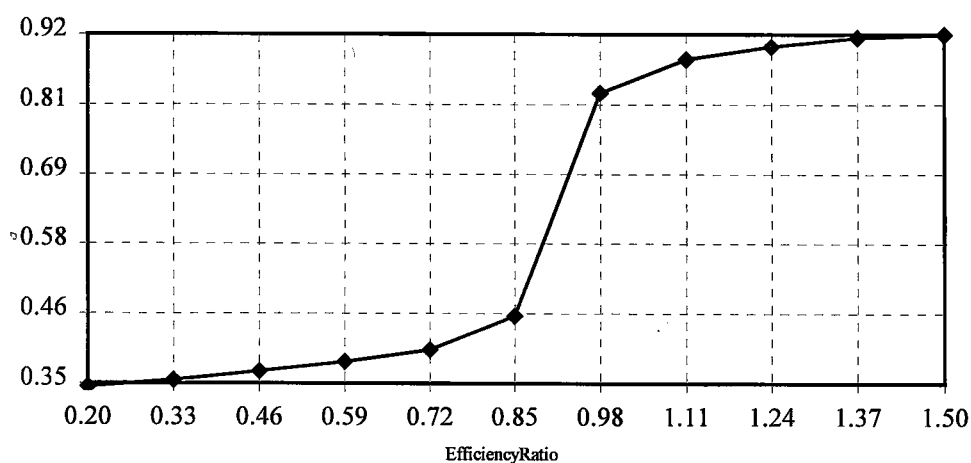


FIGURE 4.5.3.4. Efficiency Effect on agency opening & closing decision

The average monthly policy underwriting productivity of the agencies are determined by the total market effect, which will be explained in chapter 4.5.4. The Marketing Sector, the auto effect and the expected norm policy underwriting efficiency (Equation 4.11). Both effects are increasing or decreasing the norm efficiency according to the market conditions.

$$\text{PolicyPerAgency} = \text{AgencyNormPolicyEfficiency} * \text{TotalMarketEffect} * \text{AutoEffect} [\text{policy}/(\text{agency} * \text{month})] \quad (4.11)$$

The “normal” policy efficiency of the agencies which equals 5.09 has been estimated from company’s policy and agency data (Appendix D), under “normal” operating conditions. The shape of the effect graph is adapted according to the assumed causality behind the agency productivity and the market relation. Many experiments were done with different slopes and the ranges of the effect graph in order to “fine tune” the model. The slopes and the ranges which provide the most realistic and the closest pattern resemblance between the model behavior and the real behavior were chosen. This is valid also for the auto effect graph which is explained in the following passages.

The automobiles (cars) are the properties to be insured. The new auto sales determine the market of the insurance sector and exhibit a linear growth dynamic. The comparison of the current auto sales with the auto sales in base year, which is equal to the auto sales at the beginning of the simulation, defines the auto sales ratio (Equation 4.12). The auto effect is modeled as a graphical function of the auto sales ratio.

$$\text{AutoSalesRatio} = \text{SMTH1}(\text{AutoSales}/\text{AutoSalesInBaseYear}, 3) \quad (4.12)$$

The value of policies underwritten by the agencies (PoliciesUndwByAgencies) is calculated by the multiplication of agencies by policy underwriting productivity of the agencies (policy per agency).

The new total underwritten policies give the total number of new underwritten policies either by the agencies or by the direct sales force.

The new total underwriting fraction and new underwriting share give the percentage of the properties, which are new to the market, insured by the company. Namely, this is the market share in terms of number of policies if only the properties are considered, which are released to the market at the current time interval (AutoSales).

The agencies are quitting according to the market share and agency relations effect (Equation 4.13). The lower the market share, the more agencies are quitting. The market share effect on quitting of agencies is modeled as a graphical function of the yearly average market share (Figure 4.5.3.5).

$$\text{quitting_fraction} = \text{NormQuittingFraction} * \text{AgencyRelationsEffect} * \text{MarketShareEffectOnQuitting [1/month]} \quad (4.13)$$

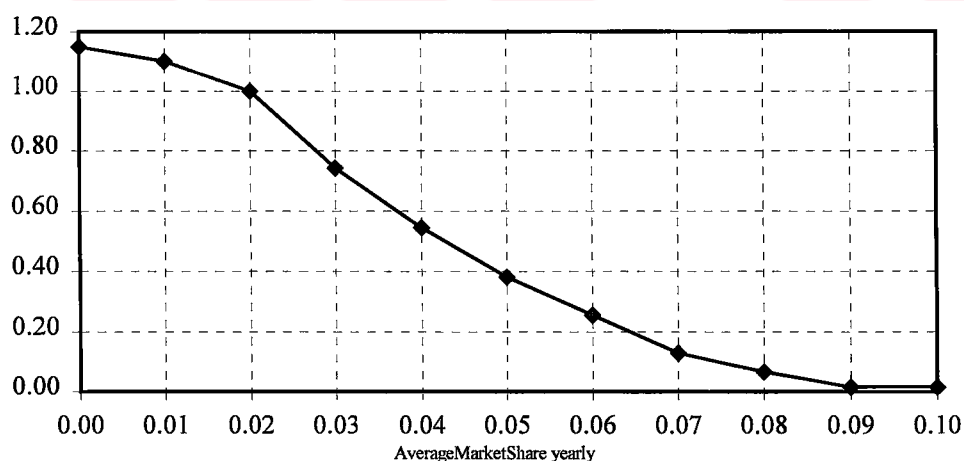


FIGURE 4.5.3.5. Market Share Effect on quitting agencies

The “normal” quitting fraction of the agencies which equals 0.04 has been estimated from company’s agency data (Appendix D), under “normal” operating

conditions. The shape of the effect graph (Figure 4.5.3.5) is adapted according to the assumed causality behind the agency quitting behavior and the market share relation. Many experiments were done with different slopes and the ranges of the effect graph in order to “fine tune” the model. The slopes and the ranges which provide the most realistic and the closest pattern resemblance between the model behavior and the real behavior were chosen. This is valid also for the agency relations effect graph which is explained in the following passages.

The employees in the policy department and the claims department constitute the total technical work force of the company, who contribute primarily to the service production of the company. All other employees are the staff personnel, which are explained in 4.5.5. The Finance Sector. The agencies are often in relation with the technical work force in different interactions: They have often questions to be answered about underwriting; they are following the claim files of their insureds; they need professional assistance in some of the insurance activities; they send policy proposals to be underwritten for evaluation, if their cover limits are exceeded, etc. If the agency per work force ratio exceeds a neutral value, which is called agency per work force norm ratio, the agency would not be able to find enough contact person in the company to get answer to her questions and to do her business activities. Under these conditions the agency would be unhappy and would quit to work with the company. The agency relations effect is modeled as a graphical function of the ratio of the agency per work force norm ratio and the agency per work force ratio (Figure 4.5.3.6).

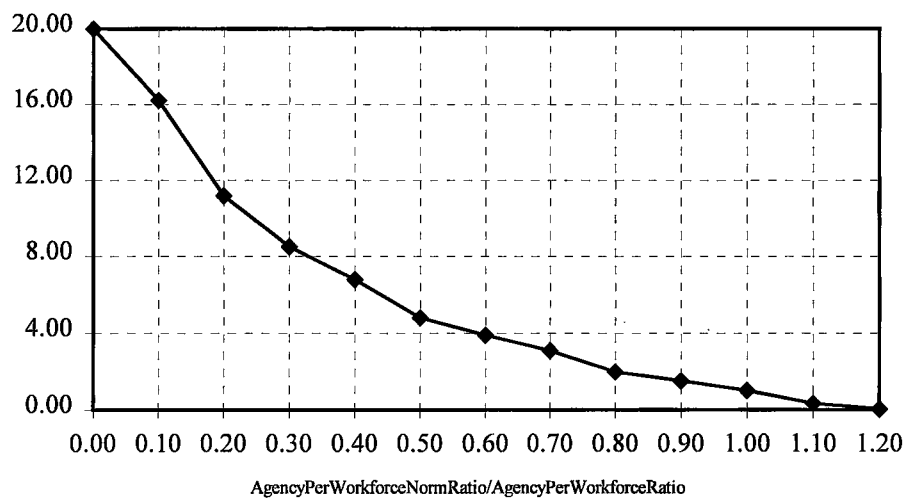


FIGURE 4.5.3.6. Agency Relations Effect on quitting agencies

See Appendix A for the other equations in this sector.

4.5.4. The Marketing Sector

In this sector the market conditions are evaluated (Figure 4.5.4.3). The total market effect, which determines the average monthly policy underwriting productivity of the agencies in a dominating manner, is calculated (Equation 4.14). The total market effect has four components:

- (a) Marketing effect,
- (b) Settlement time effect,
- (c) Market saturation effect and
- (d) Price effect.

$$\text{TotalMarketEffect} = \text{PerceivedMarketingEffect} * \text{MarketSaturationEffect} * \text{SettlementTimeEffect} * \text{PriceEffectOnNewPolicies} \quad (4.14)$$

Marketing expenditure is known to be a positive factor in attracting customers. In this sector marketing expenditure is calculated as a fraction (marketing expenditures ratio) of the total premium income (premiums) as seen in Equation 4.15.

$$\text{MarketingExpenditures} = \text{Premiums} * \text{MarketingExpendituresRatio} \quad [\$/\text{month}] \quad (4.15)$$

$$\begin{aligned} \text{CompetitorsAvgMarketingExpenditures} = \\ \text{CompetitorsAvgMarketingExpendituresRatio} * \\ (\text{CompetitorPremiums}/12)/\text{AvgNumberOfCompetingCompaniesInSector} \quad [\$/\text{month}] \quad (4.16) \end{aligned}$$

The marketing expenditure of the company is compared with the average marketing expenditure in the insurance sector in order to calculate the indicated marketing effect. The indicated marketing effect is modeled as a graphical function of the ratio of marketing expenditures and competitors average marketing expenditures (Figure 4.5.4.1). For the values of this ratio around one, there would be no big difference in the underwriting productivity. An outstanding high investment in marketing would increase the competitive power of the company increasing the underwriting productivity.

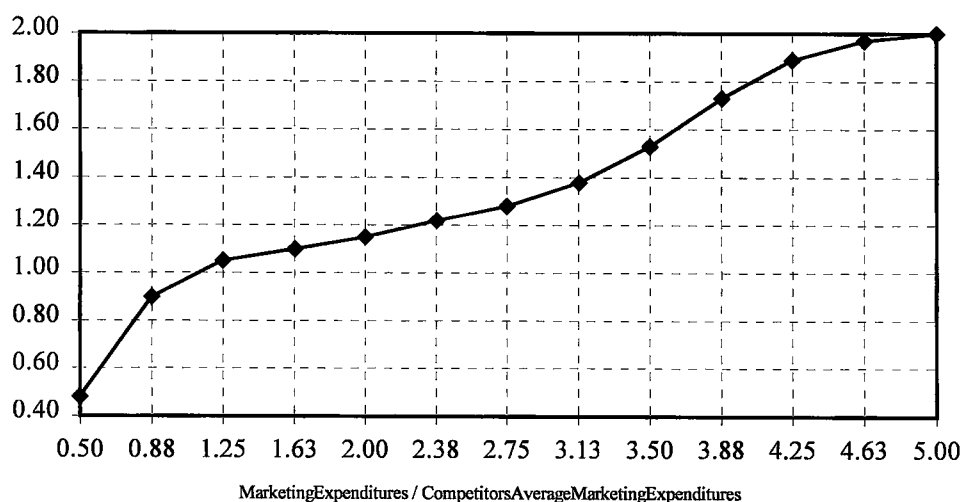


FIGURE 4.5.4.1. Indicated Marketing Effect on underwriting productivity

There is an information delay converting the indicated marketing effect into perceived marketing effect.

Although there are a lot of companies in the insurance sector, only a few of them occupy 90 per cent of the market and compete with each other. This is modeled as the average number of competing companies in sector, which has a constant value. Furthermore, only these companies have marketing budgets because the other companies with one digit or less market share values can not afford the marketing activities. Therefore, the competitors average marketing expenditures is calculated by multiplying the competitors average marketing expenditures ratio with the competitor premiums (will be explained a few paragraphs later) divided by the average number of competing companies in sector (Equation 4.16).

The short settlement time is another important factor in attracting customers in the insurance sector. If the settlement time, which depends on the work intensity of the claims department as explained in the Chapter 4.5.2, is shorter than the average settlement time in the sector, the underwriting productivity increases over the normal values. The settlement time effect is modeled as a graphic function of the ratio average time to settlement and average time to settlement in market (Figure 4.5.4.2).

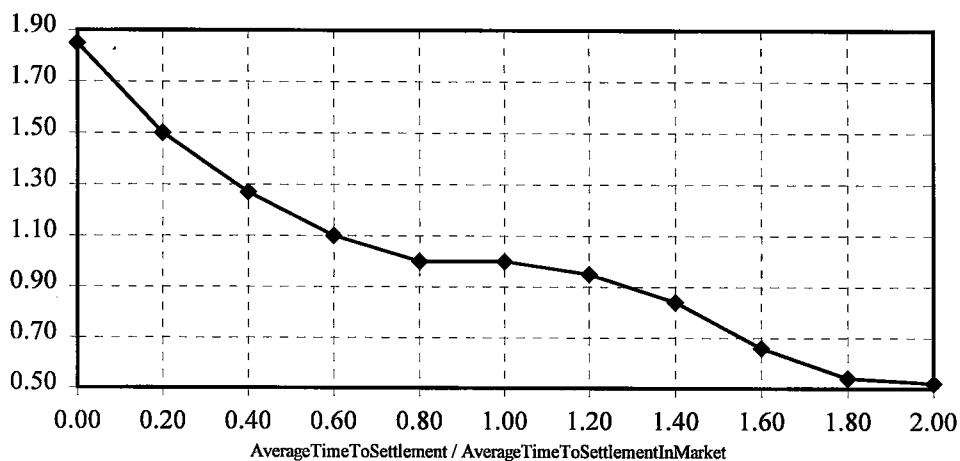


FIGURE 4.5.4.2. Settlement Time Effect on underwriting productivity

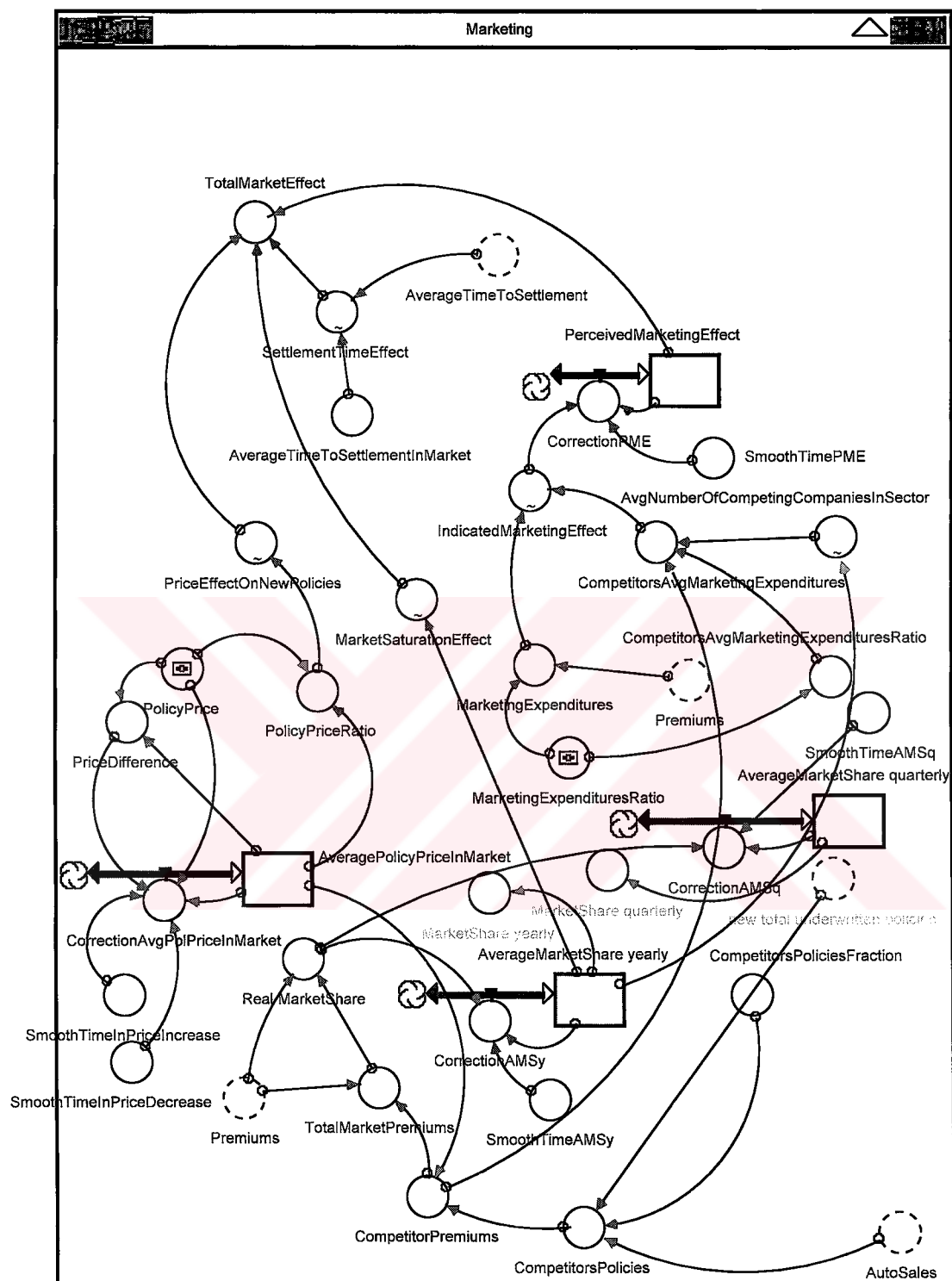


FIGURE 4.5.4.3. The Marketing Sector

The yearly and quarterly average market shares are also calculated in this sector by comparing the total market premiums. Exponential smoothing is used in the calculation of these average values. The total market premiums constitute of premiums of the company and the competitor premiums. Competitor premiums is the product of average policy price in market and the competitors policies. Competitor policies are the policies underwritten by all the other insurance companies and are amounting a fraction of the discrepancy between the new auto sales and the new total underwritten policies (See Chapter 4.5.3 and Equation 4.17). The average policy price in market is a constant value.

$$\begin{aligned} \text{CompetitorsPolicies} = \\ (\text{AutoSales} - \text{new_total_underwritten_policies}) * \text{CompetitorsPoliciesFraction} \quad (4.17) \\ [\text{policy/month}] \end{aligned}$$

The market saturation effect is a component of the total market effect that tends to decrease it when the market share increases. That means the marginal difficulty of obtaining the next per cent of market share increases. The market saturation effect is modeled as a graphic function of the yearly average market share (Figure 4.5.4.4).

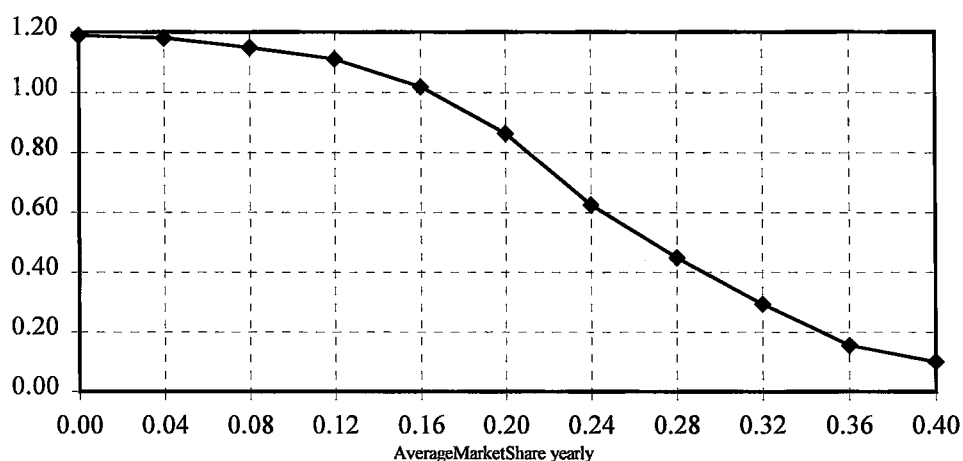


FIGURE 4.5.4.4. Market Saturation Effect on underwriting productivity

The low policy price is the last important factor in attracting customers in the insurance sector modeled so far in this study. The relative price, which is called policy price ratio and is amounting the quarterly smoothed value of the ratio of policy price and average policy price in market, has a positive effect when the company price is less than the market price and has a negative effect when the company price is more expensive (Equation 4.18).

$$\text{PolicyPriceRatio} = \text{SMTH1}(\text{PolicyPrice}/\text{AveragePolicyPriceInMarket}, 2) \quad (4.18)$$

The price effect on new policies is modeled as a graphical function of the policy price ratio (Figure 4.5.4.5).

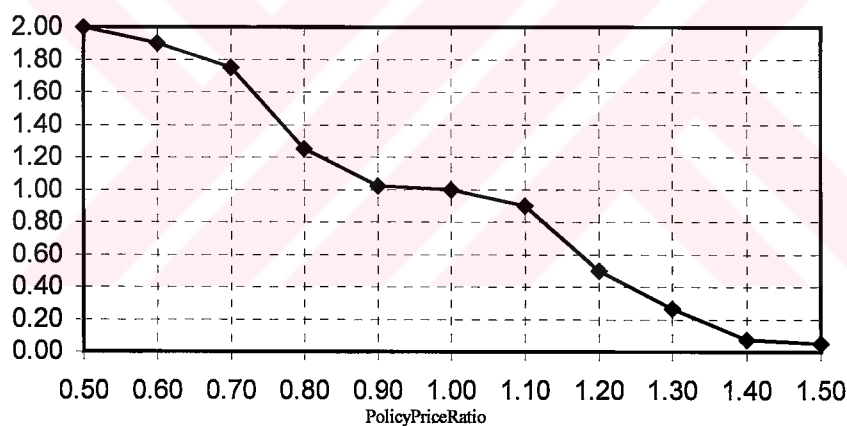


FIGURE 4.5.4.5. Price Effect on New Policies

See Appendix A for the other equations in this sector..

4.5.5. The Finance Sector

In this sector the monetary values of the company are accumulated in the cash stock (Figure 4.5.5.1). While the net premiums and the net financial income increase the cash position, the net claim payments, the interest paid and the expenditures decrease the cash

position of the company. The premiums collected, claim payments settled, commissions ceded to agencies and reinsurance companies, expenses and other cash positions (interests paid or received) are calculated.

The average prepayment is the premium prepayment per policy which equals 25 per cent of the policy price. The average premium is the equal monthly payment per policy which equals 15 per cent of the policy price. The premiums are the sum of the total prepayments and the total monthly payments. The total prepayments are calculated by the multiplication of the average prepayment by the sum of continuation flow (Continued1), which represents the new underwritten policies that are not cancelled in the first month, and the renewals flow, which represents the renewed policies after the expiration. The total monthly payments are calculated by the multiplication of the average premium by the policies accumulated in the stock policy16, which represents the policies that are underwritten before 1-6 months (Equation 4.19).

$$\text{Premiums} = \text{AveragePrePayment} * (\text{Continued1} + \text{Renewals}) + \text{AveragePremium} * \text{Policy16} \text{ [$/month]} \quad (4.19)$$

The commission rate is the rate of premiums paid to the agencies as commissions in per cent. An increase in commission rate would make the company more popular for the agencies. A higher commission rate would increase the productivity of the agencies. On the other hand it would increase the commissions paid to the agencies, i.e. the premiums retained in the company would be decreased. There is a delicate balance to seek among them.

The insurance companies are ceding a certain percentage of the premiums written to the reinsurance companies for reinsurance purposes. That means, in case of a loss the reinsurance company participates in the claim payment with the same percentage. The reinsurance company pays commission to the insurance company because of premiums ceded.

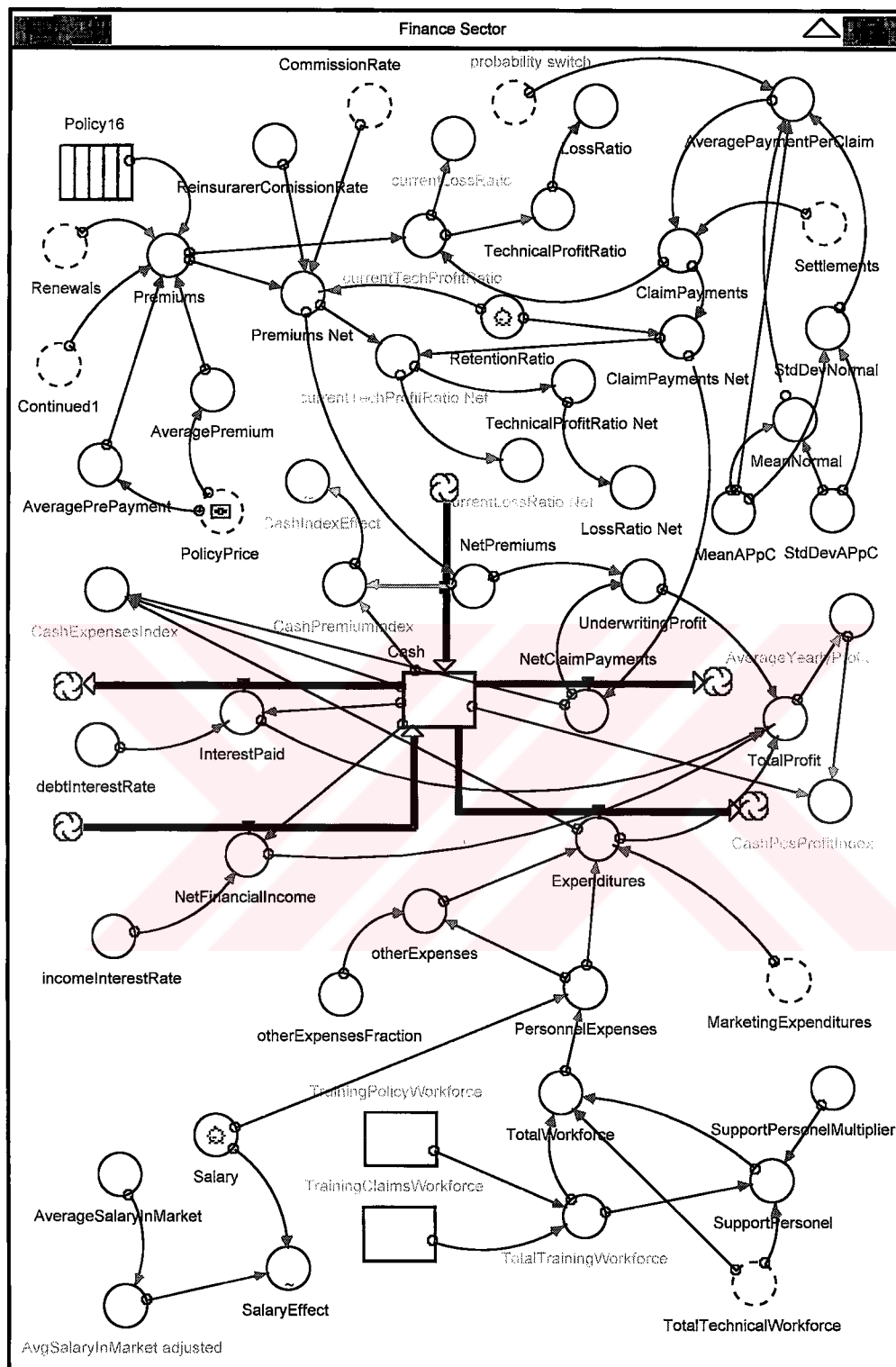


FIGURE 4.5.5.1. The Finance Sector

The retention ratio subtracted from one is the rate of premiums ceded to the reinsurance companies. That is, the retention ratio is the rate of premiums retained in the company in per cent.

The reinsurer commission rate is the rate of commissions received from the reinsurance companies as the rate of ceded premiums in per cent.

By subtracting the commissions paid to the agencies and the premiums ceded to the reinsurance companies from the premiums, and adding the commissions received from the reinsurance companies to the premiums, the net premiums is calculated (Equation 4.20).

$$\begin{aligned} \text{Premiums_Net} = & (\text{RetentionRatio} + \\ & (1 - \text{RetentionRatio}) * \text{ReinsurerCommissionRate} - \text{CommissionRate}) * \text{Premiums} \quad (4.20) \\ & [\$/\text{month}] \end{aligned}$$

The claim payments amount the product of average payment per claim and settlements (Equation 4.21). The average payment per claim is the average amount of payment per claim file. By multiplying the claim payments by the retention ratio, the net claim payments are calculated (Equation 4.22).

$$\text{ClaimPayments} = \text{Settlements} * \text{AveragePaymentPerClaim} [\$/\text{month}] \quad (4.21)$$

$$\text{ClaimPayments_Net} = \text{RetentionRatio} * \text{ClaimPayments} [\$/\text{month}] \quad (4.22)$$

The loss ratio is the rate of claim payments to the written premiums. It shows what percentage of the earned premiums is paid back to the insureds because of incurred losses under cover (Equation 4.23). The technical profit ratio is calculated by subtracting the loss ratio from one. It shows what percentage of the earned premiums is retained in the

company as underwriting profit. By dividing the net claim payments by the net premiums, the net loss ratio is calculated. The net technical profit ratio is calculated by subtracting the net loss ratio from one. These both net values are the real values after refinement of the commissions.

$$\text{LossRatio} = \text{SMTH1}(\text{ClaimPayments/Premiums}, 12) \quad (4.23)$$

The underwriting profit is the profit because of the underwriting activities. It is calculated by subtracting the net claim payments from the net premiums (Equation 4.24).

$$\text{UnderwritingProfit} = \text{NetPremiums} - \text{NetClaimPayments} [\$/\text{month}] \quad (4.24)$$

Beside underwriting, the insurance companies earn money by financial means. There are two interest rates, which determine the financial conditions of the market. One of these is the income interest rate, which is active whenever the firm is operating in a positive financial position, and the other one is the debt interest rate, which creates paid interest whenever the cash position of the firm is negative. By subtracting the sum of expenditures and interest paid from the sum of underwriting profit and net financial income, the total profit is calculated (Equation 4.25).

$$\begin{aligned} \text{TotalProfit} = & \text{UnderwritingProfit} + \text{NetFinancialIncome} - \\ & (\text{InterestPaid} + \text{Expenditures}) [\$/\text{month}] \end{aligned} \quad (4.25)$$

The expenditures constitute from three components: Personnel expenses, marketing expenditures and other expenses (Equation 4.26). The personnel expenses are calculated by multiplication of salary by total work force. The total work force is the sum of total technical work force and the support personnel. The total technical work force constitutes of the policy work force and the claims work force. The support personnel constitutes of

staff personnel which performs the non-technical operations. The support personnel multiplier is the number of necessary support work force per technical work force in order to carry out the technical operations without any problem. The other expenses depend on the size of the company in terms of personnel. The other expenses fraction is the amount of other expenses per each unit of personnel expenses.

The relative salary effects the quitting fraction of the technical work force.

$$\text{Expenditures} = \text{PersonnelExpenses} + \text{MarketingExpenditures} + \text{otherExpenses} \quad (4.26)$$

[\$/month]

See Appendix A for the other equations in this sector.

5. MODEL VERIFICATION AND VALIDATION

5.1. Overview

The model presented in the preceding section was verified and validated by a series of standard tests. The first group of tests are verification tests. These tests are intended to determine whether the model works as it is expected to work. After verification of the model, validation tests are done. Validation tests are grouped into two:

(A) Structure validation tests, which are done in order to determine whether the model has an adequate structure, by testing the behavior of the model under certain conditions;

(B) Behavior validation tests, which are done in order to determine whether the behavior that the model exhibits resembles to the behavior exhibited by the real system that was modeled.

To test the structural validation of the presented model, extreme condition tests were done. Behavior validation was tested by comparing the behavior of the model with the data on Halk Sigorta Insurance Company.

5.2. Data Collection and Parameter Estimation

Real – life data were collected and the parameters of the simulation model were estimated. The data were collected from the yearly and monthly activity reports of the Halk Sigorta Insurance Company (Monthly Reports of Halk Sigorta, 1989-1996; Yearly Reports of Halk Sigorta, 1989-1995) and the yearly reports of the Turkish Insurance Supervisory

Office (Insurance Supervisory Office Reports, 1989-1995). The past years data were stored in the management information system of the company. Year 1989 was taken as the initial year for the evaluation of the data because of the limitation of data in the management information system. Monthly data have been used preferably whenever they were available. In the cases that the monthly data were not available yearly data have been considered.

The data analysis concerned the number of active and created policies, the amount of premiums and claim payments classified into branches and regions, the number of agencies, the number of personnel, the amount of expenditures, financial income and interest paid.

Since the base year in the analysis was 1989, the monetary figures were deflated to generate real data. The monthly inflation data were obtained from the publications of State Institute of Statistics. After deflating according to the inflation rates, the monetary figures are changed to the United States Dollars using the currency rate of January 1989.

The most important data sets (premiums, policies, claims, claim payments, agencies, work force, monetary values) used in parameter estimation are given in Appendix D. There are a few parameters (such as agency applications, agency quits and agency closing, marketing expenditures ratio, average market values etc.) which were estimated as “best guesses”, because explicit data were unavailable.

According to the real life data, the randomness is introduced at three variables: (1) A normal random variable is added to the auto sales. (2) The number of claims in a period is Poisson-distributed, and (3) the average claim amount per claim is log-normal-distributed (Daykin et al., 1994; Doherty, 1985 and Berk, 1992). The parameters of these distributions are calculated from the data shown in Appendix D.

5.3. Verification of the Model

The aim of the verification tests is to determine whether the assumed relationships among the variables are embedded correctly in the computer model and whether the equations and other statements were written as they were intended to be.

To verify the model, the five sectors that the form the model were simulated one by one, isolated from the other sectors. The behaviors exhibited during these isolated simulations runs are easier to interpret, because the number of variables and feedback loops decrease considerably. The results of an isolated simulation run of the claims department sector are given in Figures 5.3.1-5.3.2 as an example.

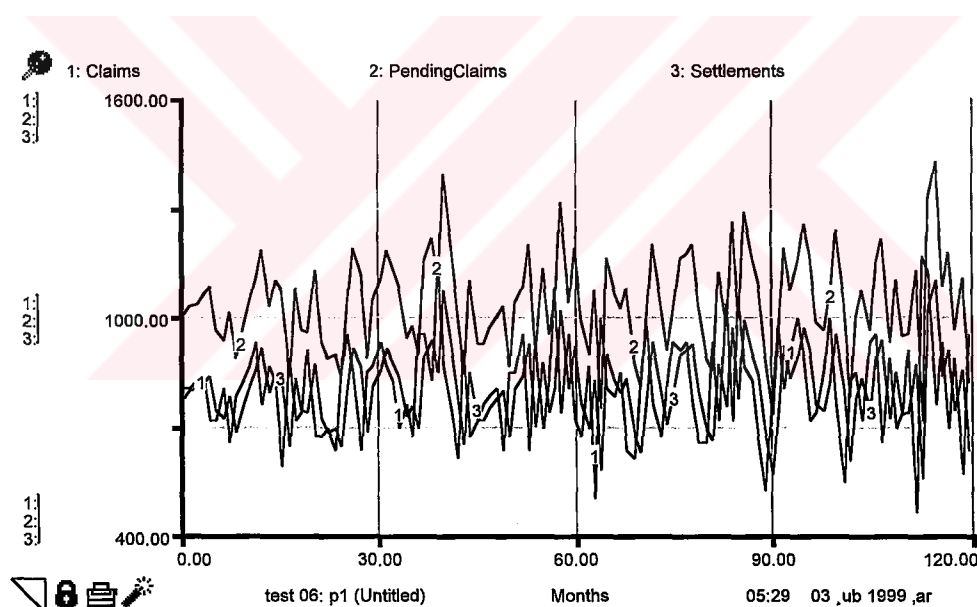


FIGURE 5.3.1. The Behaviors of Technical Measures
during the isolated run of the Claims Department

The number of active policies and the underwriting quality of the policies, which determine the extent of the number of claims, like the all other variables except the ones in the claims department sector amount their initial values and stay constant during the whole isolated simulation run. Therefore the number of claims oscillates around its long term average value, and it exhibits neither an increasing nor a decreasing behavior like the

claims work intensity, as expected, which contributes to the verification of the structure of the claims department sector.

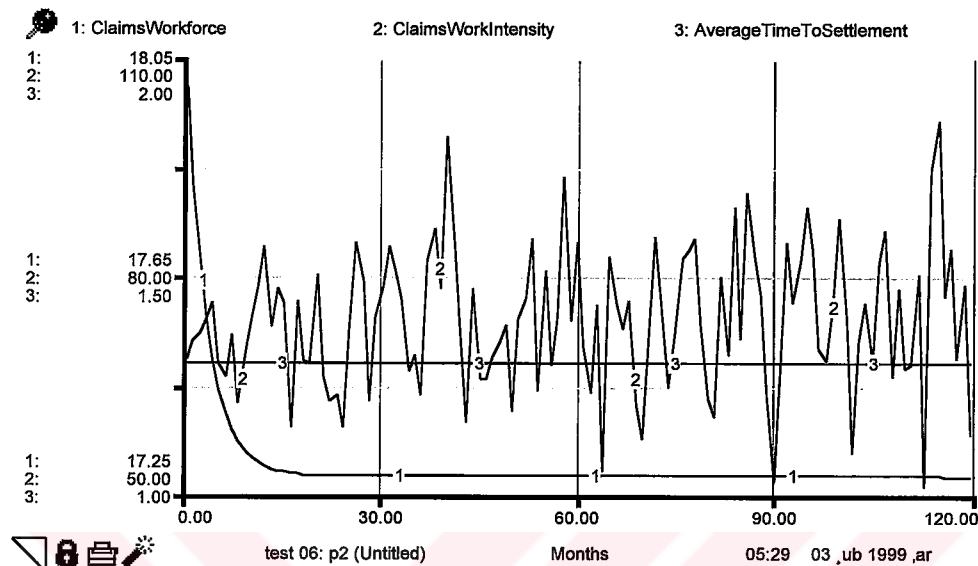


FIGURE 5.3.2. The Behaviors of Work Intensity Measures during the isolated run of the Claims Department

A wide range of conditions, both extreme and normal, and different simulation horizons were used during the isolated simulation runs. Extensive isolated runs of all sectors are not included in this thesis, as it would occupy too much space. The behaviors of the variables within the isolated sector were examined and irrelevant behaviors were traced back in order to correct the wrong causal or mathematical relationships. The equivalence of units on both sides of the equations that define the variables were checked in order to eliminate the mistakes that might be done in the equations. After all sectors were verified, the causal relationships that link the sectors to each other were verified by running the whole model under different conditions with different simulation horizons. The units equivalence check was repeated for the model as a whole and the verification tests about the model were completed.

5.4. Extreme Condition Tests

The first set of tests that were done in order to validate the model were extreme condition tests. Extreme condition tests are based on the idea that the behaviors of a given model are far more predictable under extreme conditions than they are under normal conditions. Extreme condition tests are done by setting a certain variable to an extremely high or extremely low value and examining the behavior of key variables after simulating the model. The extreme value of the chosen variable implies extreme behaviors by other variables. If the behaviors of one or more key variables are not as they are expected to be, the hypothesis that the model is valid is rejected and the model is revised in order to correct the errors. Otherwise, i.e., if the behaviors of all the key variables are as they were expected to be, the hypothesis can not be rejected. This can be explained better by giving an example: Assume that we set the number of the agencies to zero in the presented model. We expect the underwritten policies by the agencies and the agency per workforce ratios to become zero, and the created policies consist of the renewals and the direct underwritten policies by the sales force of the company only. If one or more of these variables are not equal to the expected values, we reject the hypothesis that the model is valid. If all these variables and the other variables we examine have the values or exhibit the behaviors we expected, we conclude that the hypothesis can not be rejected at that step and go on to other extreme condition tests.

In order to determine the length of the extreme condition simulation runs, bankruptcy is defined: The company goes bankrupt if the absolute value of the negative cash position exceed the average yearly net premium revenues or the policy or claims work force are reduced to zero.

Numerous extreme condition simulation runs were done on the model presented in this study. The results of a selection of these simulation runs are presented in the following sections.

5.4.1. No Work Force

The model is simulated for 20 periods (months) after setting the number of policy and claims work force to zero. The agencies are quitting because of getting no service. The number of agencies becomes zero at time $t=12$. The new underwriting share becomes zero at the same time as no new policies can be underwritten without any agency and any sales force. Furthermore, the number of pending claims increases steadily because no claims work force handles the claims. The cash position becomes negative at time $t=15$. The number of active policies (In Force Policy), the yearly and quarterly market shares, the total and underwriting profits, the premiums decrease, as expected. (Figure B.1.1.1-B.1.1.3).

5.4.2. No Agency

Another extreme condition is having no agencies. The agency per workforce ratio and underwriting by agencies become zero. The company underwrites policies only by the direct sales force and the renewals made by the head office. The loss ratio increases because of decreasing policy underwriting. The cash position becomes negative because of negative total and underwriting profits. The number of active and created policies, the yearly and quarterly market shares and the new underwriting share converge to zero. All these were expected behavior patterns. (Figure B.1.2.1-B.1.2.3).

5.4.3. No Auto Sales

The model is simulated for 48 periods (months) under the condition that the new auto sales is equal to zero. As expected, the underwriting by agencies becomes zero, as there is no new property to insure in the market. The policies are underwritten only by the renewals made in the head office by the direct sales force. The number of active and created policies converge to zero. The total and underwriting profit become negative

because of decreasing underwriting, resulting in negative cash position. (Figure B.1.3.1-B.1.3.2).

5.4.4. Strong Competitors

The model is simulated after setting the competitors policies fraction to 25.0, which is initially 2.50. That means, the competitors become ten times stronger than before. Under this condition the yearly and quarterly market shares converge very fast to one per cent without changing the current management strategies (agency, work force, price and marketing). The agencies and the work force run away from the company which becomes gradually weaker in the market. As a result the number of active policies decrease causing to the initially stagnation and later decrease of the premiums though the steadily growing of the market. The quitting of the policy work force causes to increase of the policy work intensity which results in diminishing of the underwriting quality and increasing of the claim payments. Consequentially, the loss ratio increases and the cash position worsens, as expected. (Figure B.1.4.1-B.1.4.3).

5.4.5. Weak Competitors

Another extreme run is made after setting the competitors policies fraction to 1.25, which is initially 2.50. That means, the competitors become two times weaker than before. Under this condition the company exhibits a typical uncontrolled growth dynamic. The yearly and quarterly market shares increase without changing the current management strategies (agency, work force, price and marketing). The company becomes attractive for agencies. Therefore many agencies apply and are opened. This increases the number of active policies and the amount of premiums. Simultaneously the work intensity in the policy department is increased, as well, because of increasing number of active policies and agencies, since the current work force strategy is insufficient. The increasing work intensity results in diminishing of the underwriting quality and increasing of the claim payments. Thus, the loss ratio increases and the cash position worsens. Furthermore, the

increasing number of claims causes to increase of the claims work intensity, which protracts the settlement time. This lessens the attractiveness of the company for the agencies, and so the agencies leave. Consequently, the cash position worsens more, as expected. (Figure B.1.5.1-B.1.5.3).

5.4.6. Raising the Policy Price

The model is simulated for 120 periods (months) after raising the policy price from US\$ 500 up to US\$ 800 at time $t=24$. This steep increase in policy price causes to a rapid decrease in the total market effect which results in quick decreasing of underwriting productivity of agencies. Thus the underwriting by agencies, renewals and the number of active policies decrease too. Because of the one month information delay in perceiving of the price increase by the competitors, the before mentioned decrease in underwriting takes place one month later. Therefore, the premiums increase in the first month of the price increase, but decrease sharply thereafter. The market share exhibits the same behavior as the premiums. Under the condition that the average policy price in market smoothes the policy price quarterly, the loss in productivity is recovered approximately in two years. Lastly, the loss ratio decreases and approaches to a less value than before because of the lowering effect of the high prices, as expected. (Figure B.1.6.1-B.1.6.4).

5.4.7. Reducing the Policy Price

The model is simulated for 120 periods (months) after reducing the policy price from US\$ 500 down to US\$ 200 at time $t=24$. As expected, the underwriting productivity of agencies exhibits a steep increase. Thus, the underwriting by agencies and the number of active policies increase too. The premiums decrease rapidly because of the steep decrease in policy price. The increase in underwriting does not recover the decrease in premiums because of the steep price reducing. The decrease of the market share is recovered approximately in three years because of the quarterly smoothing of the average policy price in market. (Figure B.1.7.1-B.1.7.4).

5.5. Base Run of the Model

The 'Base Run' of the model is the simulation run made under typical expected set of parameters and input values. This run is made to display the dynamic behavior of the model under such typical conditions.

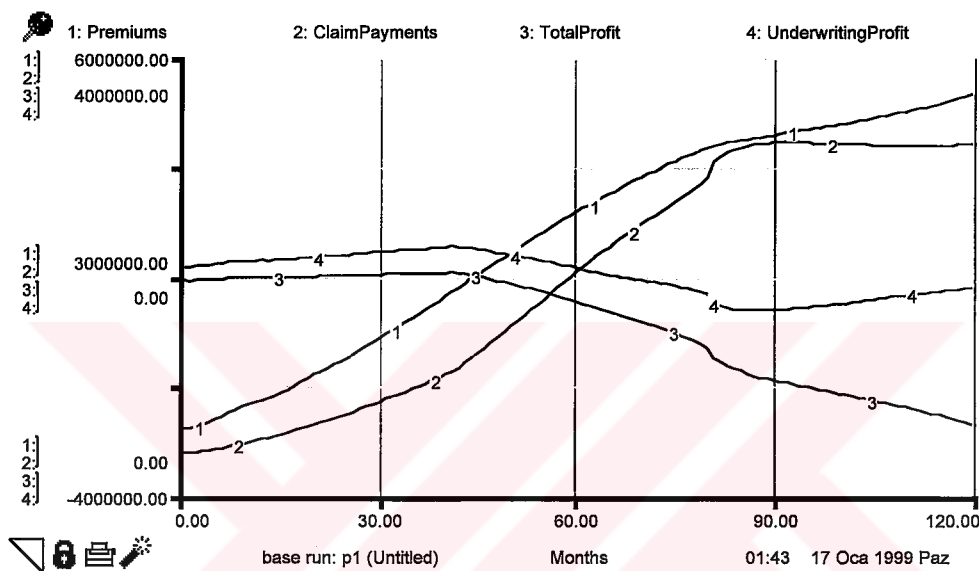


FIGURE 5.5.1. The Dynamic Behavior of Financial Measures in the Base Run

The basic dynamic of the company is a growth till about the time $t=80$, and a stagnation in the following months. Base dynamic behaviors of some important variables are shown in Figure 5.5.1-5.5.6. The market share exhibits the behavior described before. Because of the increasing market share, the company becomes attractive for the agencies. Thus, agencies apply and are opened. As a result of this, the premiums and the number of created and active policies increase. Simultaneously, the work intensity in the policy department increases because of the increasing number of active policies and agencies. The increasing policy work intensity causes the deterioration of the quality of the underwritten policies. Thus, the number of the claims increases too. This increase results in an another increase in the amount of the claim payments, which diminishes the profit and makes it negative consequently.

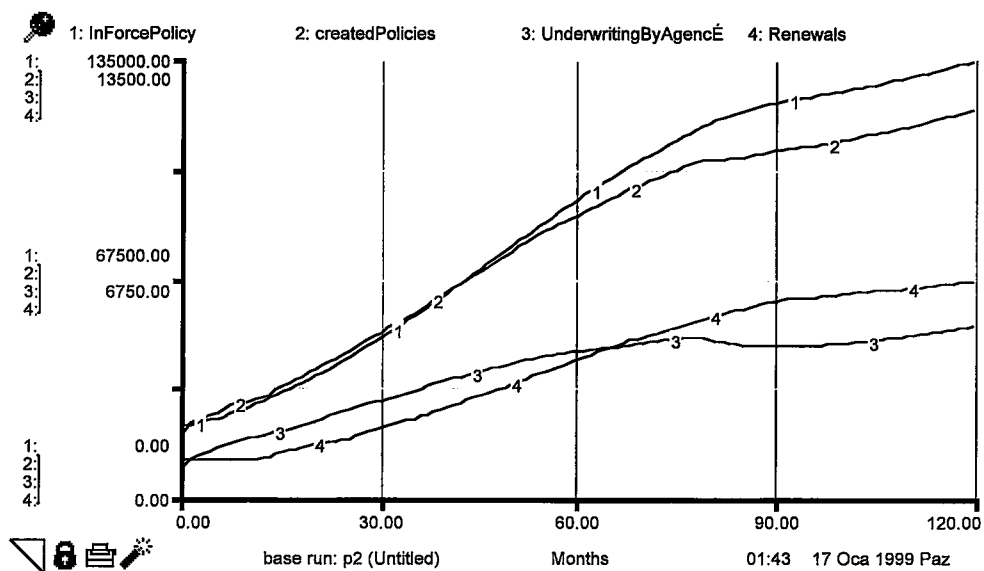


FIGURE 5.5.2. The Dynamic Behavior of Technical (Policy) Measures in the Base Run

Furthermore, the policy work intensity make the agencies unhappy, since the service quality that the company provides for the agencies deteriorates, too. So the company loses its attractiveness for the agencies. Besides some of the agencies quit working with the company, no more new agencies apply to work it. This point forward the market share stagnates and the rate of increase of premiums, of the active policies and of the created policies decreases. Even the policy and claim work intensities decrease. Consequently, the number and amount of the claims stagnate.

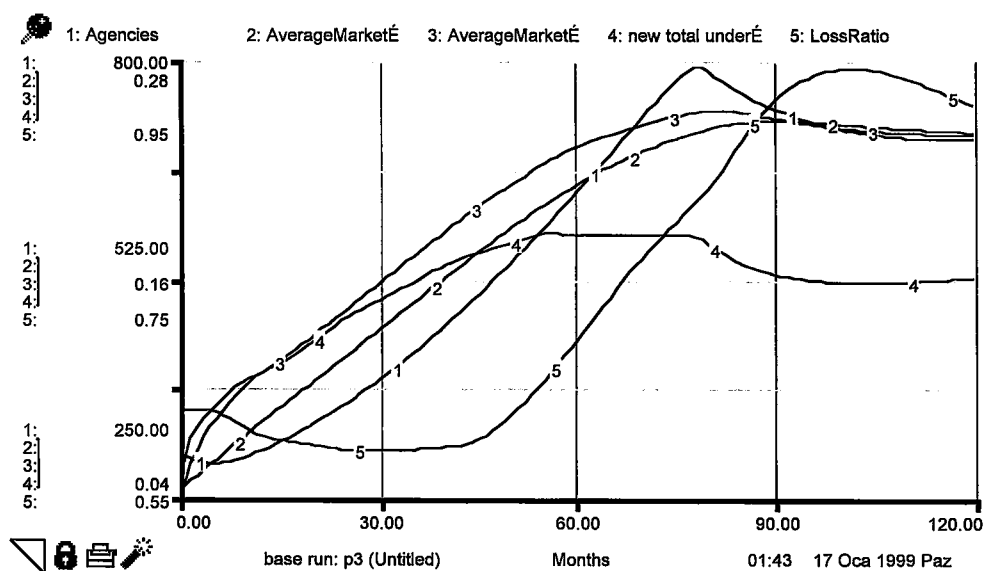


FIGURE 5.5.3. The Dynamic Behavior of Market Measures in the Base Run

The policy production depends heavily on agencies. Till about the time=70 the new underwritten policies are more than the renewed policies. This point forward, the share of the renewals in the portfolio exceeds the share of the new underwritten policies.

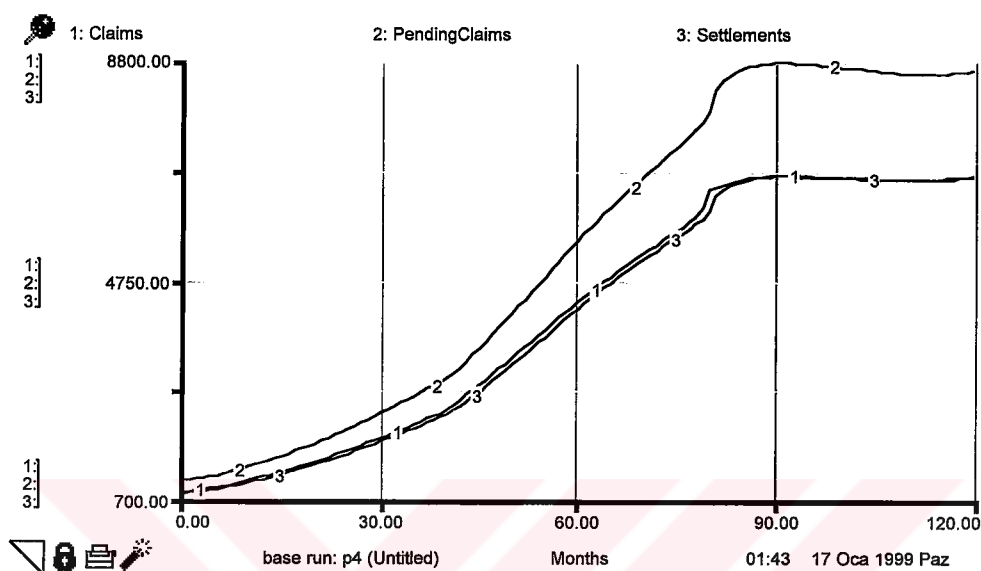


FIGURE 5.5.4. The Dynamic Behavior of Technical (Claims) Measures in the Base Run

The increase of the number of the claims increased the claims work intensity too, which causes a slight increase in settlement time for a short period. Also this is helpful by making the agencies unhappy.

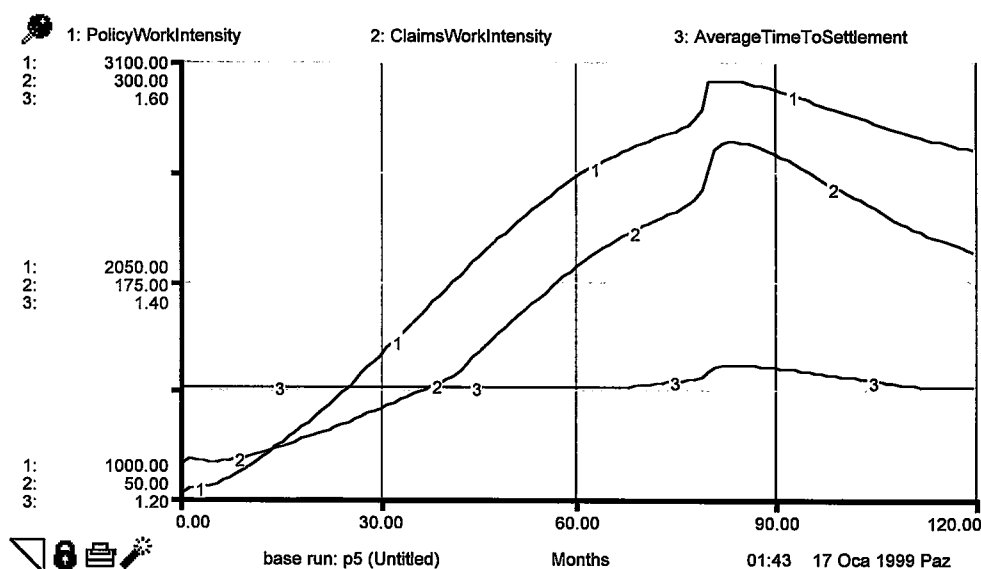


FIGURE 5.5.5. The Dynamic Behavior of Work Intensity Measures in the Base Run

5.6. Behavior Validation of the Model

After structural validation tests are completed the behavior of the model is compared with the data from Halk Sigorta Insurance Company. The monthly results of the model are converted in the yearly format since the most of the data received from Halk Sigorta Insurance Company is in the yearly format.

An exact matching between real data and model data points is not required for validating the model, because System Dynamics model is not designed to include the internal and external details and random factors that are needed in short term forecasting (Barlas, 1989). The purpose of a system dynamics model is to generate the broad dynamic behavior patterns of the system, in the long term. Thus, what is required is the matching of the major patterns of behavior of the model and real system, rather than individual data points (Diker, 1995). Furthermore, the model built in this study is not specifically built to predict the performance of Halk Sigorta Insurance Company. The model was deliberately simplified so as to obtain a generalized structure that could be formed into a generic interactive insurance management simulator. (A model making too much use of Halk Sigorta specifics would be a much better predictor of Halk Sigorta, but it would be of little value as a generic insurance management game.)

All the data about Halk Sigorta Insurance Company that could be used for behavior validation are compared with the behavior of the model and a broad pattern resemblance between the model behavior and the behavior of the real system, is obtained. That means, the basic variables such as premiums, active and underwritten policies, claims and the loss ratio in the model exhibit very similar behavior patterns as in the real life. Furthermore the mentioned variables from the model operate approximately in the same ranges as their equivalencies in the real data. Thus, it is concluded that the model is behaviorally acceptable (Figure B.2.1.1-B.2.5.2).

6. THE INTERACTIVE SIMULATION GAME DESIGN

6.1. Introduction

The interactive dynamic system simulation game based on the model presented in this study is designed to make users experience the interaction of the strategic management functions in an insurance company which has market growth goal. The software used for developing the game interface is the same as the software used to build the model, that is, Stella. The recent versions of the Stella has efficient and suitable features for interactive simulation.

For the purpose of making the work force hiring firing decision (policy work force hiring firing decision as well as claims work force hiring firing decision) a variable of user input, the hiring and firing rates are separated. Control converters are used to stop the game in the case of dropping of the work force down to zero level. The training policy work force and the training claims work force stocks are added. Once the work force is hired they accumulate into the training (inexperienced) work force and become experienced ones in four months. The firing can be done from the experienced work force.

For the purpose of making the agency opening closing decision a variable of user input, a control converter named “AppOpnClosDecControl” is added. This converter prevents hiring of agencies more than in the applying agency pool and firing of all current agencies by the player.

The average policy price in market converter is converted into an information delay structure so that any difference in the policy price will be followed by the competitors. The

smoothing time in the case of an increase in the policy price is 18 months. The smoothing time in the case of a decrease in the policy price is 6 months.

Similarly, the competitor's average marketing expenditures ratio converter is converted into an information delay structure with a smoothing time of 12 months. Thus, any change in the marketing expenditures ratio will be perceived approximately in one year by the competitors.

The average number of competing companies in sector was a constant value in the model. This converter is converted into a decreasing graphical lookup function of the yearly average market share (Figure 6.1.1). That means, by increasing the market share, the competitors are eliminated.

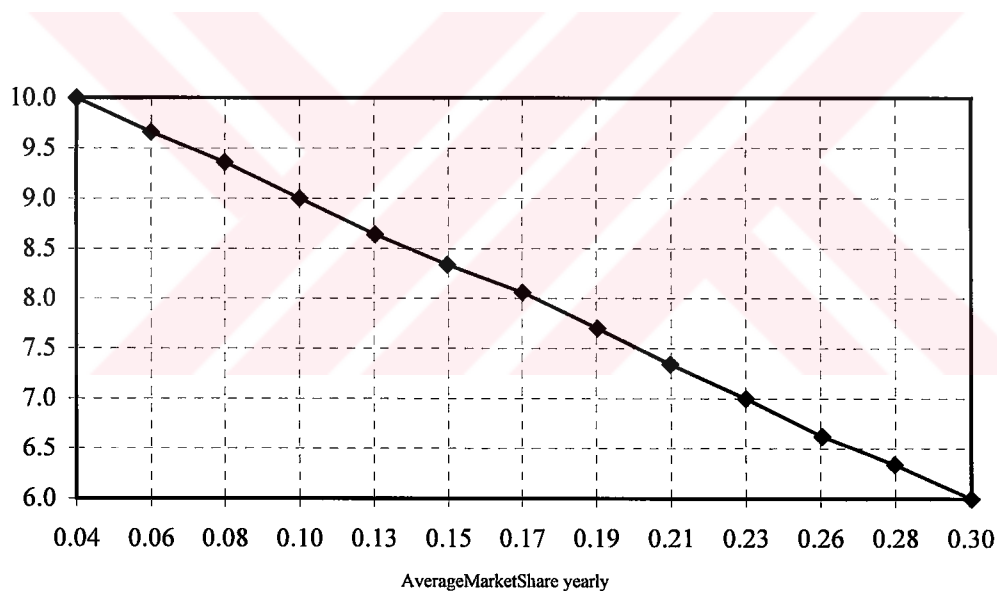


FIGURE 6.1.1. The Average Number of Competing Companies in Sector

The efficiency effect on agency opening & closing decision (Figure 4.2.3.3) was used to embed the role of a decision-maker into the model. In the game version of the model, the player is to able to trace out the efficiency of the agencies via graphs, tables and other output devices. Thus in existence of a player, the efficiency effect is removed.

In order to handle the case of negative cash, i.e. going to bankruptcy, the cash premium index is defined. This index controls whether the average yearly net premium

revenues cover the negative cash position. That means, the company goes bankrupt (the game is over) if the absolute value of the negative cash exceeds the average yearly net premium income. The cash premium index is calculated by dividing the absolute value of the negative cash by the average yearly net premium income (Equation 6.1).

$$\text{CashPremiumIndex} = (-\text{Cash}) / (12 * \text{SMTH1}(\text{NetPremiums}, 12)) \quad (6.1)$$

The running away behavior of the agencies and employees from a company, which will go bankrupt soon, is modeled through the cash index effect. The cash index effect is modeled as a graphical function of the cash premium index (Figure 6.1.2). This effect influences the quitting fraction of the agencies, the quitting fraction of the policy and claims work force and the maximum applying agency pool.

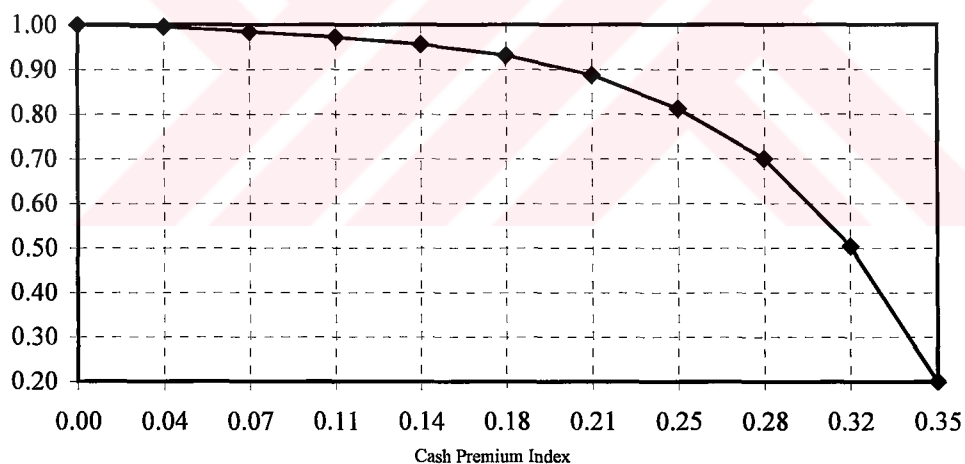


FIGURE 6.1.2. The Cash Index Effect

The shape of the effect graph is adapted according to the assumed causality behind the running away behavior of the agencies and employees from a company, which will go bankrupt soon. Many experiments were done changing the slopes and the ranges of the effect graph in order to “fine tune” the model. The slopes and the ranges which provide the most realistic behavior patterns in the sensitivity runs were chosen.

The average commission rate in market and the average salary in market converters contain constant values, which differ from the relevant initial values of the company, in the model. In the game version, the adjuster converters for the mentioned market variables are added which equalize the market variables to the relevant variables of the company initially without disturbing the underlying effects.

Two converters for two growth dynamics for the new auto sales representing the properties to be insured, which determine the market of the insurance sector, are added. One of these exhibits a steeper linear growth dynamic representing a fast growth of the sector. The other shows a flatter linear growth dynamic representing a mild growth of the sector. These converters enable to conduct different scenario analyses.

6.2. Game Description

The player plays the part of a company policy-maker, who is trying to seek a delicate balance among the main functions of the company. The decisions made by the player are:

(A) Policy Price : The company earn premiums by selling policies. The player decides the price charged for an average policy.

(B) Agency Opening & Closing : Policies are sold by agencies. The player decides how many agencies to close or how many new agencies to open per quarter.

(C) Policy Workforce Hiring & Firing : These are the company employees in charge with handling all the policies, assisting the agencies or directly selling new policies.

(D) Claim Workforce Hiring & Firing : When some of the active policies incur losses, the policyholders submit “claims”. These loss-claim applications are handled by the claims department of the company.

(E) Marketing Expenditures Ratio : This involves advertising and other similar means to attract new customers. The player decides what fraction of premium revenues will be spent for marketing.

The primary goal is to increase and sustain the market share. Secondly, the cash position should be increased. The challenge is to achieve these goals simultaneously, since increasing the market share is more difficult than gaining money in a growing market in long-term.

The game is designed as a series of screens, which are combined to each other. The opening screen displays the title of the game and the main menu items, which are listed as follows:

- (A) Game / Control Panel
- (B) Information about the model
- (C) Information about the controls
- (D) Exit from game

The main screens are described below.

6.2.1. Game / Control Panel Screen

After the “Game / Control Panel” button is pressed the main game screen appears (Figure 6.2.1.1). On the top left corner of the screen are two information buttons, which let the player to reach brief instructions about the game and the decisions during the game when they are pressed.

On the bottom left corner of the screen, the game controls are displayed. The game is initiated by pressing the Start button in the New Game frame that is displayed at the bottom left corner of the screen.

On the left side of the screen, the Decision Sliders are displayed. The player enters his decisions by dragging the slider knob to the left or right using the cursor or by entering in the small box below the slider knob. After the decisions are made, the Advance button should be pressed. When this button is pressed the simulation advances one quarter (three

months) and the new values of the variables are calculated. The simulation will pause automatically every quarter to let the player change his decision settings and review data. Pressing the Record of Decisions button on the top of the screen enables the player to examine the history of the decisions in a graphical and tabular format.

Once a decision value is changed from its original value, a “U” appears at the bottom-left corner of the slider. Clicking on it will reset the value to sliders original value. Clicking on the “?” buttons on the sliders enables the player to reach more information about the associated decision variable.

The ~ buttons on the workforce decision sliders toggle the sliders on and off “auto-pilot”. Clicking on the ~ button activates the "auto-pilot". If the slider is left on "auto-pilot" workforce will be automatically hired and fired to try to save the current workforce level. The player can override that and choose to hire or fire up to twenty workers.

The total duration will be 120 months, or 40 quarters, or 40 decision rounds, i.e. the simulation begins at January 1997 and ends at December 2007. The simulation time can be traced through the displays that are located on the top right corner of the screen. At any time, the player can quit the simulation by pressing the End Game button that is displayed at the bottom left corner of the screen.

The Reset Sliders button that is displayed at the bottom left corner of the screen initializes all five decision sliders to their original settings.

To start a new game the player should first terminate the current game pressing the End Game button. Next, the model should be initialized to its original setting pressing the Reset button in the New Game frame. Then a new game can be started pressing the Start button in the same frame. Between two sequential games the model must be “Reset” first! Otherwise the Start button would not work properly.

On the right side of the screen, the main indicators of the model (performance and market measures) are displayed in order to give the player feedback about the values and

graphical output of the major variables in the model. Pressing the “Graph” buttons on the right or bottom of the displayed values of any variable, the dynamic behavior pattern of that variable can be displayed. On the right side of the indicators, three main indicators are displayed as warning devices, for which three distinct zones are set - normal, caution, panic. As the value of the variable passes through these zones, the warning device displays the color associated with that zone – green, yellow and red, respectively. The More Variables button will turn the page to display some more indicators (Figure 6.2.1.2). Pressing the “?” buttons on the left of the variables, brief descriptions of those variables can be displayed.

6.2.2. Model Overview Screen

‘See Model’ button that is displayed on the bottom of the screen executes the link to the ‘Model Overview Screen’ (Figure 6.2.2.1). The purpose of this screen is to give the player information about the interactions between the variables in the model.

This is a high-level overview of the model, which shows the sectors in the system and the physical (thick arrows) and information (thin arrows) flows between them.

Clicking on the lower portion of the corresponding sector frame takes the player to the modeling layer and enables him to trace out the model for a particular sector one at a time. Clicking on the dots would reveal the model structure. To return back to the high-level map, the upward-pointing triangle in the left-hand margin of the window should be clicked.

The whole sector at a snapshot can be viewed by clicking the downward pointing triangle at the top right corner of the sector frame. The player can return to the high-level map by pressing the Back buttons, which are displayed on the modeling layer. The Control Panel button on the bottom of the screen takes the player back to the main game screen.

6.2.3. Varying the Scenario Screen

Vary Scenario button that is displayed on the bottom of the screen executes the link to the screen where the variables that define the major market conditions and the internal and external relations / interactions of the company are listed (Figure 6.2.3.1). Varying these variables in different combinations lets the player to play the game under different market conditions.

To change the predefined conditions the player should push one of the 'Market Growth' buttons and/or move the dials on the knobs. If the value of a condition variable is changed, a small "U" button appears in the lower left corner. To restore the knob to its original value, the "U" button should be clicked once on. The condition variables are explained briefly in this screen. Clicking once on the question mark (?) button in the upper left corner of the knob enables the player to reach more information about the associated condition variable.

These conditions can not be changed during the game but "Varying the Scenario Screen" can be visited to check what the conditions are.

6.2.4. General Information About the Model Screen

Clicking on the 'Information about the model' button in the opening / main menu screen takes the player to the "General Information About the Model Screen" (Figure 6.2.4.1). The purpose of this screen is to give the player brief information about the model, hints and warnings.

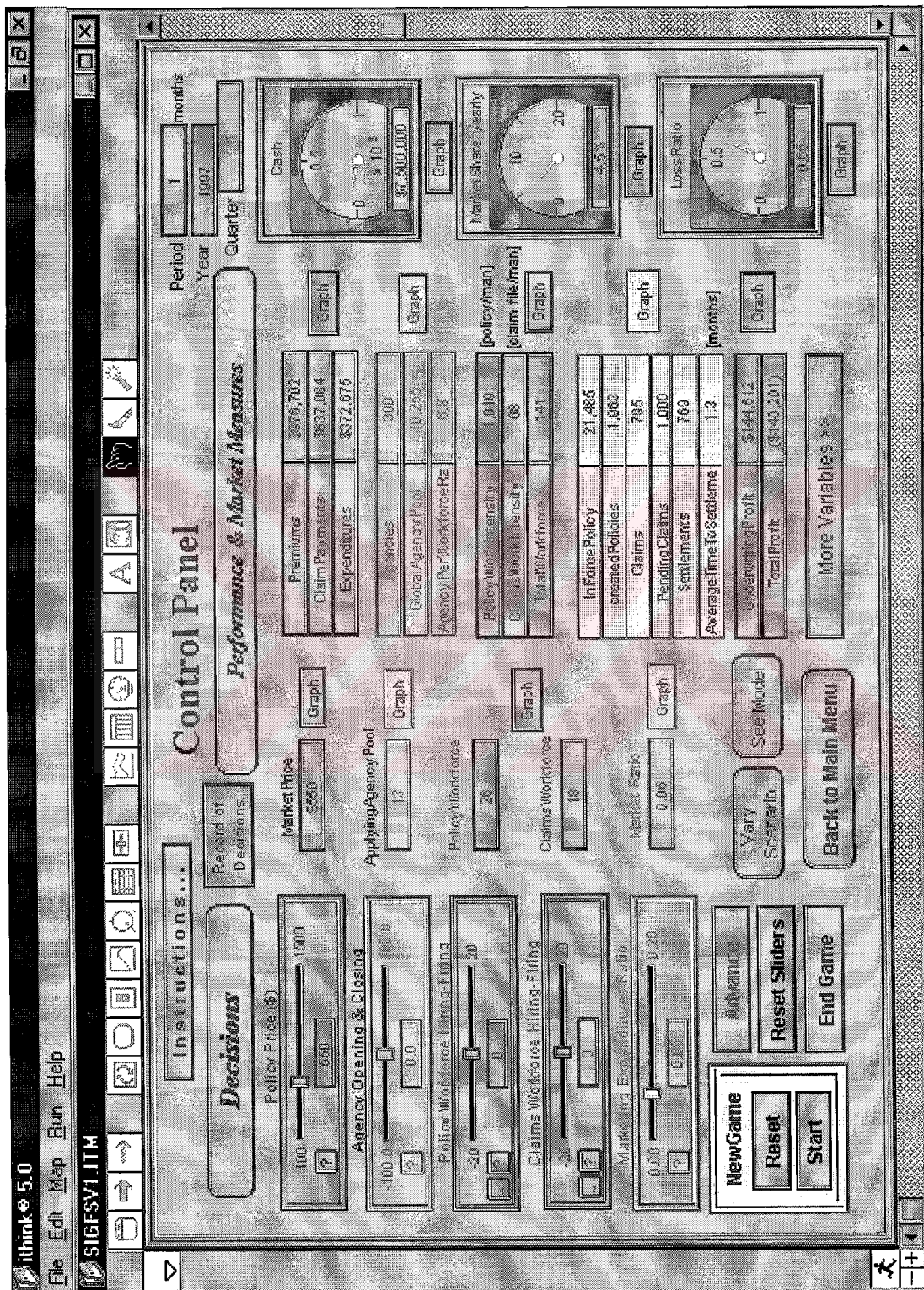


FIGURE 6.2.1.1. Game / Control Panel Screen

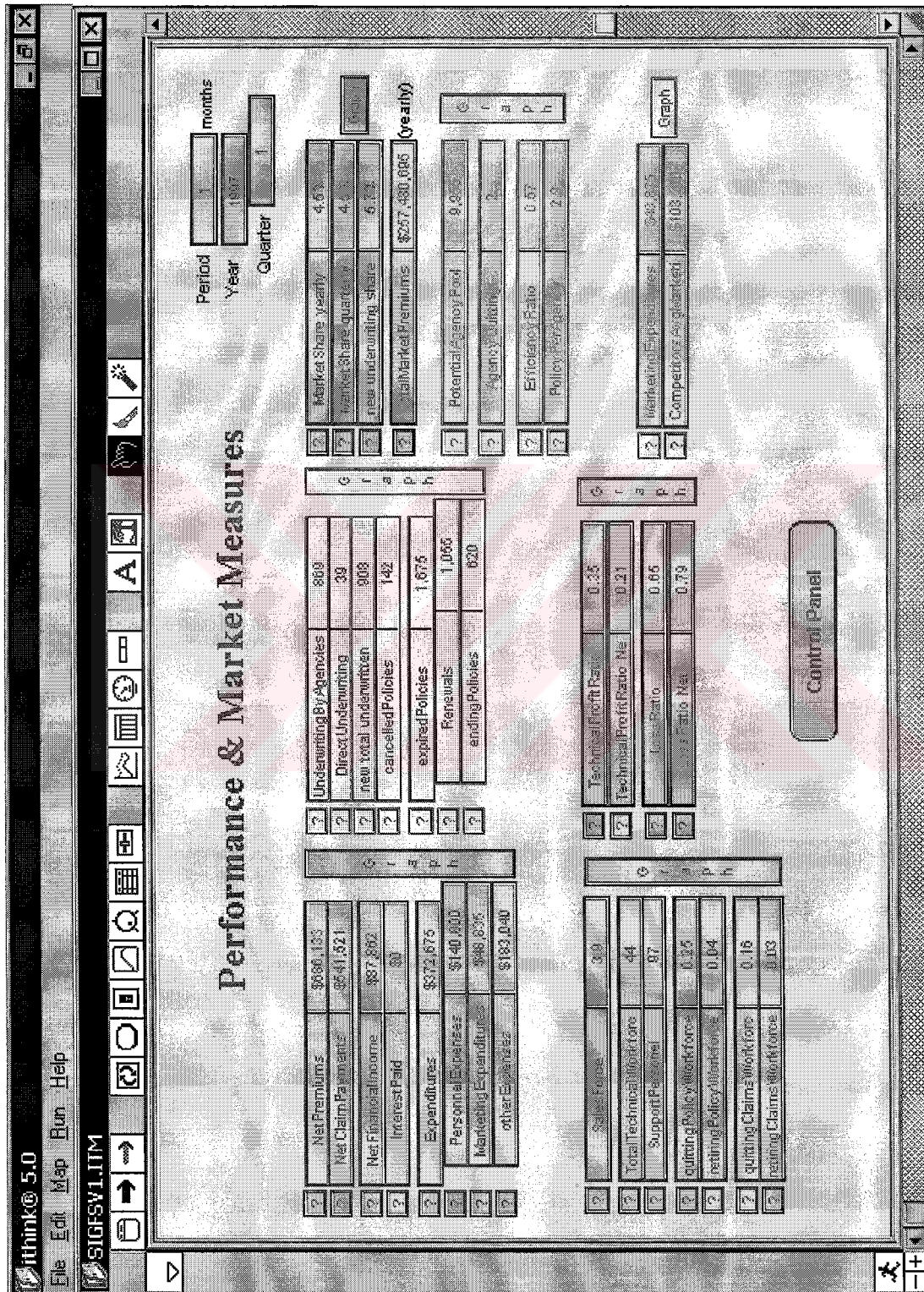


FIGURE 6.2.1.2. More Variables Screen

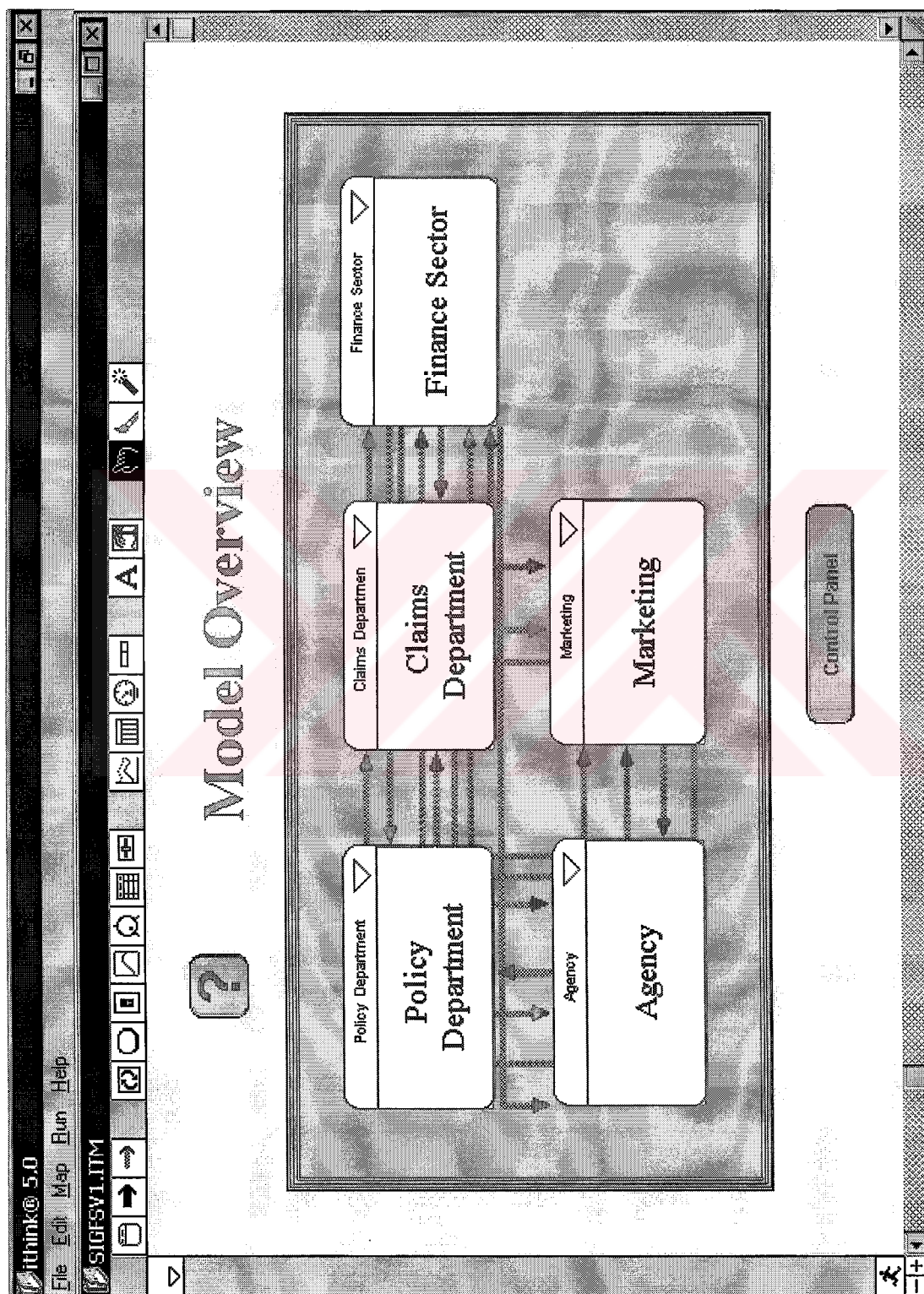


FIGURE 6.2.2.1. Model Overview Screen

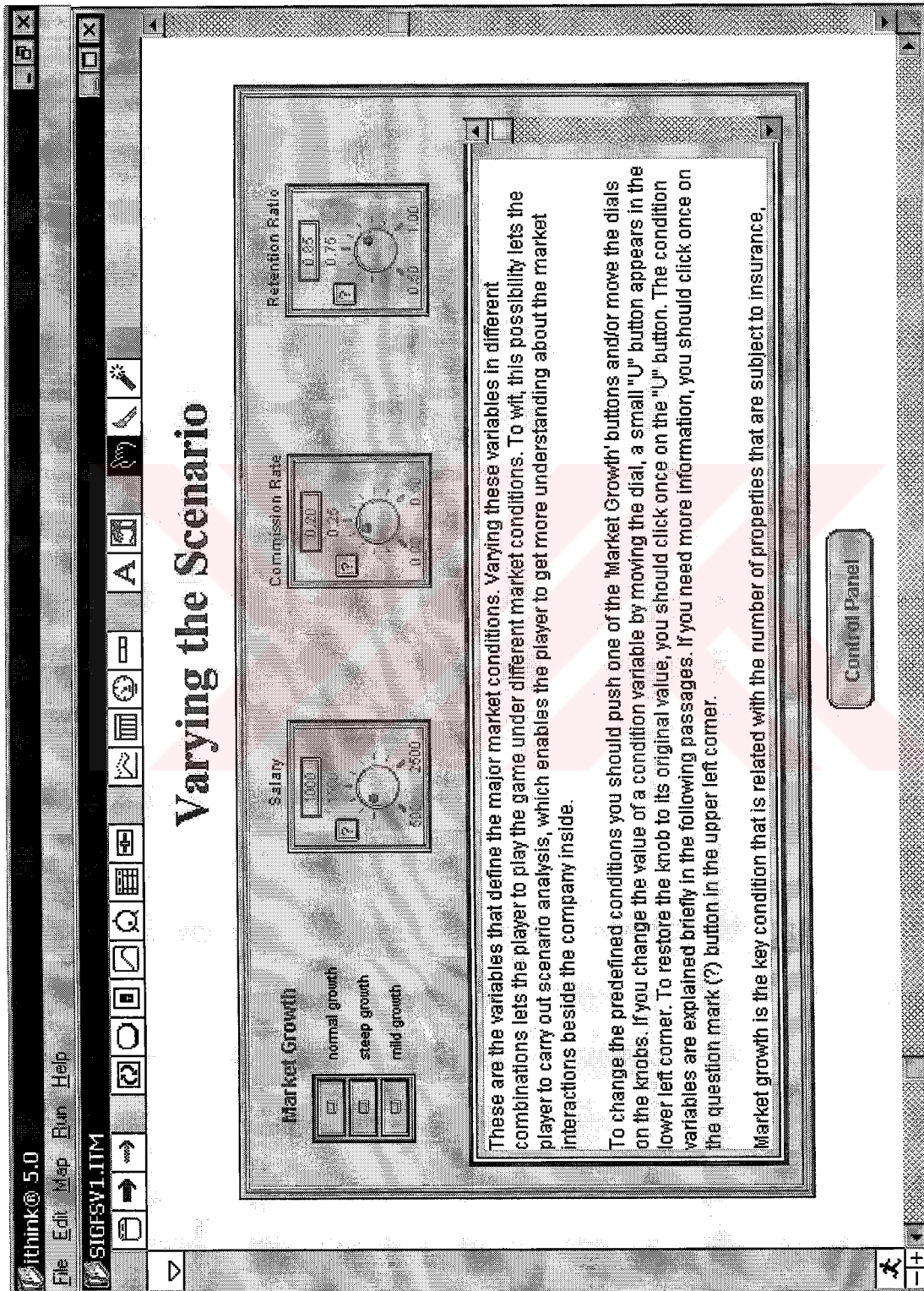


FIGURE 6.2.3.1. Varying the Scenario Screen

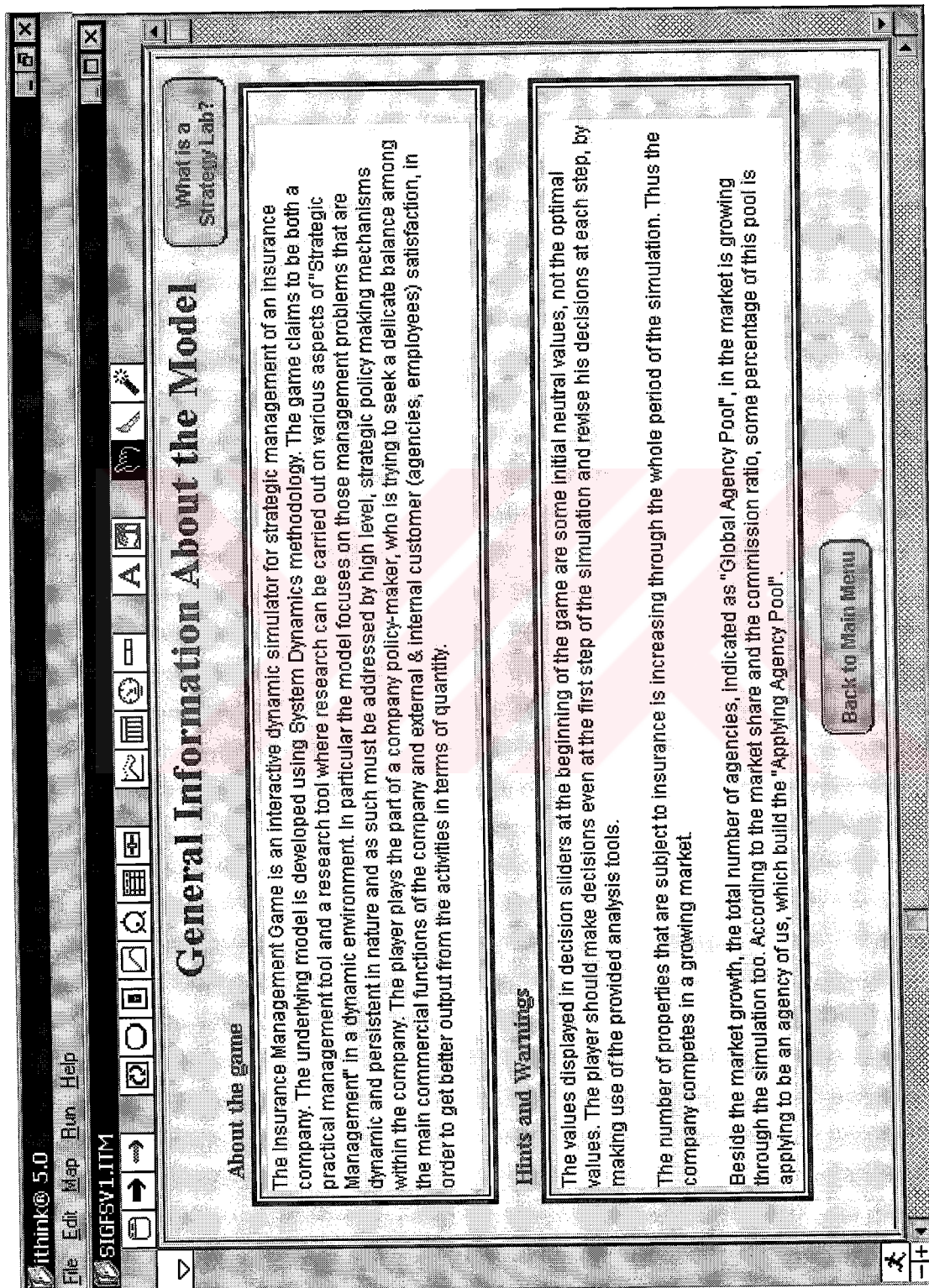


FIGURE 6.2.4.1. General Information About the Model Screen

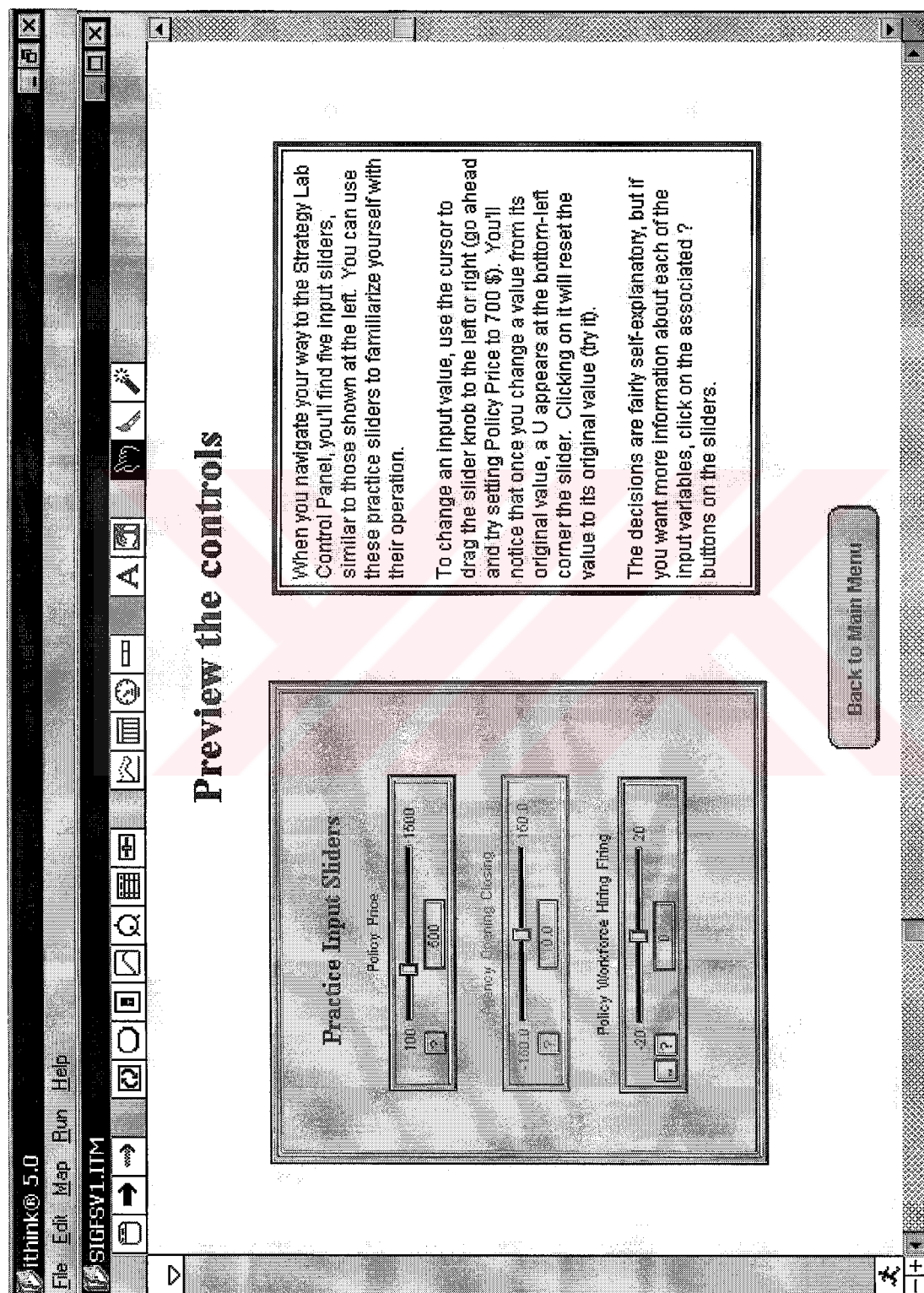


FIGURE 6.2.5.1. Preview the Controls Screen

6.2.5. Preview the Controls Screen

Clicking on the Information about the controls button in the opening / main menu screen takes the player to the “Preview the Controls Screen” (Figure 6.2.5.1). The purpose of this screen is to give the player general information about the use of the sliders.

6.2.6. Exit From Game Screens

Clicking on the Exit from game button starts the leaving the game procedure. Before exiting the game, the player will be asked to save the game results in a file. If the player choose to save the game results, he will be asked to enter a name for the file, which will keep the data of the current game results. It must have the extension .stm in Windows environment.

6.3. More About the Game

The values displayed in decision sliders at the beginning of the game are some initial neutral values, not the optimal values. The player should make decisions even at the first step of the simulation and revise his decisions at each step, by making use of the provided analysis tools.

The total potential market for insurance is increasing through the whole period of the simulation. Thus the company competes in a growing market.

The total number of agencies, indicated as “Global Agency Pool”, in the market is growing through the simulation too. According to the market share and the commission

ratio, some percentage of this pool is applying to be an agency of the company, which build the “Applying Agency Pool”.

The production depends heavily on the agencies. Therefore for an increase in policy production / market share, either the number of agencies or the productivity per agency should be increased.

Increasing the number of agencies is not easy. There exists an implicit threshold “agency/workforce” ratio. This ratio means that each agency not only sells policies, but she also constitutes a workload for the company (asking questions, visiting the company). If this implicit threshold is exceeded, the agencies basically create unnecessary workload.

In making the agency hiring decisions, the player should keep in mind the quitting agencies.

The productivity of an agency depends on many factors such as policy price, marketing activities, market saturation effect, commission effect and claims settlement time effect, besides its own quality.

In making the workforce hiring decisions, the player should keep in mind the workforce that is leaving (retiring or quitting). (The model automatically hires / fires two support personnel simultaneously with each technical employee hired / fired by the player.) The player should keep in mind, when a new employee is hired, it takes approximately four months before he becomes fully productive.

6.4. Scenario Analysis

There are four variables that define the major market conditions. Varying these variables (by clicking the ‘vary scenario’ button) in different combinations lets the player to play the game under different market conditions. To wit, this possibility lets the player

to carry out scenario analysis, which enables the player to get more understanding about the market interactions. These four variables are :

(A) Market growth is the key condition that is related with the number of properties that are subject to insurance, which is increasing through the whole period of the simulation. The market growth rate can be varied: steep growth and mild growth. If the 'steep growth' is chosen, the player competes in a fast growing market. That means, the number of properties (autos / cars) that are released to the market in unit time is more than in 'normal growth'. If the 'mild growth' is chosen, the player competes in a slow growing market. That means, the number of properties (autos / cars) that are released to the market in unit time is less than in 'normal growth'.

(B) Salary is the average monthly salary paid to an employee in \$. An increase in salary would make the company more popular for the employees. A higher salary would decrease the turnover rate of the employees. On the other hand it would increase the personnel expenses. There is a delicate balance to seek among them.

(C) Commission rate is the rate of premiums paid to the agencies as commissions in per cent. An increase in commission rate would make the company more popular for the agencies. A higher commission rate would increase the productivity of the agencies. On the other hand it would decrease the commissions paid to the agencies, i.e. the premiums retained in the company would be decreased. There is a delicate balance to seek among them.

(D) Retention ratio is the rate of premiums retained in the company in per cent. That means retention ratio subtracted from one is the rate of premiums transferred to reinsurance companies. A higher retention ratio increases the premiums retained in the company. But at the same time, it increases the share of the company on the claim payment. That means, a higher retention ratio increases the net premiums and the net claim payments simultaneously. There is a delicate balance to seek.

All these condition variables are defining the internal and external relations / interactions of the company.

6.5. Verification and Validation of the Game

A series of verification and validation tests were done on the interactive simulation game. The four components of the total market effect (See Chapter 4.5.4) were removed in all single, double and triple combinations. In this way, the behaviors of the variables under the single, double and triple combinations of all market effects were examined. Furthermore, the five sectors that form the game were simulated one by one, isolated from the other sectors, as in the verification process of the model. This time, the sectors were also simulated in double and triple combinations within different simulation horizons. The behaviors of the variables in the isolated sector runs were examined in order to catch any irrelevant patterns. Moreover, the game was run by varying only one of the decision variables for each of them separately in order to test whether it was possible to sustain growth by focusing on only one decision criteria. No growth was possible by focusing on only one or two or three or even four decision variables. Finally, the game was run under different market conditions such as fast growing market, slow growing market, etc. By achieving meaningful results after these several tests, the game was verified.

The behavior of the variables in case of extreme player decisions were tested and several sensitivity tests were done. The necessary improvements both in the model and the game were made according to the results of these tests. The resulting game is believed to be a robust and valid interactive simulation environment.

6.6. Game Results

A group of players with different academic degrees and different orientations were invited to play the game. Among the players were graduate assistants, faculty members and professionals from the insurance companies. Each of these players applied different strategies and produced different output behaviors. Some players aimed to improve the financial position no matter how bad the market share was, while some of the players tried

to raise the market share without considering the financial measures. Some results are presented below for illustration.

6.6.1. The Performance of Player 1

The first player is a professional from an insurance company who has aimed to improve the financial position no matter how low the market share was.

During the game, he raised the policy price gradually up to US\$ 1100 (Figure C.1.1.1). In order to compensate the negative effect of the price increase on the underwriting productivity he increased the marketing expenditures gradually (Figure C.1.1.5) after the first two and a half years in which the cash balance of the company was poor (Figure C.1.2.1 & Figure C.1.2.3). He saved the initial policy work force level through hiring one or two personnel every quarter (Figure C.1.1.3 & Figure C.1.2.11). Through the same personnel strategy he increased the claims work force level a little bit (Figure C.1.1.4 & Figure C.1.2.11). He also kept the number of agencies at the initial level (Figure C.1.1.2 & Figure C.1.2.10). Because of the lowering effect of high prices the loss ratio decreased (Figure C.1.2.5). Though the price increase, the number of the active policies increases because of the increase of the marketing expenditures (Figure C.1.2.6). After the second year the slope of the cash position became greater than zero resulting in an improvement of cash balance (Figure C.1.2.1 & Figure C.1.2.3). Though the market growth and the growth of active policies, the market share of the company stagnated and decreased towards to the end of the simulation because of the fast price raising strategy and the constant agency policy (Figure C.1.2.4 & Figure C.1.2.7).

6.6.2. The Performance of Player 2

The second player is a graduate assistant who has aimed to improve the financial position as well as the market share as it should be. After he bankrupted in his first two games, he was able to improve the financial position and to increase the market share

simultaneously in his fourth game which is taken under detailed examination in the following passages.

Initially he raised the policy price up to US\$ 1000 (Figure C.2.1.1). As a consequence, the cash position worsened immediately. The market share, the number of active policies, the premiums decreased too (Figure C.2.2.2 & Figure C.2.2.4 & Figure C.2.2.6). Because of the arising poor cash balance he decreased the marketing expenditures (Figure C.2.1.5) which contributed to the decrease of the underwriting efficiency. He opened all agencies applied every quarter (Figure C.2.1.2). In order to support the agencies he hired one or two policy personnel approximately every quarter after the recovery of the cash balance (Figure C.2.1.3). He applied the same personnel strategy to the claims personnel (Figure C.2.1.4). The increasing number of agencies caused to the increase of the underwritten policies which recovers the cash balance though the initial collapse. At the fourth year of the simulation the financial and technical measures approached to their initial values again. From that point on the active policies, the premiums, the market share and the profit continued to increase because of the increasing marketing expenditures and increasing number of agencies (Figure C.2.2.2 & Figure C.2.2.3 & Figure C.2.2.4 & Figure C.2.2.6). The loss ratio increased in the first years because of the initial collapse, but afterwards the lowering effect of the increasing policy price decreased the loss ratio (Figure C.2.2.5). Towards to the end of the simulation the number of claim files increased faster than the claims work force which increased the claims work intensity (Figure C.2.2.8). This protracted the settlement time which stopped the growth of the underwriting efficiency (Figure C.2.2.7). A stagnation in the market share and the number of active policies occurred.

6.6.3. The Performance of Player 3

The third player is a graduate assistant who tried to strike a balance between the financial improvement and the growth of market share. After he bankrupted in his first two games, he caught the balance in his third game.

He increased the marketing expenditures gradually by small steps (Figure C.3.1.5). He based his personnel hiring strategy on the policy and claim work intensities. If the policy work intensity exceeds 1600 policies/man, three to five employees are hired quarterly two or three quarters long (Figure C.3.1.3 & Figure C.3.2.8). If the claims work intensity exceeds 200 claim files/man, one or two employees are hired quarterly (Figure C.3.1.4 & Figure C.3.2.8). He tried to keep the number of agencies at the initial level by opening a portion of the applied agencies approximately every quarter (Figure C.3.1.2 & Figure C.3.2.10). He did not make radical changes in the policy price (Figure C.3.1.1). All these strategies applied resulted only in a marginal improvement of the cash position after the fourth year of the simulation. On the other hand they were insufficient to increase the market share from its initial level.

6.6.4. The Performance of Player 4

The fourth player is a professional from another insurance company who tried to strike a balance between the financial improvement and the growth of market share.

The policy and claims work intensities triggered her policy and claims work force hiring decisions like the player 3 (Figure C.4.1.3 & Figure C.4.1.4). Furthermore, she tried also to save the number of agencies at the beginning values like the player 3 (Figure C.4.1.2 & Figure C.4.2.10). The important difference between the decisions of player 3 and player 4 is that the marketing expenditures of the latter oscillated with high amplitudes (Figure C.4.1.5.), whereas those of the first increased gradually with a small slope. The uncontrolled behavior of the marketing expenditures obstructed the marginal improvement of the cash position, which was obtained by the player 3 (Figure C.4.2.1). Though the steady increase in the number of the active policies (Figure C.4.2.6) the market share stayed unchanged because of the growing of the market (Figure C.4.2.4).

6.6.5. The Performance of Player 5

The fifth player is a professional from an insurance company who tried also to seek a balance between the financial improvement and the growth of market share.

He increased the policy price and the marketing expenditures gradually from the start of the simulation (Figure C.5.1.1 & Figure C.5.1.5). He hired one policy employee and one claims employee quarterly (Figure C.5.1.3 & Figure C.5.1.4). As a result of this personnel strategy, he saved the initial policy work force level and increased the claims work force level a little bit (Figure C.5.2.11). He kept the number of agencies at the initial level (Figure C.5.1.2 & Figure C.5.2.10). Because of the lowering effect of high prices the loss ratio decreased (Figure C.5.2.5). Though the increasing marketing activities, the number of the active policies oscillated around 25,000 policies because of the price increase (Figure C.5.2.6). Consequently, although a marginal improvement in cash position was achieved by the player 5, the market share did not increase (Figure 5.2.1 & Figure 5.2.4).

6.6.6. The Performance of Player 6

The sixth player is a graduate assistant who has aimed to improve the financial position no matter how low the market share was, like the player 1. After he bankrupted in his two games, he was able to improve the cash position during all quarters of the simulation in his fourth game.

He increased the policy price gradually in reasonable steps (Figure C.6.1.1). To overcome the initial stagnation in the cash position, he fired policy and claims work force in the first year. After the recovery of the cash balance he based his personnel hiring strategy on the policy and claim work intensities (Figure 6.1.3 & Figure 6.1.4). His threshold values for employee hiring were 1400 policies/man for the policy work intensity and 200 claim files/man for the claims work intensity (Figure C.6.2.8). He also raised the

marketing expenditures after the recovery of the cash balance. His agency opening strategy prevented that the number of agencies became less than 200 (Figure C.6.1.2 & Figure 6.2.10). Because of the lowering effect of high prices the loss ratio decreased (Figure C.6.2.5). However, this combination of strategies were insufficient to increase the number of active policies and the market share in a growing market, although the cash position was improved (Figure C.6.2.1 & Figure C.6.2.4 & Figure C.6.2.6).



7. SUMMARY OBSERVATIONS

Analysis of the dynamic simulation model of an insurance company, its interactive game version and the game results of different players lead to some observations regarding the strategic management aspects of an insurance company.

The production of insurance companies depends heavily on the agencies. Therefore for an increase in policy production / market share, either the number of agencies or the productivity per agency should be increased. But only increasing the number of agencies is an insufficient policy for production / market share increase. There exists an implicit “agency/workforce” ratio. This ratio means that each agency not only sells policies, but she also constitutes a certain workload for the company, calling the company to ask questions, or visiting the company. If this implicit threshold is exceeded, the agencies basically create unnecessary workload. Furthermore, in such a case the agency would often not be able to find a contact person in the company to get answers to her questions and to carry out her business. Under this condition the agency would be unhappy and would tend to quit the company. Simultaneously, the work intensity increases, the employees become overloaded, which make them unhappy and they start to quitting too. Therefore, for a sustained growth, the number of agencies and the number of employees should be increased simultaneously, in harmony.

Increasing the productivity per agency would be another management goal for production increase. But it is not easy either, since the productivity of an agency depends on many factors such as policy price, advertisement, marketing and market saturation, besides his own quality. In order to overcome the market saturation, marketing and price reduction strategies should be implemented simultaneously, which may not be always profitable.

Another solution in real life would be to shift to a production less dependent on agencies, more on company’s own employees or other production tools such as “direct production” through telephone, ATM or Internet.

Raising the policy price in small increments affects the premium income positively, if this is supported by a simultaneous increase of advertising activities, since the customers notice the price increase with a certain information delay.

Reducing the policy price increases the productivity. However it does not always increase the over all premium production. The price reduction policy may not cover the decrease of the over all production because of the insufficiency of the demand elasticity.

In case of poor cash balance, decreasing the marketing expenditures instead of firing work force would give the company a better chance of survival. During a cash crisis, increasing the marketing expenditures percentage is ineffective in increasing advertisement, since these expenditures are given as a certain percentage of the premium revenues which are low during the cash crisis.

Substantial differences in the amount of marketing expenditures compared to the competitors affect the policy sales significantly. Otherwise the agency productivity is insensitive to the marketing activities.

The high work intensity in the policy department, in other words the insufficiency of the policy work force, causes the policy “quality” to drop, which results in an increase of the claim payments and the loss ratio. Therefore, the work intensity in the policy department should be kept under a certain level, if a growth policy is to be applied.

The high work intensity in the claims department, in other words the insufficiency of the claims work force, causes the protracting of the settlement time, which lessens the attractiveness of the company for the agencies and the customers. Therefore, the work intensity in the claims department should be kept under a certain level, if a growth policy is to be pursued.

8. CONCLUSION

The main objective of this research was to construct an interactive dynamic simulation model for strategic management of an insurance company. In order to construct such a simulation game, a system dynamics model of the strategic management aspects of an insurance company was built.

The system dynamics model was built using System Dynamics methodology and Stella software. The model was calibrated using data from Halk Sigorta Insurance Company and Turkish Insurance Supervisory Office. Numerous verification and validation tests were done on the model. The dynamic behavior patterns of the model were found to be consistent with the major historical time patterns obtained from Halk Sigorta Insurance Company. Based on the results of these tests, it was concluded that the model is structurally and behaviorally valid.

The interactive simulation game, based on the system dynamics model, was constructed using Stella Research software. This game version of the model was also verified and validated by a series of standard tests.

Players with different academic degrees, orientations and professions played the game and their game results were compared to explore the capabilities of the interactive gaming version of the model. The comparison of the game results of the players revealed that players with different orientations emphasized different performance measures. Furthermore, all the players out of the insurance sector bankrupted in their first games. Thereafter they achieved their targets in their later games, which indicates the educational capability of the constructed interactive simulation game. Thus, playing with the game and sustaining a healthy growth in the game is by no means a trivial task. The model has potential uses both as a laboratory for testing theories of strategic decision making and in the practice of scientific management education.

A summary result of the study is that, for sustaining a healthy growth of an insurance company, the number of the agencies and the employees should be increased simultaneously in coordination, while executing a consistent marketing strategy, and without neglecting the cash position.

There exist many interactive growth management games in the literature, but the one built in this research is the first one on insurance management. Furthermore, the game is more comprehensive than the most others, representing the interactions of five interactive decisions simultaneously. In addition, this is the first example of an interactive strategic management game built specifically using structure and data of a company from the Turkish service sector.

This research is one of the first in Turkey providing a scientific and analytical modeling of strategic management. The constructed interactive game is a reliable and realistic research and education platform concerning strategic management of an insurance company aiming to increase its market share in a growing market.

There are several possibilities of further research that can be done on the existing model and the gaming interface. The model can be extended to include more aspects of the strategic management in the company, such as other policy types, and in general more detailed representations of variables such as direct underwriting and factors included in the claims handling process. The gaming interface can be enhanced to include various new features, such as video and sound effects. It can also be formed into a network-based multi-player game. Finally, additional game results can further be analyzed for clues into the decision making behaviors of subjects.

APPENDIX A
MODEL EQUATIONS OF THE INTERACTIVE GAME



Agency Sector

```

Agencies(t) = Agencies(t - dt) + (AgencyOpening&Closing - AgencyQuitting)
* dt
INIT Agencies = 300 {agency}
AgencyOpening&Closing = IF AgencyOpening&ClosingDecision > 0 THEN
AgencyOpeningDecision
ELSE AgencyClosingDecision
{agency/month}
AgencyQuitting = Agencies * quitting_fraction {agency/month}
AgencyClosingDecision = IF (AgencyOpening&ClosingDecision + Agencies) < 0
THEN 0 ELSE AgencyOpening&ClosingDecision
AgencyNormPolicyEfficiency = 5.09 { policy/(agency*month) }
AgencyOpening&ClosingDecision = 0
{ agency/month }
AgencyOpeningDecision = IF ROUND(MaxApplyingAgencyPool) <
ROUND(AgencyOpening&ClosingDecision) THEN 0
ELSE AgencyOpening&ClosingDecision
AgencyPerWorkforceNormRatio = { agency/men } 7.5
AgencyPerWorkforceRatio = Agencies/TotalTechnicalWorkforce {agency/men}
AppOpnClosDecControl = IF AgencyOpening&ClosingDecision >=0 THEN
ROUND(AgencyOpening&ClosingDecision)/ROUND(MaxApplyingAgencyPool)
ELSE AgencyOpening&ClosingDecision/Agencies
AutoEffect = AutoSalesRatio
AutoSales = IF normal_growth THEN (15700+((33200-
15700)/120)*TIME+probability_switch*NORMAL(200,400))
ELSE IF steep_growth THEN (15700+((99600-
15700)/120)*TIME+probability_switch*NORMAL(200,400))
ELSE IF mild_growth THEN (15700+((16600-
15700)/120)*TIME+probability_switch*NORMAL(200,400))
ELSE 0 {car/month }
AutoSalesInBaseYear = 15700 {car/month}
AutoSalesRatio = SMTH1(AutoSales/AutoSalesInBaseYear,3)
AverageCommRateInMarket = 0.20
CommissionRate = CommissionRateDecision
CommissionRateAdjuster = 0.15 / 0.20 { 1 }
CommissionRateDecision = 0.20
CommissionsRatio = CommissionRateAdjuster*
CommissionRate/AverageCommRateInMarket
EfficiencyRatio = PolicyPerAgency / AgencyNormPolicyEfficiency
GlobalAgencyPool = (12000*7000/((12000-7000)*EXP(-(TIME-
36)*(1/20))+7000))+0+8000 {Agency }
MaxApplyingAgencyPool = MIN(PotentialAgencyPool *CommissionEffect *
MarketShareEffectOnApplying *MaxApplyingFraction * CashIndexEffect , 150)
{Agency/month}
MaxApplyingFraction = 0.005
mild_growth = 0
new_total_underwriting_fraction =
new_total_underwritten_policies/AutoSales {policy/car}
new_underwriting_fraction_by_agencies = PoliciesUndwByAgencies/AutoSales
{policy/car}
new_underwriting_share = 100 * new_total_underwriting_fraction
normal_growth = 1
NormQuittingFraction = 0.04
PoliciesUndwByAgencies = MIN(Agencies * PolicyPerAgency, AutoSales-
DirectUnderwriting) {policy/month}
PolicyPerAgency = AgencyNormPolicyEfficiency * TotalMarketEffect *
AutoEffect { policy/(agency*month) }
PotentialAgencyPool = GlobalAgencyPool-Agencies {agency}
probability_switch = 1
quitting_fraction = NormQuittingFraction * AgencyRelationsEffect *
MarketShareEffectOnQuitting / CashIndexEffect^2
steep_growth = 0
TotalTechnicalWorkforce = ClaimsWorkforce+PolicyWorkforce {men}

```

```

AgencyRelationsEffect =
GRAPH(AgencyPerWorkforceNormRatio/AgencyPerWorkforceRatio)
(0.00, 20.0), (0.1, 16.2), (0.2, 11.2), (0.3, 8.50), (0.4, 6.80), (0.5,
4.80), (0.6, 3.90), (0.7, 3.10), (0.8, 2.00), (0.9, 1.50), (1, 1.00),
(1.10, 0.35), (1.20, 0.05)
CommissionEffect = GRAPH(CommissionsRatio)
(0.00, 0.00), (0.1, 0.185), (0.2, 0.31), (0.3, 0.415), (0.4, 0.525),
(0.5, 0.615), (0.6, 0.725), (0.7, 0.82), (0.8, 0.895), (0.9, 0.965), (1,
1.00)
EfficiencyEffect = GRAPH(SMTH1(EfficiencyRatio,9))
(0.2, 0.345), (0.33, 0.355), (0.46, 0.37), (0.59, 0.385), (0.72, 0.405),
(0.85, 0.46), (0.98, 0.825), (1.11, 0.88), (1.24, 0.9), (1.37, 0.915),
(1.50, 0.92)
MarketShareEffectOnApplying = GRAPH(AverageMarketShare_yearly)
(0.00, 0.16), (0.05, 0.33), (0.1, 0.48), (0.15, 0.59), (0.2, 0.66),
(0.25, 0.715), (0.3, 0.76), (0.35, 0.815), (0.4, 0.86), (0.45, 0.905),
(0.5, 0.95)
MarketShareEffectOnQuitting = GRAPH(AverageMarketShare_yearly)
(0.00, 1.15), (0.01, 1.10), (0.02, 1.00), (0.03, 0.742), (0.04, 0.545),
(0.05, 0.38), (0.06, 0.255), (0.07, 0.13), (0.08, 0.065), (0.09, 0.015),
(0.1, 0.015)

```

Claims Department Sector

```

ClaimsWorkforce(t) = ClaimsWorkforce(t - dt) + (trainedClaimsWF -
retiringClaimsWorkforce - quittingClaimsWorkforce -
ClaimsWorkforceFiring) * dt
INIT ClaimsWorkforce = 15+3 {men}
trainedClaimsWF = TrainingClaimsWorkforce / TrainingTime { men/month }
retiringClaimsWorkforce = ClaimsWorkforce * RetiringFraction { men/month }
quittingClaimsWorkforce = ClaimsWorkforce *
ClaimsWorkforceQuittingFraction { men/month }
ClaimsWorkforceFiring = IF ClaimsWorkforceHiringFiringDecision<0 THEN -
ClaimsWorkforceHiringFiringDecision ELSE 0
{ men/month }
PendingClaims(t) = PendingClaims(t - dt) + (Claims - Settlements) * dt
INIT PendingClaims = 1000 {claim file}
Claims = InForcePolicy*AverageClaimPerPolicy {claim/month}
Settlements = PendingClaims/AverageTimeToSettlement {claim/month}
TrainingClaimsWorkforce(t) = TrainingClaimsWorkforce(t - dt) +
(ClaimsWorkforceHiring - trainedClaimsWF) * dt
INIT TrainingClaimsWorkforce = 0 { men }
ClaimsWorkforceHiring = ClaWF_HiringDecision { men/month }
trainedClaimsWF = TrainingClaimsWorkforce / TrainingTime { men/month }
AverageClaimPerPolicy = IF probability switch THEN
(POISSON(MeanCpP*1000,2500)/1000) * PolicyQualityEffect ELSE MeanCpP *
PolicyQualityEffect { claim/(policy*month) }
AverageTimeToSettlement = 1.3*CWIEffectOnSettTime {month}
ClaimsNormWorkIntensity = 200 { claim files/men }
ClaimsWFHirFirDecControl = ClaimsWorkforce +
ClaimsWorkforceHiringFiringDecision
ClaimsWorkforceHiringFiringDecision =
quittingClaimsWorkforce+retiringClaimsWorkforce {men/month}
ClaimsWorkforceQuittingFraction = NormClaimsWorkforceQuittingFraction *
SalaryEffect * ClaimsWorkIntensityEffect / CashIndexEffect
ClaimsWorkIntensity = ClaimsAgencyEffect*PendingClaims/ClaimsWorkforce {
claim files/men }
ClaimsWorkIntensityRatioForSettTime =
ClaimsWorkIntensity/CWNormIntensityForSettTime
ClaWF_HiringDecision = IF ClaimsWorkforceHiringFiringDecision>0 THEN
ClaimsWorkforceHiringFiringDecision ELSE 0
{ men/month }

```

```

CWNormIntensityForSettTime = 200 { claim files/men }
MeanCpP = 0.037
NormClaimsWorkforceQuittingFraction = 0.135/12
ClaimsAgencyEffect = GRAPH(1/AgencyPerWorkforceRatio)
(0.1, 1.25), (0.115, 1.25), (0.13, 1.24), (0.145, 1.24), (0.16, 1.21),
(0.175, 1.18), (0.19, 1.12), (0.205, 1.08), (0.22, 1.03), (0.235, 1.01),
(0.25, 1.00)
ClaimsWorkIntensityEffect =
GRAPH(ClaimsWorkIntensity/ClaimsNormWorkIntensity)
(0.5, 0.71), (0.875, 0.903), (1.25, 1.19), (1.63, 1.39), (2.00, 1.62),
(2.38, 1.86), (2.75, 2.14), (3.13, 2.46), (3.50, 2.79), (3.88, 3.13),
(4.25, 3.50), (4.63, 3.80), (5.00, 4.11)
CWIEffectOnSettTime = GRAPH(ClaimsWorkIntensityRatioForSettTime)
(1.00, 1.00), (1.50, 1.03), (2.00, 1.10), (2.50, 1.24), (3.00, 1.36),
(3.50, 1.56), (4.00, 1.80), (4.50, 2.08), (5.00, 2.50), (5.50, 3.00),
(6.00, 3.66), (6.50, 4.32), (7.00, 4.96)

```

Finance Sector

```

Cash(t) = Cash(t - dt) + (NetPremiums + NetFinancialIncome -
NetClaimPayments - Expenditures - InterestPaid) * dt
INIT Cash = 7500000 {US$}
NetPremiums = Premiums_Net
NetFinancialIncome = IF Cash>0 THEN Cash*incomeInterestRate ELSE 0
NetClaimPayments = ClaimPayments_Net
Expenditures = PersonnelExpenses + MarketingExpenditures + otherExpenses
InterestPaid = IF Cash<0 THEN -Cash*debtInterestRate ELSE 0
AveragePaymentPerClaim = IF probability_switch THEN
EXP(NORMAL(MeanNormal,StdDevNormal,2500)) ELSE MeanAPpC

AveragePremium = PolicyPrice*.15 { US$/policy }
AveragePrePayment = PolicyPrice * 0.25 { US$/policy }
AverageSalaryInMarket = 1000
AverageYearlyProfit = 12 * SMTH1(TotalProfit,12)
AvgSalaryInMarket_adjusted = AverageSalaryInMarket / 1000 * 1250
CashExpensesIndex = Cash / (12*SMTH1(Expenditures+NetClaimPayments,12))
CashPosProfitIndex = IF Cash>0 THEN AverageYearlyProfit/Cash ELSE 0
CashPremiumIndex = (-Cash) / (12*SMTH1(NetPremiums,12))
ClaimPayments = Settlements*AveragePaymentPerClaim
ClaimPayments_Net = RetentionRatio*ClaimPayments
currentLossRatio = 1- currentTechProfitRatio
currentLossRatio_Net = 1- currentTechProfitRatio_Net
currentTechProfitRatio = (Premiums-ClaimPayments)/Premiums
currentTechProfitRatio_Net = (Premiums_Net-
ClaimPayments_Net)/Premiums_Net
debtInterestRate = (1+0.20)^(1/12)-1
incomeInterestRate = (1+0.15)^(1/12)-1
LossRatio = 1-TechnicalProfitRatio
LossRatio_Net = 1-TechnicalProfitRatio_Net
MeanAPpC = 725
MeanNormal = LOGN(MeanAPpC^2/SQRT(StdDevAPpC^2+MeanAPpC^2))
otherExpenses = PersonnelExpenses*otherExpensesFraction
otherExpensesFraction = 1.3
PersonnelExpenses = Salary * TotalWorkforce { $/month }
Premiums =
AveragePrePayment*(Continued1+Renewals)+AveragePremium*Policy16 {US$}
Premiums_Net = (RetentionRatio+(1-
RetentionRatio)*ReinsurerComissionRate-CommissionRate)*Premiums
ReinsurerComissionRate = 0.35
RetentionRatio = 0.85
Salary = 1000
{ US$/(month*man) }
StdDevAPpC = 150

```

```

StdDevNormal = SQRT(LOGN((StdDevAppC^2+MeanAppC^2)/MeanAppC^2))
SupportPersonel = (TotalTechnicalWorkforce + TotalTrainingWorkforce) *
SupportPersonelMultiplier { men }
SupportPersonelMultiplier = 2.2
TechnicalProfitRatio = SMTH1(currentTechProfitRatio,12)
TechnicalProfitRatio_Net = smth1(currentTechProfitRatio_Net,12)
TotalProfit = UnderwritingProfit + NetFinancialIncome - ( InterestPaid +
Expenditures )
TotalTrainingWorkforce = TrainingPolicyWorkforce +
TrainingClaimsWorkforce
TotalWorkforce = TotalTechnicalWorkforce + SupportPersonel +
TotalTrainingWorkforce { men }
UnderwritingProfit = NetPremiums-NetClaimPayments
CashIndexEffect = GRAPH(CashPremiumIndex)
(0.00, 1.00), (0.035, 0.996), (0.07, 0.984), (0.105, 0.972), (0.14,
0.956), (0.175, 0.932), (0.21, 0.888), (0.245, 0.812), (0.28, 0.7),
(0.315, 0.504), (0.35, 0.2)
SalaryEffect = GRAPH(AvgSalaryInMarket_adjusted/Salary)
(0.5, 0.755), (0.625, 0.782), (0.75, 0.838), (0.875, 0.912), (1.00,
1.00), (1.13, 1.07), (1.25, 1.13), (1.38, 1.17), (1.50, 1.20), (1.63,
1.21), (1.75, 1.23), (1.88, 1.24), (2.00, 1.25)

```

Marketing Sector

```

AverageMarketShare_quarterly(t) = AverageMarketShare_quarterly(t - dt) +
(CorrectionAMSq) * dt
INIT AverageMarketShare_quarterly = AverageMarketShare_yearly
CorrectionAMSq = (Real_MarketShare-
AverageMarketShare_quarterly)/SmoothTimeAMSq
AverageMarketShare_yearly(t) = AverageMarketShare_yearly(t - dt) +
(CorrectionAMSy) * dt
INIT AverageMarketShare_yearly = 0.045
CorrectionAMSy = (Real_MarketShare-
AverageMarketShare_yearly)/SmoothTimeAMSy
AveragePolicyPriceInMarket(t) = AveragePolicyPriceInMarket(t - dt) +
(CorrectionAvgPolPriceInMarket) * dt
INIT AveragePolicyPriceInMarket = 550 { US$/policy }
CorrectionAvgPolPriceInMarket = (PolicyPrice-
AveragePolicyPriceInMarket)/(IF PriceDifference>0 THEN
SmoothTimeInPriceIncrease ELSE SmoothTimeInPriceDecrease)
PerceivedMarketingEffect(t) = PerceivedMarketingEffect(t - dt) +
(CorrectionPME) * dt
INIT PerceivedMarketingEffect = 0.48
CorrectionPME = (IndicatedMarketingEffect-
PerceivedMarketingEffect)/SmoothTimePME
AverageTimeToSettlementInMarket = 1.5 {month/claim}
CompetitorPremiums = CompetitorsPolicies * AveragePolicyPriceInMarket *12
{US$}
CompetitorsAvgMarketingExpenditures =
CompetitorsAvgMarketingExpendituresRatio*(CompetitorPremiums/12)/AvgNumbe
rOfCompetingCompaniesInSector
CompetitorsAvgMarketingExpendituresRatio =
SMTH1(MarketingExpendituresRatio,12, 0.05)
CompetitorsPolicies = (AutoSales-
new_total_underwritten_policies)*CompetitorsPoliciesFraction {policy}
CompetitorsPoliciesFraction = 2.50
MarketingExpenditures = Premiums*MarketingExpendituresRatio
MarketingExpendituresRatio = 0.05
MarketShare_quarterly = 100 * AverageMarketShare_quarterly
MarketShare_yearly = 100 * AverageMarketShare_yearly
PolicyPrice = 550 { US$/policy }
PolicyPriceRatio = SMTH1(PolicyPrice/AveragePolicyPriceInMarket, 2)
PriceDifference = PolicyPrice - AveragePolicyPriceInMarket { US$ }

```

```

Real_MarketShare = 12*Premiums/TotalMarketPremiums
SmoothTimeAMSq = 3
SmoothTimeAMSy = 12
SmoothTimeInPriceDecrease = 6 { month }
SmoothTimeInPriceIncrease = 18 { month }
SmoothTimePME = 2
TotalMarketEffect =
PerceivedMarketingEffect*MarketSaturationEffect*SettlementTimeEffect*PriceEffectOnNewPolicies
TotalMarketPremiums = CompetitorPremiums + 12*Premiums {US$}
AvgNumberOfCompetingCompaniesInSector = GRAPH(AverageMarketShare_yearly)
(0.04, 10.0), (0.0617, 9.66), (0.0833, 9.36), (0.105, 9.00), (0.127,
8.64), (0.148, 8.34), (0.17, 8.06), (0.192, 7.70), (0.213, 7.34), (0.235,
7.00), (0.257, 6.62), (0.278, 6.34), (0.3, 6.00)
IndicatedMarketingEffect =
GRAPH(MarketingExpenditures/CompetitorsAvgMarketingExpenditures)
(0.5, 0.48), (0.875, 0.9), (1.25, 1.05), (1.63, 1.10), (2.00, 1.15),
(2.38, 1.22), (2.75, 1.28), (3.13, 1.38), (3.50, 1.53), (3.88, 1.73),
(4.25, 1.89), (4.63, 1.97), (5.00, 2.00)
MarketSaturationEffect = GRAPH(AverageMarketShare_yearly)
(0.00, 1.19), (0.04, 1.18), (0.08, 1.15), (0.12, 1.11), (0.16, 1.02),
(0.2, 0.863), (0.24, 0.625), (0.28, 0.45), (0.32, 0.294), (0.36, 0.156),
(0.4, 0.1)
PriceEffectOnNewPolicies = GRAPH(PolicyPriceRatio)
(0.5, 2.00), (0.6, 1.90), (0.7, 1.75), (0.8, 1.25), (0.9, 1.02), (1,
1.00), (1.10, 0.9), (1.20, 0.5), (1.30, 0.265), (1.40, 0.075), (1.50,
0.05)
SettlementTimeEffect =
GRAPH(AverageTimeToSettlement/AverageTimeToSettlementInMarket)
(0.00, 1.85), (0.2, 1.50), (0.4, 1.27), (0.6, 1.10), (0.8, 1.00), (1.00,
1.00), (1.20, 0.95), (1.40, 0.84), (1.60, 0.66), (1.80, 0.54), (2.00,
0.52)

```

Policy Department Sector

```

expiredPolicies(t) = expiredPolicies(t - dt) + (finishedPolicies -
Renewals - endingPolicies) * dt
INIT expiredPolicies = {policy} 1675
finishedPolicies = CONVEYOR OUTFLOW
Renewals = expiredPolicies*RenewalFraction {policy/month}
endingPolicies = expiredPolicies*(1-RenewalFraction) {policy/month}
Policy01(t) = Policy01(t - dt) + (UnderwritingByAgencies +
DirectUnderwriting - Continued1 - cancelledPolicies) * dt
INIT Policy01 = {policy} 910
    TRANSIT TIME = 1
    INFLOW LIMIT = INF
    CAPACITY = INF
UnderwritingByAgencies = PoliciesUndwByAgencies {policy/month}
DirectUnderwriting = Salesforce*SalesForceProductivity {policy/month}
Continued1 = CONVEYOR OUTFLOW
cancelledPolicies = LEAKAGE OUTFLOW
    LEAKAGE FRACTION = CancellingFraction
    NO-LEAK ZONE = 0
Policy16(t) = Policy16(t - dt) + (Renewals + Continued1 - Continued2) *
dt
INIT Policy16 = 8800 {policy}
    TRANSIT TIME = 5
    INFLOW LIMIT = INF
    CAPACITY = INF
Renewals = expiredPolicies*RenewalFraction {policy/month}
Continued1 = CONVEYOR OUTFLOW
Continued2 = CONVEYOR OUTFLOW
Policy612(t) = Policy612(t - dt) + (Continued2 - finishedPolicies) * dt

```

```

INIT Policy612 = 10100 {policy}
    TRANSIT TIME = 6
    INFLOW LIMIT = INF
    CAPACITY = INF
Continued2 = CONVEYOR OUTFLOW
finishedPolicies = CONVEYOR OUTFLOW
PolicyWorkforce(t) = PolicyWorkforce(t - dt) + (trainedPolicyWF -
retiringPolicyWorkforce - quittingPolicyWorkforce -
PolicyWorkforceFiring) * dt
INIT PolicyWorkforce = 21+5 {men }
trainedPolicyWF = TrainingPolicyWorkforce / TrainingTime { men/month }
retiringPolicyWorkforce = PolicyWorkforce * RetiringFraction { men/month }
quittingPolicyWorkforce = PolicyWorkforce *
PolicyWorkforceQuittingFraction { men/month }
PolicyWorkforceFiring = IF PolicyWorkforceHiringFiringDecision<0 THEN -
PolicyWorkforceHiringFiringDecision ELSE 0
{ men/month }
TrainingPolicyWorkforce(t) = TrainingPolicyWorkforce(t - dt) +
(PolicyWorkforceHiring - trainedPolicyWF) * dt
INIT TrainingPolicyWorkforce = 0 { men }
PolicyWorkforceHiring = PolWF_HiringDecision { men/month }
trainedPolicyWF = TrainingPolicyWorkforce / TrainingTime { men/month }
CancellingFraction = 0.156
createdPolicies = UnderwritingByAgencies + DirectUnderwriting + Renewals
{policy/month}
InForcePolicy = Policy01+Policy16+Policy612+expiredPolicies {policy}
new_total_underwritten_policies = DirectUnderwriting
+UnderwritingByAgencies {policy/month}
NormPolicyWorkforceQuittingFraction = 0.145/12
PolicyNormWorkIntensity = 2000 {policy/men}
PolicyWFHirFirDecControl = PolicyWorkforce +
PolicyWorkforceHiringFiringDecision
PolicyWorkforceHiringFiringDecision =
quittingPolicyWorkforce+retiringPolicyWorkforce { men/month }
PolicyWorkforceQuittingFraction = NormPolicyWorkforceQuittingFraction *
SalaryEffect * PolicyWorkIntensityEffect / CashIndexEffect
PolicyWorkIntensity = PolicyAgencyEffect*InForcePolicy/PolicyWorkforce
{policy/men}
PolWF_HiringDecision = IF PolicyWorkforceHiringFiringDecision>0 THEN
PolicyWorkforceHiringFiringDecision ELSE 0
RenewalFraction = 0.63*PriceEffectOnRenewals
RetiringFraction = 0.017/12
SalesForce = SalesForceFraction*PolicyWorkforce { men }
SalesForceFraction = .15
SalesForceProductivity = 10 {policy/(month*men)}
TrainingTime = 4 { months }
PolicyAgencyEffect = GRAPH(1/AgencyPerWorkforceRatio)
(0.1, 1.25), (0.115, 1.25), (0.13, 1.24), (0.145, 1.24), (0.16, 1.21),
(0.175, 1.18), (0.19, 1.12), (0.205, 1.08), (0.22, 1.03), (0.235, 1.01),
(0.25, 1.00)
PolicyQualityEffect = GRAPH(PolicyWorkIntensity/PolicyNormWorkIntensity)
(1.00, 1.00), (1.25, 1.25), (1.50, 1.50), (1.75, 1.75), (2.00, 2.00),
(2.25, 2.25), (2.50, 2.50), (2.75, 2.75), (3.00, 3.00), (3.25, 3.25),
(3.50, 3.50), (3.75, 3.75), (4.00, 4.00)
PolicyWorkIntensityEffect =
GRAPH(PolicyWorkIntensity/PolicyNormWorkIntensity)
(0.5, 0.71), (0.875, 0.903), (1.25, 1.19), (1.63, 1.39), (2.00, 1.62),
(2.38, 1.86), (2.75, 2.14), (3.13, 2.46), (3.50, 2.79), (3.88, 3.13),
(4.25, 3.49), (4.63, 3.80), (5.00, 4.11)
PriceEffectOnRenewals = GRAPH(PolicyPrice/AveragePolicyPriceInMarket)
(0.5, 1.85), (0.6, 1.77), (0.7, 1.40), (0.8, 1.18), (0.9, 1.00), (1,
1.00), (1.10, 0.867), (1.20, 0.289), (1.30, 0.14), (1.40, 0.1), (1.50,
0.05)

```

Not in a Sector

```
Agency_Opening_Closing = 0
cumulativeQuarter = INT(TIME/3)+1
currentQuarter = IF NOT MOD(cumulativeQuarter,4) THEN 4 ELSE
MOD(cumulativeQuarter,4)
Policy_Price = 500
Policy_Workforce_Hiring_Firing = TIME/12
TimeStamp = IF TIME = 120 THEN TIME ELSE TIME+1
Year = INT(TIME/12)+1+1996
```



APPENDIX B
FIGURES OF MODEL BEHAVIOR IN VALIDATION TESTS



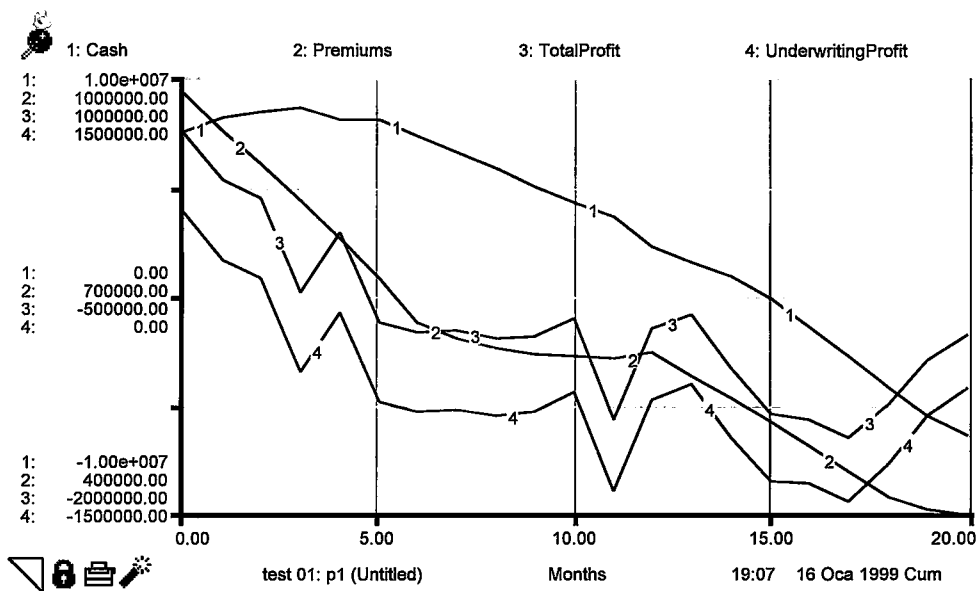


FIGURE B.1.1.1. The Behaviors of Financial Measures in Case of No Work Force

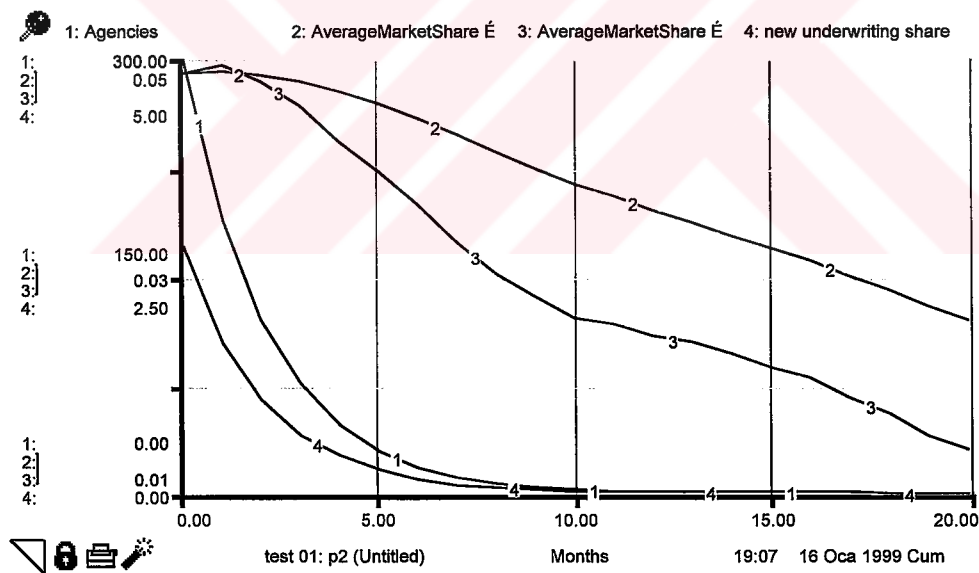


FIGURE B.1.1.2. The Behaviors of Market Measures in Case of No Work Force

(2: Average Market Share yearly, 3: Average Market Share quarterly)

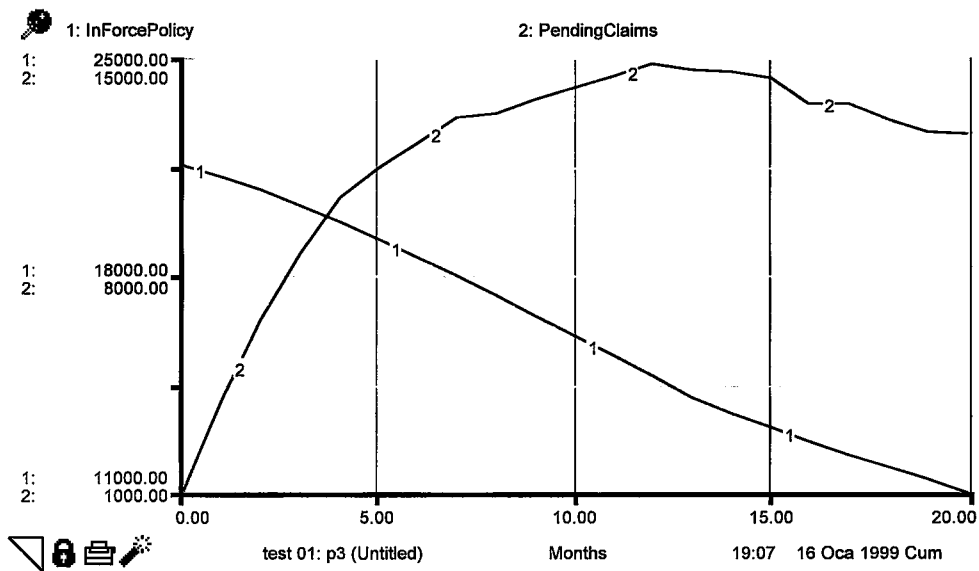


FIGURE B.1.1.3. The Behaviors of Technical Measures in Case of No Work Force

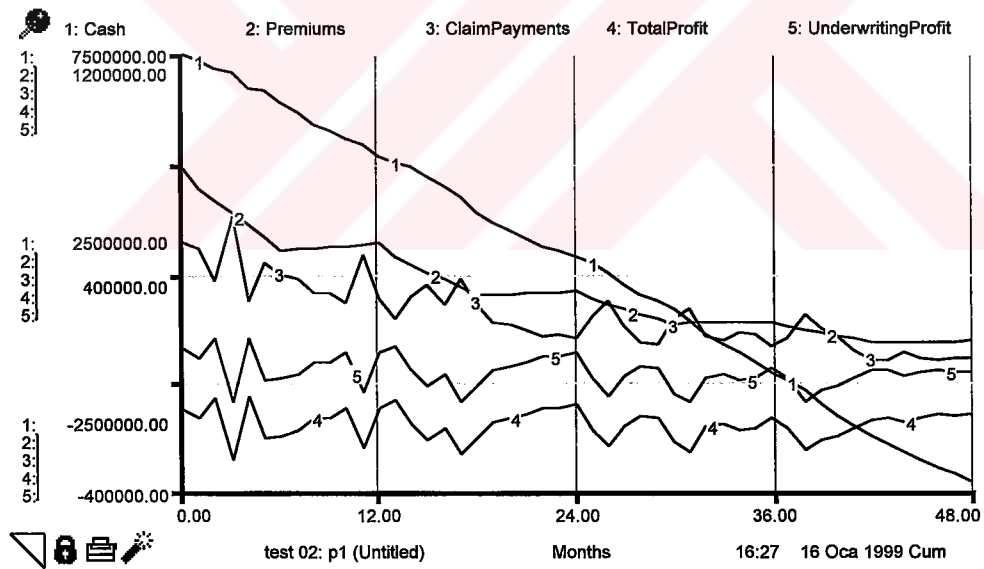


FIGURE B.1.2.1. The Behaviors of Financial Measures in Case of No Agency

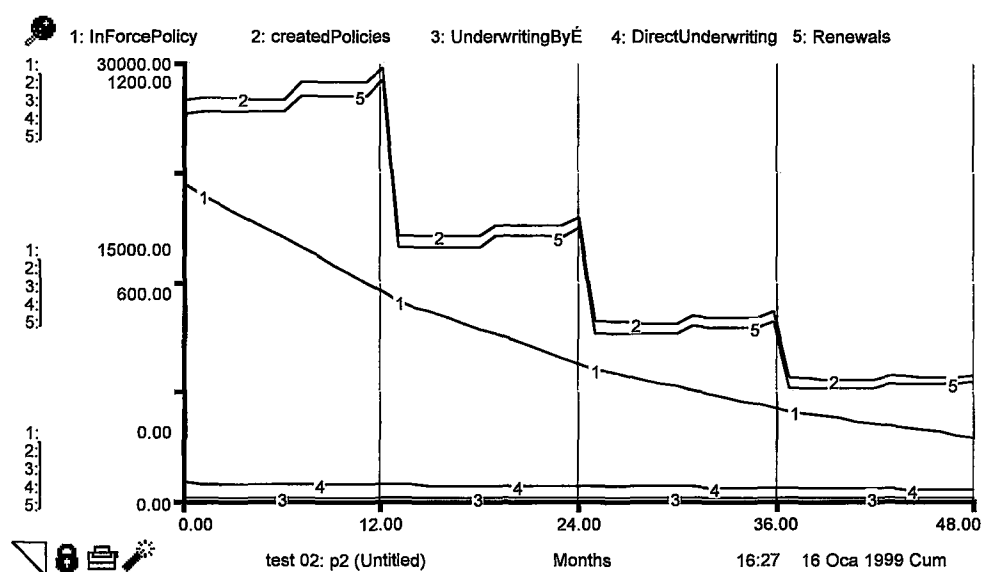


FIGURE B.1.2.2. The Behaviors of Technical Measures in Case of No Agency
(3: Underwriting by Agencies)

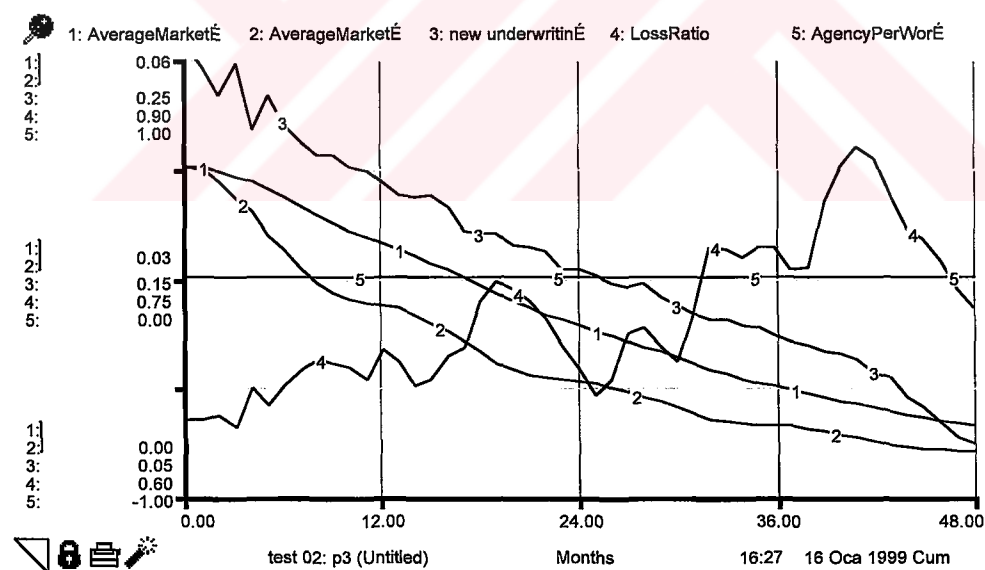


FIGURE B.1.2.3. The Behaviors of Market Measures in Case of No Agency
(1: Average Market Share yearly, 2: Average Market Share quarterly,
3: New Underwriting Share, 5: Agency per Workforce Ratio)

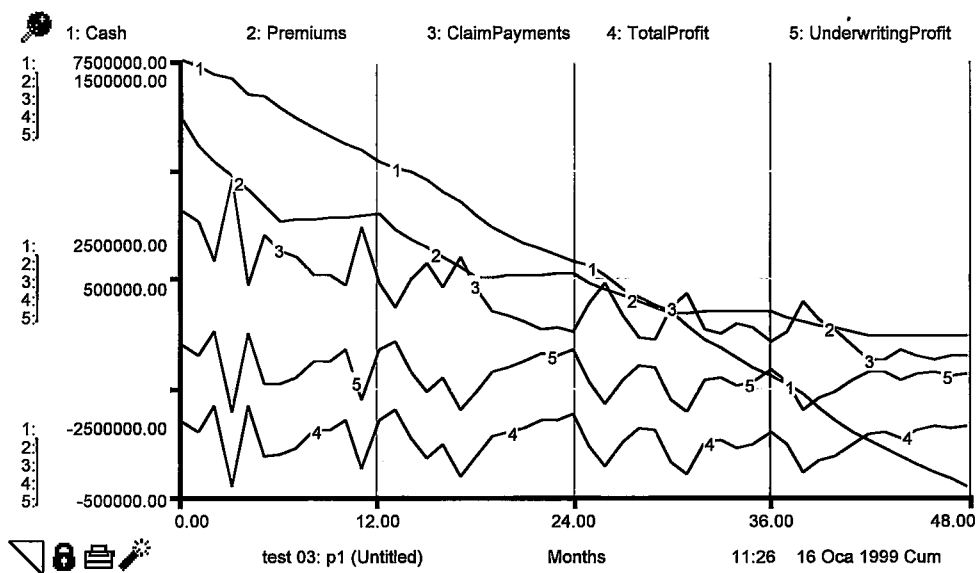


FIGURE B.1.3.1. The Behaviors of Financial Measures in Case of No Auto Sales

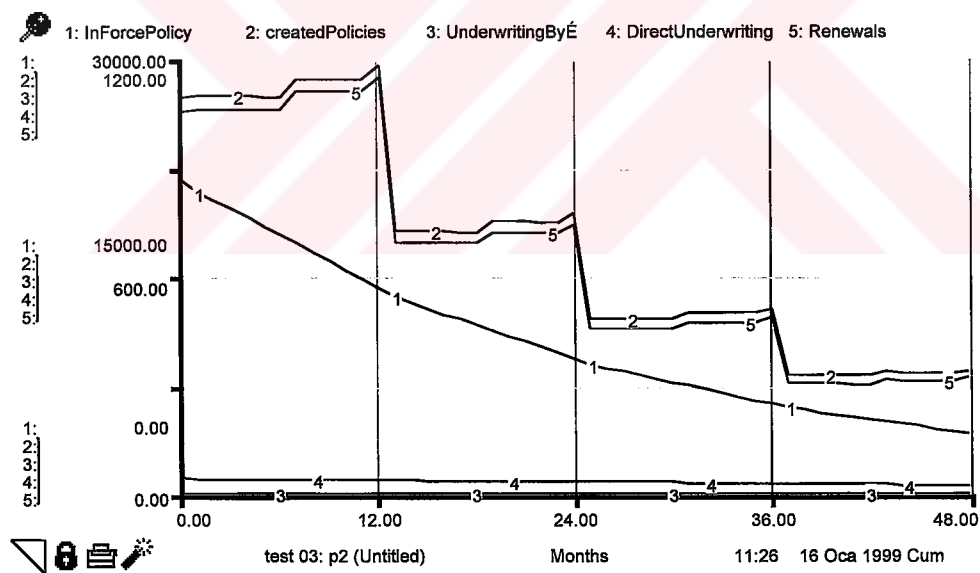


FIGURE B.1.3.2. The Behaviors of Technical Measures in Case of No Auto Sales
(3: Underwriting by Agencies)

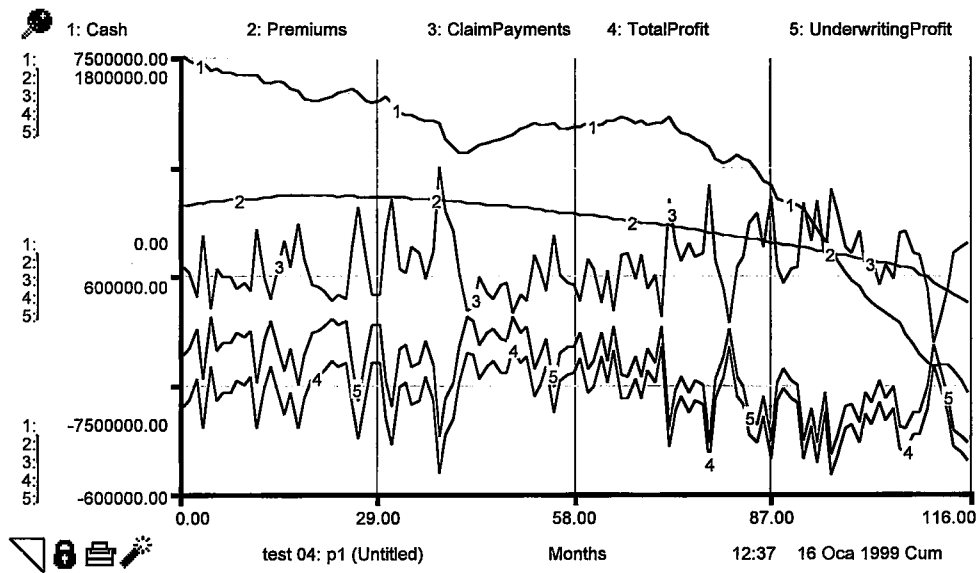


FIGURE B.1.4.1. The Behaviors of Financial Measures in Case of Strong Competitors

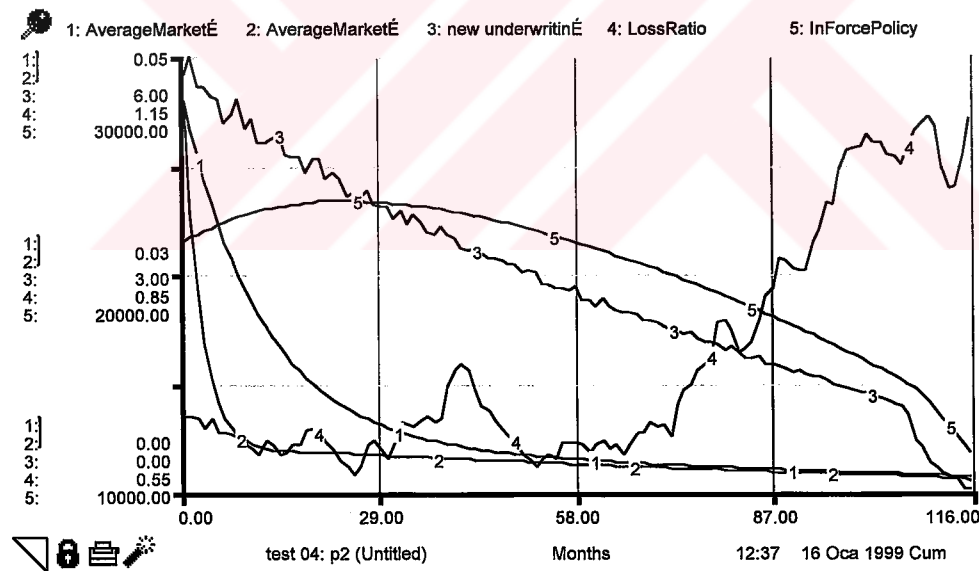


FIGURE B.1.4.2. The Behaviors of Market Measures in Case of Strong Competitors

(1: Average Market Share yearly, 2: Average Market Share quarterly,
3: New Underwriting Share)

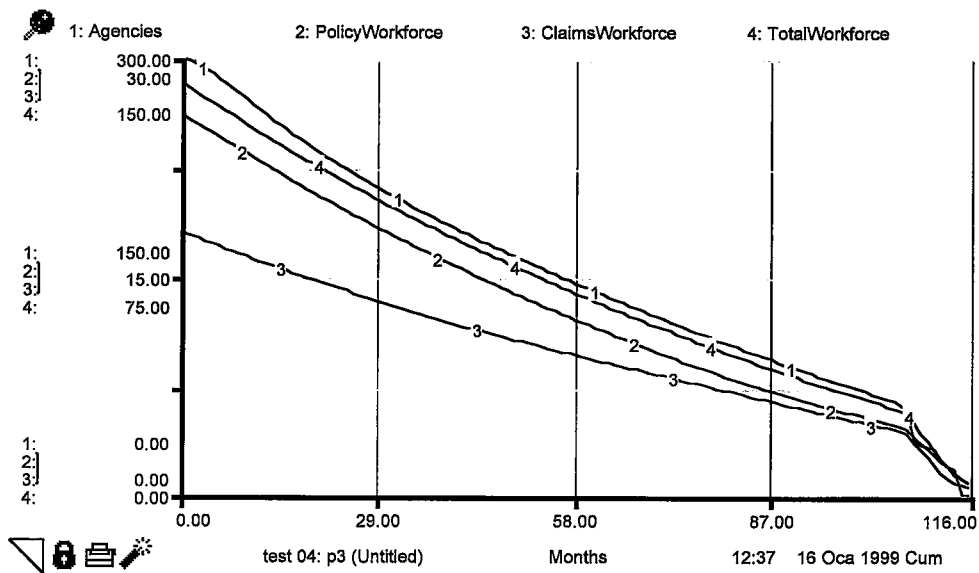


FIGURE B.1.4.3. The Behaviors of Technical Measures in Case of Strong Competitors

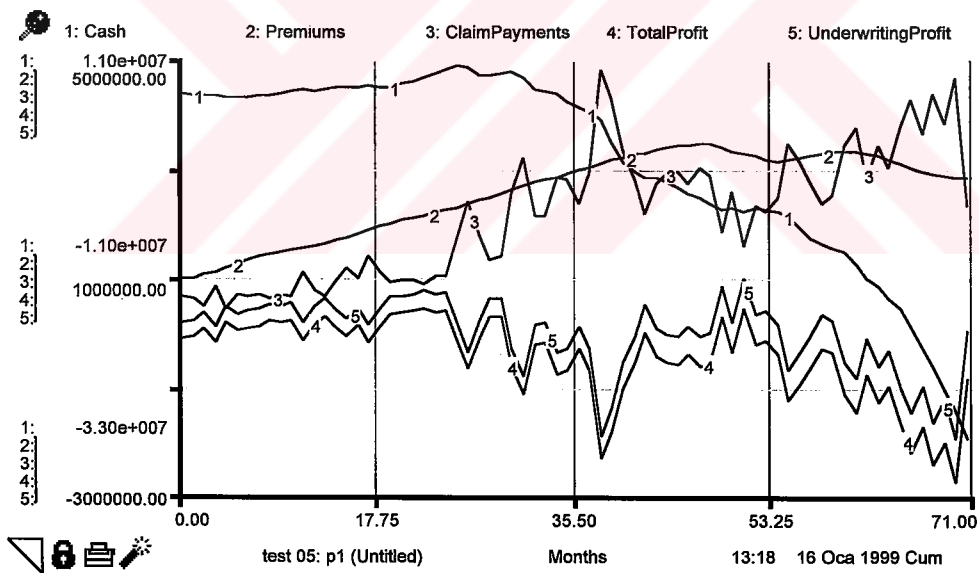


FIGURE B.1.5.1. The Behaviors of Financial Measures in Case of Weak Competitors

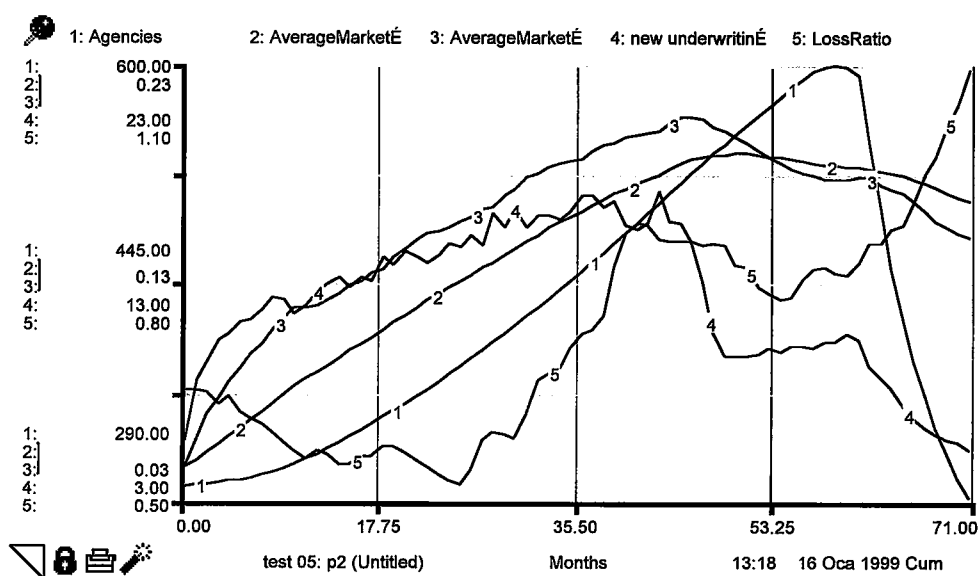


FIGURE B.1.5.2. The Behaviors of Market Measures in Case of Weak Competitors
(2: Average Market Share yearly, 3: Average Market Share quarterly,
4: New Underwriting Share)

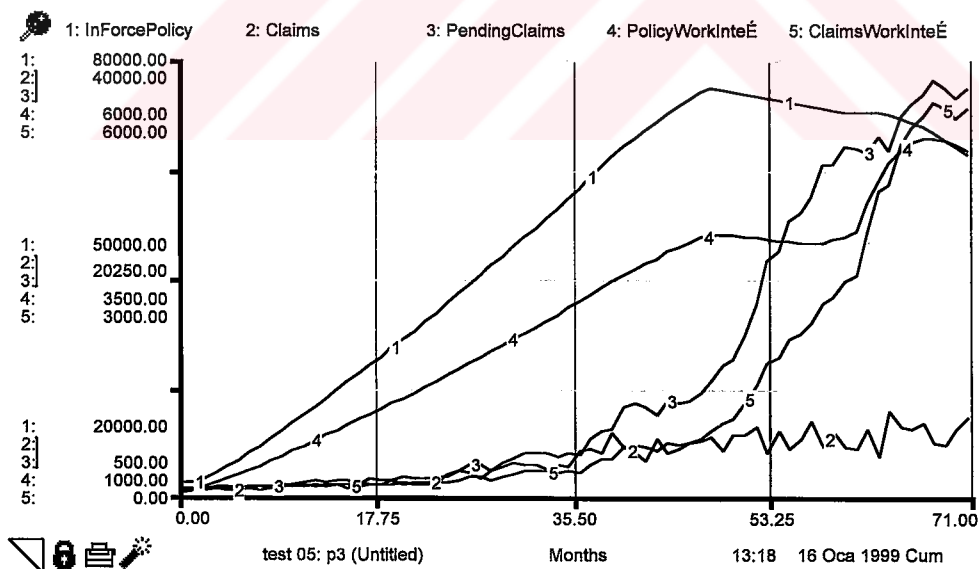


FIGURE B.1.5.3. The Behaviors of Technical Measures in Case of Weak Competitors
(4: Policy Work Intensity, 5: Claims Work Intensity)

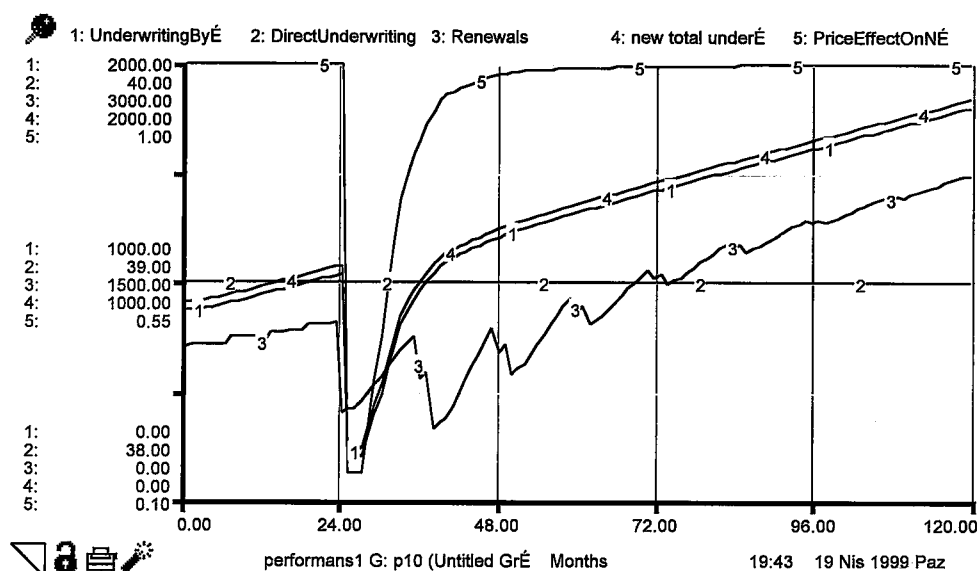


FIGURE B.1.6.1. The Behavior of Technical Measures in Case of Raising the Policy Price

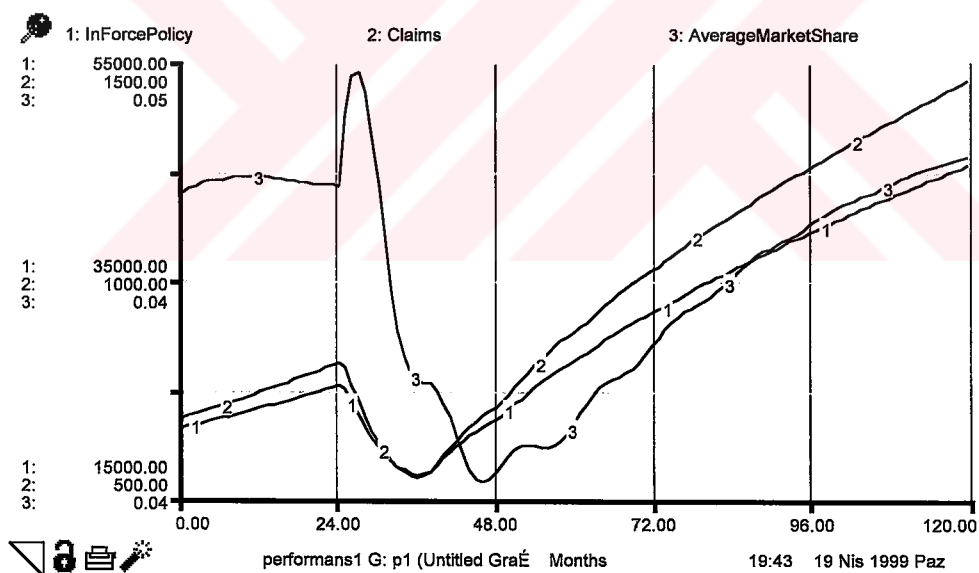


FIGURE B.1.6.2. The Behavior of further Technical Measures in Case of Raising the Policy Price

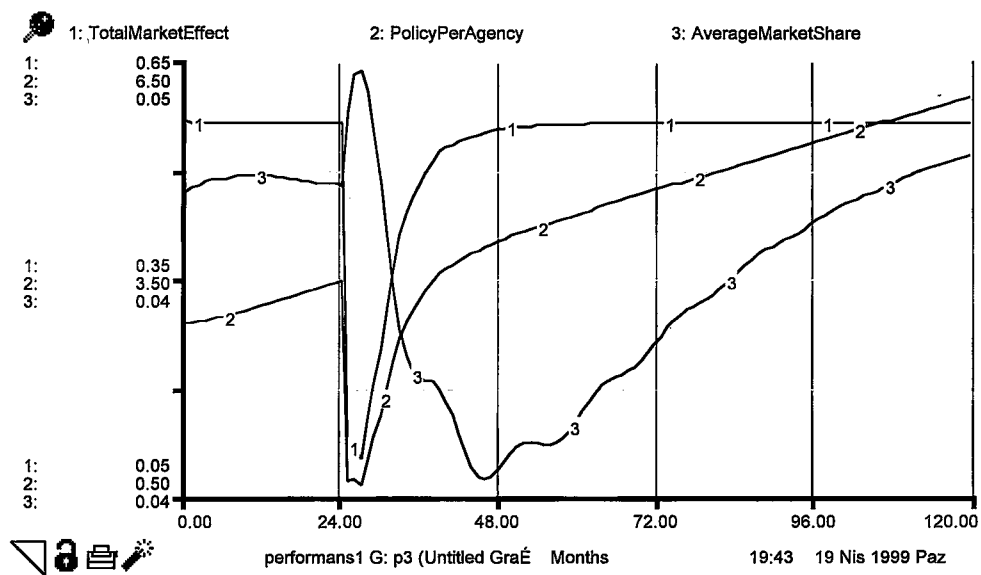


FIGURE B.1.6.3. The Behavior of Market Measures in Case of Raising the Policy Price

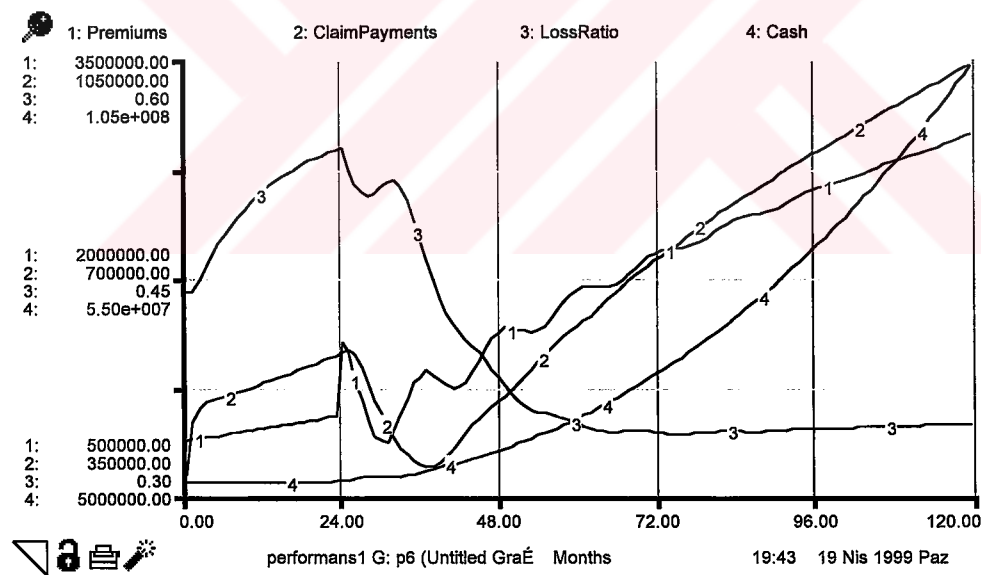


FIGURE B.1.6.4. The Behavior of Financial Measures in Case of Raising the Policy Price

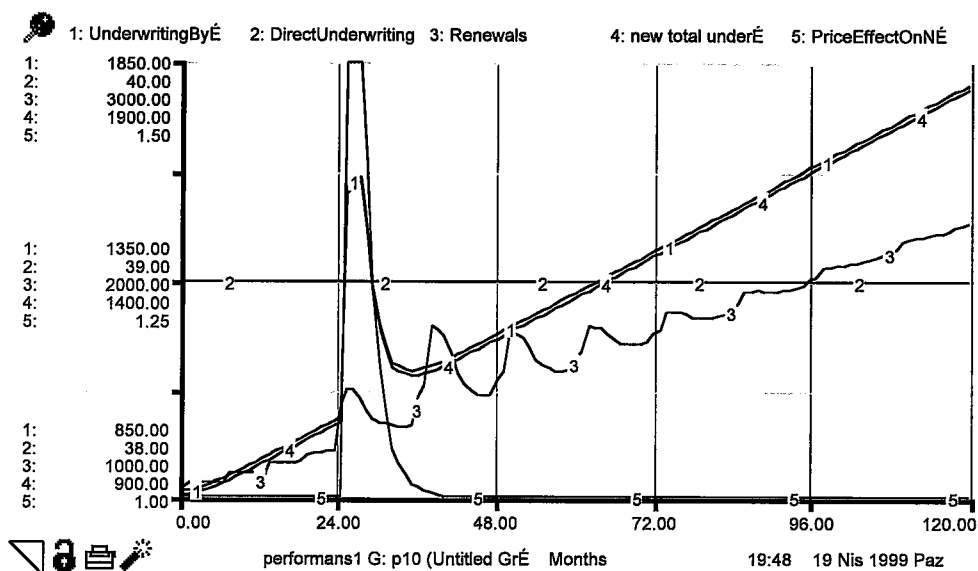


FIGURE B.1.7.1. The Behavior of Technical Measures in Case of Reducing the Policy Price

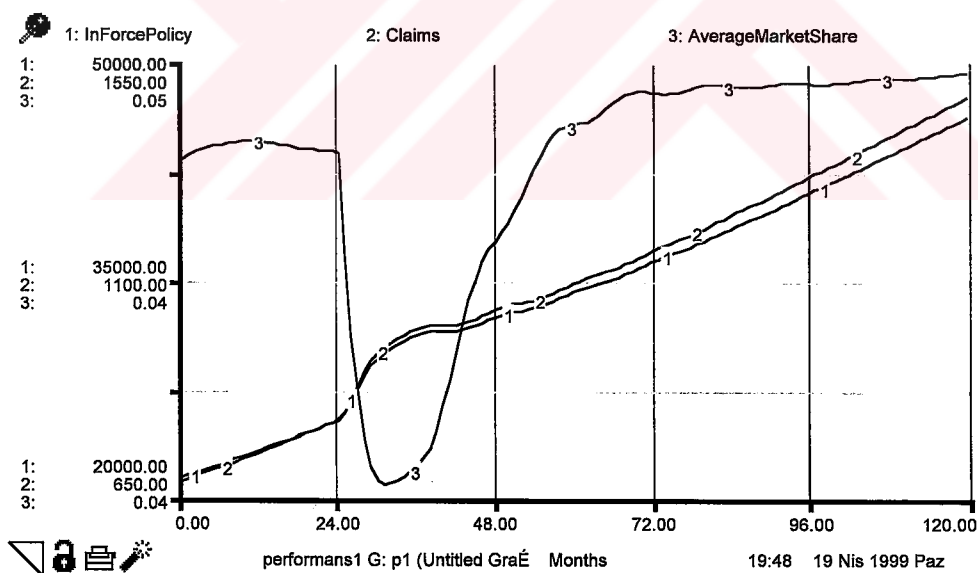


FIGURE B.1.7.2. The Behavior of further Technical Measures in Case of Reducing the Policy Price

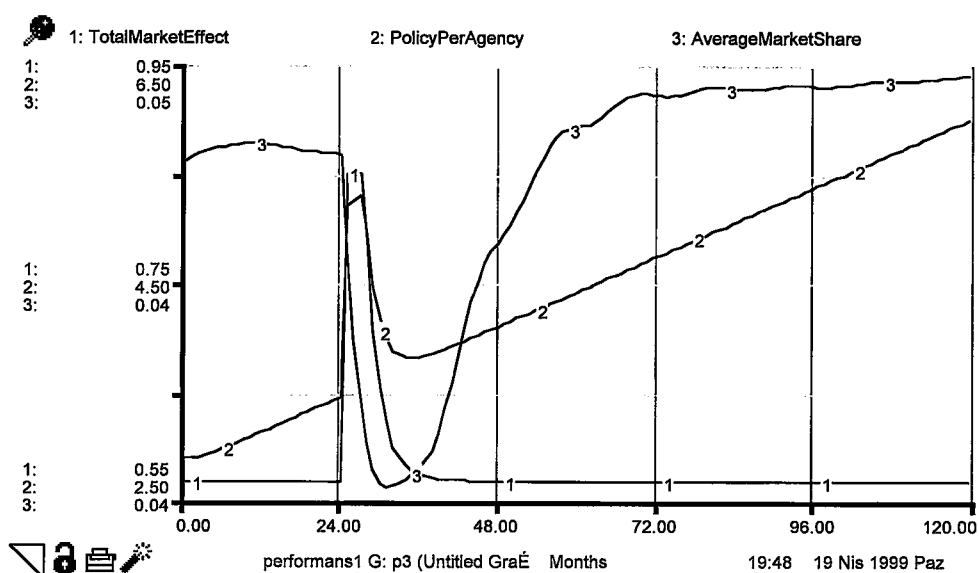


FIGURE B.1.7.3. The Behavior of Market Measures in Case of Reducing the Policy Price

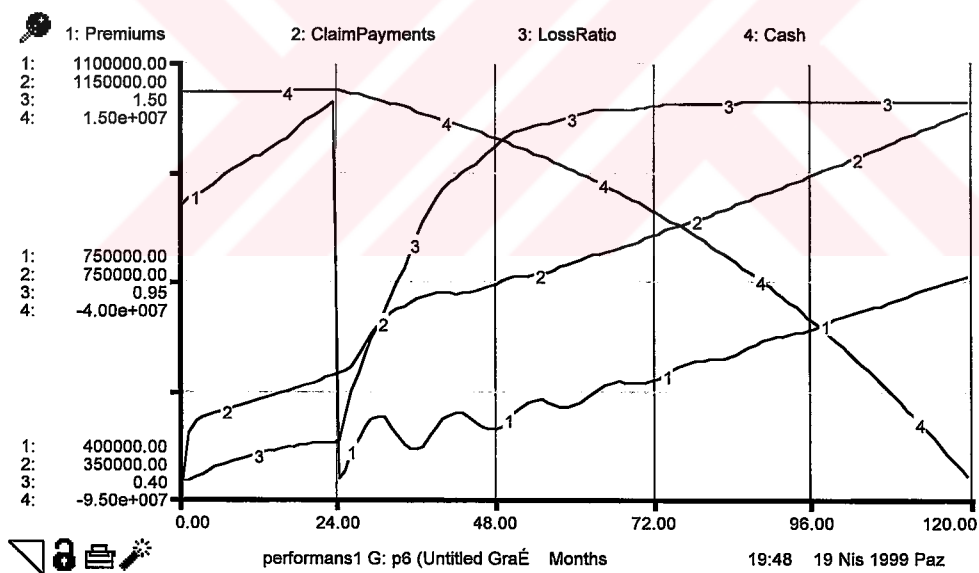


FIGURE B.1.7.4. The Behavior of Financial Measures in Case of Reducing the Policy Price

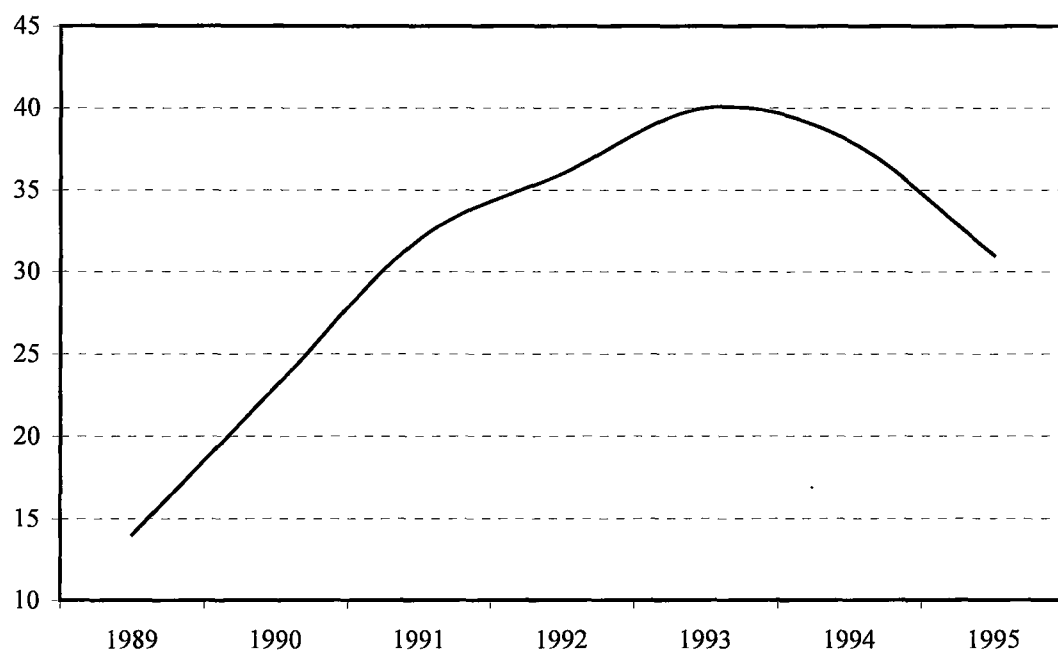


FIGURE B.2.1.1. Real Behavior of Premiums [US\$ mio, in 1989 constant prices]

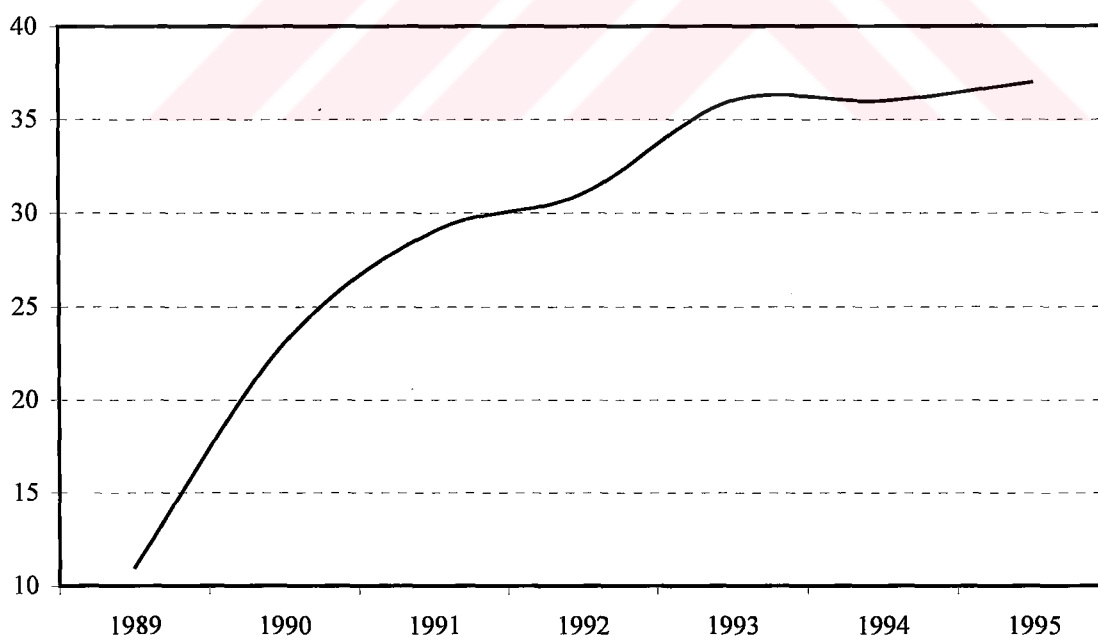


FIGURE B.2.1.2. Model Behavior of Premiums [US\$ mio, in 1989 constant prices]

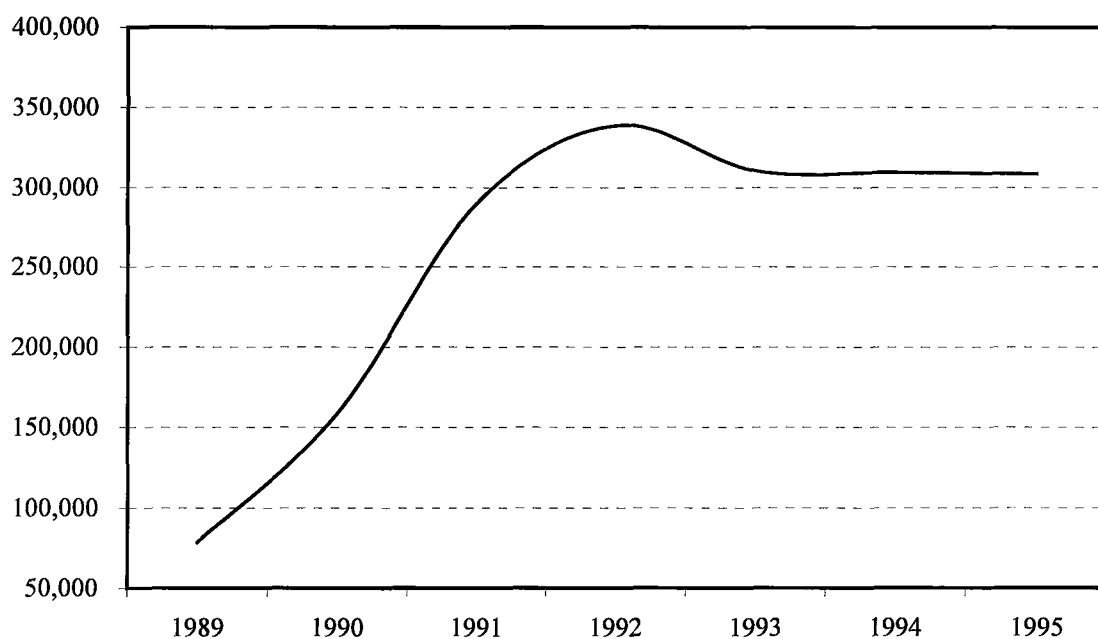


FIGURE B.2.2.1. Real Behavior of Active (In Force) Policies

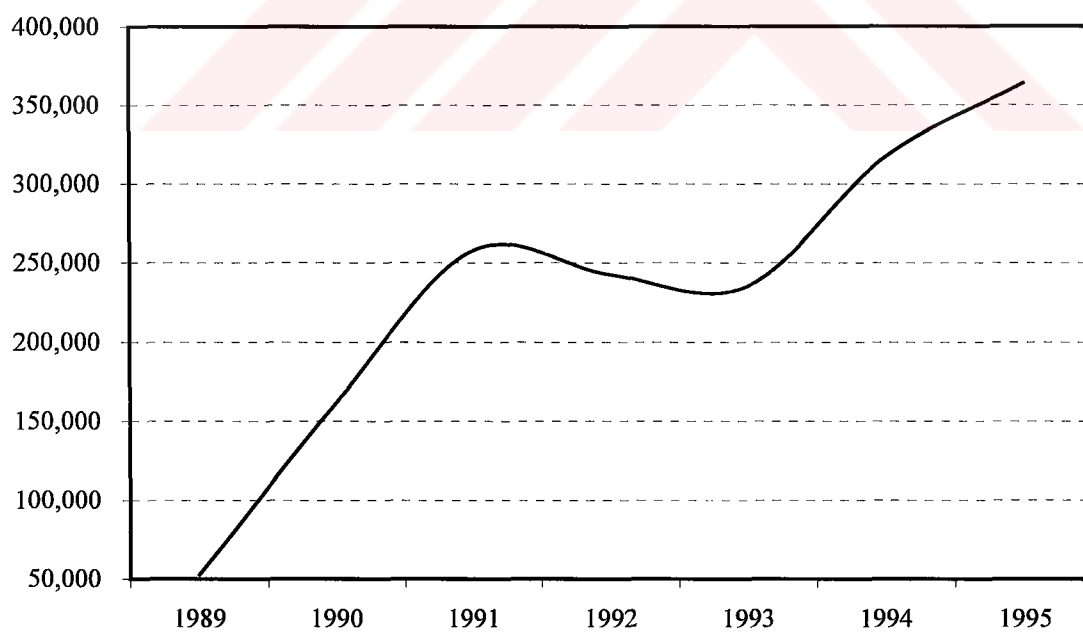


FIGURE B.2.2.2. Model Behavior of Active (In Force) Policies

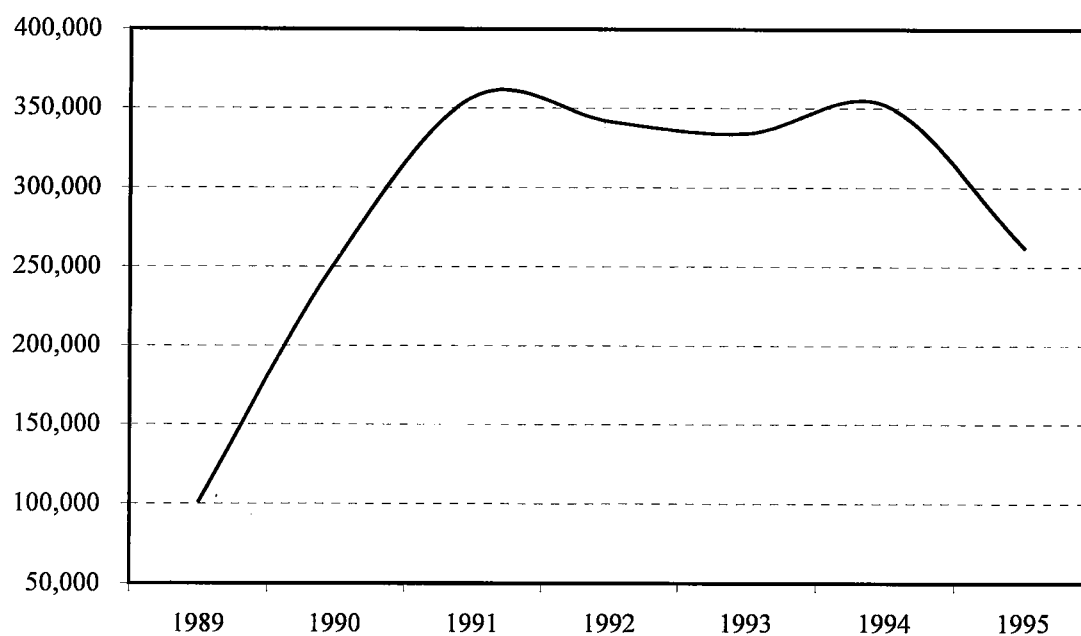


FIGURE B.2.3.1. Real Behavior of Underwritten (Created) Policies

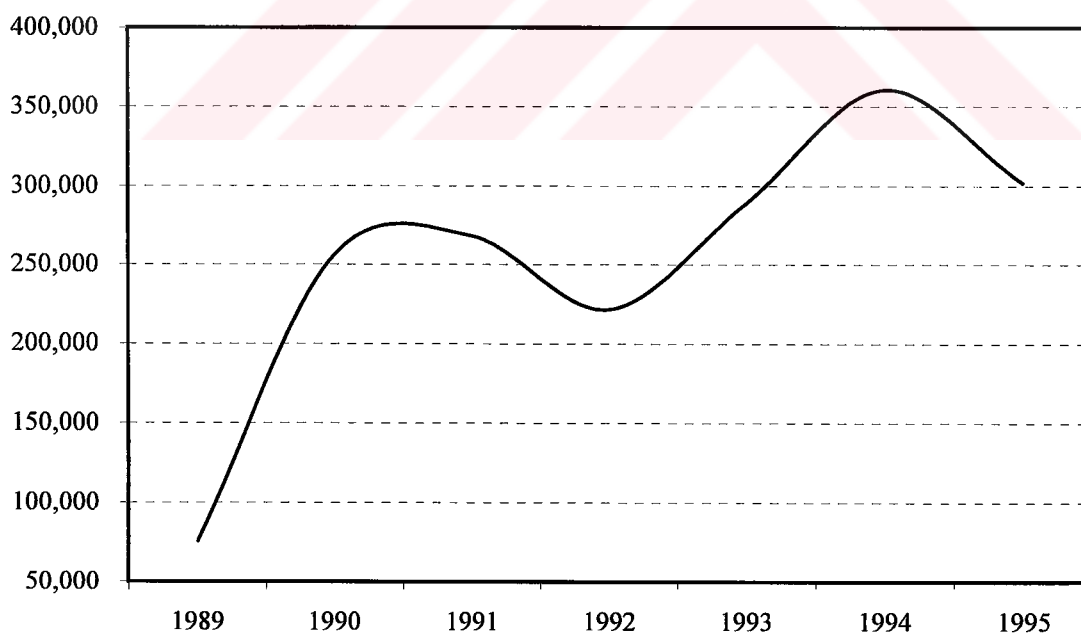


FIGURE B.2.3.2. Model Behavior of Underwritten (Created) Policies

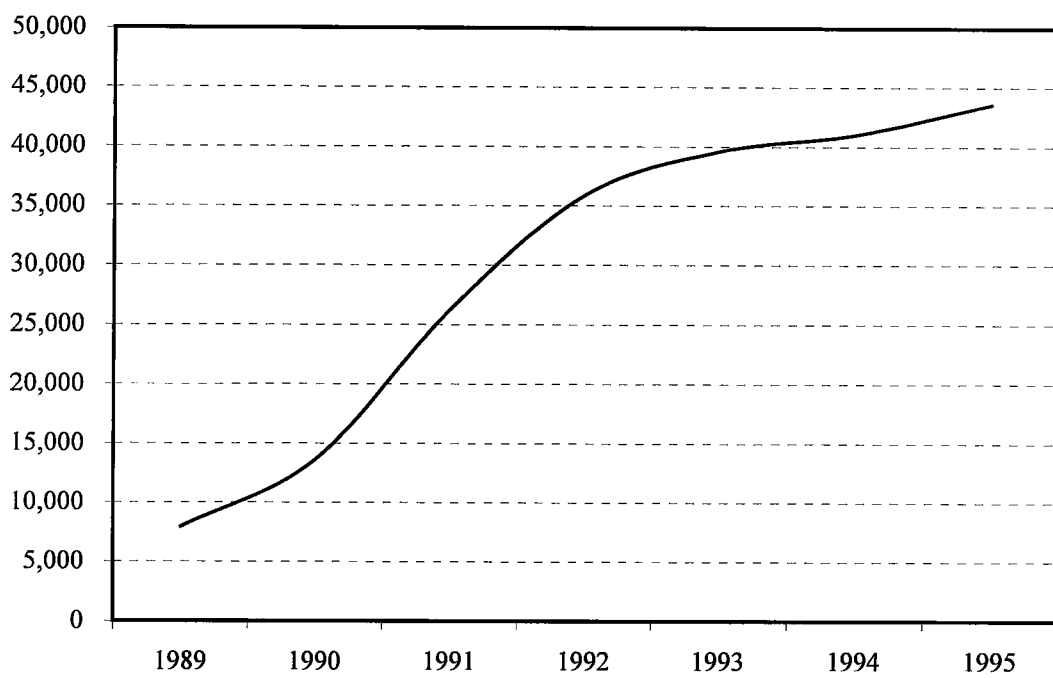


FIGURE B.2.4.1. Real Behavior of Claims

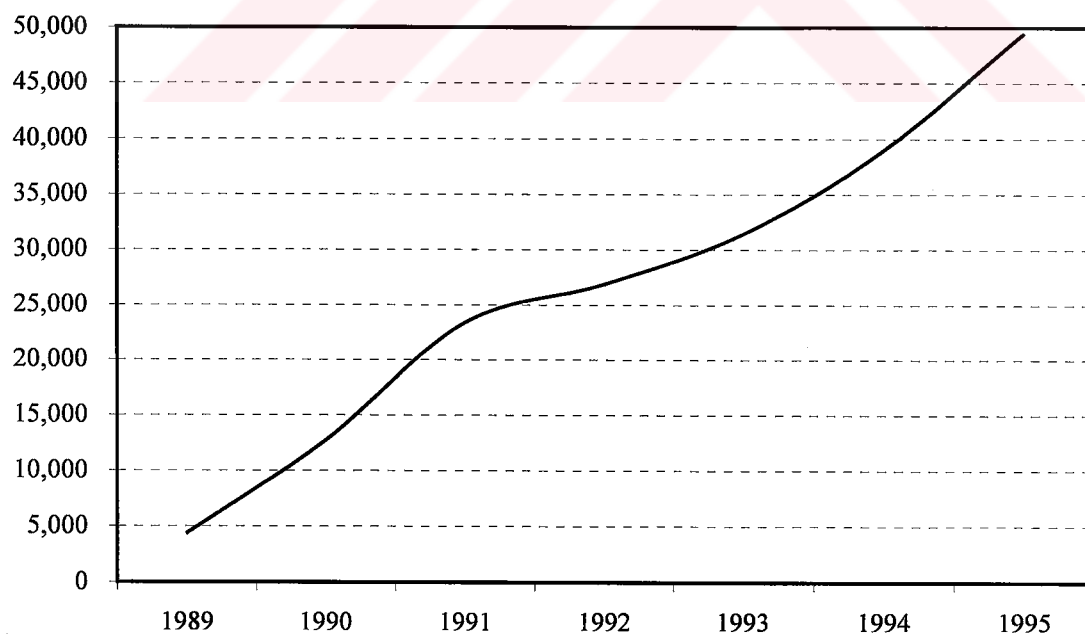


FIGURE B.2.4.2. Model Behavior of Claims

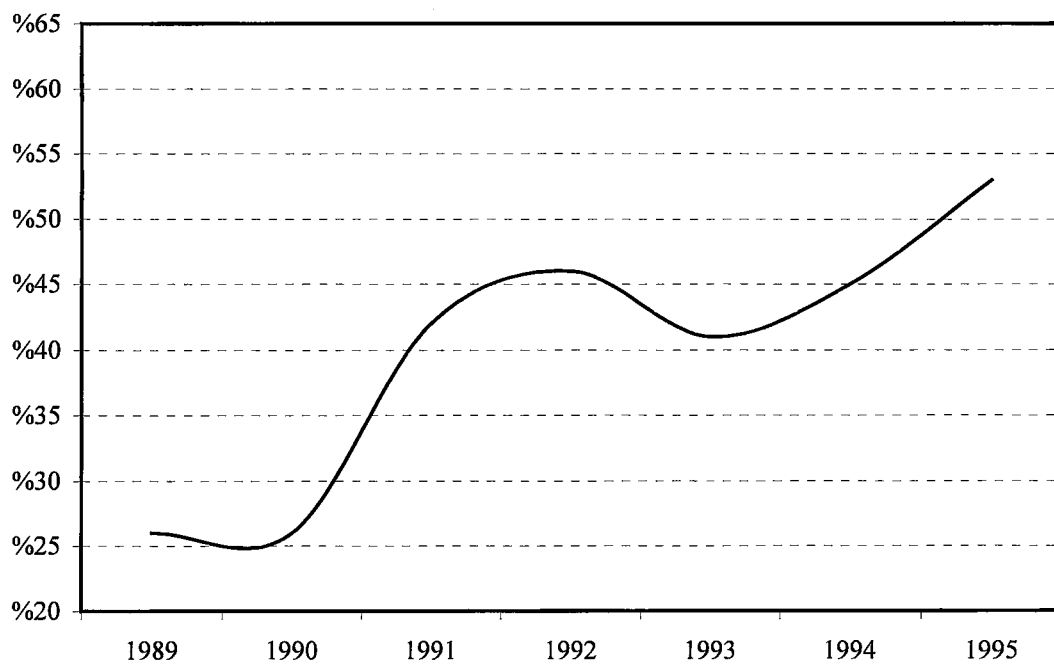


FIGURE B.2.5.1. Real Behavior of Loss Ratio

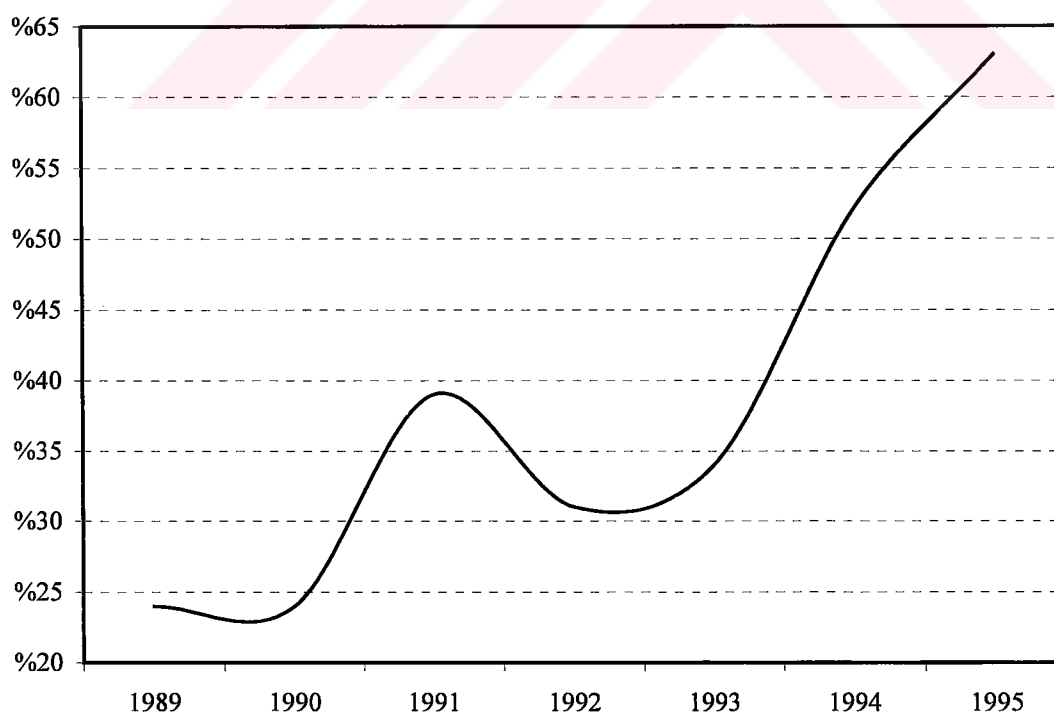


FIGURE B.2.5.2. Model Behavior of Loss Ratio

APPENDIX C

FIGURES OF GAME RESULTS

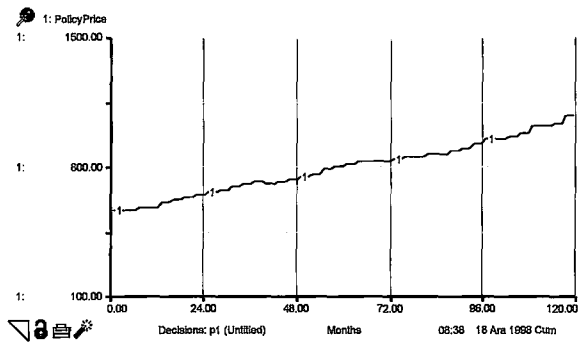


FIGURE C.1.1.1. Policy Price Decision of Player 1

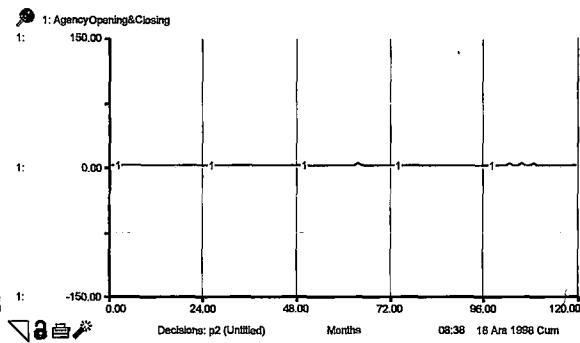


FIGURE C.1.1.2. Agency Opening Closing Decision of Player 1

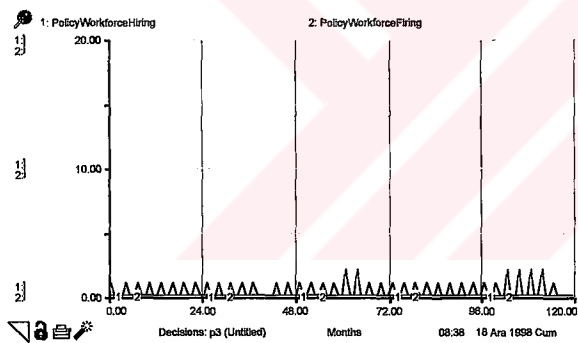


FIGURE C.1.1.3. Policy Work Force Hiring Firing Decision of Player 1

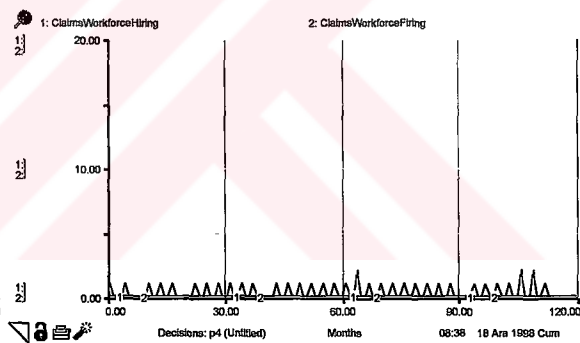


FIGURE C.1.1.4. Claims Work Force Hiring Firing Decision of Player 1

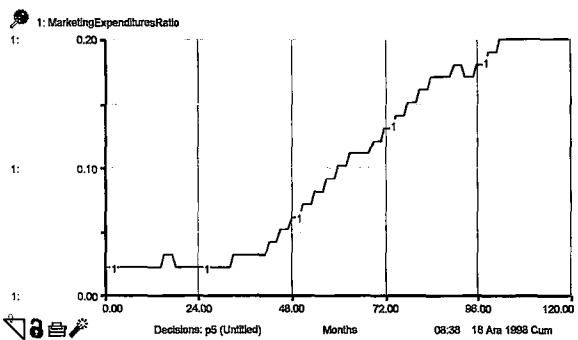


FIGURE C.1.1.5. Marketing Expenditures Ratio Decision of Player 1

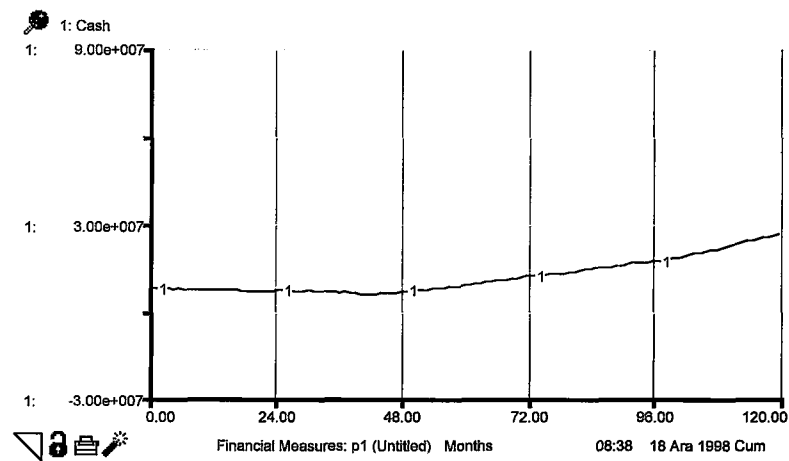


FIGURE C.1.2.1. Cash Position of Player 1

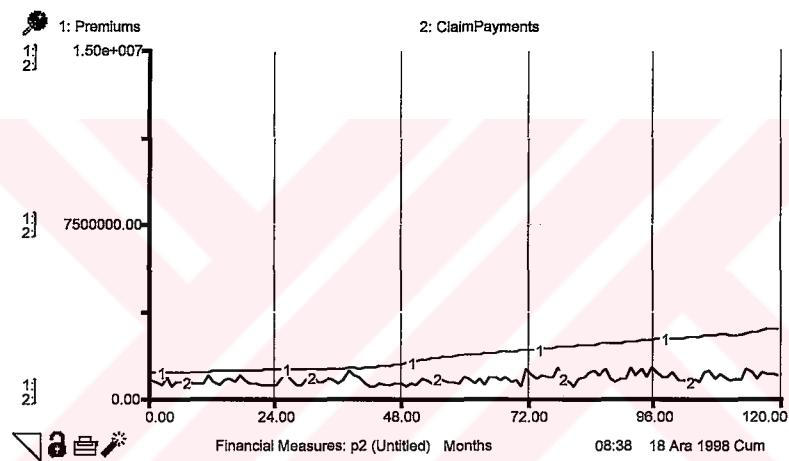


FIGURE C.1.2.2. Premiums and Claim Payments of Player 1

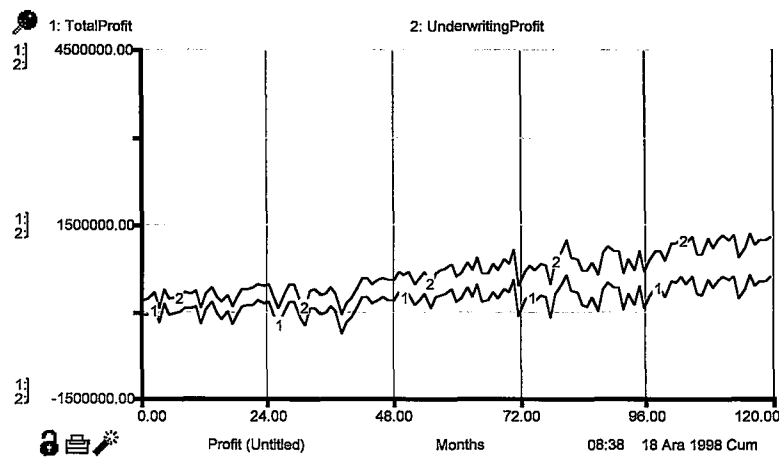


FIGURE C.1.2.3. Profits of Player 1

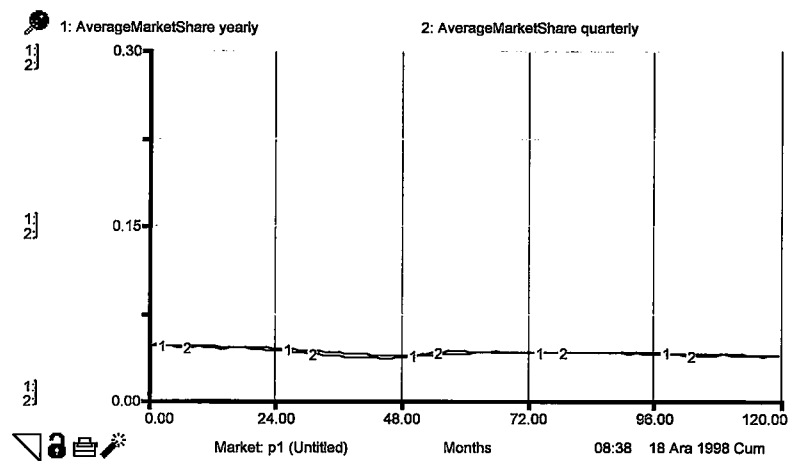


FIGURE C.1.2.4. Market Share of Player 1

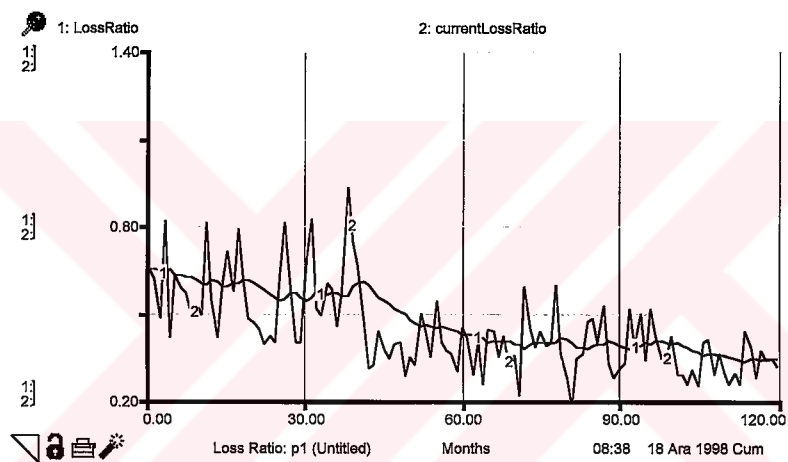


FIGURE C.1.2.5. Loss Ratio of Player 1

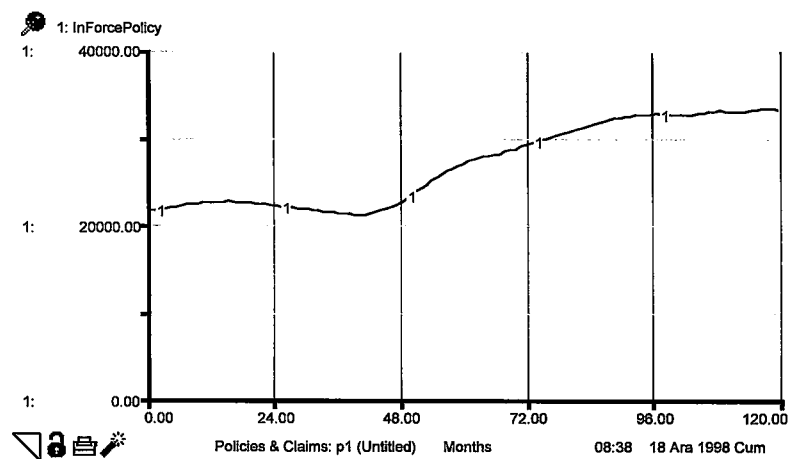


FIGURE C.1.2.6. Active Policies of Player 1

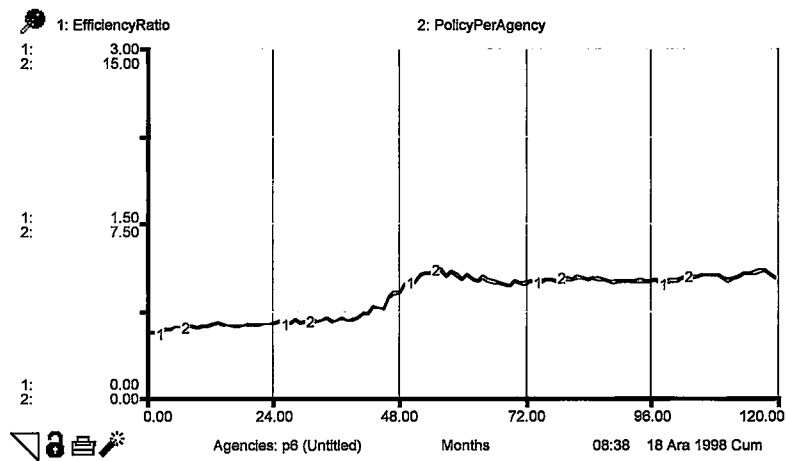


FIGURE C.1.2.7. Productivity Measures of Agencies of Player 1

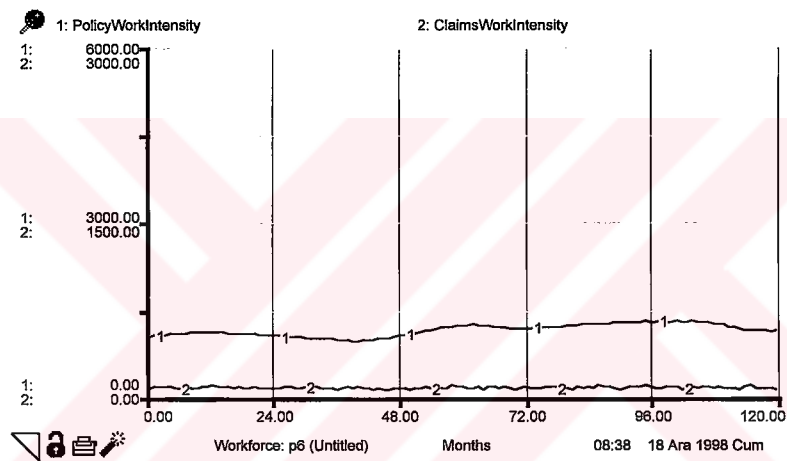


FIGURE C.1.2.8. Work Intensities of Player 1

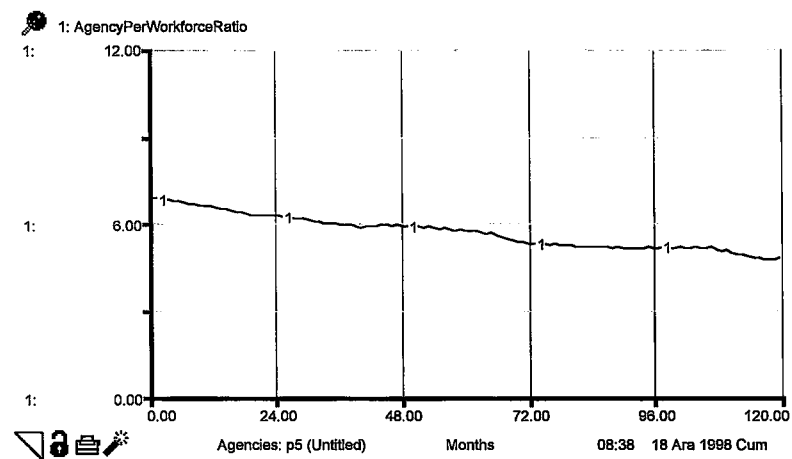


FIGURE C.1.2.9. Agency / Workforce Ratio of Player 1

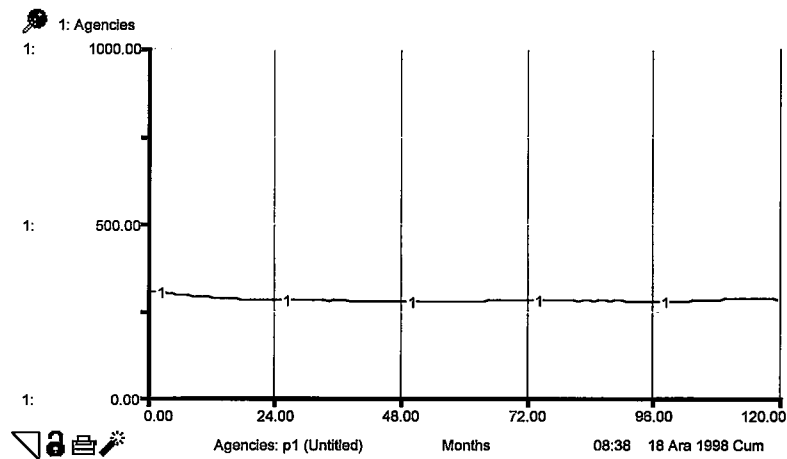


FIGURE C.1.2.10. Agencies of Player 1

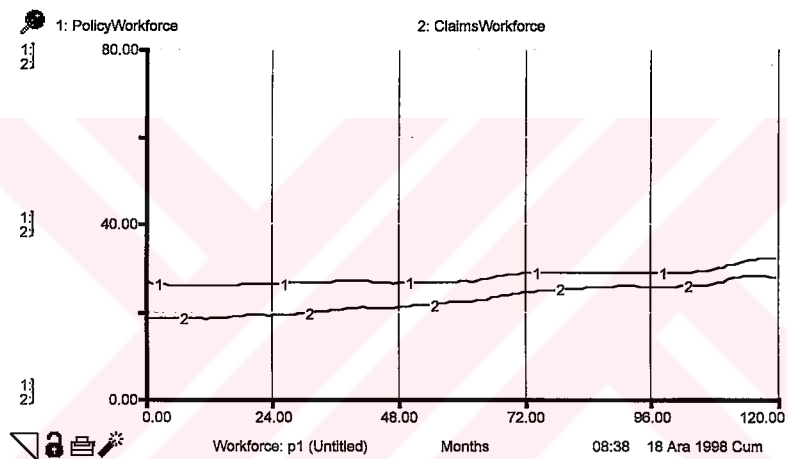


FIGURE C.1.2.11. Technical Work Force of Player 1

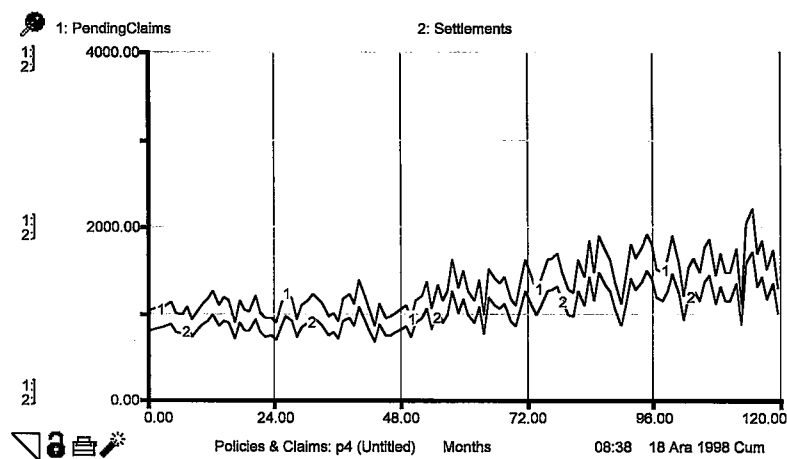


FIGURE C.1.2.12. Claims of Player 1

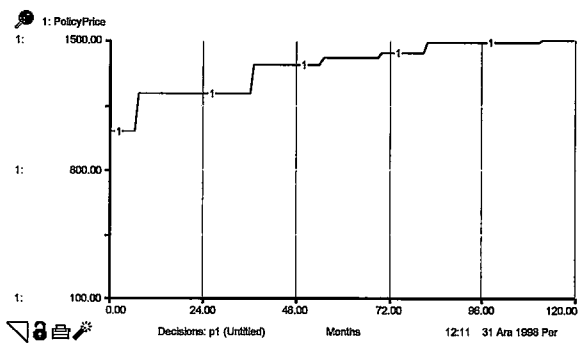


FIGURE C.2.1.1. Policy Price Decision
of Player 2

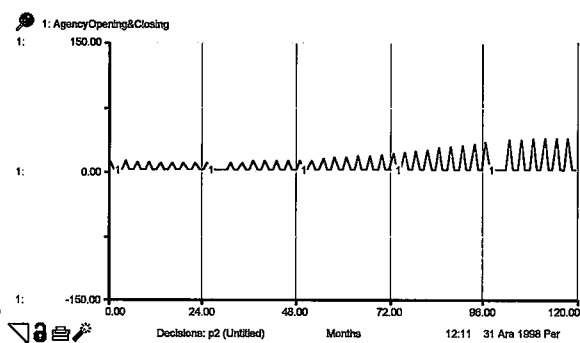


FIGURE C.2.1.2. Agency Opening
Closing Decision of Player 2

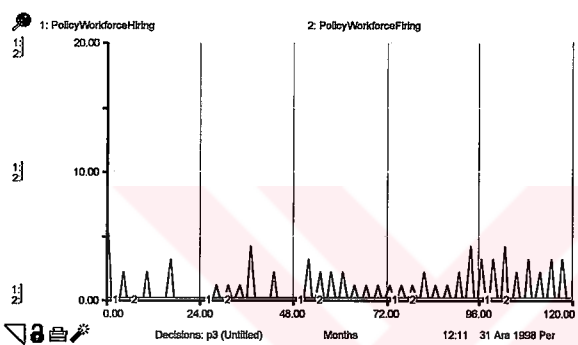


FIGURE C.2.1.3. Policy Work Force
Hiring Firing Decision of Player 2

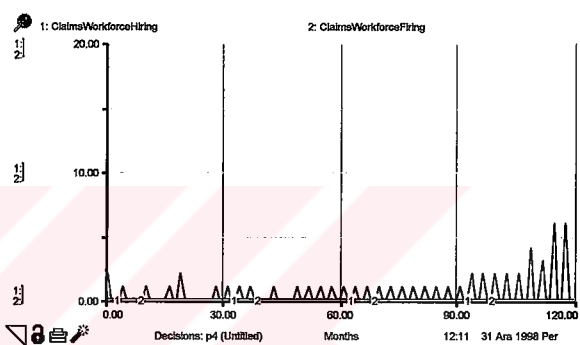


FIGURE C.2.1.4. Claims Work Force
Hiring Firing Decision of Player 2

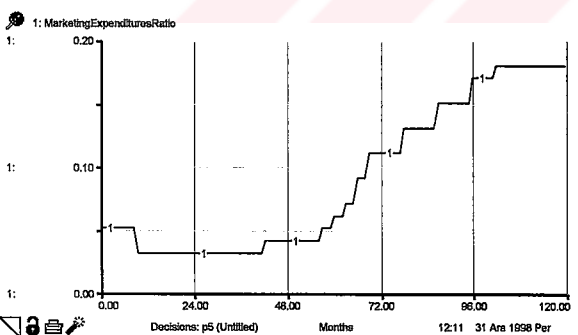


FIGURE C.2.1.5. Marketing
Expenditures Ratio Decision of Player 2

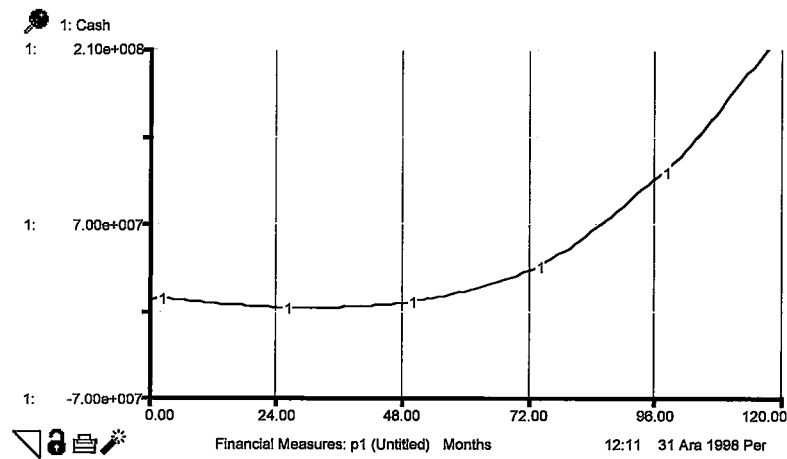


FIGURE C.2.2.1. Cash Position of Player 2

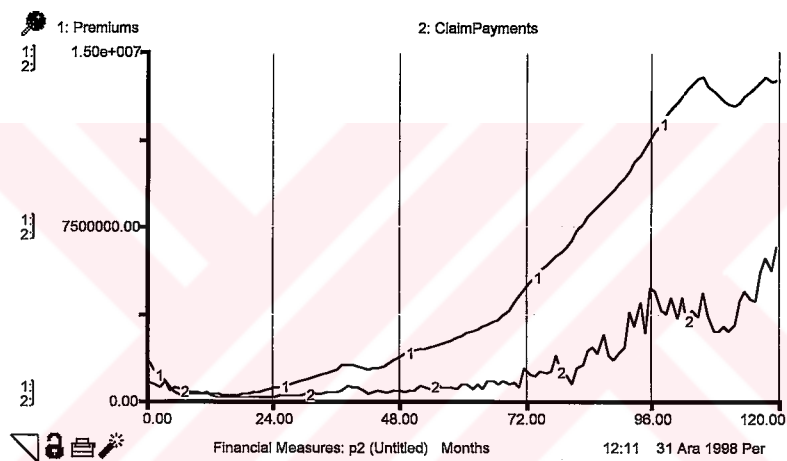


FIGURE C.2.2.2. Premiums and Claim Payments of Player 2

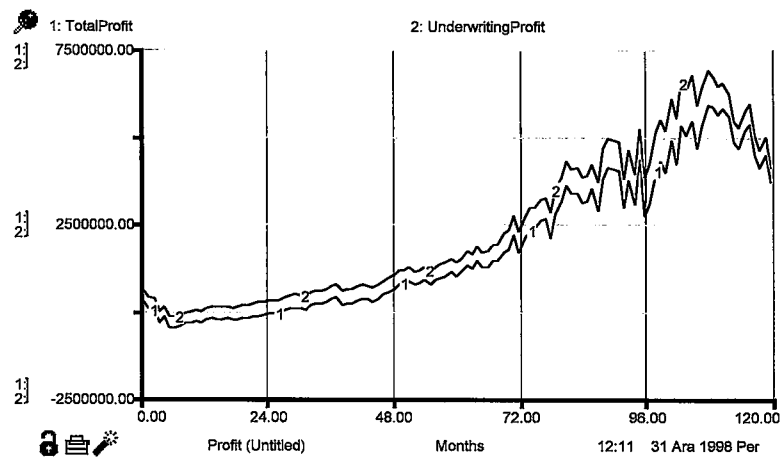


FIGURE C.2.2.3. Profits of Player 2

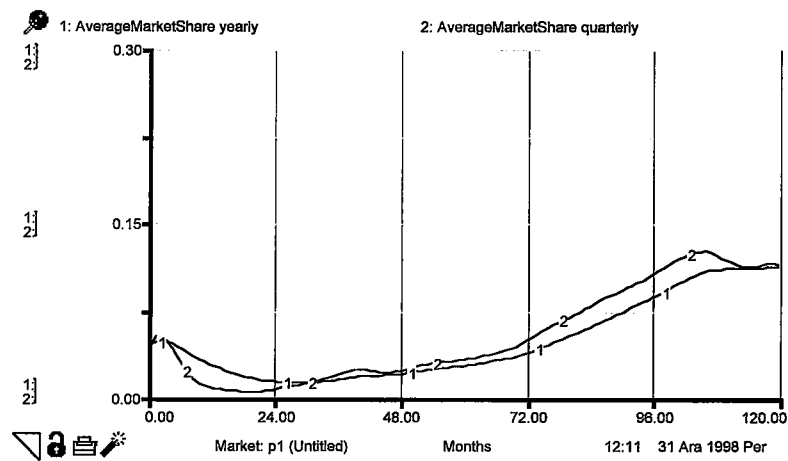


FIGURE C.2.2.4. Market Share of Player 2

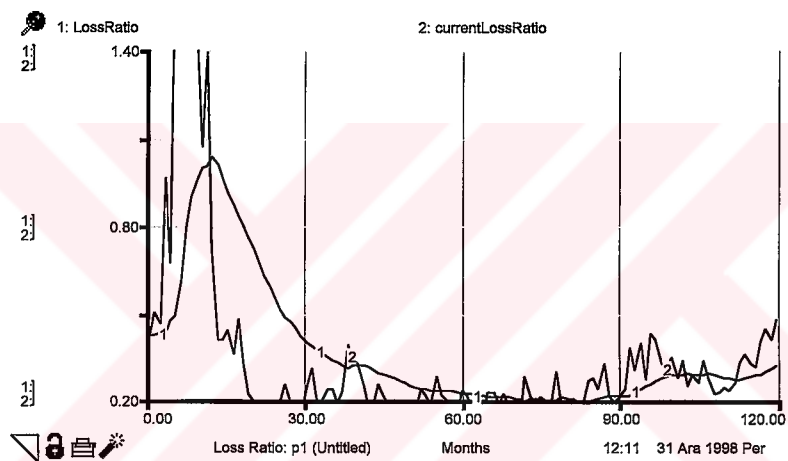


FIGURE C.2.2.5. Loss Ratio of Player 2

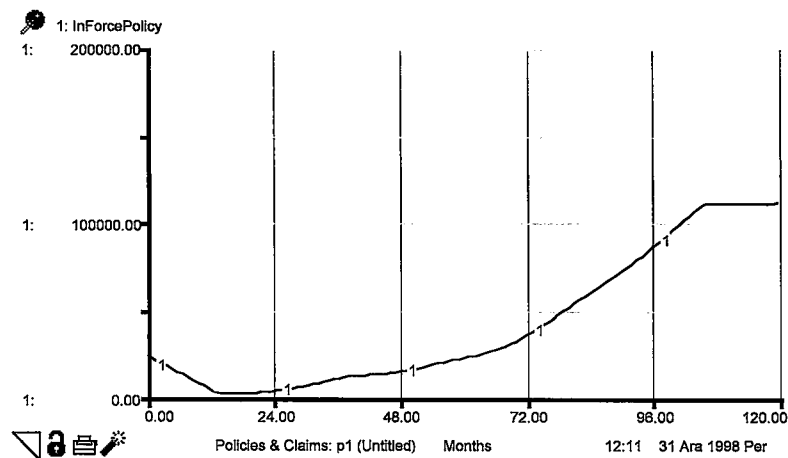


FIGURE C.2.2.6. Active Policies of Player 2

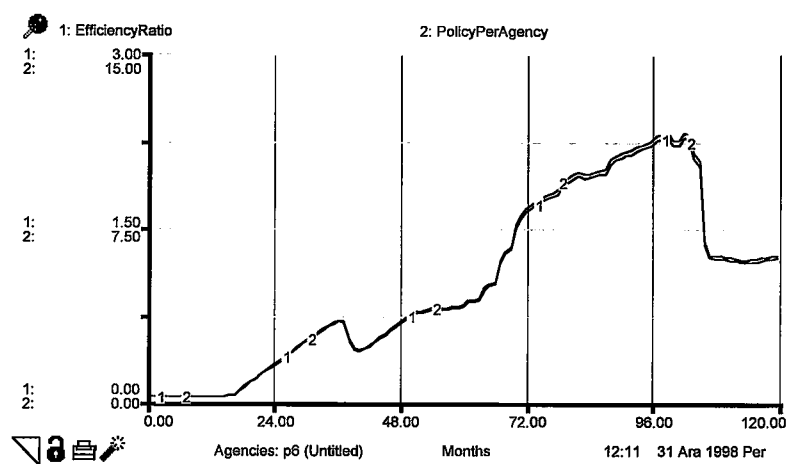


FIGURE C.2.2.7. Productivity Measures of Agencies of Player 2

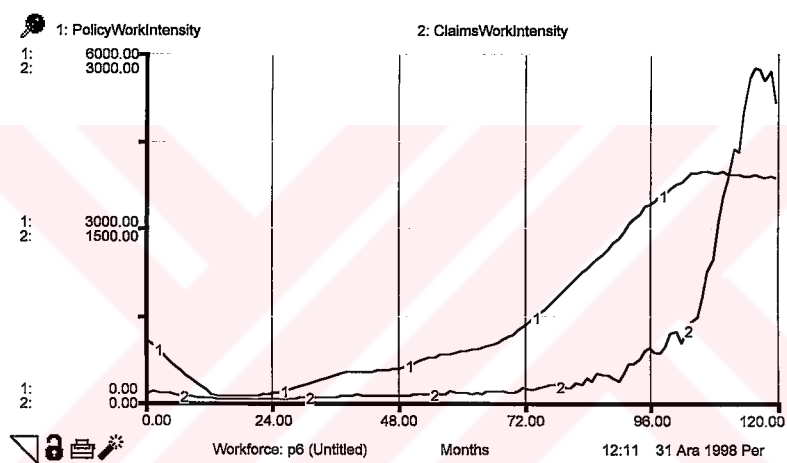


FIGURE C.2.2.8. Work Intensities of Player 2

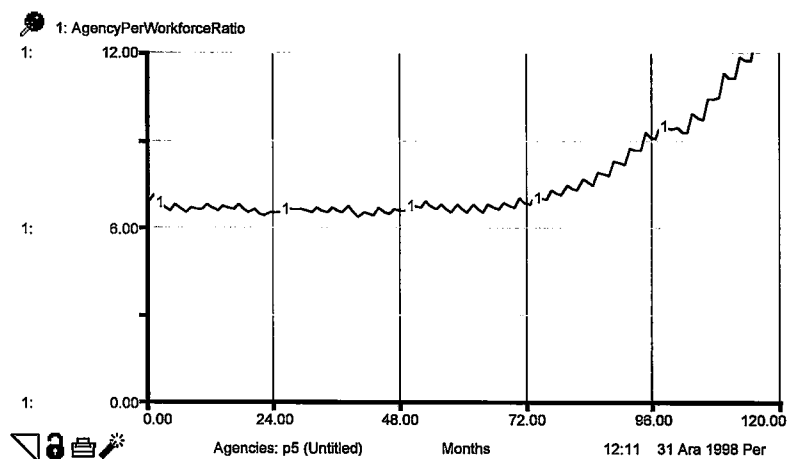


FIGURE C.2.2.9. Agency / Workforce Ratio of Player 2

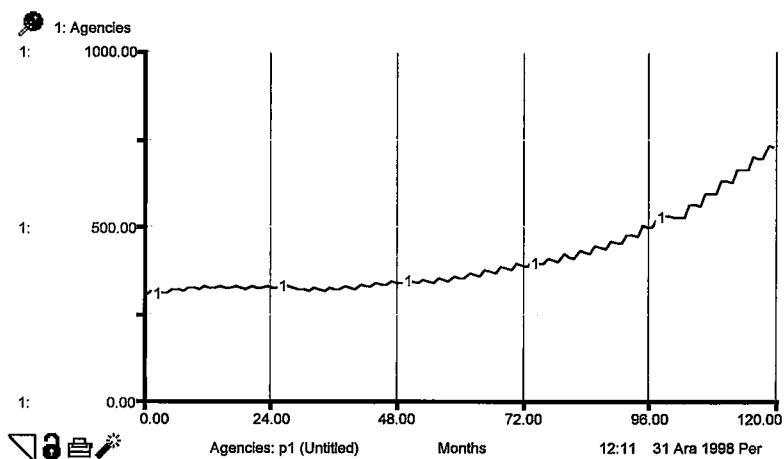


FIGURE C.2.2.10. Agencies of Player 2

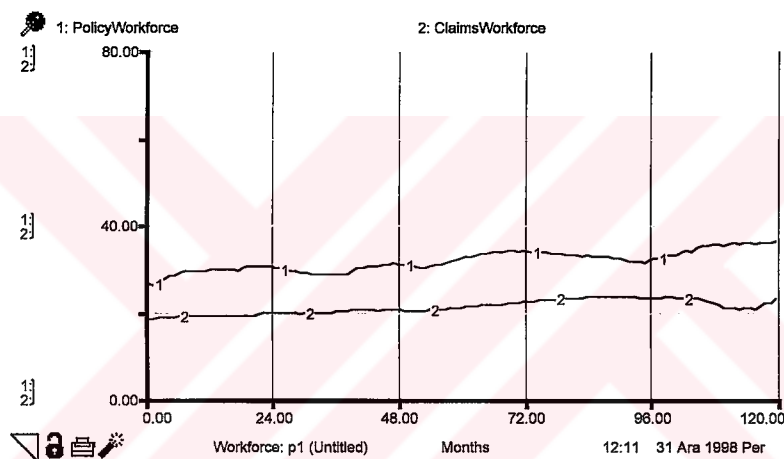


FIGURE C.2.2.11. Technical Work Force of Player 2

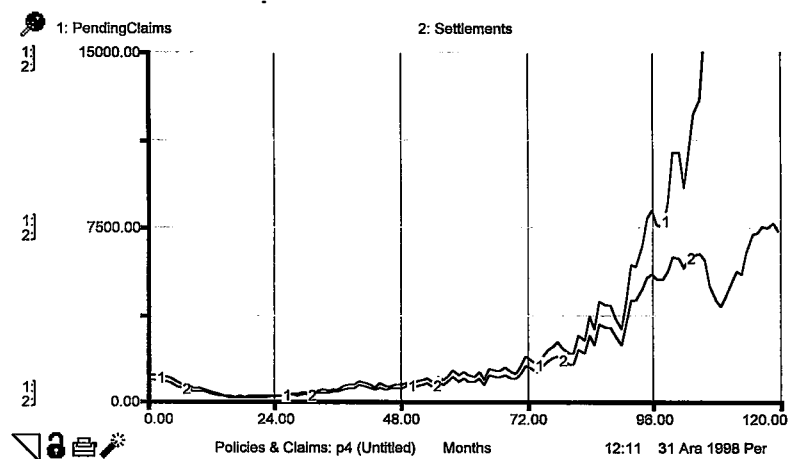


FIGURE C.2.2.12. Claims of Player 2

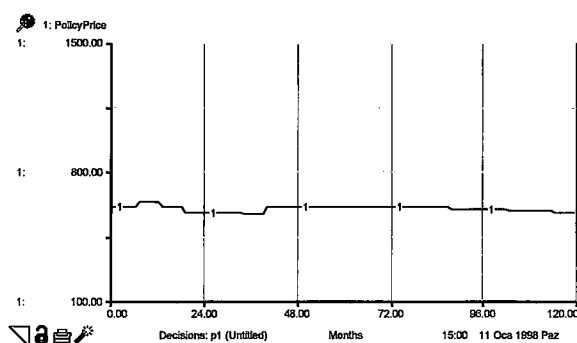


FIGURE C.3.1.1. Policy Price Decision of Player 3

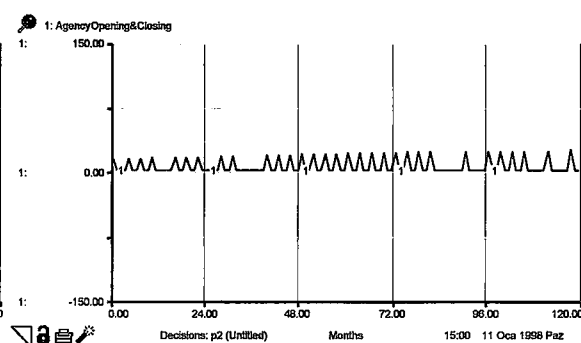


FIGURE C.3.1.2. Agency Opening Closing Decision of Player 3

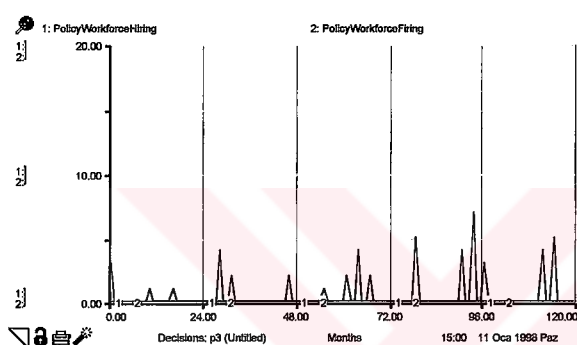


FIGURE C.3.1.3. Policy Work Force Hiring Firing Decision of Player 3

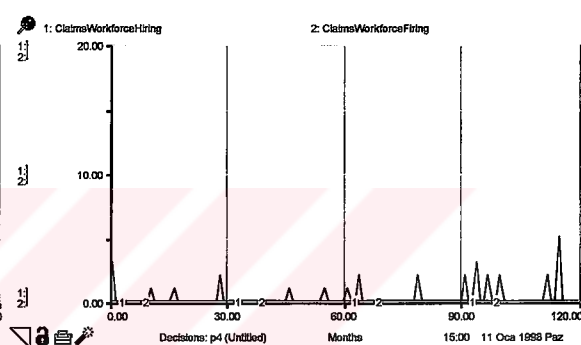


FIGURE C.3.1.4. Claims Work Force Hiring Firing Decision of Player 3

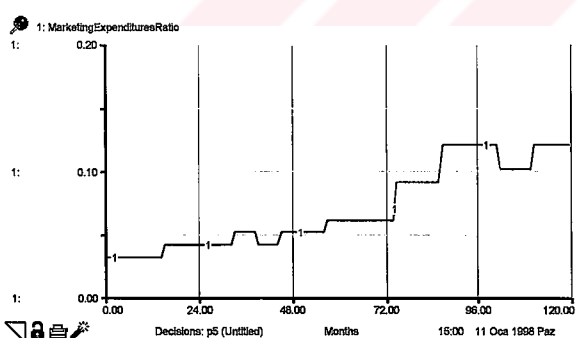


FIGURE C.3.1.5. Marketing Expenditures Ratio Decision of Player 3

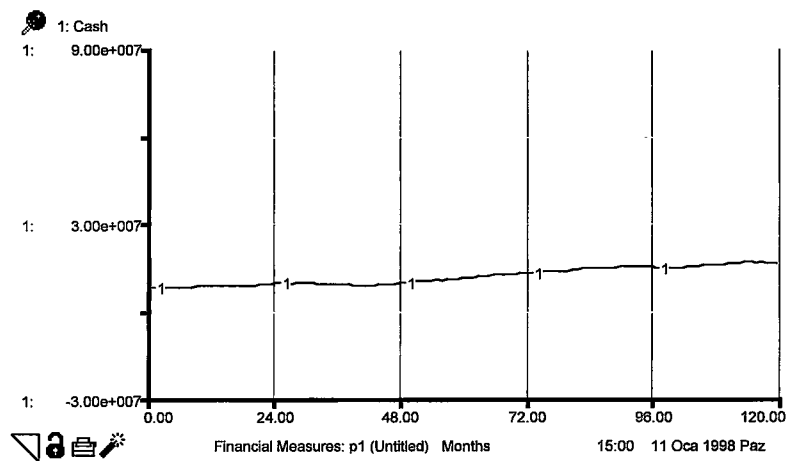


FIGURE C.3.2.1. Cash Position of Player 3

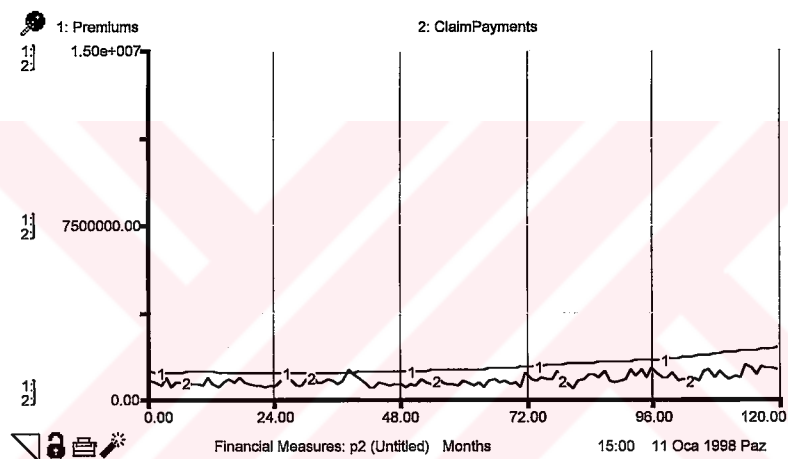


FIGURE C.3.2.2. Premiums and Claim Payments of Player 3

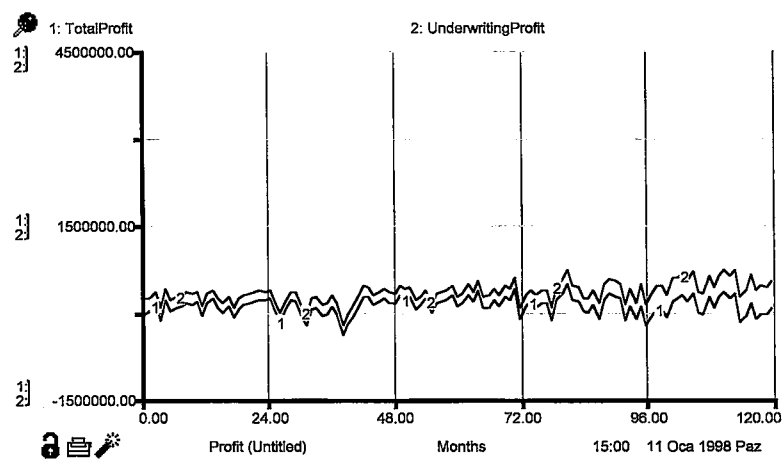


FIGURE C.3.2.3. Profits of Player 3

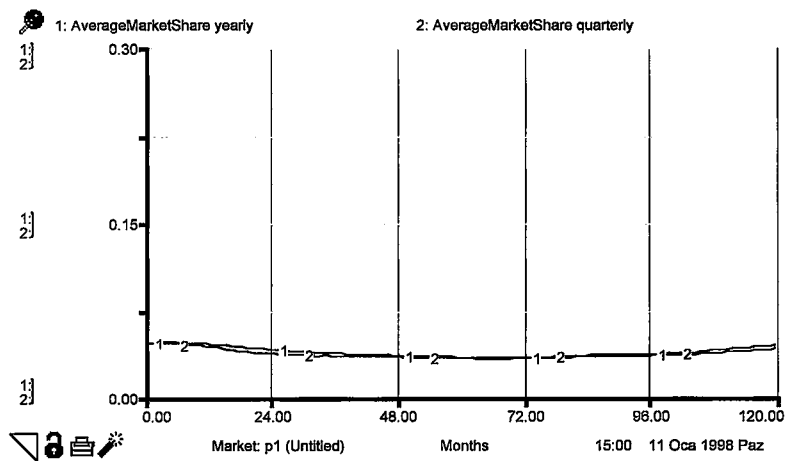


FIGURE C.3.2.4. Market Share of Player 3

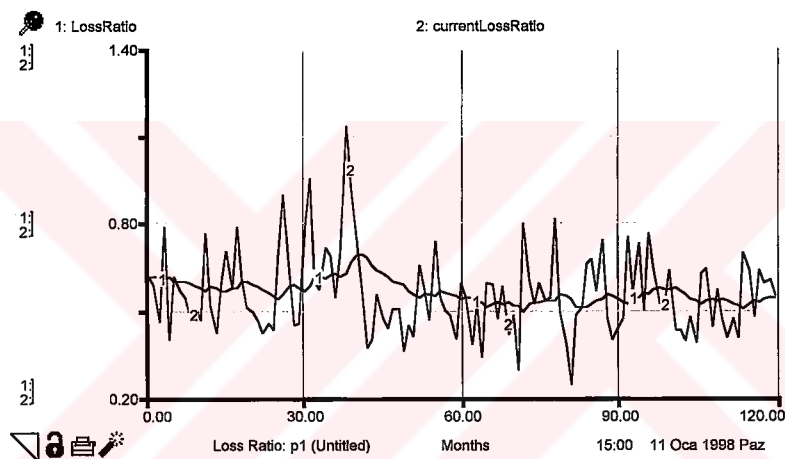


FIGURE C.3.2.5. Loss Ratio of Player 3

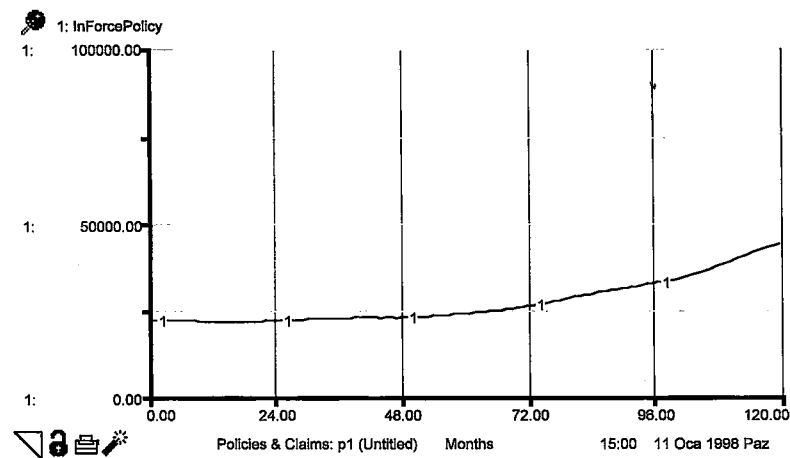


FIGURE C.3.2.6. Active Policies of Player 3

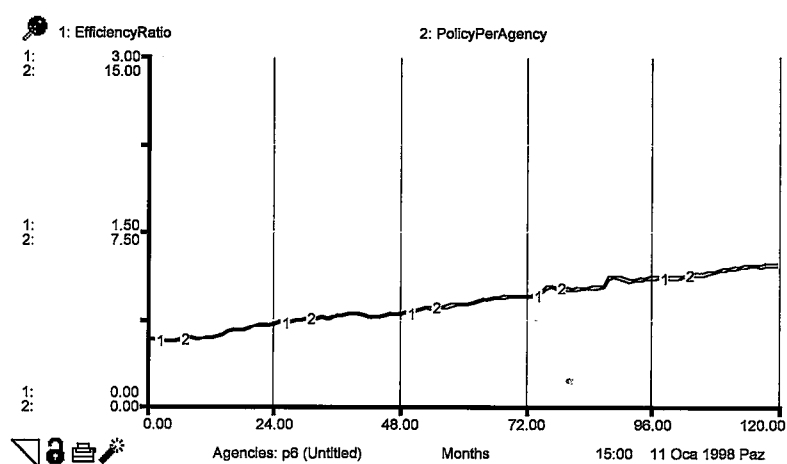


FIGURE C.3.2.7. Productivity Measures of Agencies of Player 3

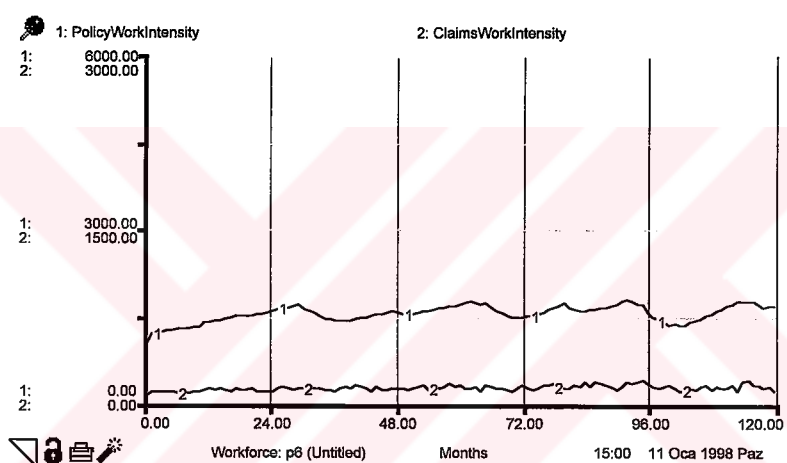


FIGURE C.3.2.8. Work Intensities of Player 3

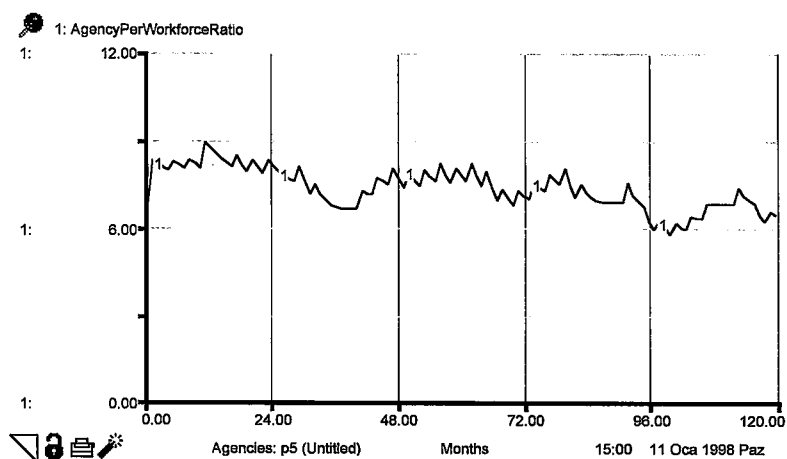


FIGURE C.3.2.9. Agency / Workforce Ratio of Player 3

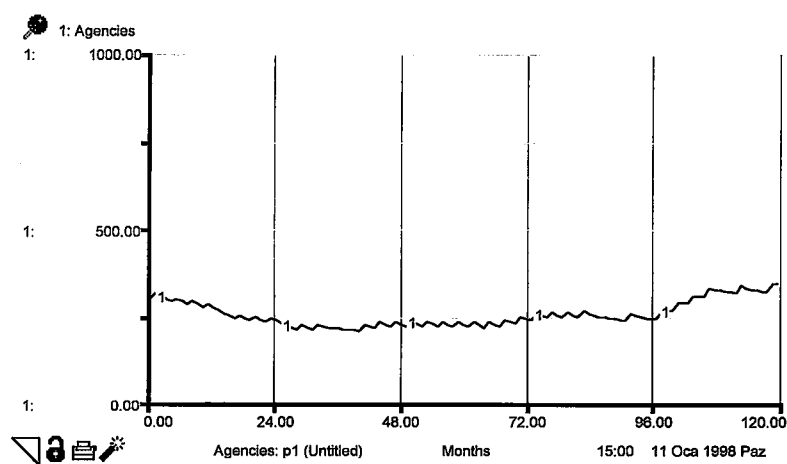


FIGURE C.3.2.10. Agencies of Player 3

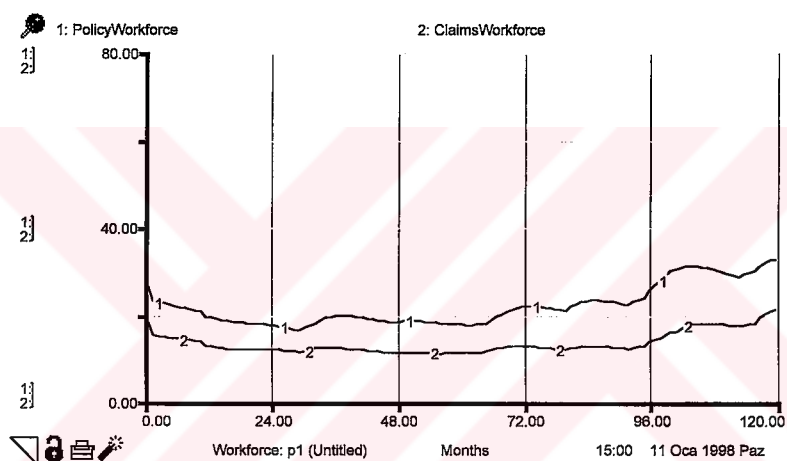


FIGURE C.3.2.11. Technical Work Force of Player 3

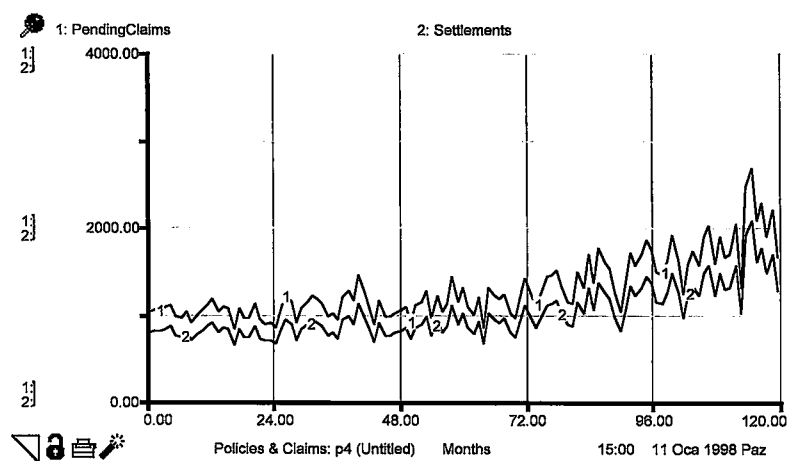


FIGURE C.3.2.12. Claims of Player 3

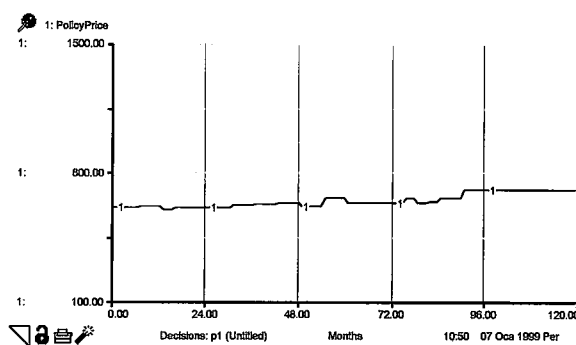


FIGURE C.4.1.1. Policy Price Decision of Player 4

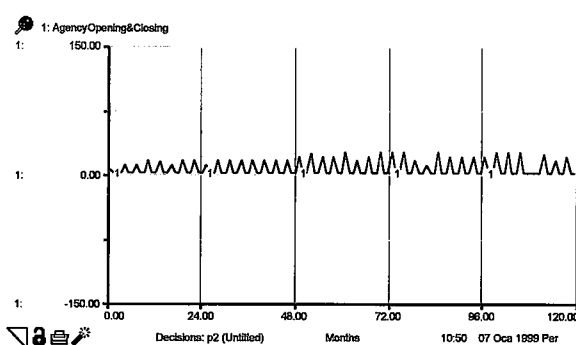


FIGURE C.4.1.2. Agency Opening Closing Decision of Player 4

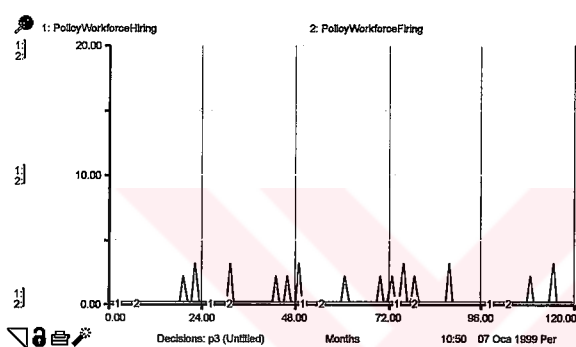


FIGURE C.4.1.3. Policy Work Force Hiring Firing Decision of Player 4

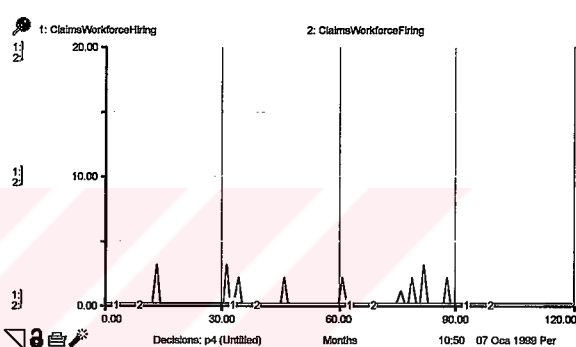


FIGURE C.4.1.4. Claims Work Force Hiring Firing Decision of Player 4

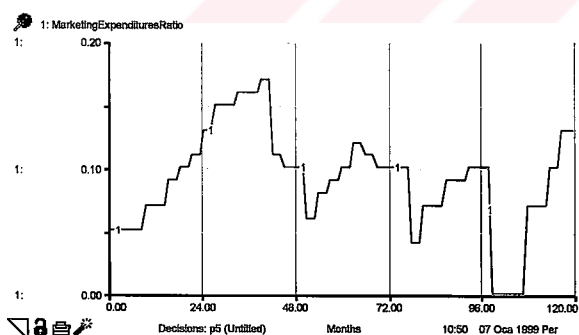


FIGURE C.4.1.5. Marketing Expenditures Ratio Decision of Player 4

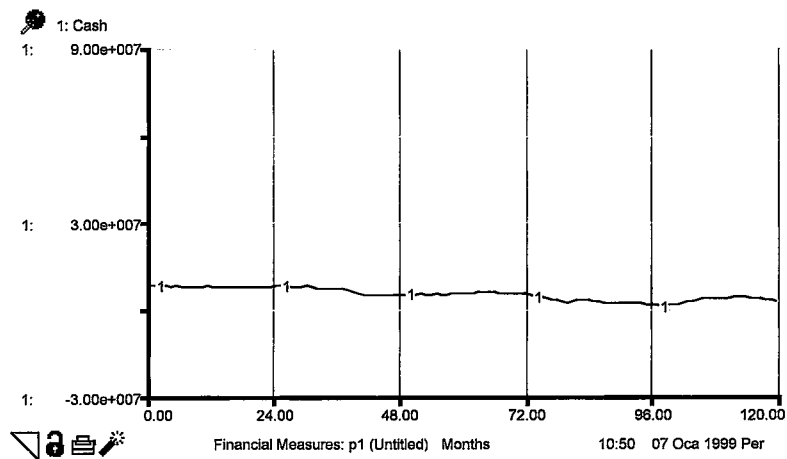


FIGURE C.4.2.1. Cash Position of Player 4

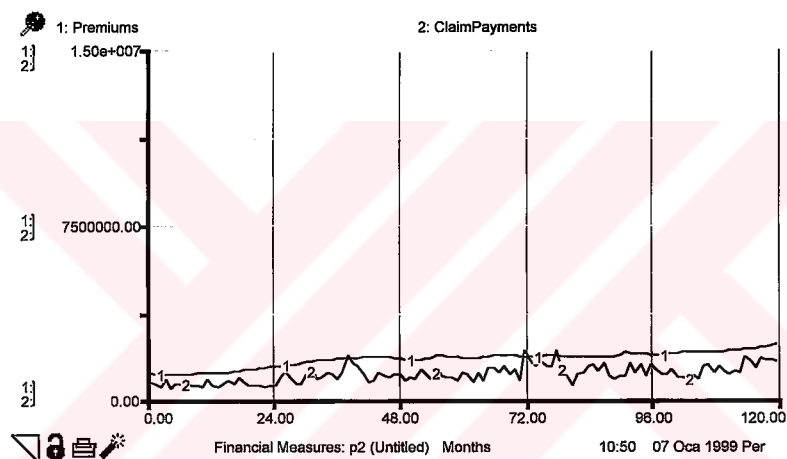


FIGURE C.4.2.2. Premiums and Claim Payments of Player 4

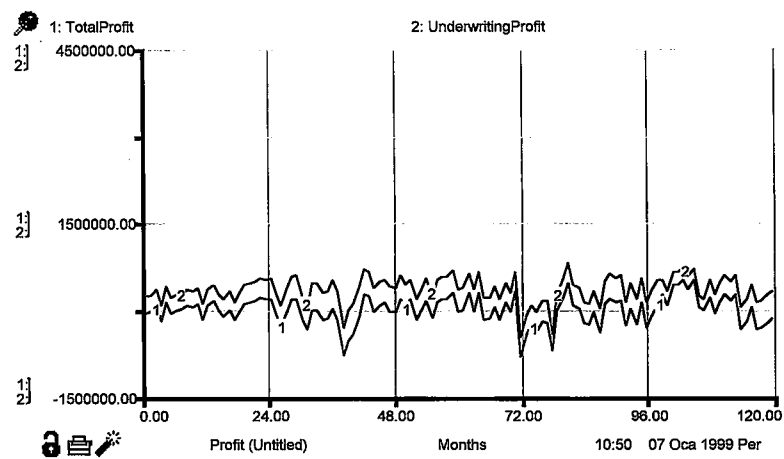


FIGURE C.4.2.3. Profits of Player 4

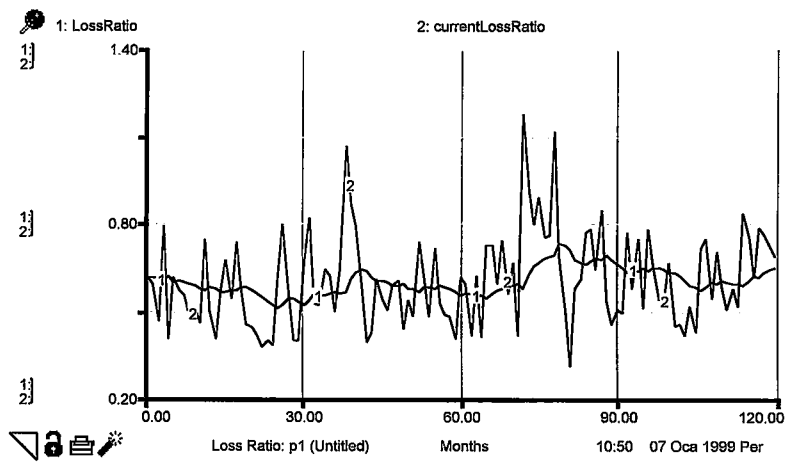


FIGURE C.4.2.5. Loss Ratio of Player 4

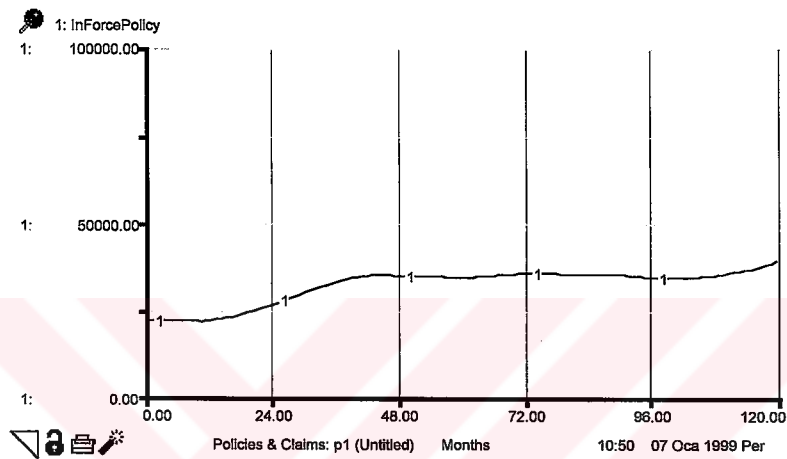


FIGURE C.4.2.6. Active Policies of Player 4

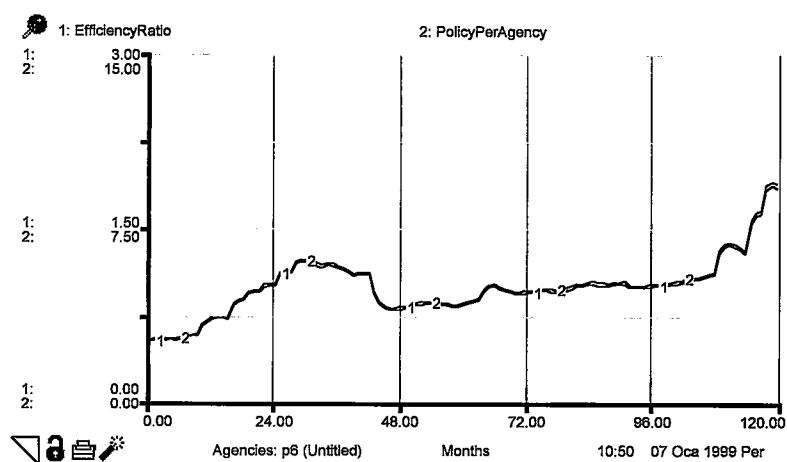


FIGURE C.4.2.7. Productivity Measures of Agencies of Player 4

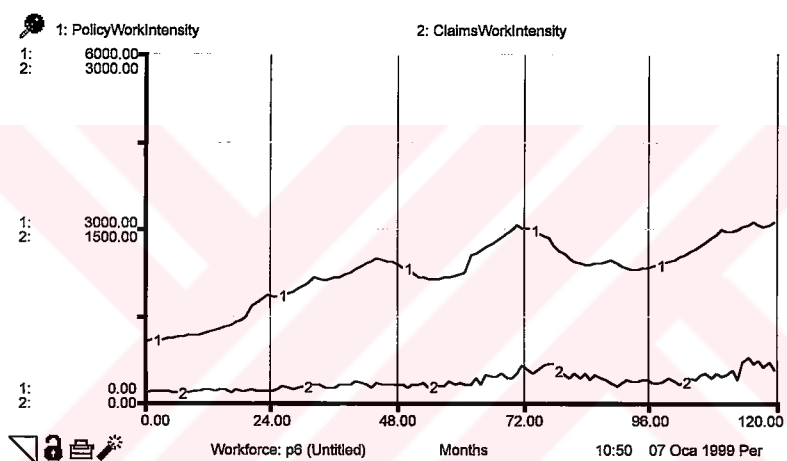


FIGURE C.4.2.8. Work Intensities of Player 4

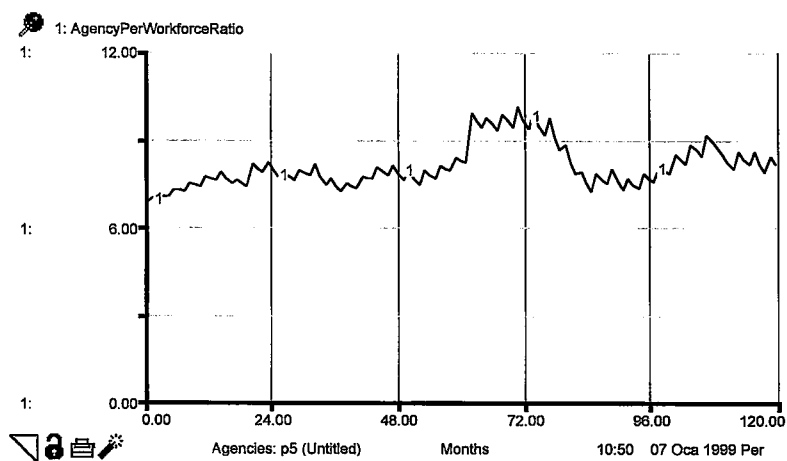


FIGURE C.4.2.9. Agency / Workforce Ratio of Player 4

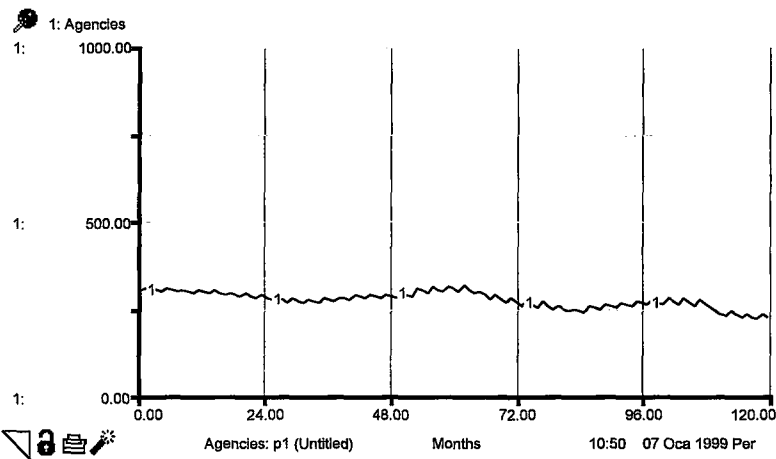


FIGURE C.4.2.10. Agencies of Player 4

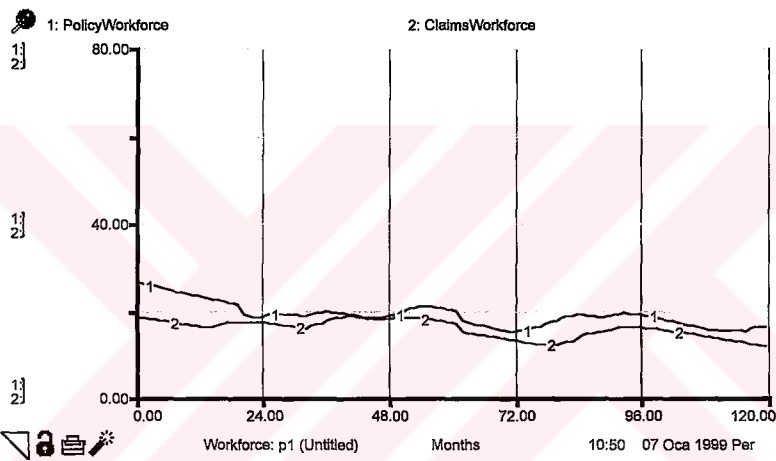


FIGURE C.4.2.11. Technical Work Force of Player 4

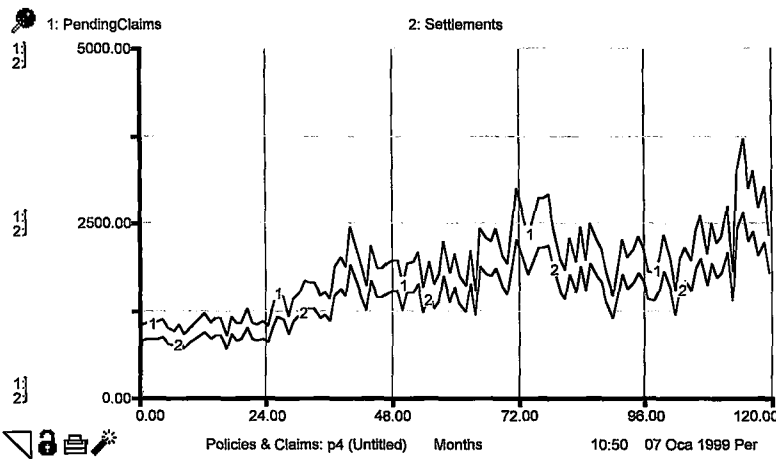


FIGURE C.4.2.12. Claims of Player 4

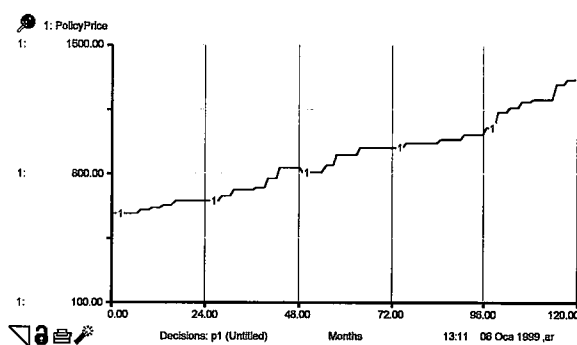


FIGURE C.5.1.1. Policy Price Decision of Player 5

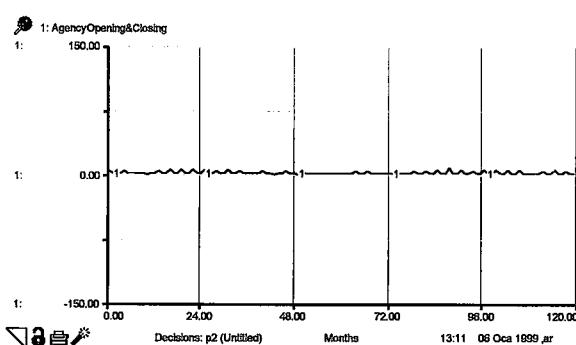


FIGURE C.5.1.2. Agency Opening Closing Decision of Player 5

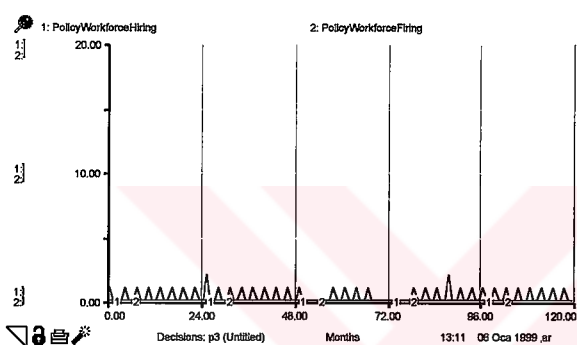


FIGURE C.5.1.3. Policy Work Force Hiring Firing Decision of Player 5

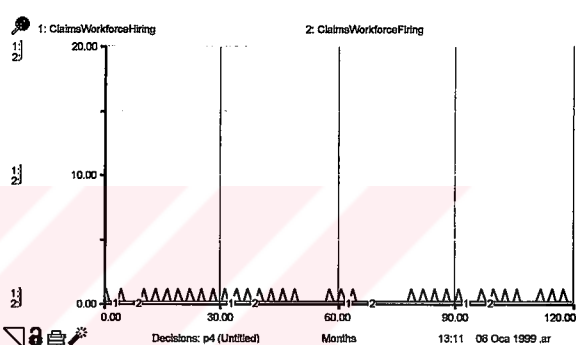


FIGURE C.5.1.4. Claims Work Force Hiring Firing Decision of Player 5

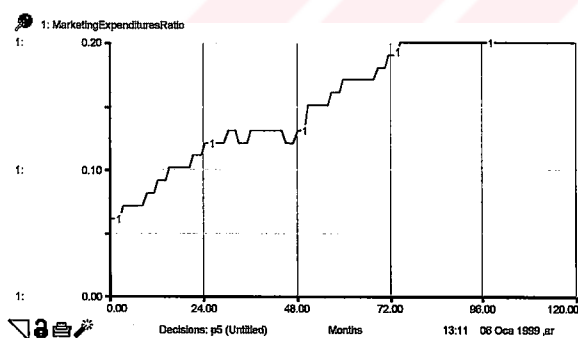


FIGURE C.5.1.5. Marketing Expenditures Ratio Decision of Player 5

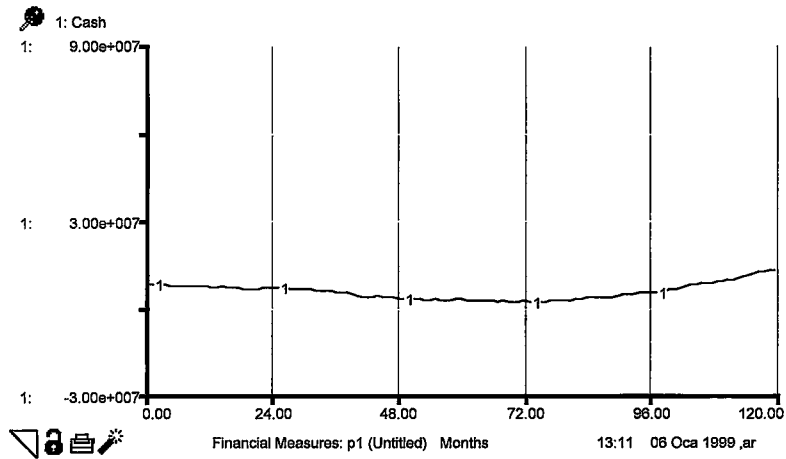


FIGURE C.5.2.1. Cash Position of Player 5

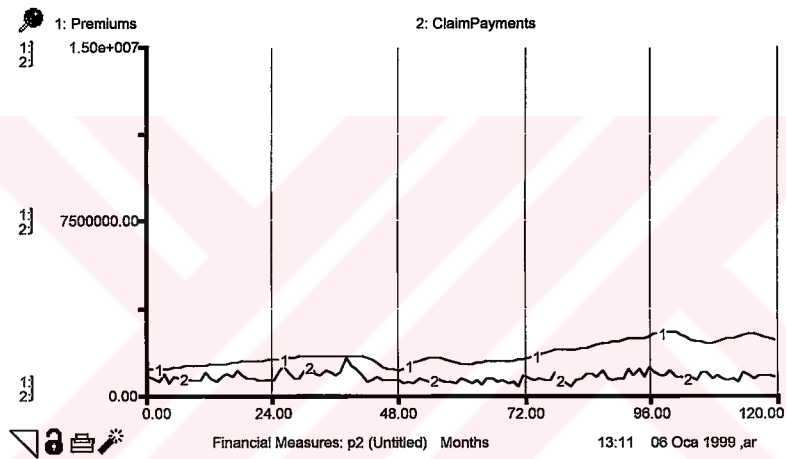


FIGURE C.5.2.2. Premiums and Claim Payments of Player 5

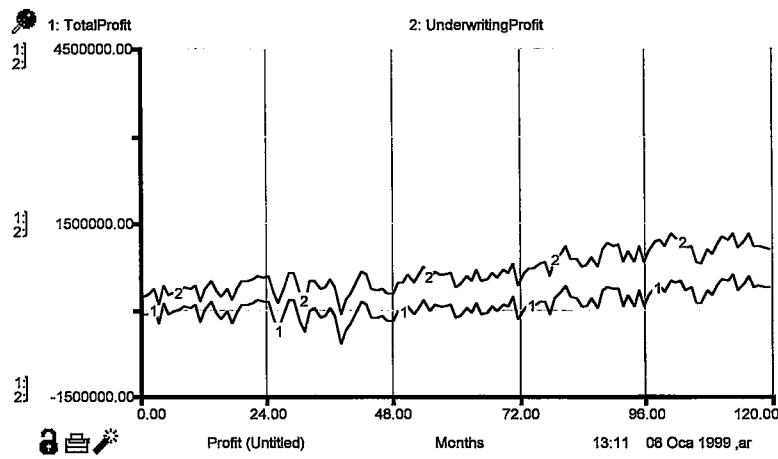


FIGURE C.5.2.3. Profits of Player 5

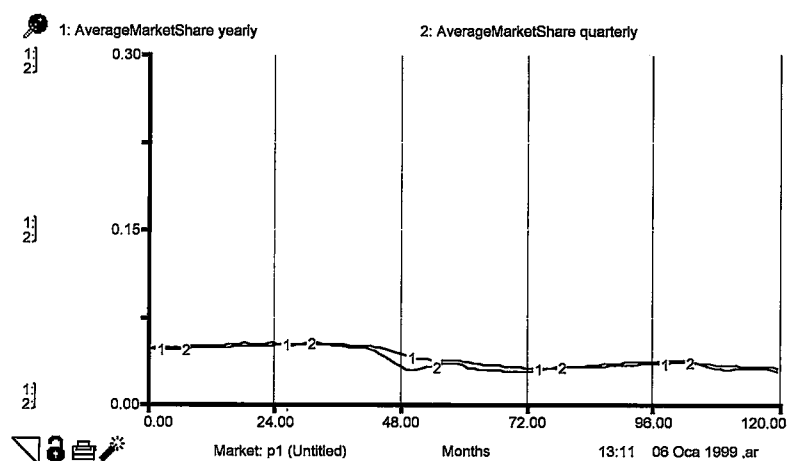


FIGURE C.5.2.4. Market Share of Player 5

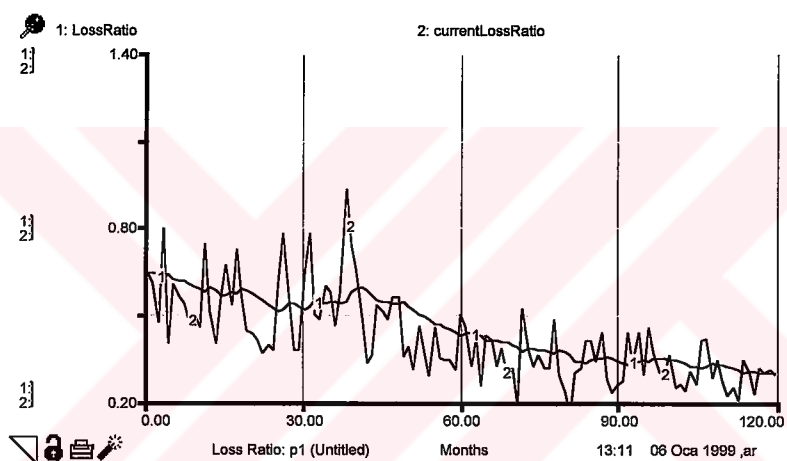


FIGURE C.5.2.5. Loss Ratio of Player 5

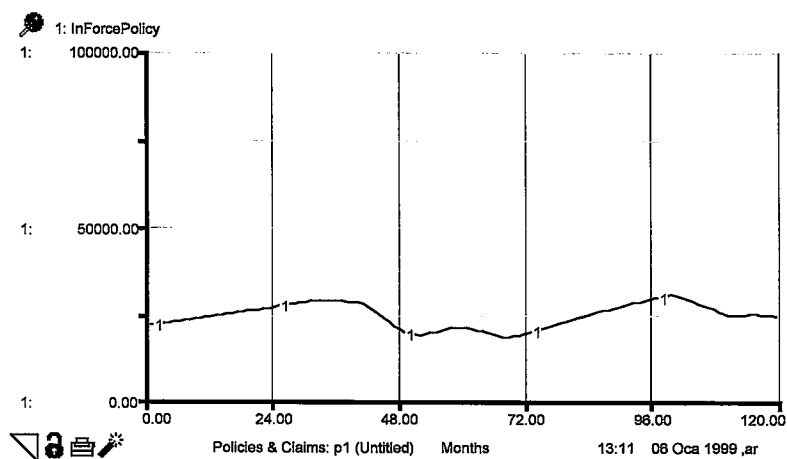


FIGURE C.5.2.6. Active Policies of Player 5

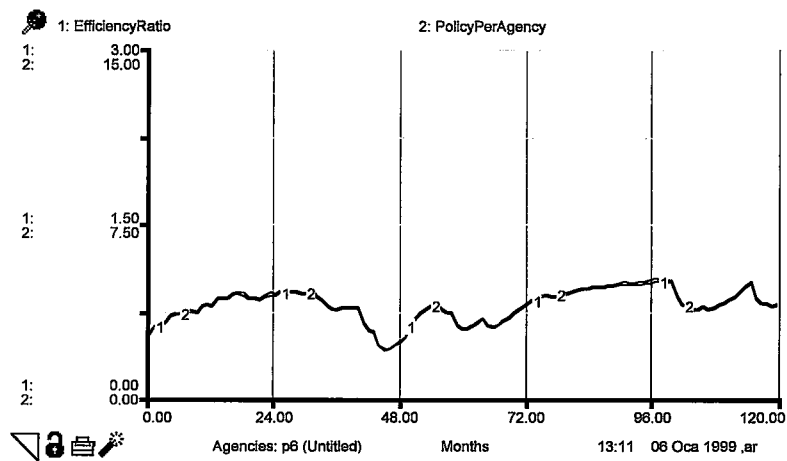


FIGURE C.5.2.7. Productivity Measures of Agencies of Player 5

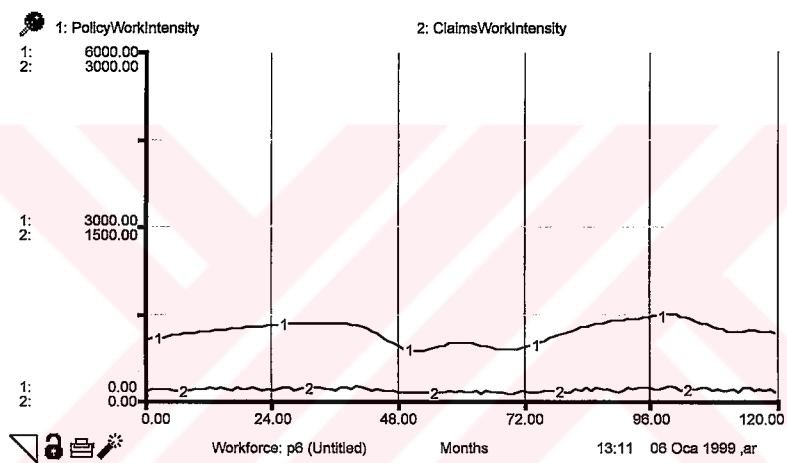


FIGURE C.5.2.8. Work Intensities of Player 5

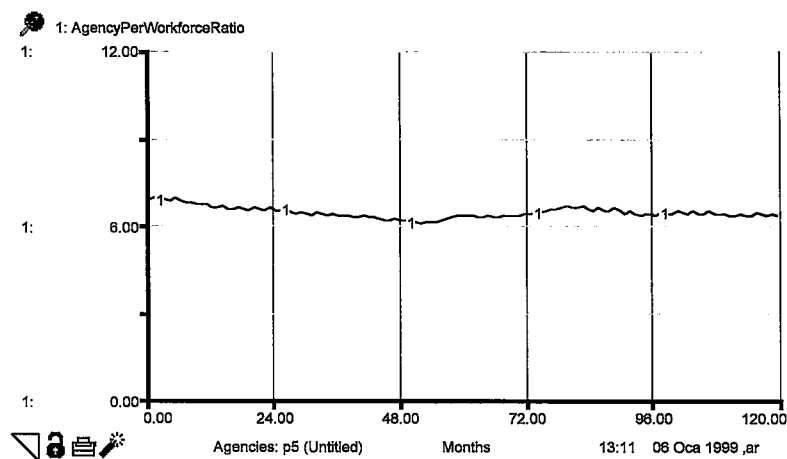


FIGURE C.5.2.9. Agency / Workforce Ratio of Player 5

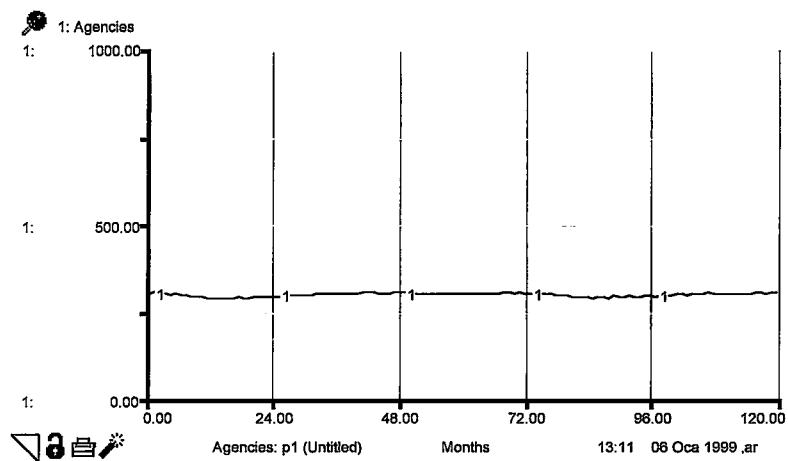


FIGURE C.5.2.10. Agencies of Player 5

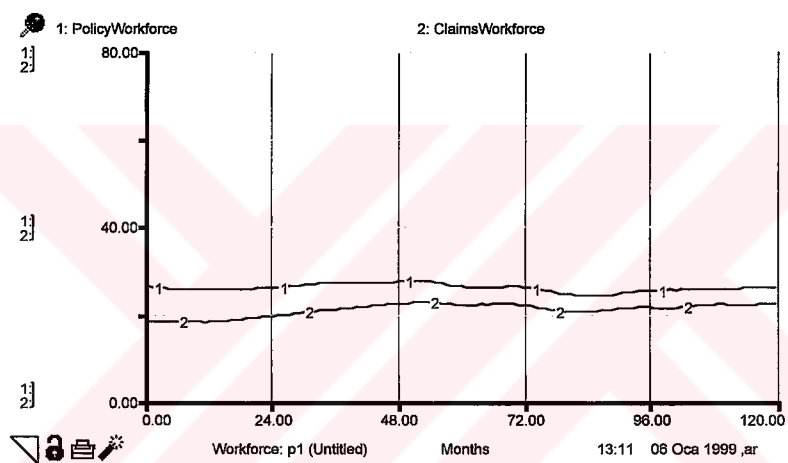


FIGURE C.5.2.11. Technical Work Force of Player 5

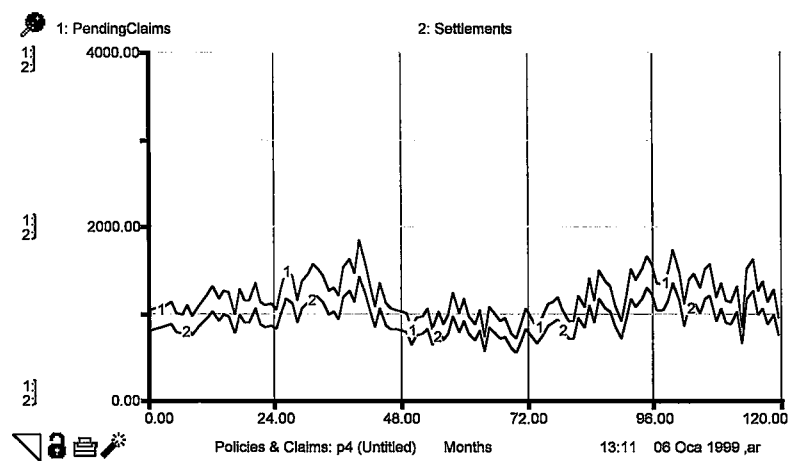


FIGURE C.5.2.12. Claims of Player 5

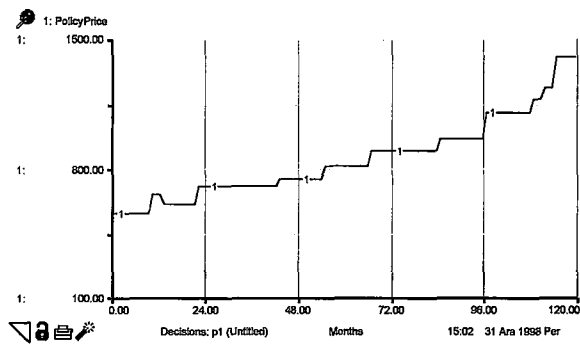


FIGURE C.6.1.1. Policy Price Decision of Player 6

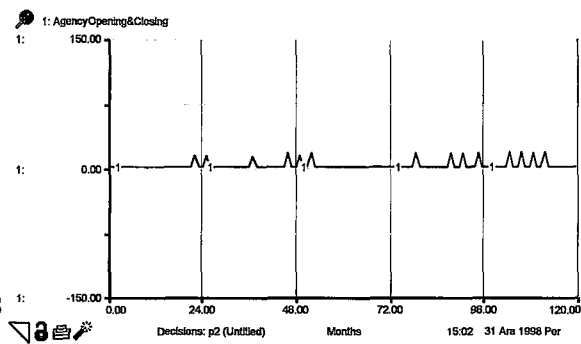


FIGURE C.6.1.2. Agency Opening Closing Decision of Player 6

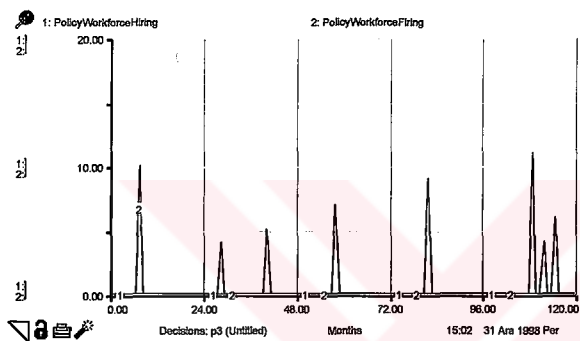


FIGURE C.6.1.3. Policy Work Force Hiring Firing Decision of Player 6

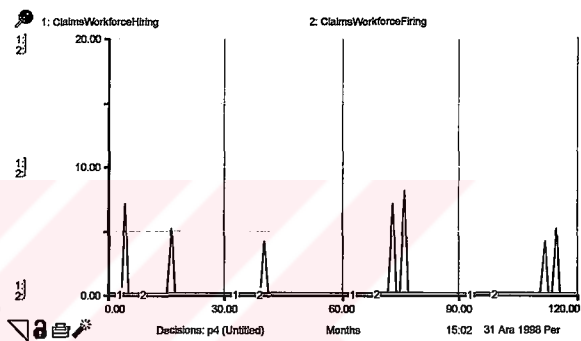


FIGURE C.6.1.4. Claims Work Force Hiring Firing Decision of Player 6

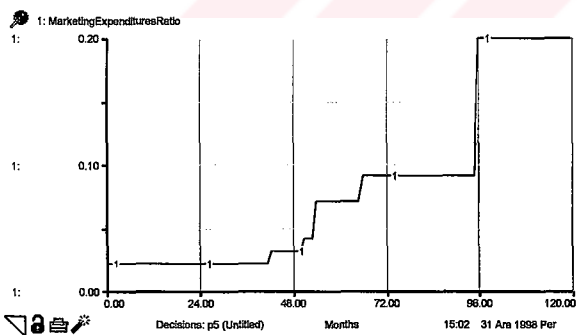


FIGURE C.6.1.5. Marketing Expenditures Ratio Decision of Player 6

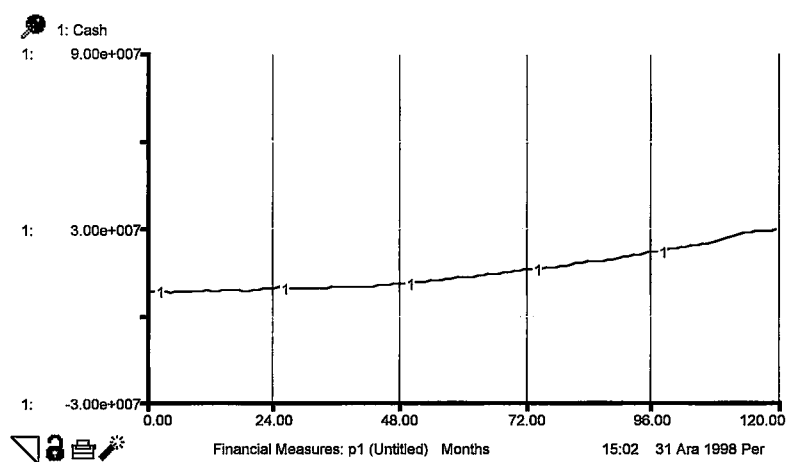


FIGURE C.6.2.1. Cash Position of Player 6

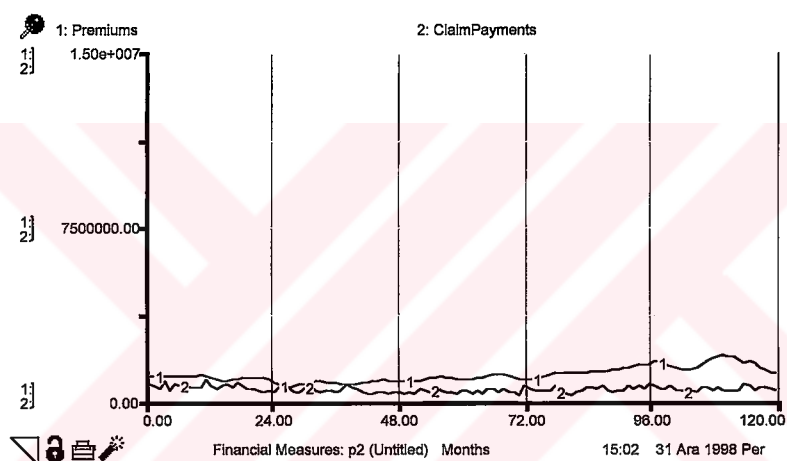


FIGURE C.6.2.2. Premiums and Claim Payments of Player 6

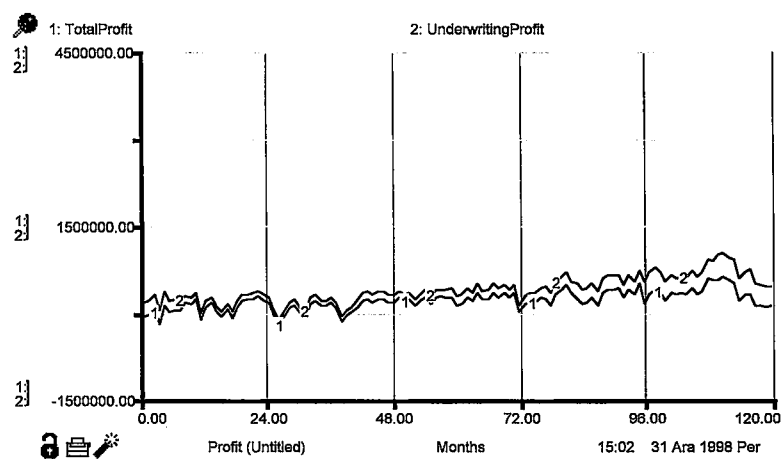


FIGURE C.6.2.3. Profits of Player 6

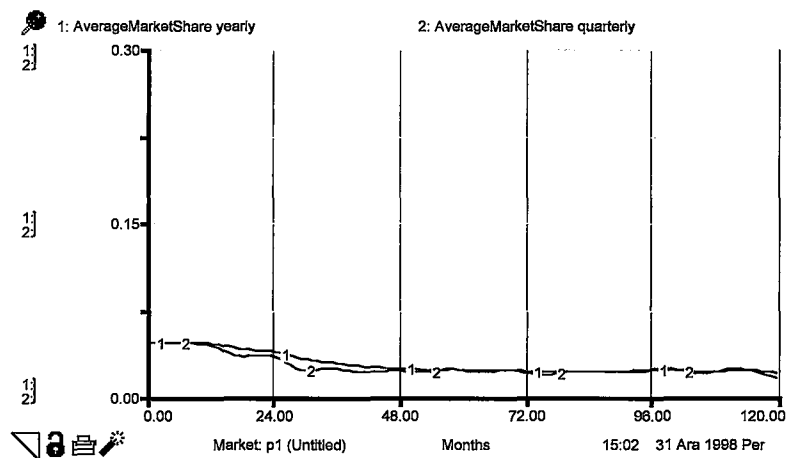


FIGURE C.6.2.4. Market Share of Player 6

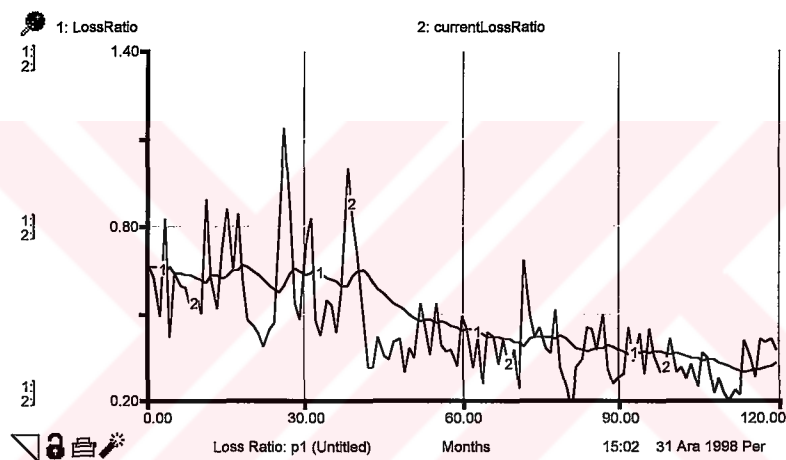


FIGURE C.6.2.5. Loss Ratio of Player 6

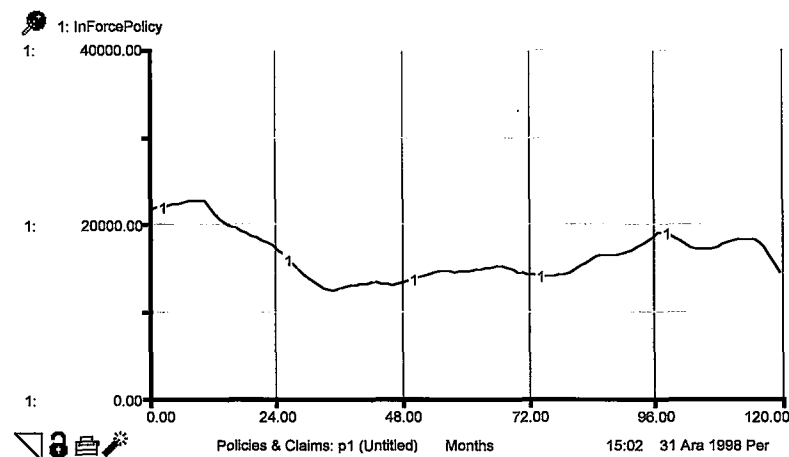


FIGURE C.6.2.6. Active Policies of Player 6

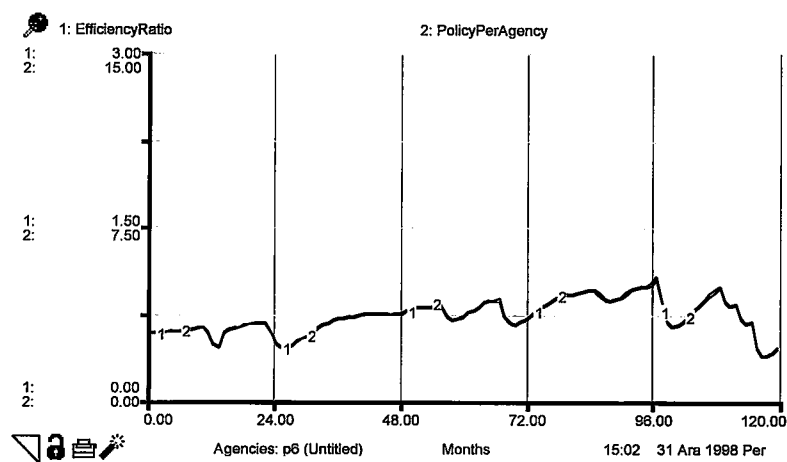


FIGURE C.6.2.7. Productivity Measures of Agencies of Player 6

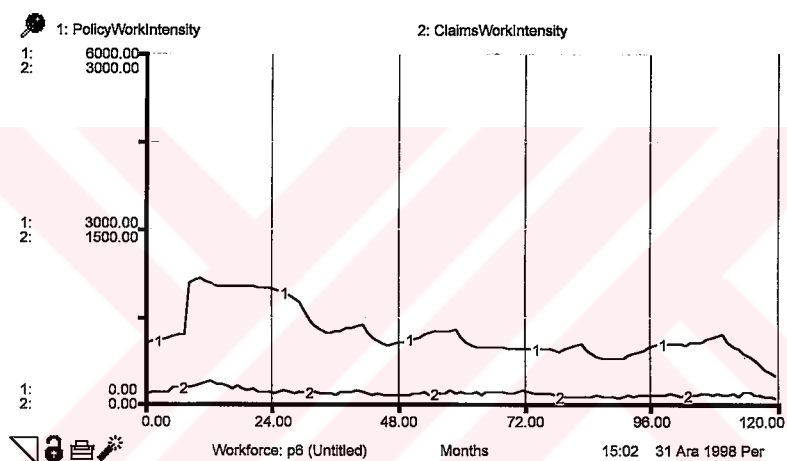


FIGURE C.6.2.8. Work Intensities of Player 6

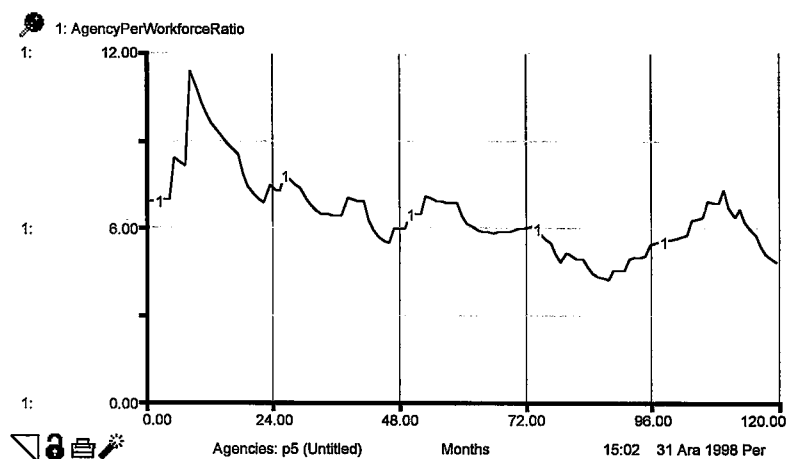


FIGURE C.6.2.9. Agency / Workforce Ratio of Player 6

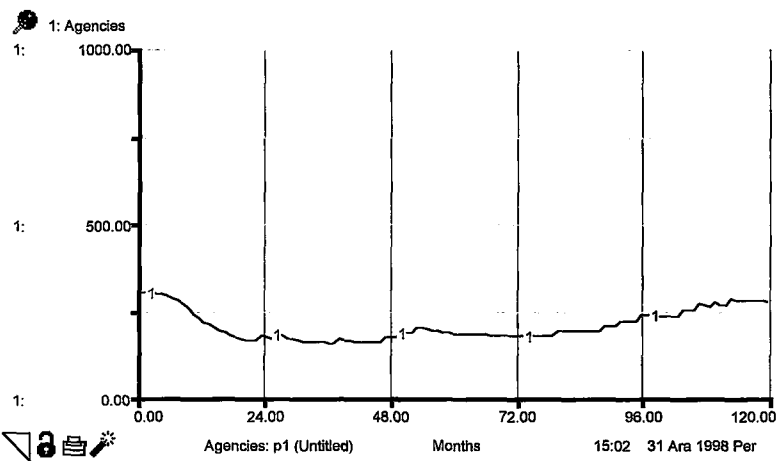


FIGURE C.6.2.10. Agencies of Player 6

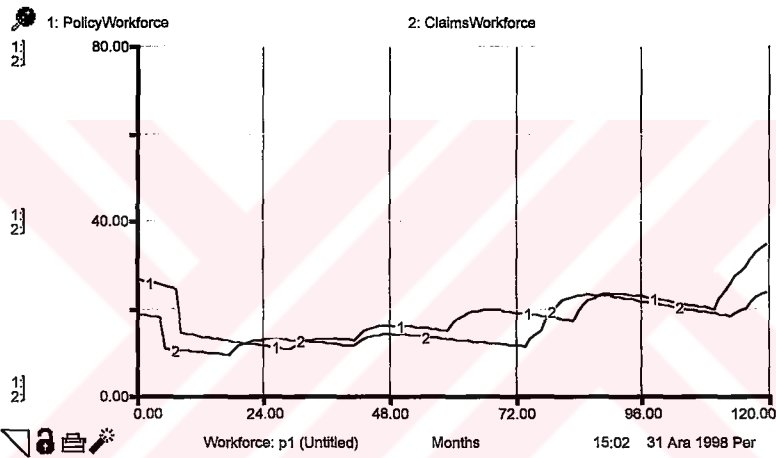


FIGURE C.6.2.11. Technical Work Force of Player 6

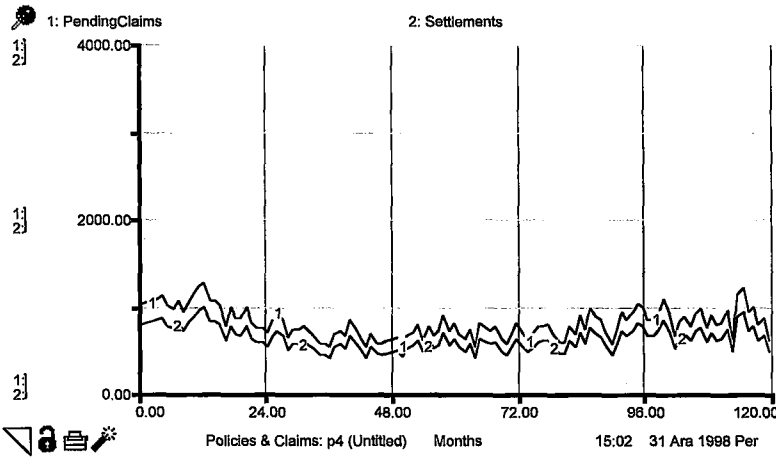


FIGURE C.6.2.12. Claims of Player 6

APPENDIX D
DATA SETS USED IN PARAMETER ESTIMATION



TABLE D.1. Underwritten Policies (Renewals included, regional details)

Region	Policy Type	1989	1990	1991	1992	1993	1994	1995
Center	Fire	24,142	32,622	40,175	42,907	41,721	43,243	43,022
Center	Marine	25,047	36,183	28,412	32,002	35,892	29,680	35,059
Center	Accident	57,682	91,270	108,803	114,378	113,830	123,793	124,889
Center	Engineering	324	625	849	1,747	2,008	2,241	3,236
Center	Agriculture	1,133	1,732	2,141	834	904	491	287
Adana	Fire	3,283	4,406	6,159	8,473	7,538	8,564	8,678
Adana	Marine	4,487	2,666	4,480	4,564	4,368	3,541	4,991
Adana	Accident	12,203	23,705	35,122	36,184	33,706	39,435	35,031
Adana	Engineering	57	152	144	160	234	326	650
Adana	Agriculture	682	1,777	2,147	891	455	269	140
Ankara	Fire	6,864	9,957	12,794	14,985	16,534	15,499	14,638
Ankara	Marine	3,895	5,318	5,942	5,641	7,248	5,126	6,200
Ankara	Accident	6,862	71,254	84,184	103,965	97,212	99,147	72,362
Ankara	Engineering	51	114	130	140	306	218	262
Ankara	Agriculture	2,774	6,066	7,051	542	144	22	13
Bursa	Fire	3,669	3,899	5,113	5,976	7,140	5,404	4,714
Bursa	Marine	2,222	3,343	2,830	5,178	7,591	3,807	2,843
Bursa	Accident	4,792	16,306	17,351	22,878	24,571	23,600	20,893
Bursa	Engineering	34	35	46	88	56	91	187
Bursa	Agriculture	422	556	838	22	18	0	5
İzmir	Fire	13,461	17,144	21,456	21,387	21,070	18,521	16,303
İzmir	Marine	5,958	9,107	9,755	9,921	11,643	7,586	8,130
İzmir	Accident	17,682	46,671	108,012	76,718	73,524	77,684	42,811
İzmir	Engineering	43	95	104	102	132	292	514
İzmir	Agriculture	55	401	1,116	191	45	17	19
Kayseri	Fire	0	0	187	1,493	1,636	699	0
Kayseri	Marine	0	0	45	566	431	62	0
Kayseri	Accident	0	0	2,421	20,019	28,802	11,909	0
Kayseri	Engineering	0	0	1	28	21	4	0
Kayseri	Agriculture	0	0	0	55	110	0	0

TABLE D.2. Total Underwritten Policies (Renewals included)

Policy Type	1989	1990	1991	1992	1993	1994	1995
Accident	101,169	252,977	357,139	341,578	334,131	351,787	262,129
Acc.-Motor	17,382	29,708	44,261	54,694	58,714	59,191	56,844
Fire	43,212	58,718	70,406	76,766	77,042	73,729	64,315
CTPL-Mot	54,463	184,651	251,904	256,828	258,915	281,983	196,531
Non-Motor	29,324	38,618	60,974	30,056	16,502	10,613	8,754

TABLE D.3. Premiums (nominal, TL mio)

Policy Type	1989	1990	1991	1992	1993	1994	1995
Accident	31,494	83,778	195,286	382,837	697,372	1,305,095	2,142,188
Acc.-Motor	15,990	48,163	102,834	233,945	458,034	826,744	1,303,163
Fire	22,201	41,407	61,458	99,844	207,476	436,185	815,407
CTPL-Mot	2,160	10,442	44,063	62,724	99,303	188,998	363,474
Non-Motor	13,344	25,173	48,389	86,169	140,035	289,353	475,551

TABLE D.4. Total Work Force

Department	31.12.89	31.12.90	31.12.91	31.12.92	31.12.93	31.12.94	31.12.95
Accident	17	17	20	20	19	19	18
Fire	17	16	24	17	17	16	15
Claims	12	14	19	25	24	24	27
Other	197	285	163	164	175	168	158
Center	243	332	226	226	235	227	218
Regions	58	76	93	91	96	90	85
TOTAL	301	408	319	317	331	317	303

TABLE D.5. Technical Work Force

Department	31.12.89	31.12.90	31.12.91	31.12.92	31.12.93	31.12.94	31.12.95
Accident	17	17	20	20	19	19	18
Fire	17	16	24	17	17	16	15
Claims	12	14	19	25	24	24	27
Other	65	84	87	93	92	84	82
Center	111	131	150	155	152	143	142
Regions	58	75	87	83	86	90	85
TOTAL	169	206	237	238	238	233	227

TABLE D.6. Agencies

	31.12.88	31.12.89	31.12.90	31.12.91	31.12.92	31.12.93	31.12.94
Central	138	135	205	222	197	195	212
Regional	206	212	265	300	292	272	276
TOTAL	344	347	470	522	489	467	488

Authorized	97	109	165	188	202	216	230
Non-authorized	247	238	305	334	287	251	258
TOTAL	344	347	470	522	489	467	488

Central

Authorized	59	62	97	97	103	106	119
Non-authorized	79	73	108	125	94	89	93

Regional

Authorized	38	47	68	91	99	110	111
Non-authorized	168	165	197	209	193	162	165

TABLE D.7. Claim Payments (nominal, TL mio)

Claim Type	1989	1990	1991	1992	1993	1994	1995
Accident	8,274	22,148	82,995	176,597	287,064	590,130	1,141,639
Fire	4,713	29,143	35,775	41,025	88,780	134,100	559,389
Total	18,676	60,954	131,825	252,705	434,610	821,801	1,931,728

TABLE D.8. Claim Payments (nominal, TL mio, regional details)

Region	1989	1990	1991	1992	1993	1994	1995
Center	9,881	34,656	74,416	115,914	230,099	440,711	1,175,069
Regions	8,795	26,298	57,409	136,790	204,512	381,090	756,659
Total	18,676	60,954	131,825	252,704	434,610	821,801	1,931,728

TABLE D.9. Central Claim Payments (nominal, TL mio)

Claim Type	1989	1990	1991	1992	1993	1994	1995
Fire	2,494	16,570	20,195	18,818	47,004	71,914	340,276
Accident	4,377	12,592	46,851	81,004	151,982	316,472	694,458
Other	3,010	5,494	7,370	16,092	31,113	52,325	140,335

TABLE D.10. Total Claim Files

	1989	1990	1991	1992	1993	1994	1995
Accident	7,942	13,610	26,255	35,886	39,593	40,994	43,546
Fire	920	1,523	2,545	2,905	2,592	2,562	3,006
Total	10,527	16,920	32,330	40,589	44,004	45,014	48,277

TABLE D.11. Claim Files (details)

Year	Region	Claim Type	
1989	Center	Fire	566
1989	Center	Marine	363
1989	Center	Accident	3900
1989	Center	Engineering	109
1989	Center	Agriculture	32
1989	Adana	Fire	40
1989	Adana	Marine	21
1989	Adana	Accident	562
1989	Adana	Engineering	6
1989	Adana	Agriculture	52
1989	Ankara	Fire	72
1989	Ankara	Marine	35
1989	Ankara	Accident	1455
1989	Ankara	Engineering	9
1989	Ankara	Agriculture	847
1989	Bursa	Fire	42
1989	Bursa	Marine	21
1989	Bursa	Accident	560
1989	Bursa	Engineering	11
1989	Bursa	Agriculture	63
1989	İzmir	Fire	197
1989	İzmir	Marine	81
1989	İzmir	Accident	1423
1989	İzmir	Engineering	3
1989	İzmir	Agriculture	1
1989	Samsun	Fire	3
1989	Samsun	Marine	11
1989	Samsun	Accident	42
1990	Center	Fire	924

TABLE D.11 continued

Year	Region	Claim Type	
1990	Center	Marine	565
1990	Center	Accident	6511
1990	Center	Engineering	157
1990	Center	Agriculture	16
1990	Adana	Fire	127
1990	Adana	Marine	48
1990	Adana	Accident	1085
1990	Adana	Engineering	17
1990	Adana	Agriculture	205
1990	Ankara	Fire	124
1990	Ankara	Marine	42
1990	Ankara	Accident	2274
1990	Ankara	Engineering	19
1990	Ankara	Agriculture	442
1990	Bursa	Fire	62
1990	Bursa	Marine	34
1990	Bursa	Accident	871
1990	Bursa	Engineering	16
1990	Bursa	Agriculture	31
1990	İzmir	Fire	284
1990	İzmir	Marine	139
1990	İzmir	Accident	2806
1990	İzmir	Engineering	12
1990	İzmir	Agriculture	32
1990	Samsun	Fire	2
1990	Samsun	Marine	11
1990	Samsun	Accident	63
1990	Samsun	Engineering	1
1991	Center	Fire	1558

TABLE D.11 continued

Year	Region	Claim Type	
1991	Center	Marine	534
1991	Center	Accident	12674
1991	Center	Engineering	236
1991	Center	Agriculture	50
1991	Adana	Fire	179
1991	Adana	Marine	77
1991	Adana	Accident	2034
1991	Adana	Engineering	23
1991	Adana	Agriculture	370
1991	Ankara	Fire	210
1991	Ankara	Marine	29
1991	Ankara	Accident	4551
1991	Ankara	Engineering	28
1991	Ankara	Agriculture	1568
1991	Bursa	Fire	106
1991	Bursa	Marine	26
1991	Bursa	Accident	1446
1991	Bursa	Engineering	9
1991	Bursa	Agriculture	285
1991	İzmir	Fire	489
1991	İzmir	Marine	139
1991	İzmir	Accident	5482
1991	İzmir	Engineering	38
1991	İzmir	Agriculture	100
1991	Kayseri	Fire	1
1991	Kayseri	Accident	9
1991	Samsun	Fire	2
1991	Samsun	Marine	18
1991	Samsun	Accident	58

TABLE D.11 continued

Year	Region	Claim Type	
1991	Antalya	Accident	1
1992	Center	Fire	1487
1992	Center	Marine	639
1992	Center	Accident	16389
1992	Center	Engineering	307
1992	Center	Agriculture	55
1992	Adana	Fire	278
1992	Adana	Marine	63
1992	Adana	Accident	3231
1992	Adana	Engineering	50
1992	Adana	Agriculture	136
1992	Ankara	Fire	350
1992	Ankara	Marine	52
1992	Ankara	Accident	6903
1992	Ankara	Engineering	39
1992	Ankara	Agriculture	75
1992	Bursa	Fire	125
1992	Bursa	Marine	69
1992	Bursa	Accident	2168
1992	Bursa	Engineering	24
1992	İzmir	Fire	612
1992	İzmir	Marine	144
1992	İzmir	Accident	6670
1992	İzmir	Engineering	70
1992	İzmir	Agriculture	65
1992	Kayseri	Fire	53
1992	Kayseri	Marine	3
1992	Kayseri	Accident	525
1992	Kayseri	Agriculture	7

TABLE D.11 continued

Year	Region	Claim Type	
1993	Center	Fire	1440
1993	Center	Marine	739
1993	Center	Accident	17988
1993	Center	Engineering	341
1993	Center	Agriculture	39
1993	Adana	Fire	224
1993	Adana	Marine	50
1993	Adana	Accident	3387
1993	Adana	Engineering	58
1993	Adana	Agriculture	74
1993	Ankara	Fire	245
1993	Ankara	Marine	56
1993	Ankara	Accident	8238
1993	Ankara	Engineering	68
1993	Ankara	Agriculture	18
1993	Bursa	Fire	101
1993	Bursa	Marine	103
1993	Bursa	Accident	2608
1993	Bursa	Engineering	33
1993	İzmir	Fire	541
1993	İzmir	Marine	118
1993	İzmir	Accident	6361
1993	İzmir	Engineering	90
1993	İzmir	Agriculture	5
1993	Kayseri	Fire	41
1993	Kayseri	Marine	5
1993	Kayseri	Accident	1011
1993	Kayseri	Engineering	5
1993	Kayseri	Agriculture	17

TABLE D.11 continued

Year	Region	Claim Type	
1994	Center	Fire	1456
1994	Center	Marine	502
1994	Center	Accident	19261
1994	Center	Engineering	420
1994	Center	Agriculture	12
1994	Adana	Fire	252
1994	Adana	Marine	17
1994	Adana	Accident	3224
1994	Adana	Engineering	61
1994	Adana	Agriculture	29
1994	Ankara	Fire	205
1994	Ankara	Marine	35
1994	Ankara	Accident	8552
1994	Ankara	Engineering	76
1994	Ankara	Agriculture	2
1994	Bursa	Fire	99
1994	Bursa	Marine	38
1994	Bursa	Accident	2768
1994	Bursa	Engineering	33
1994	İzmir	Fire	529
1994	İzmir	Marine	105
1994	İzmir	Accident	6273
1994	İzmir	Engineering	121
1994	Kayseri	Fire	21
1994	Kayseri	Marine	3
1994	Kayseri	Accident	916
1994	Kayseri	Engineering	4
1995	Center	Fire	1623
1995	Center	Marine	606

TABLE D.11 continued

Year	Region	Claim Type	
1995	Center	Accident	21923
1995	Center	Engineering	540
1995	Center	Agriculture	17
1995	Adana	Fire	266
1995	Adana	Marine	59
1995	Adana	Accident	3966
1995	Adana	Engineering	81
1995	Adana	Agriculture	17
1995	Ankara	Fire	223
1995	Ankara	Marine	46
1995	Ankara	Accident	8205
1995	Ankara	Engineering	115
1995	Ankara	Agriculture	1
1995	Bursa	Fire	122
1995	Bursa	Marine	43
1995	Bursa	Accident	2690
1995	Bursa	Engineering	9
1995	İzmir	Fire	769
1995	İzmir	Marine	70
1995	İzmir	Accident	6612
1995	İzmir	Engineering	121
1995	Kayseri	Fire	3
1995	Kayseri	Accident	150

TABLE D.12. Active Policies (yearly)

	1989	1990	1991	1992	1993	1994	1995
Accident	78,563	158,676	289,873	338,775	310,400	309,569	308,511
Fire	39,102	51,322	64,746	74,558	75,062	73,333	68,446

TABLE D.13. Active Policies (monthly)

Month	Accident	Fire
1989-01	64,820	36,123
1989-02	67,969	36,527
1989-03	70,933	37,218
1989-04	72,573	37,636
1989-05	74,578	38,047
1989-06	76,998	38,426
1989-07	80,522	38,938
1989-08	82,118	39,770
1989-09	85,501	40,461
1989-10	87,676	41,212
1989-11	89,614	41,867
1989-12	89,448	42,994
1990-01	96,607	44,007
1990-02	103,601	45,422
1990-03	111,244	46,865
1990-04	117,882	47,651
1990-05	130,347	49,537
1990-06	140,206	51,000
1990-07	158,780	51,872
1990-08	179,680	53,077
1990-09	195,935	54,485
1990-10	210,807	55,963

TABLE D.13 continued

Month	Accident	Fire
1990-11	224,315	57,465
1990-12	234,713	58,514
1991-01	249,286	59,537
1991-02	258,865	60,141
1991-03	265,664	60,944
1991-04	275,930	62,178
1991-05	283,194	63,269
1991-06	289,703	64,051
1991-07	292,589	65,746
1991-08	300,769	66,386
1991-09	307,429	67,402
1991-10	312,339	68,174
1991-11	317,738	69,011
1991-12	324,975	70,112
1992-01	342,325	71,475
1992-02	346,776	73,012
1992-03	350,099	74,026
1992-04	350,960	74,860
1992-05	349,029	75,510
1992-06	348,386	75,113
1992-07	348,567	74,761
1992-08	335,491	75,028
1992-09	327,308	74,974
1992-10	323,037	75,192
1992-11	321,110	75,335
1992-12	322,206	75,407
1993-01	312,464	74,857
1993-02	312,929	74,749
1993-03	312,634	74,309

TABLE D.13 continued

Month	Accident	Fire
1993-04	311,675	73,969
1993-05	314,581	74,004
1993-06	314,363	74,357
1993-07	309,056	75,287
1993-08	311,785	75,875
1993-09	309,663	76,120
1993-10	306,352	75,931
1993-11	303,467	75,728
1993-12	305,835	75,554
1994-01	307,425	75,295
1994-02	301,579	74,600
1994-03	298,480	73,996
1994-04	297,483	73,942
1994-05	293,059	73,269
1994-06	295,534	73,032
1994-07	305,262	72,894
1994-08	307,616	72,499
1994-09	316,578	72,661
1994-10	323,269	72,210
1994-11	328,439	72,446
1994-12	340,098	73,156
1995-01	336,034	71,365
1995-02	335,500	70,292
1995-03	333,912	70,189
1995-04	330,309	69,906
1995-05	325,786	69,274
1995-06	318,984	69,082
1995-07	307,160	68,577
1995-08	300,930	68,813

TABLE D.13 continued

Month	Accident	Fire
1995-09	291,595	67,396
1995-10	282,800	66,178
1995-11	276,823	65,967
1995-12	262,302	64,315

TABLE D.14. Monetary Values of the Turkish Insurance Sector (nominal, TL mio)

	31.12.88	31.12.89	31.12.90	31.12.91	31.12.92	31.12.93	31.12.94	31.12.95	31.12.96
Cash and Bank Accounts	74,381	115,933	198,397	275,821	532,468	769,008	2,982,313	8,430,238	14,587,646
Shares – free	78,602	148,571	274,765	416,733	456,253	938,238	2,664,424	3,502,863	9,943,025
Shares – blocked	7,505	13,205	37,664	74,676	123,213	167,242	167,938	447,564	715,532
Securities – free	56,396	144,160	229,103	474,528	949,502	2,751,483	5,613,650	19,990,431	47,039,536
Securities – blocked	59,342	163,481	304,534	744,936	1,721,198	4,016,091	9,605,090	18,353,852	48,365,831
Loans on Life Policies	3,401	5,633	10,564	18,429	34,950	58,347	91,169	154,030	83,562
Loans on Mortgages	1,167	1,329	2,075	2,389	2,270	1,401	2,573	2,268	3,364
Real Estate	141,480	238,639	379,484	535,516	861,519	1,385,229	3,089,450	7,867,321	12,196,609
Shares Income	18,228	45,360	108,872	117,383	158,519	193,710	547,530	779,864	2,333,095
Securities Income	25,994	61,448	87,947	269,221	575,620	1,584,358	4,805,382	10,486,108	33,717,593
Loans on Mortgages Income	944	163	257	1,162	283	216	63	1,024	3,646
Interests	5,727	9,309	13,347	17,458	53,014	202,055	418,550	1,500,552	1,661,182
Real Estate Income	2,072	2,963	6,479	7,989	27,988	31,227	169,415	180,392	395,540
Other Income	8,432	10,084	13,887	59,021	113,935	191,312	1,184,021	2,045,744	3,845,438
Total Financial Income	61,397	129,327	230,789	472,233	929,359	2,202,878	7,124,961	14,993,684	41,956,494
General Expenditures	59,443	138,117	286,252	601,133	1,127,180	2,045,132	3,796,076	7,918,749	17,103,464
Other Expenditures	9,517	28,952	81,231	138,515	275,905	570,306	1,457,742	3,102,992	8,430,287
Total Financial Expenditures	68,960	167,069	367,483	739,648	1,403,085	2,615,438	5,253,818	11,021,741	25,533,751

APPENDIX E

GAME INSTRUCTIONS

What is The Insurance Management Game

The Insurance Management Game is an interactive dynamic simulator for strategic management of an insurance company. The underlying model is developed using System Dynamics methodology. The game claims to be both a practical management tool and a research tool where research can be carried out on various aspects of "Strategic Management" in a dynamic environment. The player plays the part of a company policy-maker, who is trying to seek a delicate balance among the main functions of the company. The decisions made by the player are:

(A) Policy Price : The company earn premiums by selling policies. The player decides the price charged for an average policy.

(B) Agency Opening & Closing : Policies are sold by agencies. The player decides how many agencies to close or how many new agencies to open per quarter.

(C) Policy Workforce Hiring & Firing : These are the company employees in charge with handling all the policies, assisting the agencies or directly selling new policies.

(D) Claim Workforce Hiring & Firing : When some of the active policies incur losses, the policyholders submit "claims". These loss-claim applications are handled by the claims department of the company.

(E) Marketing Expenditures Ratio : This involves advertising and other similar means to attract new customers. The player decides what fraction of premium revenues will be spent for marketing.

The primary goal is to increase and sustain the market share. Secondly, the cash position should be increased. The challenge is to achieve these goals simultaneously, since increasing the market share is more difficult than gaining money in a growing market in long-term.

Starting the Game

The user must have Stella® Research Version 5.1 installed in his computer in order to play the game. The game can be started by simply clicking the “Insurance Management” icon (shortcut) twice without having to run i-think first.

Logical Flow of the Game

The game is designed as a series of screens, which are combined to each other. The opening screen displays the title of the game and the main menu items, which are listed as follows:

- (A) Run a new game / Control Panel
- (B) Information about the model
- (C) Information about the controls
- (D) Exit from game

Control Panel

Running a New Game

After the “Game / Control Panel” button is pressed the main game screen appears (Figure E.1). On the top left corner of the screen are two information buttons, which let the player to reach brief instructions about the game and the decisions during the game when they are pressed.

On the bottom left corner of the screen, the game controls are displayed. The game is initiated by pressing the Start button in the New Game frame that is displayed at the bottom left corner of the screen.

On the left side of the screen, the Decision Sliders are displayed. The player enters his decisions by dragging the slider knob to the left or right using the cursor or by entering in the small box below the slider knob. After the decisions are made, the Advance button

should be pressed. When this button is pressed the simulation advances one quarter (three months) and the new values of the variables are calculated. The simulation will pause automatically every quarter to let the player change his decision settings and review data. Pressing the Record of Decisions button on the top of the screen enables the player to examine the history of the decisions in a graphical and tabular format.

Once a decision value is changed from its original value, a “U” appears at the bottom-left corner of the slider. Clicking on it will reset the value to sliders original value. Clicking on the “?” buttons on the sliders enables the player to reach more information about the associated decision variable.

The ~ buttons on the workforce decision sliders toggle the sliders on and off “auto-pilot”. Clicking on the ~ button activates the "auto-pilot". If the slider is left on "auto-pilot" workforce will be automatically hired and fired to try to save the current workforce level. The player can override that and choose to hire or fire up to twenty workers.

The total duration will be 120 months, or 40 quarters, or 40 decision rounds, i.e. the simulation begins at January 1997 and ends at December 2007. The simulation time can be traced through the displays that are located on the top right corner of the screen. At any time, the player can quit the simulation by pressing the End Game button that is displayed at the bottom left corner of the screen.

The Reset Sliders button that is displayed at the bottom left corner of the screen initializes all five decision sliders to their original settings.

To start a new game the player should first terminate the current game pressing the End Game button. Next, the model should be initialized to its original setting pressing the Reset button in the New Game frame. Then a new game can be started pressing the Start button in the same frame. Between two sequential games the model must be “Reset” first! Otherwise the Start button would not work properly.

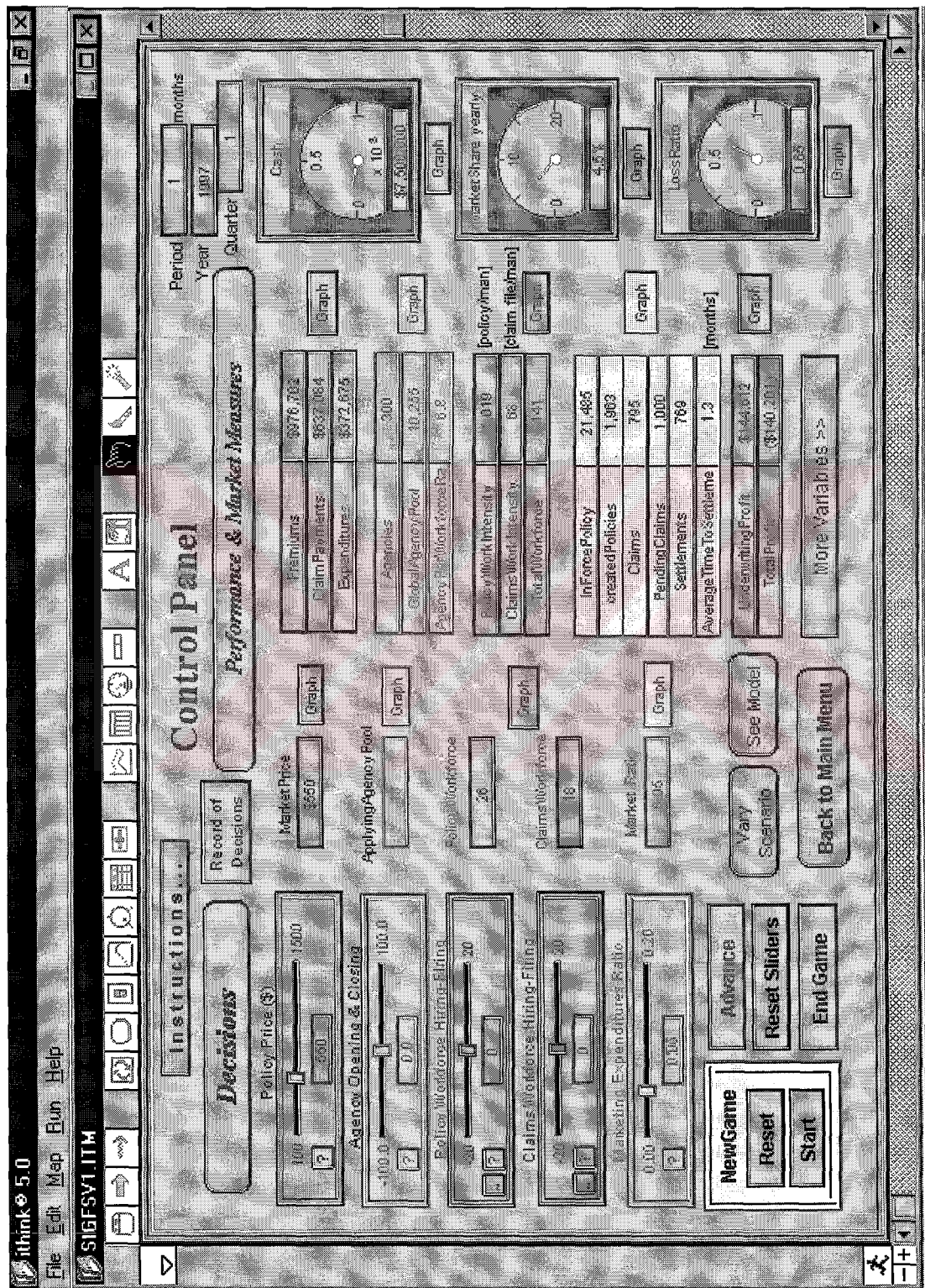


FIGURE E.1. Main Game Screen

On the right side of the screen, the main indicators of the model (performance and market measures) are displayed in order to give the player feedback about the values and graphical output of the major variables in the model. Pressing the “Graph” buttons on the right or bottom of the displayed values of any variable, the dynamic behavior pattern of that variable can be displayed. On the right side of the indicators, three main indicators are displayed as warning devices, for which three distinct zones are set - normal, caution, panic. As the value of the variable passes through these zones, the warning device displays the color associated with that zone – green, yellow and red, respectively. The More Variables button will turn the page to display some more indicators. Pressing the “?” buttons on the left of the variables, brief descriptions of those variables can be displayed.

Analysis of the Model

Clicking the See Model button that is displayed on the bottom of the screen will take the player to the Model Overview Screen. The purpose of this screen is to give the player information about the interactions between the variables in the model.

This is a high-level overview of the model, which shows the sectors in the system and the physical (thick arrows) and information (thin arrows) flows between them.

Clicking on the lower portion of the corresponding sector frame takes the player to the modeling layer and enables him to trace out the model for a particular sector one at a time. Clicking on the dots would reveal the model structure. To return back to the high-level map, the upward-pointing triangle in the left-hand margin of the window should be clicked.

The whole sector at a snapshot can be viewed by clicking the downward pointing triangle at the top right corner of the sector frame. The player can return to the high-level map by pressing the Back buttons, which are displayed on the modeling layer. The Control Panel button on the bottom of the screen takes the player back to the main game screen.

Varying the Scenario

Clicking on the Vary Scenario button that is displayed on the bottom of the screen takes the player to the screen where the variables that define the major market conditions and the internal and external relations / interactions of the company are listed. Varying these variables in different combinations lets the player to play the game under different market conditions.

To change the predefined conditions the player should push one of the 'Market Growth' buttons and/or move the dials on the knobs. If the value of a condition variable is changed, a small "U" button appears in the lower left corner. To restore the knob to its original value, the "U" button should be clicked once on. The condition variables are explained briefly in this screen. Clicking once on the question mark (?) button in the upper left corner of the knob enables the player to reach more information about the associated condition variable.

These conditions can not be changed during the game but "Varying the Scenario Screen" can be visited to check what the conditions are.

Information about the Model

Clicking on the Information about the model button in the opening / main menu screen takes the player to the "General Information About the Model Screen". The purpose of this screen is to give the player brief information about the model, hints and warnings.

Information about the Controls

Clicking on the Information about the controls button in the opening / main menu screen takes the player to the "Preview the Controls Screen". The purpose of this screen is to give the player general information about the use of the sliders.

Exit From Game

Clicking on the Exit from game button starts the leaving the game procedure. Before exiting the game, you are asked to save the game results in a file. If you don't save your game results you lose them. If you choose to save them you are asked to enter a name for the file, which will keep the data of the current game results. It must have the extension ".stm" in Windows environment.

Hints and Warnings

The values displayed in decision sliders at the beginning of the game are some initial neutral values, not the optimal values. The player should make decisions even at the first step of the simulation and revise his decisions at each step, by making use of the provided analysis tools.

The total potential market for insurance is increasing through the whole period of the simulation. Thus the company competes in a growing market.

The total number of agencies, indicated as "Global Agency Pool", in the market is growing through the simulation too. According to the market share and the commission ratio, some percentage of this pool is applying to be an agency of us, which build the "Applying Agency Pool".

The production depends heavily on the agencies. Therefore for an increase in policy production / market share, either the number of agencies or the productivity per agency should be increased.

Increasing the number of agencies is not easy. There exists an implicit threshold "agency/workforce" ratio. This ratio means that each agency not only sells policies, but she also constitutes a workload for the company (asking questions, visiting the company). If this implicit threshold is exceeded, the agencies basically create unnecessary workload.

In making the agency hiring decisions, the player should keep in mind the quitting agencies.

The productivity of an agency depends on many factors such as policy price, marketing activities, market saturation effect, commission effect and claims settlement time effect, besides its own quality.

In making the workforce hiring decisions, the player should keep in mind the workforce that is leaving (retiring or quitting). (The model automatically hires / fires two support personnel simultaneously with each technical employee hired / fired by the player.) The player should keep in mind, when a new employee is hired, it takes approximately four months before he becomes fully productive.

The initial values of the game are as shown on the screen.

Finally, please keep in mind that there is no winning or losing in such systemic games! The purpose is not to be on some 'high scores' list, but to learn during the game. And for this purpose, the player should try to base his decisions on the information feedback displayed through the game. The expectation is that the player's understanding of the problem issues will gradually increase after playing the game numerous times.

REFERENCES

Andersen, D.F., I.J. Chung, G.P. Richardson, and T.P. Stewart, "Issues in Designing Interactive Games Based on System Dynamics Models", *System Dynamics '90*, pp. 31-45, 1990.

Baken, B., J. Gould, and D. Kim, "Experimentation in learning organizations: A management flight simulator approach", *European Journal of Operational Research* 59, pp. 167-182, 1992.

Barlas, Y., E. Duman, K. Çırak, and G. Uzunosmanoğlu, "System Dynamics Approach to Problem Solving in an Insurance Company", *Proceedings of the 15th International System Dynamics Conference*, Istanbul-Turkey, 18-22 August 1997, Vol. 2, pp. 689-692, 1997.

Barlas, Y., "Dynamic Systems Modeling and Analysis", IE-602 Lecture Notes, Spring Sem. 1996, Dep. of Ind. Eng., Boğaziçi University, 1996

Barlas, Y., "Dynamics of Socio-Economic Systems", IE-582 Lecture Notes, Fall Sem. 1995, Dep. of Ind. Eng., Boğaziçi University, 1995.

Barlas, Y., "Multiple Tests for Validation of System Dynamics Type of Simulation Models", *European Journal of Operational Research* 48, pp. 59-87, 1989.

Barlas, Y., and I. Bayraktutar, "Interactive Dynamic Simulation Games: An Application in Software Project Management", *Proceedings of the Advances in Simulation '92 Symposium*, Istanbul, 1992.

Berk, N., *Sigortacılıkta Risk Yönetimi*, Emek Sigorta, Istanbul, 1992.

Carrero L.L., A. Bencosme, R. Farrell, and R. Benbanan, "Viasa's Microworld: A Strategic Management Learning Laboratory", *Proceedings of the 10th International System Dynamics Conference*, pp. 347-353, Utrecht, 1992.

Daykin, C.D., T. Pentikäinen, and M. Pesonen, *Practical Risk Theory*, Chapman & Hall, London, 1994.

Diker, V., "An Interactive Dynamic Simulation Model of a University Management System" MS. Thesis, Boğaziçi University, 1995.

Doherty, N.A., *Corporate Risk Management*, McGraw-Hill, New York, 1985.

Forester, J.W., "Market Growth as Influenced by Capital Investments" in E.E. Roberts (Eds.), *Managerial Applications of System Dynamics*, The MIT Press, Cambridge, MA, 1978.

Graham, A.K., J.D.W. Morecroft, P.M. Senge, and J.D. Sterman, "Model supported case studies for management education", *European Journal of Operational Research* 59, pp. 151-166, 1992.

Graham, A.K., P.M. Senge, J.D. Sterman, and J.D.W. Morecroft, "Computer-based Case Studies in Management Education and Research", in P. Milling and E. Zahn (Eds.), *Computer Based Management of Complex Systems*, pp. 317-326, Springer-Verlag, Berlin, 1989.

Greenley, G.E., *Strategic Management*, Prentice Hall (UK), Hertfordshire, 1989.

Insurance Supervisory Office Reports, 1989 to 1995, Istanbul.

Kim, D.H., "Learning Laboratories: Designing a Reflective Learning Environment", in P. Milling and E. Zahn (Eds.), *Computer Based Management of Complex Systems*, pp. 327-334, Springer-Verlag, Berlin, 1989.

Kreutzer W.B., D.P. Kreutzer, and J.M. Gould, "The Quahog Oil Production Simulator: A Case Study of the Rapid Development of a Management Flight Simulator for Training", *Proceedings of the 10th International System Dynamics Conference*, pp. 329-336, Utrecht, 1992.

Mahmoud, M., and P. Genta, "Microworld of an Open University: A Strategic Management Learning Laboratory", *System Dynamics*, 1993.

Monthly Reports of Halk Sigorta T.A.Ş., January 1989 to June 1996, Istanbul.

Peterson, S., "Designing Learning Environment", *Proceedings of the 1990 International System Dynamics Conference*, Chestnut Hill, Mass., 1990.

Saeed, K., "A Dynex-based Learning Laboratory For Economic Development Planning", in P. Milling and E. Zahn (Eds.), *Computer Based Management of Complex Systems*, pp. 358-365, Springer-Verlag, Berlin, 1989.

Senge, P.M., and J.D. Sterman, "System thinking and organizational learning: Acting locally and thinking globally in the organization of the future", *European Journal of Operational Research* 59, pp. 137-150, 1992.

Stahl, M.J., and D.W. Grigsby, *Strategic Management and Organizational Policy - Text and Cases*, PWS-Kent Publishing Company, Boston, 1991.

Yearly Reports of Halk Sigorta T.A.Ş., 1989 to 1995, Istanbul.

REFERENCES NOT CITED

Firat, A., and E. Balıbek, “A Management Simulation Model of an Insurance Company,” B.S. Thesis, Boğaziçi University, 1996.

Mintzberg, H., “Patterns in Strategy Formation”, *Management Science* 24, pp. 934-948, 1978.

POWERSIM Version 2.0 User’s Guide and Reference, ModellData AS, 1993-1994.

Senge, P., *The Fifth Discipline: The Art and Practice of the Learning Organization*, Currency & Doubleday Publications, 1990.

STELLA II: An Introduction to Systems Thinking, User’s Manual and Technical Documentation, High Performance Systems, 45 Lyme Road, Hanover NH, 1992.

VENSIM DSS Version 1.61-5 User’s Guide and Reference Manual, Ventana System Inc., 1988-1994.