

ANALYZING THE DYNAMICS OF INFORMAL EMPLOYMENT RATE IN
TURKEY: A SYSTEM MODELING APPROACH

by

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ABSTRACT

ANALYZING THE DYNAMICS OF INFORMAL EMPLOYMENT RATE IN TURKEY: A SYSTEM MODELING APPROACH

Informal employment problem exists with varying degrees around the world. Especially in developing countries, the extent of the problem is worrisome. Similarly, for the Turkish labor market, the problem has not been solved even though improvements have taken place recently. The purpose of the study is to build a generic system dynamics model to investigate the driving mechanisms responsible for the informal employment dynamics of the Turkish labor market. By doing this, the governmental target, to decrease the informal employment ratio from 34 percent to 15 percent is examined. Additionally, the model seeks to examine some of the policy options related to the informal employment problem. The results of the model suggest that the governmental target cannot be realized under the current state for the following 15 years. On the other hand, the target will be reached under some scenario and policy conditions. The model verify that the problem can be significantly decreased without making an extra policy while the economy is growing aggressively and continuously. Additionally, the target can be achieved by applying coherent policies under the current economic conditions. The decreasing labor cost gap ratio between the formal and informal sectors creates significant improvements in the informal employment problem. Moreover, the study finds out that that protecting formal workers against firing risks can be an alternative solution for the informality. On the other hand, the study interestingly suggests that the more efficient formal market in the job seeker-vacancy matching process cannot be a solution for the informality problem.

ÖZET

TÜRKİYE'DE KAYIT DIŞI İSTİHDAM ORANI DİNAMİKLERİNİN ANALİZİ: SİSTEM MODELLEME YAKLAŞIMI

Kayıt dışı istihdam problemi, dünya çapında değişen derecelerde bulunmaktadır. Özellikle gelişmekte olan ülkelerde sorunun boyutu endişe vericidir. Benzer şekilde, Türkiye işgücü piyasası için son zamanlarda gelişmeler yaşanmış olsa da sorun çözülmemiştir. Bu çalışmanın amacı, Türkiye işgücü piyasasının kayıt dışı istihdam dinamiklerinden sorumlu olan mekanizmalarını araştırmada, genel bir Sistem Dinamikleri modeli oluşturmaktır. Bunu yaparak, kayıt dışı istihdam oranını yüzde 34'ten yüzde 15'e düşürmek olan hükümet hedefi analiz edilmek istenmiştir. Ek olarak, modelle, kayıt dışı istihdam sorununa ilişkin bazı politika seçeneklerinin incelemesi amaçlanmaktadır. Modelin sonuçları, hükümet hedefinin önümüzdeki 15 yıl boyunca, mevcut durum altında gerçekleştirilemeyeceğini göstermektedir. Öte yandan, bazı senaryo ve politika koşullarında hedefe ulaşılabilir. Model, ekonomi agresif ve sürekli olarak büyürken, ek bir politika yapmadan sorunun önemli ölçüde azaltılabileceğini doğrulamaktadır. Ayrıca, mevcut ekonomik koşullar altında tutarlı politikalar uygulanarak hedefe ulaşılabilir. Kayıtlı ve kayıt dışı sektörler arasındaki azalan işgücü maliyeti oranı, kayıt dışı istihdam problemin çözümünde önemli gelişmeler yaratmaktadır. Dahası, çalışma, kayıtlı çalışanları işten çıkarılma risklerine karşı korumanın kayıt dışılığı alternatif bir çözüm olabileceğini ortaya koymaktadır. Öte yandan, kayıtlı iş arayan ve iş imkanı arasındaki eşleşme sürecinin daha etkin olması, kayıt dışılık sorununa çözüm olamayacağını çalışma ilginç bir şekilde göstermektedir.

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LIST OF SYMBOLS

m_t	Number of matches per unit of time t
p	Probability of finding a job
q	Market tightness
u_t	Number of unemployed at a given time t
v_t	Number of vacancy at a given time t
α	Matching elasticity
β	Constant parameter
μ	Matching efficiency

LIST OF ACRONYMS/ABBREVIATIONS

Adj	Adjustment
Avg	Average
B	Balancing
CRS	Constant Returns to Scale
ECT	Extreme Condition Tests
EF	Employed Formal
EI	Employed Informal
Emp	Employment
FE	Formal Employment
Fr	Fraction
FV	Formal Vacancy
GDP	Gross Domestic Product
IE	Informal Employment
ILCS	Income and Living Conditions Survey
ILO	International Labor Organization
IV	Informal Vacancy
JS	Job Seeker
LF	Labor Force
NLF	Non-Labor Force
OECD	The Organization for Economic Co-operation and Development
Prob	Probability
R	Reinforcing
RE	Required Employment
SD	System Dynamics
SSI	Turkish Social Security Institution
TEA	Turkish Employment Agency
TurkStat	Turkish Statistical Institute
UF	Unemployed Formal

UFI	Unemployed Formal and Informal
UI	Unemployed Informal

1. INTRODUCTION

The organization for economic co-operation and development (OECD) defines “Informal Employment” as a way of employing staff without registration and social security coverage in producing legal goods and services. Also called “underground”, “grey”, “undeclared” or “shadow” employment, it bypasses legal employment requirements such as taxes, social security contributions and insurances [1]. Since the first recognition of the informal employment problem in the 1970s, there has been a significant debate on its definition. However, all attempts at defining it similarly focus on lacking and missing points of informal employment relative to formal employment [2].

Although there have been noticeable improvements over the past few years, informal employment is a persisting problem. The informal employment problem occurs with varying degrees from sub-Saharan Africa to Southeast Asia and to Latin America and even to European Union countries [3]. According to International Labor Organization (ILO), the ratio of non-agricultural informal employment to total employment is 66 percent in sub-Saharan Africa, 65 percent in East and Southeast Asia (excluding China), 51 percent in Latin America and 10 percent in eastern Europe and central Asia [4]. In developing countries where people suffer from poverty and insufficient job opportunities, informal employment has become very common. Under inadequate economic growth conditions, millions of job seekers try to find a job for survival. However, higher economic growth does not give a guarantee to solve the informality problem. The informal employment ratios rise parallel to GDP growth in Southeast Asia and Latin America between 1980s and 2000s. Similarly, the examples of China and India imply that growth in informal self/paid employment is faster than growth occurring in its formal counterpart. Furthermore, informal employment has become normal in developed countries because of a competitive business environment with globalization [3, 5].

Many opinions have been put forward about the causes of this complex issue in the literature. Firstly, a balance between job supply and job demand in a labor market determines job seekers’ tendency to informality. Economic growth and job cre-

ation ability levels can be considered as significant determinants of the job creation side in that balance. On the other side, unemployment and population growth levels with participation ratios to a labor market seem very important. In addition to labor market situations, poverty makes job seekers more vulnerable to resist entering informal sectors. For firms/employers, costs play a crucial role in formal or informal job creation decisions. Especially, tax/contribution rates and other regulative burdens in labor costs can be attributed as main factors of informal employment. Moreover, government regulations and enforcement efficiency levels also affect incentive for informal vacancy creations. Besides these factors, market-level changes (e.g. governmental trusts, economic crises and migrations) and agent-level characteristics (e.g. education, gender) are considered to be factors in the informal employment problem [1,2].

In the light of the aforementioned factors, a critical question about whether informality is a voluntary or forced choice emerges. Some observations indicate that workers or firms have willingly become informal in order to maximize their benefits [6]. On the other hand, there is evidence to suggest that informality is the last resort under hard market conditions [7]. Both these suggestions are reasonable and acceptable under specific conditions. Depending on economic and market structures, these two typical behaviors of labor market agents can be seen around the world [8].

Results of informal employment seem undesirable, as expected. These should be considered from three stakeholder perspectives (i.e. an employee, an employer and a government). People who cannot gain social security benefits and protections from their labour in particular suffer from informality mistreatments. Even in most cases, they have to work in unsafe conditions. Additionally, they receive neither sufficient wage/salary nor desired career opportunities to make their situations better. From the government side, tax and social security contribution evasions incurred by informal employment cause financial damage in a government's revenue. This brings about a chain of effects that could have an impact on, for example, a government's quality. Furthermore, the employers/firms/self-employed people in the formal sector suffers from an unfair competition due to informality. Additionally, informal employment may become an obstacle to higher productivity and growth for the informal sector. By

staying small in order to protect itself from legal risks and controls, the informal sector may face limitations of accessibility to capital, technology and new markets [9].

As seen in other developing countries, informal employment problem exists in the Turkish labor market. By the Turkish Households Labor Force Survey (TurkStat), the informal employment size is estimated monthly and yearly [10]. In determining the informality, just one question is asked to survey participants about social security registrations of their current works. Based on the labor force survey, the informal employment ratios (ratio of informal employment to total employment), changing between 30 percent and 50 percent, have been significantly high over years (Figure 1.1). Although there has been a decrease in the rate, this trend has recently been getting over slowly and the rate is even inclined to go up.

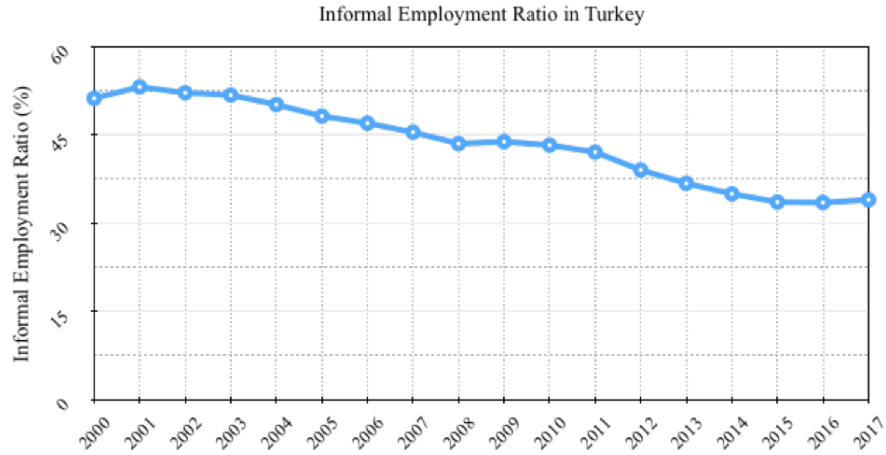


Figure 1.1. Informal employment ratio in Turkey (TurkStat).

In addition to the informal employment ratio which depends on both number of formally and informally employed people, now just the number of informally employed people dynamics are shown in Figure 1.2. The number of informally employed people has gone down by just 1.5 million over the last 17 years. Therefore, in 2017, over 9.5 million workers are still informal. By the way, the difference between the informal employment ratio dynamics and the number of informally employed people dynamics comes from the formal employment dynamics. Even though, there is no significant

decrease in the number of informally employed people, the informal employment ratio decreases because of a higher growth rate in the formal employment. Additionally, about the financial results of these high levels, one of the rare studies says that the estimation of direct and indirect economic damage of informal employment was about 95 billion Turkish Liras in 2009, which means nearly 75 percent of the annual income of the Turkish Social Security Institution (SSI) [11]. In addition, Dr. Müezzinoğlu, the former Minister of Labor and Social Security, claims that this amount was yearly 60 billion Turkish Liras in 2016 [12].

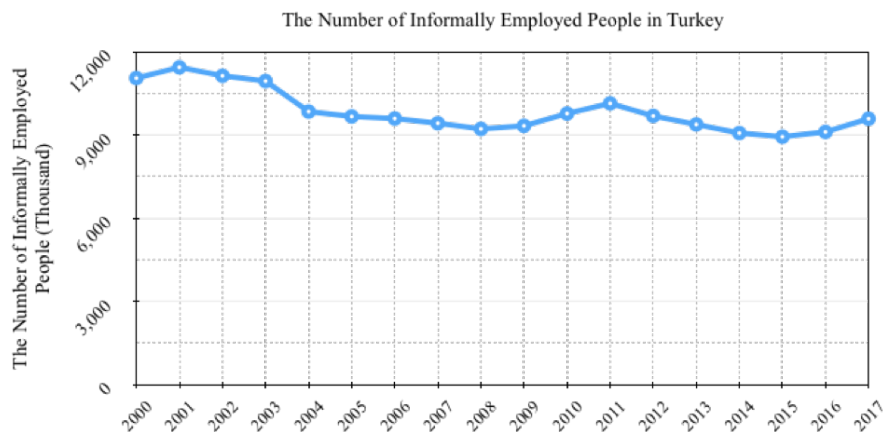


Figure 1.2. The number of informally employed people in Turkey (TurkStat).

2. LITERATURE REVIEW

Generally, informal employment is considered as a part of an informal economy which is basically defined as all economic activities beyond official lines. One of the known research made in this informal economy field, by Schneider and Hassan, summarizes drivers of the informal economy problem in three categories which are monetary, regulatory and institutional. The authors count avoiding tax/contribution rates as the monetary driver. Regulatory burdens such as bureaucracy, entry cost etc. are considered as the regulatory factors why economic activities are made informally. Finally, institutional drivers come from low government quality plus weak law and rights. Additionally, they consider unemployment and self-employment rates as factors on an informal economy. For the period of from 1999 to 2013, they make estimations about informal sector sizes and examine effects of the aforementioned drivers for 157 countries. In that period, the average share of informality is nearly 33 percent of a total market. Furthermore, they conclude that institutional quality plus tax and regulation burdens play significant roles on the informality [13].

In addition to the study about the general informal sector, now we focus on the studies which specifically analyze the informal employment problem. Most of these studies have been conducted to analyze causes and results of the informal employment problem. Before presenting examples about the informal employment studies, we briefly provide information about the labor market equilibrium approach which is commonly used with minor changes in the informal employment literature. Firstly, the equilibrium approach depends on the assumption that firms prefer to hire workers (labor demand) when a wage level is low whereas job seekers prefer to work (labor supply) when this wage level is high. So the labor supply increases with an increase in the wage level whereas the labor demand decreases with an increase in the wage level. Basically, there is a trade between firms (providing wage) and workers (providing production revenue). From this conflicting situation related to the wage level, a system always reaches equilibrium when labor demand is equal to labor supply. In that point, a system determines a market-clearing wage level and employment level. In

addition to employers, a labor market contains just employed or unemployed workers. A specific employment level is seen under a specific wage level. Firms hire workers by considering a relationship between a wage level and production revenue. A total employment level of firms will be equal to a market's equilibrium employment level. Similarly, all job seekers who seek a job at a market wage level are hired or in other words find jobs [14]. Changes (such as tax/contribution rates, regulative costs, subsidies etc.) in basically labor supply and demand curves affect a system and alter the equilibrium point. In addition to the general framework, there is a discrimination between formal and informal sectors in the informal employment studies. These sectors differ in factors like wage levels, labor productivity levels or sectoral revenues etc. Each sector has particular advantages and disadvantages. According to these properties and dynamic environmental conditions, agents in both labor supply and demand sides rationally make decisions (with profit maximization). In that content, various scenario and policy analyses are made in the studies by interfering equilibrium systems. With these analyses, observations are made about factors and their effects on both formal and informal sectors. Models in the literature are mainly built in that base.

Firstly, Ulyssea attempts to understand influences of regulative factors (i.e. payroll taxes, unemployment benefits, entering cost, government controls) on the informal employment rate and also on overall labor market performances by using the steady state equilibrium framework. Two sector (i.e. formal and informal) matching model is used in the study. As mentioned above, formal and informal hiring decisions are made by comparing these two sectors' characteristic advantages and disadvantages. For example, a firm does not have to pay regulative costs to hire an informal person; yet it may suffer from a lower productivity level of this person. The author examines how the regulative factors affect sectors' benefits and how sectors respond to these effects in terms of formal/informal employment ratios. Their observations suggest that entry cost and enforcement factors have powerful effects on informal employment, whereas effects of payroll taxes and unemployment benefits seem insignificant [15]. Moreover, Zenou performs similar research on determining direct/indirect impacts of factors (e.g. unemployment benefit, entry cost and subsidy) on the formal and informal sectors by making slight changes in assumptions about sector situations. Main results show that

decreases in entry cost and unemployment benefit levels make a formal sector more profitable so an informal employment ratio starts to go down. Unlike the Ulyssea's findings, Zenou finds out a noticeable role of unemployment benefits on informality. In addition, he interestingly finds that increasing hiring subsidies reduce informal employment whereas increasing employment/wage subsidies increase informality [16]. Thirdly, Satchi *et al.* perform research on a comparison of two sectors with making an extra division in a market: rural (agricultural) and an urban. They assume that the urban sector comprises of just formal and informal self-employment. In that base, various scenario and policy analyses (e.g. facing productivity shocks or changing parameters such as tax rate, bargaining power, matching efficiency etc.) are made in the study with similarly using the steady state equilibrium and two sector matching frameworks. Additionally, the theoretical model is calibrated with the labor market data of Mexico. Besides similar findings, a higher bargaining power of workers causes higher informality whereas a higher matching efficiency causes higher formality [17]. Another similar research is made with theoretically and empirically calibrated models for the period from 2001 to 2012 in different regions of Italy. Finally, Caro and Nicotra seek main drivers of informality and their findings suggest these factors; regulations, taxes and productivity standards in public goods and services. As a contribution to the literature, the researchers consider migrations made by job seekers within the Italian regions and they estimate the trend and effects of these migrations on informal sectors. They analyze relations and interactions between regional sectors. Additionally, responds of these regions to economic shocks are examined in the part of the study [18].

Loayza and Rigolini conduct research to answer the basic question of whether informal job creation is a safety net or a growth engine in long and short time runs, separately. Mainly, they compare two sectors according to their responses to economic shocks. In order to test propositions about informality factors, they include an empirical model to the study by gathering labor market data from 58 countries for the period from 1984 to 2008. In the constructed model, informal self-employment rate is chosen as a dependent variable and they seek relations with independent variables such as GDP per capita (also called labor productivity in the study), regulation and enforcement levels, market flexibility and government quality. Results suggest that GDP

per capita, regulation flexibility and government quality are negatively correlated to informality in the long run. There is no significant difference in short-run results. For most examined countries, consequents consistently indicate that informal employment is a safety net since it responds to production shocks counter-cyclically in respect to an economic growth cycle [7]. Fies *et al.* do similar research by investigating responses of informal self-employment and formal wage employment sectors to various economic shocks. Nevertheless, their model which is calibrated with labor market data from four Latin America countries suggests totally different results compared to the previous work. In some of the studied cases, interestingly there is evidence about a pro-cyclical behavior of informal self-employment, which means informal self-employment is not a safety net but a voluntary choice [6].

Günther and Launov seek an answer to the question of whether informality is a voluntary or a forced choice for job seekers. They build an econometric model which depends on wage functions (earnings of agents) of different sectoral segments and try to observe whether a distribution of workers to sectors depend on the wage factor or the limitations seen in market segments. After calibrating the econometric model with the empirical data from Côte d'Ivoire, a West-African country, results primarily suggest that a labor market has both types of individual, which means some of them are voluntary and the others are forced to accept informality. Because of barriers between market segments, some of the job seekers cannot maximize their utilities so they have to work informally as a last resort [8].

There are also studies which are similar to above conceptual and methodological content with minor differences and additional views, see [19–29]. There are also authors performing research on conceptualization and reviews of the informal employment issue, see [2, 30–33].

These aforementioned studies are considered for the purpose of determining various potential drivers on the informality problem form all over the world. By taking certain of these drivers and their relationships with the problem into the consideration, our model is built. Relationships in the model are quantitatively different but qualita-

tively similar to these studies. However, the model is not limited to the chosen drivers and relations. Additional driver mechanisms with various causal relationships can be seen in the model.

In addition to the informal employment studies, now we focus on the studies which are related to the Turkish case of the problem. Sahin *et al.* examine relationships between produced outputs and created employment by Turkish economy and labor market. They conclude that a growing trend of outputs causes increase in a formal employment rate in the long run. However, this effect is observed in low paid and low productivity jobs, which means informal jobs in these levels are replaced with formal ones whereas there are no significant changes in higher level informal employment rate [34].

In a 2008 study, Saracoğlu makes an extension to investigating the informality problem by considering a consumer factor. She claims that when incomes continuously rise due to economic growth, households start to avoid consuming goods and services produced by the informal sector. So with growing economy, the informal sector goes down over time. Additionally, the author shows that non-agricultural informal employment decreases with decreasing tax rate [35].

Dayangac and Goktuna focus on a job seeker's tendency to accepting informality like the study made by Günther and Launov (2012). However, they approach to the issue by comparing formal working opportunities (e.g. pension and insurance) to allegedly informal working insurances (e.g. bequests and family supports) via an evolutionary analysis. They assume that informal employment is a voluntary choice of job seekers since family supports may more than compensate for taking pension and insurance in a formal sector [36].

In a 2014 study, Tansel and Kan focus on a specific part of the problem, which is a wage gap among formal and informal workers. By taking the Turkish Income and Living Conditions Survey (ILCS) data for their econometric model, essentially, they demonstrate the fact that informal workers are less paid than formal workers,

which is known as the main drawback of informality [34]. Furthermore, Balkan and Tumen conclude similar results from their study which mainly focus on wage gaps in the context of different sized firms. In addition to interesting findings in various size and categorizes, they also underlie that informal workers are not only less paid but also forced to work longer than formal counterparts [37]. Moreover, Baltagi *et al.* investigate wage curves separately for formal and informal workers in order to find connection between an unemployment rate and an hourly real wages of these workers. By using a regression model, they analyze an unemployment elasticity of real wages for specifically divided groups according to for example, education backgrounds. Evidence shows that real wages of informally employed people are more sensitive to changes in an unemployment rate than wages of formally employed people. In other words, an increase in an unemployment rate affects informal workers' real wages more severely [38]. For the period from 2004 to 2014, Pelek (2015) studies an impact of minimum wage decisions on an employment rate of a specific age group, 15-29, in Turkey. Even tough, there is no evidence of a noticeable negative impact of minimum wage decisions on formal employment rate, a positive correlation between minimum wage level and informal employment rate can be concluded [39].

In general, studies in this field have been interested in informal employment's size, drivers and results. We essentially consider research that focused on causal factors about the problem. In determining how argued causes affect the problem, equilibrium models are common in the literature. As explained above, the labor market equilibrium approach depend on an equilibrium between labor supply and labor demand. Many studies use this approach with statistical data and try to observe possible factors on informal employment. By directly interfering labor demand and supply curves of both formal and informal sectors, factors are examined under various scenario and policy conditions. Even though models generally give similar results such as a positive effect of regulative burdens on informal employment, these results and their effect levels alter across countries' labor markets, even across regions of the same country. This demonstrates that every country has specific properties about the problem and each one should be analyzed separately with considering its own characteristic and environmental conditions.

3. PROBLEM DESCRIPTION AND RESEARCH OBJECTIVES

As mentioned above, multi-dimensional consequences emerge in micro and macro levels as an outcome of an informality problem in employment. For example, workers suffer from lower wage and unhealthy working conditions. On the firm's side, unfair competition ruins market regulations. Additionally, governments complain about tax evasion and losses of budget.

In the Turkish case, apparently, this dynamic problem still has been in existence and contributing to serious economic and social problems (Figure 1.1; Figure 1.2). Fluctuations are seen in the number of informally employed people and informal employment ratio dynamics. In order to comprehend the problem clearly and offer solutions to stakeholders, socio-economic aspects of the problem should be carefully considered all together. Moreover, informal employment characteristics, drivers and trends differ in even similar developed countries, so the Turkish case should be considered specifically with its own features [1].

In a wide range of previous studies on the issue, there have been conceptual and methodological deficiencies. At first, there is no study analyzing the problem as a whole by considering all labor force states (i.e. basically non-labor force, formal employment, informal employment, unemployment) and transitions among these states (such as participation in labor force, leaving from labor force, retirement, hiring, firing etc.) together. Secondly, the studies, using the labor market equilibrium models, depend on the assumption that a system always generates equilibrium when the number of labor demand and supply are equal. However, a complex labor market does not have to attain equilibrium and actually in real, it is mostly not [14]. Additionally, we cannot interpret behaviors of the problem over months or years since models, built in the informal employment studies, fail to consider their dynamic behaviors changing year by year. They do not explain historical informal employment dynamics and also they do not have

a word about how an informal employment trend goes under base/current conditions or how it behaves in the following years under different conditions. Thirdly, these models generally miss feedback mechanisms. For example, they can capture a positive effect of an increasing regulatory burdens on an informal employment ratio whereas a possible balancing/reinforcing result is missed. Additionally, there is no noticeable and calibrated dynamic model which analyze the informal employment dynamics and its drivers for the Turkish case.

In order to cope with the problem of informality without these deficiencies, we build a System Dynamics model and try to find responses to the research questions. Research questions and related methodological steps are given below;

Q1) What could be the driving mechanisms responsible for the informal employment dynamics of the Turkish labor market?

At first, socio-economic causes and their direct affects are gathered by searching literature and data about the informal employment problem in Turkey. Characteristics, drivers and trends of the problem differ from country to country. So the Turkish case should be analyzed by considering its own features. After identifying main causes and relationships, causal loop diagrams in the SD approach are used to connect these variables with causal relationships. With these causal loop diagrams, the problem can be analyzed by considering feedback mechanisms. On the basis of that structure, stock and flow diagrams of SD approach are constructed to simulate the problem over time. After verification tests, we examine explanatory sufficiency of the model by looking at consistency between the generated dynamic patterns and the real dynamic patterns of informal employment rate.

Q2) Could the target, of the Turkish Government, to decrease the informal employment ratio from 34 percent to 15 percent be achieved under current state?

According to Dr. Müezzinoğlu, the former Minister of Labor and Social Security, the government is aiming to decrease the informal employment ratio firstly to 25 percent

in the short time yet the main target is to decrease the ratio to 15 percent. After model credibility and sensitivity tests, simulation experiments are conducted to understand important dynamic properties of the problem. We observe how rates act in the following years under base conditions. Additionally, we test whether the target can be reached or not, by considering regulations and actions related to the government target.

Q3) On the basis of the constructed model what could be alternative policies to decrease the informal employment rate in Turkey?

In addition to reference runs, various policies and scenarios are analyzed through simulation experiments. According to these analyses, we try to come up with better ways to decrease informal employment rate in Turkey.

4. RESEARCH METHODOLOGY

In order to analyze complex, large-scale and dynamic systems, system dynamics is an appropriate method. Barlas describes the methodology as given below [40];

”System dynamics discipline deals with dynamic policy problems of systemic, feedback nature. Such problems arise from the interactions between system variables and from the feedback between the managerial actions and the system’s reactions. The purpose of a system dynamics study is to understand the causes of a dynamic problem, and then search for policies that alleviate/eliminate them.”

System dynamics particularly deal with the dynamics caused by the internal feedback structure of the system. A model represents a real system of interest which is related to a problem. System dynamics models consists of two main building blocks: stocks (levels) and flows (rates) [41]. Stock variables represent accumulations and there are flows representing rate of changes in these stocks over time [40]. Besides stocks and flows, there are also converters (auxiliary variables) which are useful to define parameters and variables explicitly [41].

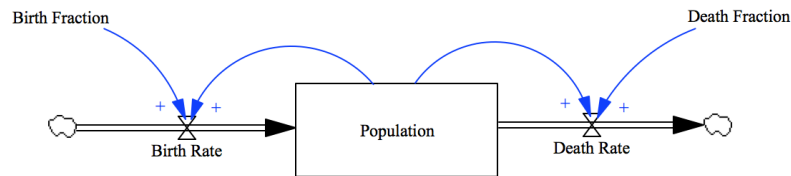


Figure 4.1. Stock-flow diagram of the population model.

A simple population model can be given as an example of a stock-flow diagram in system dynamics. As seen in Figure 4.1, a rectangular box represents a population stock. Birth rate is an inflow and death rate is an outflow of the population stock. The population stock is changed by these flows. If the births are more than the deaths, then the net-flow of the population stock becomes positive, and the population stock increases from its present value. If the birth rate is less than the death rate, then the

net-flow of the population stock becomes negative, and the population stock decreases from its present value. Moreover, the birth and death fractions are converters (auxiliary variables). The causal relationships between variables are represented by the arrows. A positive sign indicates a relationship which is that an increase in the population and birth fraction results in an increase in the birth rate. Similarly, if the population and death fraction increases, then the death rate increases. On the other hand, an increase in the birth rate also increases the population while an increase in the death rate decreases the population stock from its present value. Related differential equations are given below:

$$\text{Population}(t) = \text{Population}(t - dt) + (\text{BirthRate} - \text{DeathRate}) \times dt \quad (4.1)$$

$$\text{BirthRate} = \text{Population} \times \text{BirthFraction} \quad (4.2)$$

$$\text{DeathRate} = \text{Population} \times \text{DeathFraction} \quad (4.3)$$

5. MODEL DESCRIPTION

At a macro level, the model is constructed to analyze the labor market and informal employment dynamics in Turkey. As mentioned before, we handle the problem from three views i.e.-employee, employer and government. The employee and employer views are represented in two distinct sectors within the model. The government view is mainly considered in the scenario and policy analysis.

5.1. Overview of the Model

Mainly, we perform research on the driving mechanism of the informal employment problem in Turkey. From the System Dynamics perspective, analyzing drivers and their effects separately cannot clearly describe the problem. Thus, we are aiming to gather these drivers, their relationships and possible effects within a whole in order to look at the bigger picture. Within this framework, we compile information and evidence about the informal employment problem and build a structure by assembling them with specific relations. By considering relationships, feedback mechanisms, time-dependent behaviors within this structure, we want to evaluate the dynamic informal employment problem in Turkey.

The model is composed of two parts which are called “labor supply sector” and “labor demand sector”. The labor supply sector represents people in labor market states (i.e. non-labor force and labor force) while the labor demand sector represents employers/firms with job vacancy creation/closure/cancellation processes.

In addition to the discrimination between labor market stakeholders, the model consists of two market sectors which are formal and informal sectors.

Before making a discrimination between the formal and informal sectors, the simplified causal loop and stock-flow diagrams of the labor market are given below in

order to provide a general overview (Figure 5.1, Figure 5.2¹);

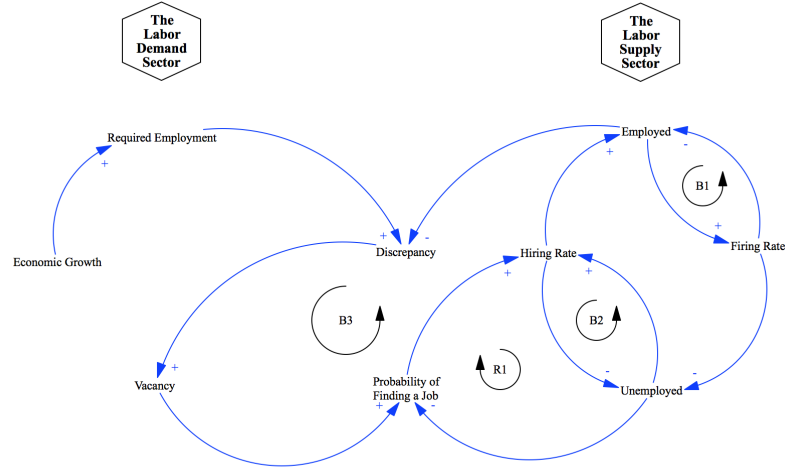


Figure 5.1. Simplified causal loop diagram of the labor market model.

In the labor supply sector, there are labor market states which are non-labor force and labor force. In the labor force, there are people who are either employed or unemployed. As seen in Figure 5.2, people flow from the non-labor force state to the labor force state via the labor force participation rate flow. These people are first-time job seekers. In the unemployed stock, there are first-time job seekers and other regular job seekers who willingly or unwillingly leave their jobs. Unemployed people are hired according to a probability of finding a job. The probability of finding a job for a job seeker depends on the number of unemployed people and the number of job vacancy in the market. In the model, the labor supply and labor demand sectors contact with each other via the probability variable. There is a relationship between the economy and the required employment in the labor market. With the growing economy, the required employment grows whereas the required employment goes down under an economic recession. While making a decisions on an amount of vacancy creation, the discrepancy between the required employment and current employment plays a role. According to this discrepancy, the total number of vacancy creation is determined at

¹In the stock-flow diagram, variables in the labor demand sector are colored red, variables in the labor supply sector are colored orange and common variables in both sectors are colored green.

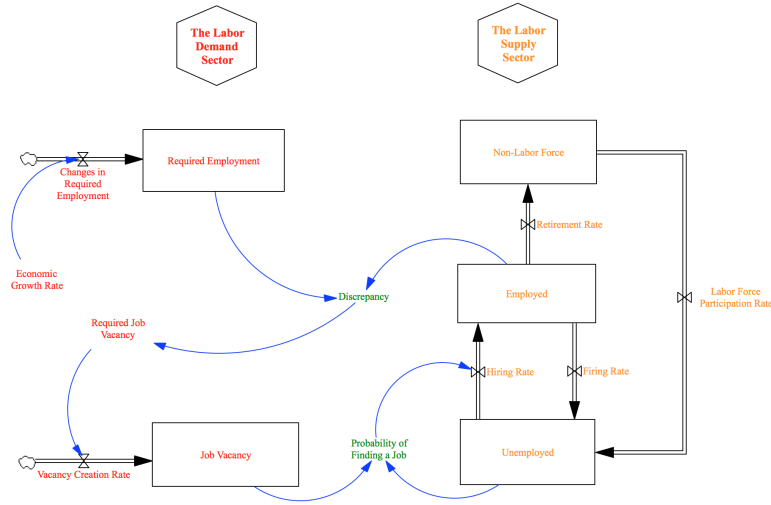


Figure 5.2. Simplified stock-flow diagram of the labor market model.

a macro level. There are no individual decisions of employer/firms in the model.

Additionally, people become retired over time and return to the non labor force state. We will elaborately explain the whole structure with required information, justifications and citations in the following sections.

In addition to the brief explanations about the simplified stock-flow diagram, now we present related explanations about the simplified causal loop diagram of the labor market model. As seen in Figure 5.1, there are causal feedback loops between variables;

- Balancing Feedback Loop 1 (B1): The firing rate is a function of the employed states. So that if the employed grows then the firing rate also grows. On the other hand, an increase in the firing rate causes a decrease in the number of employed people.
- Balancing Feedback Loop 2 (B2): Similar to the relation between the firing rate and employed, the hiring rate is a function of the unemployed state. So that if the unemployed grows then the hiring rate also grows. However, an increase in the hiring rate causes an decrease in the unemployed.

- Reinforcing Feedback Loop 1 (R1): Besides the B2 loop, there is also a reinforcing relationship between the hiring rate and unemployed. As mentioned above, the probability of finding a job variable is affected negatively by the unemployed. Finding a job becomes easier (harder) when there are less (more) unemployed people in the market. With this higher (lower) probability, more (less) people are hired at a specific time period. With the higher (lower) hiring rate, the unemployed goes down (goes up).
- Balancing Feedback Loop 3 (B3): The number of employed people increases with the higher hiring rate. However, the discrepancy between the required employment and current employment decreases with the higher employed people. Then, the decreasing discrepancy affects the vacancy creation process negatively. With the negatively affected vacancy, the probability decreases and so the hiring rate decreases. This process balances the system. By the way, a decrease in the hiring rate does not mean a decrease in the employed since the hiring rate is the inflow of the employed, as seen in Figure 5.1. The employed is negatively affected by the decreasing hiring rate. Similar relation exists in between the vacancy creation rate and vacancy variables.

As mentioned above, the model consists of formal and informal sectors. In the model, hiring and firing processes are same for both formal and informal sectors. However, there are common and specific unemployment pools for formal and informal sectors and sectors use these pools in hiring and firing processes. In the labor supply side, unemployed people join these pools according to particular factors like poverty. Additionally, the vacancy creation process is same for both formal and informal sectors. However, there are specific vacancy pools of sectors. After determining required vacancy value, these vacancies are distributed to formal and informal vacancy categories. In the distribution process, an incentive for informality level of employers/firms plays a significant role. Required vacancy values are distributed according to this incentive for informality level. There are also particular factors on the incentive for informality level like a government control over the informality problem.

As an SD software, we choose Vensim. The model is continuous time model and integration type is Euler. For the simulation runs, the selected time step is 0.03125 (2 to the power minus 5), which is sufficiently small.

The time unit of the model is taken as a month. The time horizon of the simulation is set to 32 years (384 months), for the period from 2000 to 2032 (5.1). A 34 year-time horizon can be useful to observe the labor market behaviors occurring in the wide range economic conditions. The first part of the period (i.e. 2000-2017) is for calibration and it is extended long enough to capture the real labor market dynamics. Moreover, the behaviors can be evident only in the long run thus the simulation time horizon is set to be an extra 15 years (i.e. 2017-2032).

Table 5.1. The time horizon (month notations in the model and their equivalent years).

Month Notation	Equivalent Year	Month Notation	Equivalent Year	Month Notation	Equivalent Year
0-11	2000	132-143	2011	264-275	2022
12-23	2001	144-155	2012	276-287	2023
24-35	2002	156-167	2013	288-299	2024
36-47	2003	168-179	2014	300-311	2025
48-59	2004	180-191	2015	312-323	2026
60-71	2005	192-203	2016	324-335	2027
72-83	2006	204-215	2017	336-347	2028
84-95	2007	216-227	2018	348-359	2029
96-107	2008	228-239	2019	360-371	2030
108-119	2009	240-251	2020	372-383	2031
120-131	2010	252-263	2021	384-395	2032

5.2. The Labor Supply Sector

5.2.1. Introduction to the Sector

The labor supply sector represents people who are in the labor market states, i.e.- non-labor force and labor force, in the model. The labor force state comprises all employed and unemployed people in the market [42]. So there are two basic sub-states which are employment and unemployment in the labor force state. In the labor force states, there is also a discrimination according to the formal and informal sectors. In the formal sector, people are hired with social security coverage whereas people are hired without any official requirements in the informal sector. With this discrimination, the labor market states are represented by these six stocks; Non-Labor Force, Employed Formal, Employed Informal, Unemployed Formal, Unemployed Informal and finally Unemployed Formal and Informal (Figure 5.4). Over the simulation time, people flow between these states. Labor force participation, hiring, firing, retirement processes are given as examples of transitions among these states. Additionally, changes in the model population take place with birth (represented by maturation rate in the model) and death processes.

5.2.2. Background Information

By the Turkish Labour Law, children younger than 15 year-old cannot participate in the labor market as a full-time worker [43]. Thus, we ignore children below this age limit in the model population. The model population represents the real non-institutional working age population, provided by TurkStat [10]. The non-institutional population is officially defined as *comprises all the population excluding the residents of dormitories of universities, orphanage, rest homes for elderly people, special hospitals, prisons and military barracks etc* [42].

In the model, the labor supply sector stocks, representing labor force states, and flows are totally consistent with the real labor market behaviors. For example, a student generally does not make an economic activity during education, but after

finishing a school, he/she willingly participates in labor force or a worker is fired or an older self-employed worker is retired due to disability etc.

All employment types (i.e. employer, employee, self-employed and family worker) are regarded as a potential informality source in the model. We do not limit the model in specific employment types unlike research in the literature (as an example, see [17]). Additionally, we apply this wide-ranging framework not only for informal employment but also for formal employment. So the model can capture the real formal and informal employment dynamics by considering all employment types.

5.2.3. Causal Loop Diagram of the Labor Supply Sector

As mentioned earlier, there are labor market states in the model and people are distributed to these states in the labor supply sector. In addition to the simplified causal loop diagram in the overview section, now we present the simplified causal loop diagram for just the labor supply sector with the discrimination between the formal and informal sectors (Figure 5.3)².

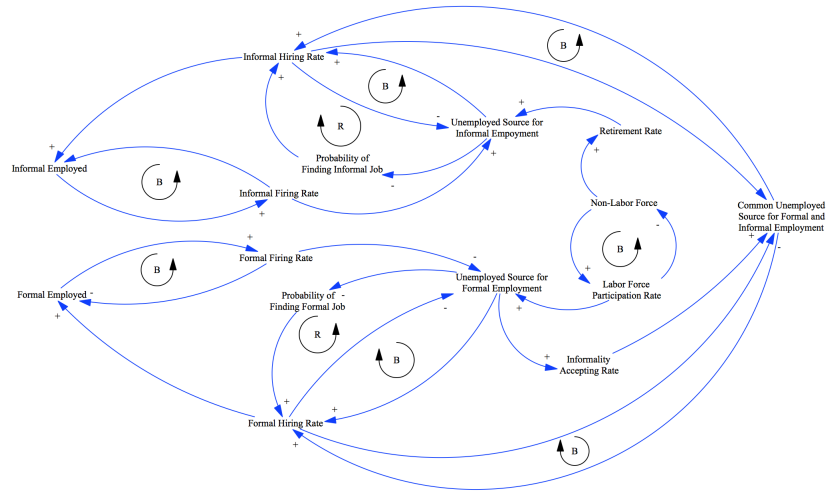


Figure 5.3. Simplified causal loop diagram of the labor supply sector.

²Variable names in this causal loop diagram can be different than the variable names in the model for the sake of simplicity

Firstly, in the diagram, there is a balancing loop between non-labor force and labor force participation rate. As mentioned earlier, people participate in the labor force state via the labor force participation rate flow (Figure 5.2). With the increasing non-labor force, the participation rate increases. However, the increasing participation rate decreases the non-labor force stock.

Additionally, there is a positive effect of labor force participation rate on unemployed source for formal employment. As mentioned in the overview section, first-time job seekers try to find a job in the formal sector. In addition to this positive effect, non-labor force also increases unemployed source for informal employment via retirement rate. In the model, retired people are assumed to be potential workers for the informal sector. In the model description section, we will elaborately explain this assumption. With the increasing unemployed sources, formal and informal hiring rates increase as seen in the Figure 5.3. However, these unemployed people sources also affect hiring rates negatively via the probability functions. As mentioned in the overview section, the probability functions depend on both unemployment and vacancy values. With the increasing unemployment, the probability functions go down.

In addition to the two unemployed sources, there is also an unemployed people source for both formal and informal employment which is called 'common unemployed source for formal and informal employment' in the causal loop diagram. Some of unemployed people decide to seek a job also in the informal sector due to some factors such as poverty and insufficient formal job opportunities. In other words, poverty and insufficient formal job opportunities force unemployed people to accept informal working conditions so that people start to seek jobs in both formal and informal sectors rather than seeking just in the formal sector. Similarly, this common source affects hiring rates positively and also it is affected negatively by hiring rates.

As mentioned in the overview section, there is a balancing loop between employed and firing rate. In both formal and informal sectors, there are balancing loops between employed states and firing rates, as seen in Figure 5.3.

We elaborately explain all variables and their causal relationships in the following section.

5.2.4. Description of the Structure

In this subsection, we present the variables and related explanations of the labor supply sector in detail. Before the detailed explanations for each stock variable, the general stock-flow diagram of the labor supply sector is shown in Figure 5.4 ³.

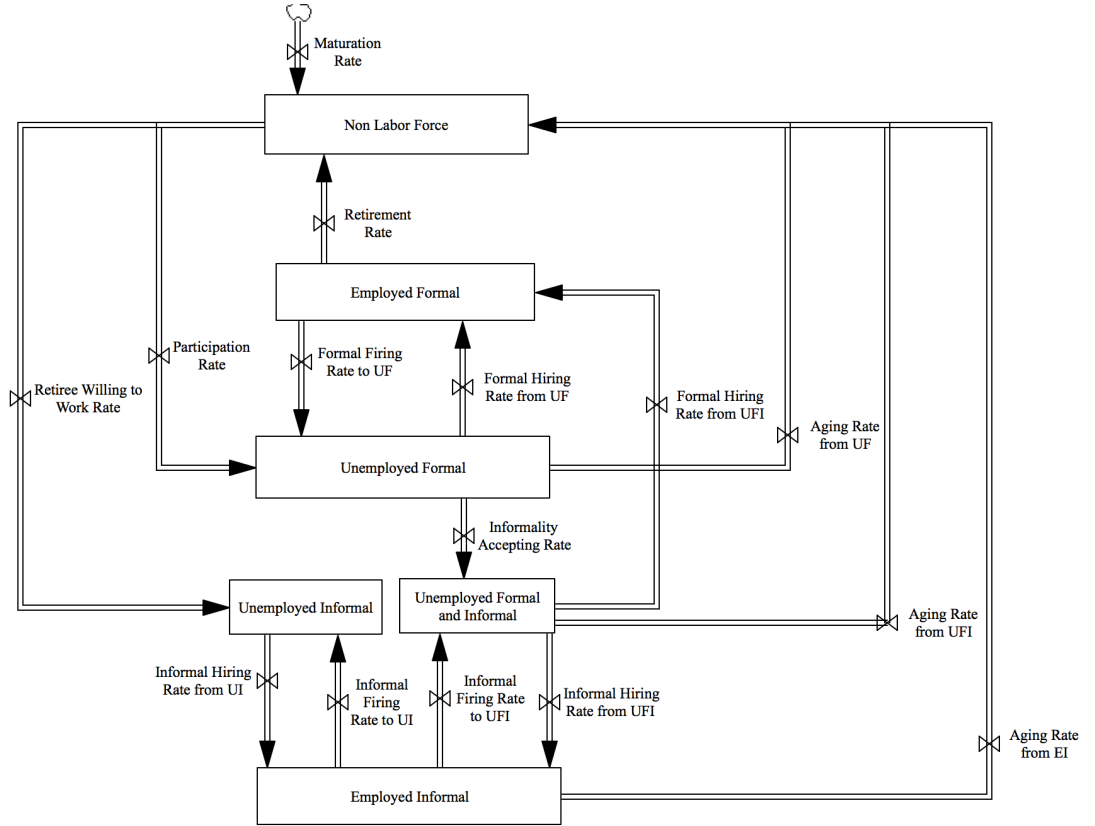


Figure 5.4. Simplified stock-flow diagram of the labor supply sector.

5.2.4.1. Non-Labor Force (NLF). Non-labor force is officially defined as comprising older than 15 year-old people who are neither unemployed nor employed [42]. Non-labor force is one of states in the labor market. Similar to the official definition, the stock in the model consists of people who are not in labor force such as housewives, students,

³In Figure 5.4, converters and death rate variables are excluded for the sake of simplicity. For the full structure, see Appendix B.

retirees, disabled workers or seasonal workers etc. Some of them never participate in labor force like housewives who do not want to make an economic activity. Some of them do not yet participate in labor force because of educational activities. Moreover, there are people who come from labor force and do not want to go there again like retired or disabled people. In addition to these not working people, seasonal workers are also regarded as in non-labor force.

As seen in Figure 5.5, the non-labor force stock has relationships with the other five labor force states in the model. Via the transitions, people flow from the non-labor force stock to the unemployed formal and unemployed informal stocks. Additionally, the non-labor force stock is fed by the exogenous source, maturation rate, and the endogenous sources like retirement rate. We elaborately discuss the structure as following;

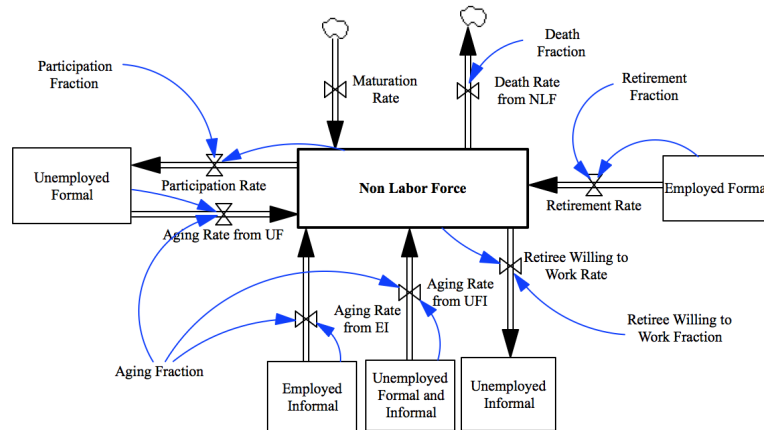


Figure 5.5. Simplified stock-flow diagram related to non-labor force.

People, 15 years of ages and over (excluding the residents of dormitories of universities, orphanage, rest homes for elderly people, special hospitals, prisons and military barracks etc.), enter the system via the maturation rate inflow, their first stop is the non-labor force stock (Figure 5.5). It is assumed that the maturation rate flow is time-dependent in order to capture the real population dynamics. It varies from 120000

to 170000, which means the number of people between one hundred twenty thousand and one hundred seventy thousand enter the system monthly. In the model validation section, we elaborately discuss this assumption and possible effects on the model.

People, who want to make any economic activity, leave the non-labor force stock via the participation rate outflow. The participation rate flow is determined by the participation fraction parameter (Equation 5.2). As seen in Figure 5.6, participation fraction is assumed to be linearly increasing over time since the real participation ratio (a ratio of labor force to total population) has been rising in the last decade [10]. So, we set the participation fraction according to the related real non-labor force and labor force data. Similar to the maturation rate assumption, we also discuss this time-dependent participation parameter in the model validation section. Basically, we compare the time-dependent parameters to the constant versions of them in order to examine possible effects of these assumptions on the model dynamics.

$$\begin{aligned}
 \text{NonLaborForce}(t) = & \text{NonLaborForce}(t - dt) \\
 & + (\text{MaturationRate} - \text{ParticipationRate} \\
 & - \text{RetireeWillingtoWorkRate} \\
 & + \text{AgingRatefromUF} + \text{AgingRatefromEI} \\
 & + \text{AgingRatefromUFI} + \text{RetirementRate} \\
 & - \text{DeathRatefromNLF}) \times dt
 \end{aligned} \tag{5.1}$$

$$\text{ParticipationRate} = \text{NonLaborForce} \times \text{ParticipationFraction} \tag{5.2}$$

$$\text{AgingRatefromUF} = \text{AgingFraction} \times \text{Unemployment} \tag{5.3}$$

$$\text{AgingRatefromEI} = \text{AgingFraction} \times \text{EmployedInformal} \tag{5.4}$$

$$\text{AgingRatefromUFI} = \text{AgingFraction} \times \text{UnemployedFormalandInformal} \tag{5.5}$$

$$\text{AgingFraction} = 0.0025 \tag{5.6}$$

In the model, aging rates basically represent leaving informally working or unemployed situations and going to the non-labor force pool because of same reasons as seen in retirement decisions such as aging, health disorders, tiredness, disabilities etc. Firstly, people leave the employed informal stock and go to non-labor force. Similar to formally employed people (leaving the formally working situation is represented by the retirement rate rather than the aging rate, which will be explained following paragraphs), informally employed people have to leave the employed state mainly due to aging. It is assumed that informally employed people go to the non-labor force state with a constant fraction. Secondly, unemployed people who seek a formal job (in the unemployed formal stock) and unemployed people who seek both formal and informal jobs (in the unemployed formal and informal stock) leave current states and go to the non-labor force stock mainly due to aging. Similarly, it is assumed that people in these states go to the non-labor force state with a constant fraction. On the other hand, there is no leaving rate from the unemployed informal stock since this stock consists of the aged and retired people so that there is no reason to leave the stock due to aging except death.

It is assumed that the aging fraction is constant and also valid for all three aging rates in the model (Equation 5.6). This constant value is determined as close to the average retirement fraction which is time-dependent parameter for the retirement rate.

$$\begin{aligned} \text{RetirementRate} &= \text{EmployedFormal} \times \text{RetirementFraction} \\ &\quad \times \text{RetirementAdjustment} \end{aligned} \tag{5.7}$$

$$\text{RetirementAdjustment} = 0.7 \tag{5.8}$$

As seen in Figure 5.7, we set retirement fraction as a time-dependent parameter. While doing this, we consider the real retirement rate per year by SSI [44]. It is assumed to be linearly decreasing in order to calibrate retirement rates to the real retirement rates. As seen in the previous time-dependent parameters, we also compare this varying parameter to the constant version of it, in the model validation section.

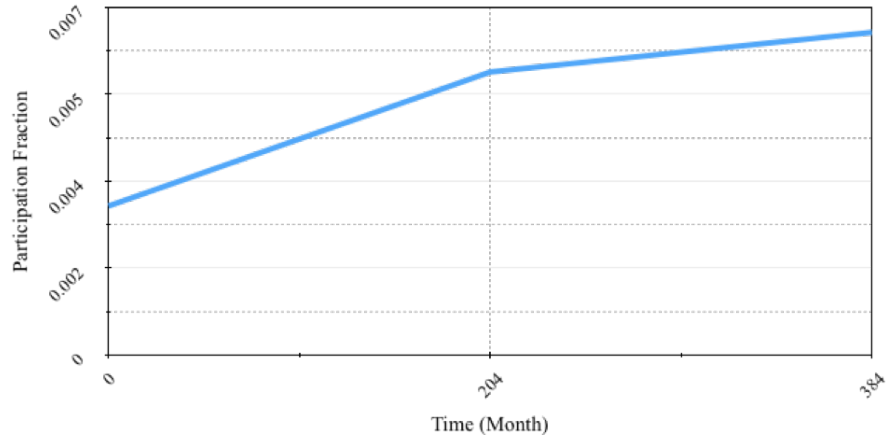


Figure 5.6. Participation fraction over time.

Moreover, we multiply the fraction with the retirement adjustment parameter which is equal to 0.7. According to the Income and Living Condition Survey (Turk-Stat), 33 percent of retired people still work formally in the market [45]. On the other hand, according to a board member of Union Insurance and Reinsurance Companies of Turkey, Eredenk, 28 percent of retired people still work formally in the market [46]. We accept this both information by rounding it up. So 30 percent (so that the retirement adjustment fraction is equal to 0.7) of retired people still work formally, and we do not include these people in the retirement rate flow. Rather, the retirement rate flow represents retired people who will not work in the formal sector.

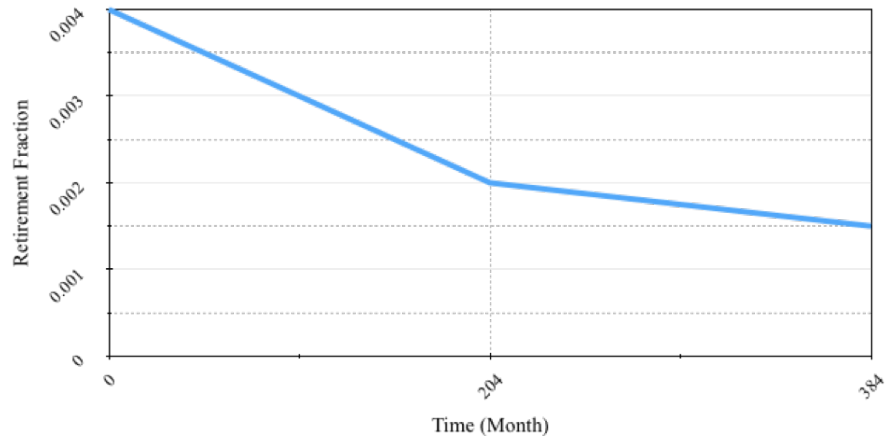


Figure 5.7. Retirement fraction over time.

$$\text{RetireeWillingtoWorkRate} = \text{RetirementRate} \times \text{RetireeWillingtoWorkFraction} \quad (5.9)$$

$$\text{RetireeWillingtoWorkFraction} = 0.4 \quad (5.10)$$

Besides formal retired workers, there are retirees who are willing to work again after their retirements. It is assumed that these people cannot find a job in the formal sector. In an equal net wage condition, a labor cost of a formal retired employee is higher than the labor cost of a regular employee [47]. Moreover, efficiency levels of retired people are lower than regular ones in general. Thus, we assume that retired people who are willing to work have to find a job in the informal employment state. There is no information about the ratio of these willing retirees to total retirees. Thus, retiree willing to work fraction is assumed to be a moderate value. So we set it as constant, and equal to 40 percent. In other words, 40 percent of retired people are not satisfied in non-working situations and then decide to seek a job. In the sensitivity analysis section, we test the model sensitivity to this constant value.

In spite of these logical constraints for retired people, they are still able to work as formal in the model. As mentioned while explaining retirement rate, we consider the fact that there are retired workers in the formal employment state by decreasing the retirement rate outflow of the employed formal stock by 30 percent. Long story in short, there are two types of retired people. One of them is still in the formal employment state and they continue to work and they do not leave this state via the retirement rate flow. The other retired people leave the formal employment state via the retirement rate flow and go to the non-labor force state. Some of these retired people, 40 percent of them, want to work again but they have to seek informal jobs due to the reasons, explained above. Then, these people participate in the unemployed

informal stock and start to seek a job.

$$\text{DeathRatefromNLF} = \text{DeathFraction} \times \text{NonLaborForce} \quad (5.11)$$

Finally, we use the death rate outflows in order to represent deaths in the population. The death fraction parameter is assumed to be time-dependent and determined according to the real death data provided by TurkStat [48]. The death fraction parameter is valid for all stocks in the labor supply side.

5.2.4.2. Unemployed, Formal (UF). The unemployed people is officially defined as *comprising all people 15 years of age and over who were not employed and have used at least one channels for seeking a job during the last three months and were available to start work within two weeks* [42]. In the model, official unemployed people are divided into two distinct stocks. One of these stocks, called 'unemployed formal' represents unemployed people who seek jobs in the formal sector. The other, called 'unemployed formal and informal' represents unemployed people who seek jobs in both formal and informal sectors. While doing this discrimination between unemployed states, we consider the real labor market states. In the labor market, there are people who do not accept informal working conditions and just seek a job in the formal sector. Additionally, there are people who accept both working conditions and seek a job in the formal and informal sectors. So we consider two distinct stocks for these people. In this subsection, we elaborately focus on the unemployed formal stock which represents unemployed people who seek formal jobs. People in that stock do not accept informal working opportunities and so they just seek jobs in formal sector.

As seen in Figure 5.8, the unemployed formal stock has relationships with the other three labor force states in the model. Via the transitions, people flow from the unemployed formal stock to the employed formal, non-labor force and unemployed formal and informal stocks. Additionally, the unemployed formal stock is fed by job seeker rate and formal firing rate. We elaborately discuss the structure as following;

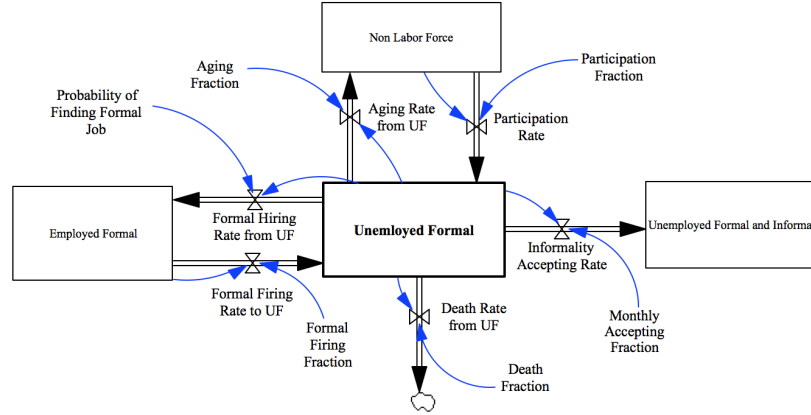


Figure 5.8. Simplified stock-flow diagram related to unemployed formal.

$$\begin{aligned}
 \text{UnemployedFormal}(t) = & \text{UnemployedFormal}(t - dt) \\
 & + (\text{ParticipationRate} - \text{FormalHiringRatefromUF} \\
 & - \text{InformalityAcceptingRate} - \text{AgingRatefromUF} \\
 & - \text{DeathRatefromUF} \\
 & + \text{FormalFiringRatetoUF}) \times dt
 \end{aligned} \tag{5.12}$$

$$\begin{aligned}
 \text{FormalHiringRatefromUF} = & \text{UnemployedFormal} \\
 & \times \text{ProbabilityofFindingFormalJob}
 \end{aligned} \tag{5.13}$$

Firstly, as explained in the non-labor force subsection, people participate in labor force states via the participation rate flow. The first stop of first-time job seekers is the unemployed formal stock. People who want to make any economic activity start to seek formal jobs.

Moreover, a formal hiring process from the unemployment states to employment states is basically represented by hiring rates in the model. In that case, people flow from the unemployed formal stock to the employed formal stock via the formal hiring

rate from UF (unemployed formal) flow. So via this flow, unemployed people are hired in the formal sector. In this process, probability functions play a significant role. The variable which represents a probability of finding a formal job of a single job seeker is used as a fraction for the formal hiring rate. In the labor demand sector section, we will elaborately explain the probability functions.

$$\text{FormalFiringRate to UF} = \text{EmployedFormal} \times \text{FormalFiringFraction} \quad (5.14)$$

$$\text{FormalFiringFraction} = 0.02 \quad (5.15)$$

Furthermore, a firing process from the employment states to unemployment states is basically represented by firing rates in the model. In that case, people flow from employed formal stock to the unemployed formal stock via the formal firing rate to UF (unemployed formal) flow. So via this flow, employed people are fired in the formal sector. By the way, firing rates in the model do not comprise only fired people but also voluntarily quieting people and self-employed people who closed their own businesses. In order to have brief flow titles, the flows which are related to both firing and quit processes are called just 'firing'.

About the firing fraction parameter (Equation 5.15), we make searches in the related literature. Sengul analyzes unemployment flow rates for the period of 2005 to 2010, by using the TurkStat labor force survey. And she finds that the unemployment inflow rate is averagely equal to 1.3 percent per month of the unemployment pool [49]. However, the author makes assumptions about a labor market growth rate and related labor force changes so that she could not capture real labor market dynamics. Additionally, the analyzing period is quite narrow, so it seems to not being useful for our model. Rather taking this estimation, we determine a different but close value to this estimation for the firing fraction parameter. While doing this, we consider the real employment and unemployment dynamics. Moreover, this constant firing fraction

parameter is used for all formal and informal firing rates in the model.

In addition to regular firing rates, the system makes an extra firing when a present value of total employment is more than a present value of required employment. This means, there is an employment surplus in the system. So the system responds to this employment surplus by making an extra firing. All firing rates (formal and informal) are increased equally by an employment surplus (the extra firing equations are not shown in the firing equations, provided in the model description section for the sake of simplicity. For the full firing equations, see Appendix A). In the labor demand sector section, we will mention this process again.

$$\begin{aligned} \text{InformalityAcceptingRate} &= \text{MonthlyAcceptingFraction} \\ &\quad \times \text{UnemployedFormal} \end{aligned} \quad (5.16)$$

$$\text{MonthlyAcceptingFraction} = \text{AcceptingFrYearly}/12 \quad (5.17)$$

$$\begin{aligned} \text{AcceptingFrYearly} &= \text{InitialInformalAcceptingFraction} \\ &\quad \times \text{EffectofJobSeekerPoverty} \\ &\quad \times \text{EffectofFindingFormalJobProb} \end{aligned} \quad (5.18)$$

$$\text{InitialInformalAcceptingFraction} = 0.75 \quad (5.19)$$

It is assumed that some unemployed people decide to seek alternative opportunities in the informal market due to some significant factors such as poverty. These people flow from the unemployed formal stock to the unemployed formal and informal stock which contains people seeking both formal and informal jobs via the informality accepting rate flow. In the model, there are two main drivers which determine this informality accepting rate. One of them is poverty among job seekers. For the poverty effect on informality accepting rate, we use the poverty ratio parameter which is a ratio of poor people to total population. While doing this, we use the statistical poverty ratio by equalized household disposable income data provided by TurkStat for the pe-

riod from 2006 to 2016 [50]. For the remaining period, from 2000 to 2006, we assume poverty ratio in population starts with 30 percent and linearly decrease down to 25.4 percent which is seen in 2006. Moreover, we use the average decreasing rate between 2006-2016 as a reference in order to decrease the poverty ratio for the following years (Figure 5.9). As mentioned above about the previous time-dependent parameters, this time-dependent poverty ratio parameter is also examined in the model validity chapter.

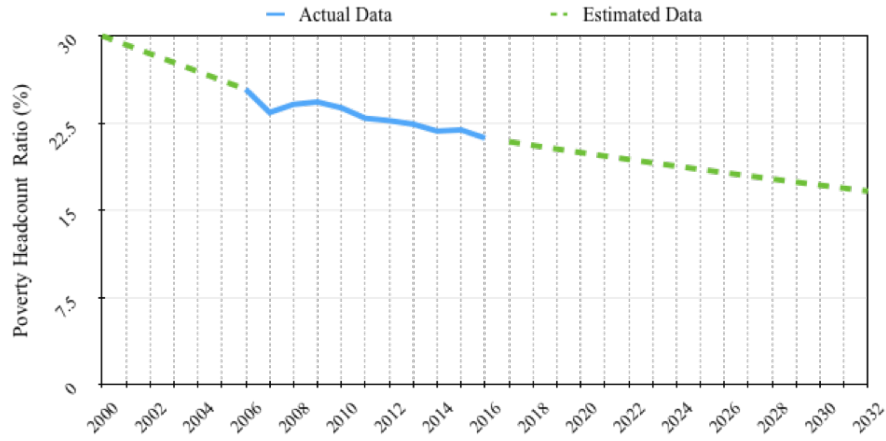


Figure 5.9. Poverty headcount ratio over time (TurkStat, between 2006-2016).

$$\text{EffectofJobSeekerPoverty} =$$

$$f\left(\frac{\text{JobSeekerPovertyRatio}}{\text{InitialJobSeekerPovertyRatio}}\right) \quad (5.20)$$

$$\text{InitialJobSeekerPovertyRatio} = 0.3 \quad (5.21)$$

In the model, the effect of job seeker poverty on informality accepting rate function is given below (Figure 5.10);

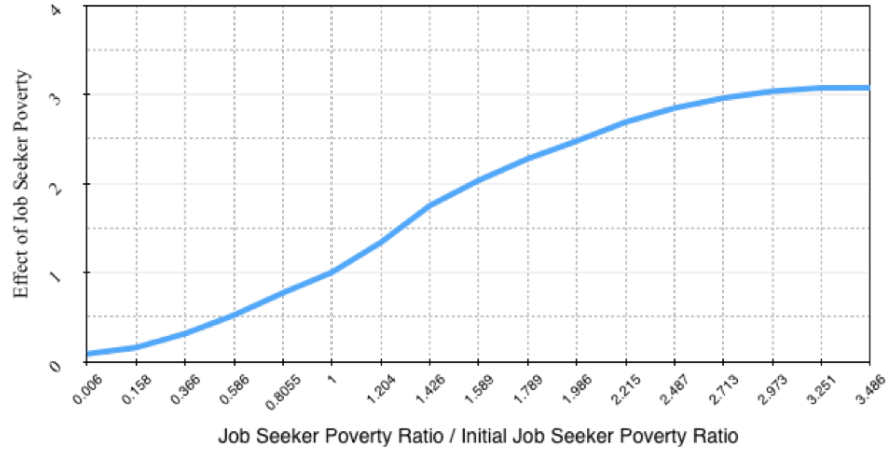


Figure 5.10. Effect function of job seeker poverty on informality accepting rate.

EffectofFindingFormalJobProbability =

$$g\left(\frac{\text{ProbofFindingFormalJob}}{\text{InitialProbofFindingFormalJob}}\right) \quad (5.22)$$

The other effect on the informality accepting rate is the probability of finding formal job (Equation 5.22). Job seekers are inclined to accept informality in a case where finding a formal job becomes hard. The probability and matching functions will be explained in the labor demand sector.

$$\text{DeathRatefromUF} = \text{DeathFraction} \times \text{UnemployedFormal} \quad (5.23)$$

$$\text{AgingRatefromUF} = \text{AgingFraction} \times \text{UnemployedFormal} \quad (5.24)$$

$$\text{TotalUnemployment} = \text{UnemployedFormal} + \text{UnemployedFormalandInformal} \quad (5.25)$$

Additionally, there is a flow from the unemployed formal to the non-labor force stock. People leave this stock mainly due to aging.

As explained in the previous subsection, death rates are seen in all labor force states and depend on the constant death fraction.

Finally, in the model, total unemployment represents official number of unemployed people. As defined above, official unemployment consists of people who are in the unemployed formal and unemployed formal and informal stocks. So people who are in the unemployed informal stock are not counted as unemployed people. Rather, they are considered as in the non-labor force state.

5.2.4.3. Unemployed, Formal and Informal (UFI). The stock consists of unemployed people who accept informal working conditions. In addition to formal job opportunities, now they are able to access to informal job opportunities by accepting informal working conditions. So that job seekers increase total job finding probabilities since now they are able to find either formal and informal jobs. As seen in Figure 5.11, the unemployed formal and informal stock has relationships with the other four labor force states in the model. Via the transitions, people flow from the unemployed formal and informal stock to the employed formal, employed informal, non-labor force and unemployed formal stocks. Additionally, the unemployed formal and informal stock is fed by informal firing rate. We elaborately discuss processes as following:

$$\begin{aligned}
\text{UnemployedFormalandInformal}(t) = & \text{UnemployedFormalandInformal}(t - dt) \\
& + (\text{InformalityAcceptingRate} \\
& - \text{InformalHiringRatefromUFI} \\
& - \text{FormalHiringRatefromUFI} \\
& - \text{AgingRatefromUFI} - \text{DeathfromUFI} \\
& + \text{InformalFiringRate to UFI}) \times dt \quad (5.26)
\end{aligned}$$

$$\begin{aligned}
\text{InformalFiringRate to UFI} = & \text{EmployedInformal} \\
& \times \text{InformalFiringFraction} \\
& \times \text{FiringDistributionFraction} \quad (5.27)
\end{aligned}$$

$$\text{InformalFiringFraction} = 0.02 \quad (5.28)$$

$$\text{FiringDistributionFraction} = 0.75 \quad (5.29)$$

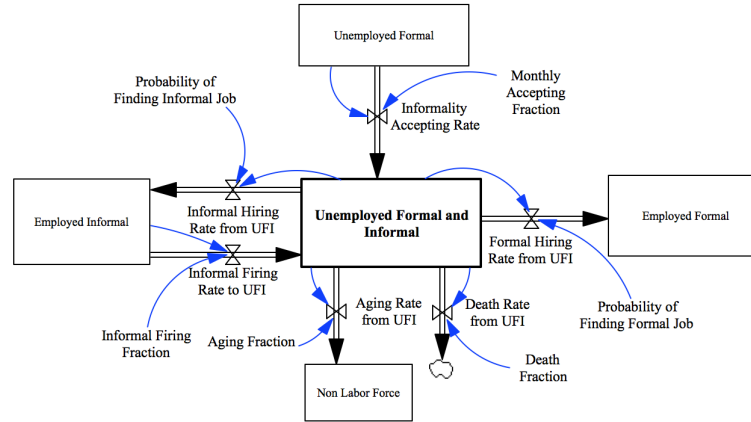


Figure 5.11. Simplified stock - flow diagram related to unemployed formal and informal.

Firstly, the informality accepting rate flow which is from one of the unemployment pool to the another unemployment pool is determined by the effects of poverty ratio and probability of finding formal job, as explained in the previous subsection.

Moreover, firing process happens also in the unemployed formal and informal stock, from the employed informal stock to this stock. Similar to other firing rates, the informal firing rate to UFI flow is determined by the firing fraction. There is no difference between formal and informal firing fractions which are constant and equal to 0.02. Unfortunately, there is no evidence about a difference in formal and informal firing fractions. In order to avoid making an extra assumption about this difference, we assume informal and formal firing fractions to be equal. However, in the scenario and policy chapter, we will examine a case where formal and informal firing fractions are valued differently.

In the informal sector, there are two firing rates whose employment source is same, which is the employed informal stock. In addition to the mentioned informal firing rate, the other informal firing rate occurs from the employed informal stock to the unemployed informal stock. So a total informal firing rate have to be distributed to these rates. By taking into consideration an average ratio of hiring rates of these unemployment stocks, we determine a constant distribution fraction for firing rates. By multiplying total firing rates by 0.75, a large portion occurs in the informal firing rate to UFI flow, then the remaining quarter occurs in the informal firing rate to UI flow.

$$\begin{aligned} \text{InformalHiringRatefromUFI} &= \text{ProbabilityofFindingInformalJob} \\ &\times \text{UnemployedFormalandInformal} \end{aligned} \quad (5.30)$$

$$\begin{aligned} \text{FormalHiringRatefromUFI} &= \text{ProbabilityofFindingFormalJob} \\ &\times \text{UnemployedFormalandInformal} \end{aligned} \quad (5.31)$$

Furthermore, an informal hiring process from the unemployment states to employment states is basically represented by informal hiring rates in the model. In that case, people flow from the unemployed formal and informal stock to the employed in-

formal stock via the informal hiring rate from UFI (unemployed formal and informal) flow. So via this flow, unemployed people are hired in the informal sector. In this process, the probability of finding informal job variable determines the hiring rate with the related stock.

In addition to the informal hiring process, one of the formal hiring processes takes place from the unemployed formal and informal stock to the employed formal stock. As mentioned above, unemployed people in this stock are able to still find formal jobs even though they accept informal working conditions. The formal hiring rate from UEI flow is determined by the probability of finding formal job with the related stock. We will explain all probability functions in the labor demand sector.

$$\begin{aligned} \text{AgingRatefromUFI} &= \text{AgingFraction} \\ &\times \text{UnemployedFormalandInformal} \end{aligned} \quad (5.32)$$

$$\begin{aligned} \text{DeathRatefromUFI} &= \text{DeathFraction} \\ &\times \text{UnemployedFormalandInformal} \end{aligned} \quad (5.33)$$

Finally, people leave the unemployed formal and informal stock and go to the non-labor force stock mainly due to aging, as explained in the previous sections. And deaths happen in this stock similar to the previous stocks.

5.2.4.4. Unemployed, Informal (UI). The stock consists of people who still seek a job even though they are not counted in labor force. So, they are forced to seek a job in the informal sector. In the base model, there are only retired people in that stock. However, refugees will be added there while running the model in different scenarios.

As explained before, retired people who are willing to work have to find a job in the informal employment status due to their higher labor costs and lower productivity

levels. As seen in Figure 5.12, the unemployed informal stock has relationships with the other two labor force states in the model. Via the transitions, people flow from the unemployed informal stock to the employed informal or non-labor force stocks. Additionally, the unemployed informal stock is fed by retiree willing to work rate and informal firing rate. We elaborately discuss processes as following:

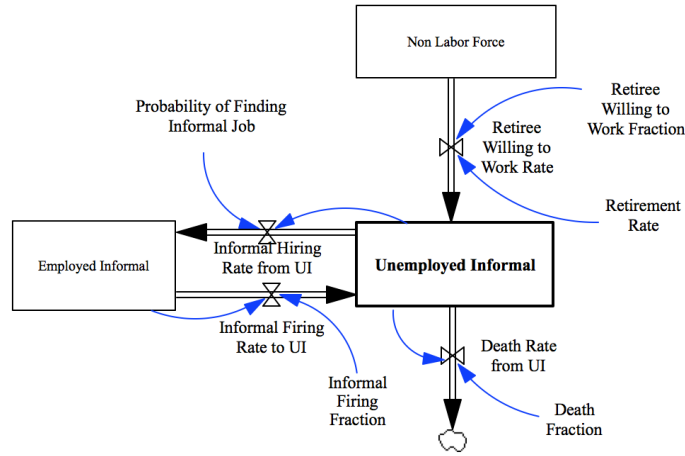


Figure 5.12. Simplified stock-flow diagram related to unemployed informal.

$$\begin{aligned}
 \text{UnemployedInformal}(t) = & \text{UnemployedInformal}(t - dt) \\
 & + (\text{RetireeWillingtoWorkRate} \\
 & + \text{InformalFiringRatetoUI} - \text{DeathRatefromUI} \\
 & + \text{InformalHiringRatefromUI}) \times dt
 \end{aligned} \tag{5.34}$$

$$\begin{aligned}
 \text{InformalHiringRatefromUI} = & \text{ProbabilityofFindingInformalJob} \\
 & \times \text{UnemployedInformal}
 \end{aligned} \tag{5.35}$$

$$\begin{aligned}
 \text{InformalFiringRatetoUI} = & \text{EmployedInformal} \times \text{InformalFiringFraction} \\
 & \times (1 - \text{FiringDistributionFraction})
 \end{aligned} \tag{5.36}$$

$$\begin{aligned}
 \text{DeathRatefromUI} = & \text{DeathFraction} \times \\
 & \text{UnemployedInformal}
 \end{aligned} \tag{5.37}$$

Firstly, there is a flow from the non-labor force pool to this pool. Retired people have to find a job in the informal sector due to mentioned factors. The retiree willing to work flow is determined by the retirement rate and retiree willing to work fraction. There is no information about the retiree willing to work fraction parameter, so we set this parameter to acceptable constant value. In the sensitivity analysis section, we will examine the model sensitivity to this parameter.

As mentioned in the previous subsection, one of the informal hiring process takes place from the unemployed informal stock to the employed informal stock. Similar to the other informal firing rate, the informal firing rate from UI flow is determined by the probability of finding informal job variable with the related stock. Unlike the unemployed formal and informal stock, there is a single way for hiring processes which occurs in the informal sector. In other words, there is no hiring rate from this stock to the employed formal stock.

Furthermore, the other informal firing rate happens from the employed informal stock to this stock. The firing fraction is identical to the other firing fractions. As explained in the previous subsection, total informal firing is distributed to the informal firing rates and the informal firing rate to EI flow takes a quarter of total rates (for more information, see explanations about the firing distribution fraction parameter in the previous subsection). Finally, deaths also take place in this stock.

5.2.4.5. Employed, Formal (EF). Employed people are officially defined as; *comprises all the non-institutional working age population who are engaged in economic activity*. There are two types of employed people, which are formal and informal. In this subsection, we focus on the formal employment. This stock consists of registered employees, employers, self-employed and unpaid family workers. As seen in Figure 5.13, the employed formal stock has relationships with the other three labor force states in the model. Via the transitions, people flow from the employed formal stock to the unemployed formal and non-labor force stocks. Additionally, the employed formal stock is fed by formal hiring rates from the unemployed formal and unemployed formal and

informal stocks. We elaborately discuss processes as following: The simplified stock flow diagram of formal employment is shown in Figure 5.13.

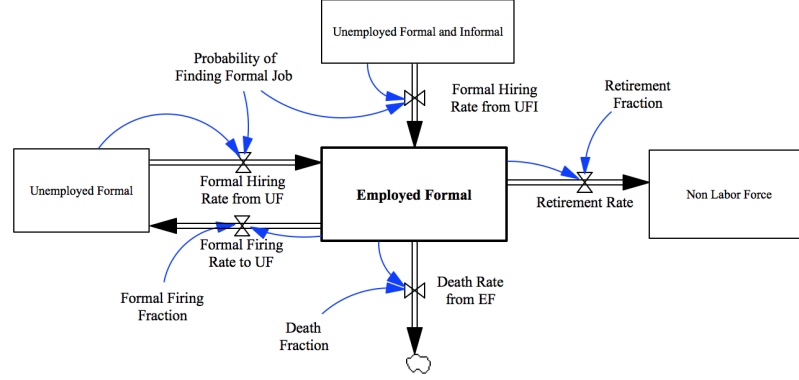


Figure 5.13. Simplified stock-flow diagram related to employed formal.

$$\begin{aligned}
 \text{EmployedFormal}(t) = & \text{EmployedFormal}(t - dt) \\
 & + (\text{FormalHiringRatefromUF} + \text{FormalHiringRatefromUFI} \\
 & - \text{DeathRatefromEF} - \text{FormalFiringRate to UF} \\
 & - \text{RetirementRate}) \times dt
 \end{aligned} \tag{5.38}$$

$$\begin{aligned}
 \text{FormalHiringRatefromUFI} = & \text{ProbabilityofFindingFormalJob} \\
 & \times \text{UnemployedFormalandInformal}
 \end{aligned} \tag{5.39}$$

$$\text{DeathRatefromEF} = \text{DeathFraction} \times \text{EmployedFormal} \tag{5.40}$$

Firstly, people flow the employed formal stock to the non-labor force stock via a retirement process. In the model, the retirement process is determined by the retirement rate fraction with the related stock. As explained before, the retirement rate parameter is determined according to the real retirement rates per year [44]. Additionally, the retirement rate flow is decreased by 30 percent due to formal retired workers (for more information, see the non-labor force subsection).

Secondly, formal hiring processes take place with the two distinct formal hiring flows in the model. One of these flows comes from the unemployed formal stock which contains people seeking just a formal job. The other flow comes from the unemployed formal and informal stock which contains people seeking both formal and informal jobs. As seen, the unemployed formal and informal stock is common source for the formal and informal employment. Changes in the formal and informal hiring rates directly affect this stock so as the formal and informal employment dynamics. One of the strong relations between the formal and informal sectors can be represented by this stock in the model.

Additionally, the formal firing process takes place from this stock to the unemployed formal stock via the formal firing rate to UF flow. Finally, deaths also occur in that stock.

5.2.4.6. Employed, Informal (EI). The other employment type in the model is the informal employment. The employed informal stock represents people who are unregistered employees, employers, self-employed and unpaid family workers. As seen in Figure 5.14, the employed informal stock has relationships with the other three labor force states in the model. Via the transitions, people flow from the employed informal stock to the non-labor force, unemployed formal and unemployed formal and informal stocks. Additionally, the employed informal stock is fed by informal hiring rates from the unemployed informal and unemployed formal and informal stocks. We elaborately discuss processes as following:

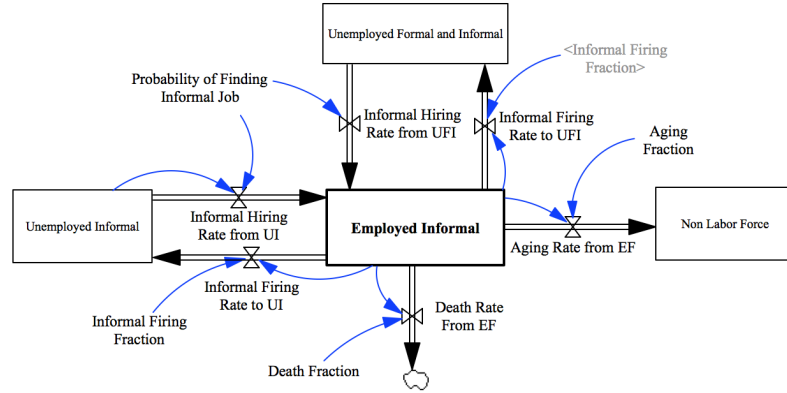


Figure 5.14. Simplified stock-flow diagram related to employed informal.

$$\begin{aligned}
 \text{EmployedInformal}(t) = & \text{EmployedInformal}(t - dt) \\
 & + (\text{InformalHiringRatefromUFI} \\
 & + \text{InformalHiringRatefromUI} - \text{DeathRatefromEI} \\
 & - \text{InformalFiringRate to UFI} - \text{InformalFiringRate to UI} \\
 & - \text{AgingRatefromEI}) \times dt
 \end{aligned} \tag{5.41}$$

$$\begin{aligned}
 \text{InformalHiringRatefromUI} = & \text{ProbabilityofFindingInformalJob} \\
 & \times \text{UnemployedInformal}
 \end{aligned} \tag{5.42}$$

$$\text{DeathRatefromEI} = \text{DeathFraction} \times \text{EmployedInformal} \tag{5.43}$$

$$\text{AgingRatefromEI} = \text{AgingFraction} \times \text{EmployedInformal} \tag{5.44}$$

Firstly, informal hiring processes take place from the unemployed formal and unemployed formal and informal stocks. These informal hiring rates are determined by the probability of finding informal job with the related stocks.

Lastly, informal firing processes occur with the two distinct firing rates. One of the informal firing rate flows to the unemployed formal pool and the other flows to the unemployed formal and informal pool. There is a distribution fraction between these firing rates. Finally, leaving and death rates take place similar to the previous stocks.

5.2.5. Parameter Estimation and Assumptions

In the labor supply sector, initial values of the stocks are determined by considering the Household Labor Force Survey (TurkStat) [10]. However, there is an unrealistic behavior observing in the year, 2004. While carefully examining the real non-institutional working age population data for the period from 2000 to 2017, we notice a significant decrease in 2004 (Figure 5.15). It seems to be unrealistic to decrease the population by 1.4 million during a year. Moreover, interestingly the population dynamics continue in this decreased line. Thus, we modify the data by just changing the year 2004 and previous years' data according to the linear trend seen between 2005-2017 (Figure 5.16). Then we have to redistribute this modified population data to the labor force states. While doing this, we consider annual ratios of these states to population. For example, if the employed formal stock is let's say a half of a population, then a change, made in a population value, occurs in the employed formal stock by this ratio.

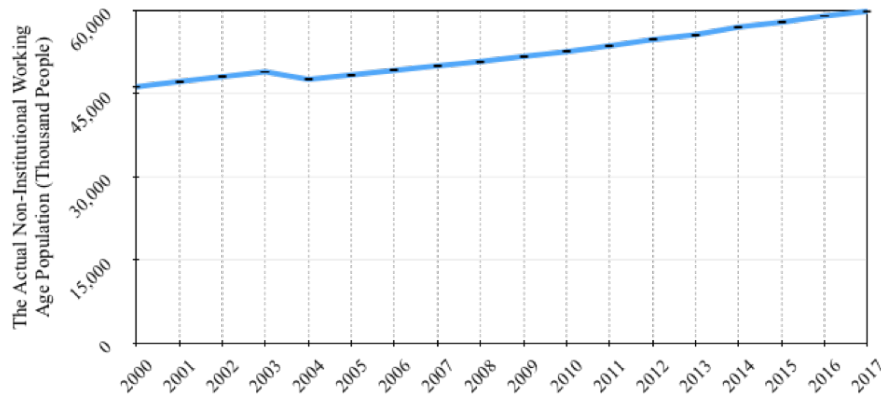


Figure 5.15. The actual non-institutional working age population (TurkStat).

After modifying the data of population and labor force states, we determine initial values of the stocks (non-labor force, unemployed informal, employed formal, employed informal, unemployed formal, unemployed formal and informal) in the labor supply sector (Table 5.2). The unemployed informal and unemployed formal and informal stocks are the sub-stocks of the non-labor force and unemployed people pools, respectively.

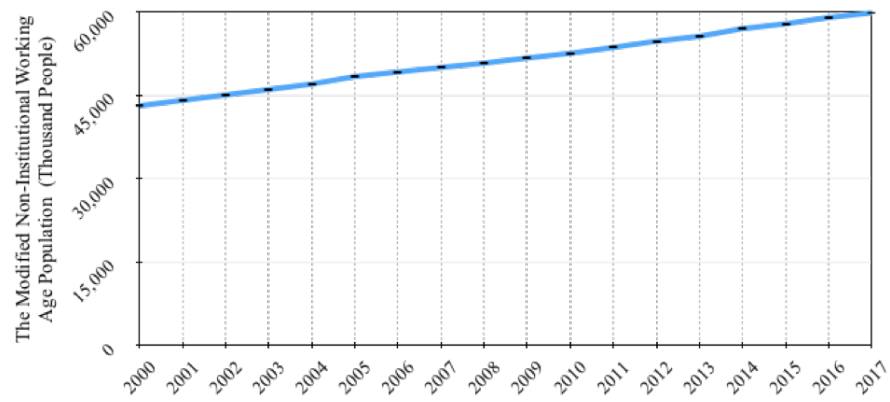


Figure 5.16. The modified non-institutional working age population.

Table 5.2. Initial values of the labor supply sector stocks.

In 2000 (t=0)	NLF	UI	EF	EI	UF	UFI
Initial Values	21275	300	9823	10306	746	650
Related Actual Data	21575		9823	10306	1396	

5.3. The Labor Demand Sector

5.3.1. Introduction to the Sector

After mentioning the labor supply side, now we are focusing on how firms / employers create labor demand. So the sector represents job creation processes. In the labor demand sector, we inspire from the labor supply chain model made by Sterman [41]. There are three stocks (i.e. required employment, formal vacancy and informal vacancy) and related flows and converters. Vacancy stocks represent the amount of current formal or informal job opportunities in the market. And the required employment stock represents the amount of required employment according to the economic growth.

Basically, the amount of required workers is determined according to the size of the national economy. With a discrepancy between the required employment and current employment, the amount of job vacancy creation is determined. Finally, these vacancies are distributed to formal and informal sectors by the endogenous structure.

5.3.2. Background Information

As it is widely known, changes in a labor market size mostly depend on economic growth dynamics. A labor market size is increasing with the growing economy. Additionally, significant changes may occur among labor force states according to economic dynamics. For example, an unemployment ratio increases with the shrinking economy. Thus, we consider the gross domestic production (GDP) measure as one of the main determinants of the labor market size and states over time.

In addition to this exogenous economic variable, firms/employers/potential employers make a decision about whether a vacancy creation/cancellation occurs formally or informally. While making this crucial decision, it is assumed that factors such as a labor cost gap between formal and informal sectors, informal employment ratio in the market, and also informality control level by the government play crucial roles.

Firstly, employers/firms mainly consider labor costs in the vacancy creation/cancellation process. Especially, a cost gap between the formal and informal sectors play a significant role in an informality incentive. In the literature, there are studies where effects of a labor cost and a cost gap are considered (for some examples, see [15]; [16]; [17]). There has been a significant difference between formal and informal workers' costs in Turkey [10].

Furthermore, governments suffer from tax and contribution evasions due to the informality. Thus, they want to control labor market. So an informality control level by the government is assumed to have a significant effect on the informal vacancy creation/cancellation process. This effect is also examined by Ulyseas in the literature [15]. The author observes the negative effect of the governmental control on the informality, which is consistent with the assumption in our model. In other words, the informality goes down with an increase in the government enforcement.

Finally, it is hypothesized that a growing informality ratio causes an increase in the informal vacancy creation process. Employers/firms are affected by their neighbors on the vacancy creation process. Before making decisions on the vacancy distribution to the formal and informal sectors, employers/firms look at their environments mainly due to economic competition. The growing informality creates unfair competition and employers/firms are inclined to create new vacancies in the informal sector. Formal vacancy creation seems to uneconomical while the informality is growing. So that the growing informality causes new informal vacancy decisions. On the other hand, while the formality dominates the labor market with growing rates then, new vacancies will be predominantly formal.

5.3.3. Causal Loop Diagram of the Labor Demand Sector

In this section, the simplified causal loop diagram of the sector is presented and explained, before elaborately explaining the labor demand sector structure (Figure 5.17).

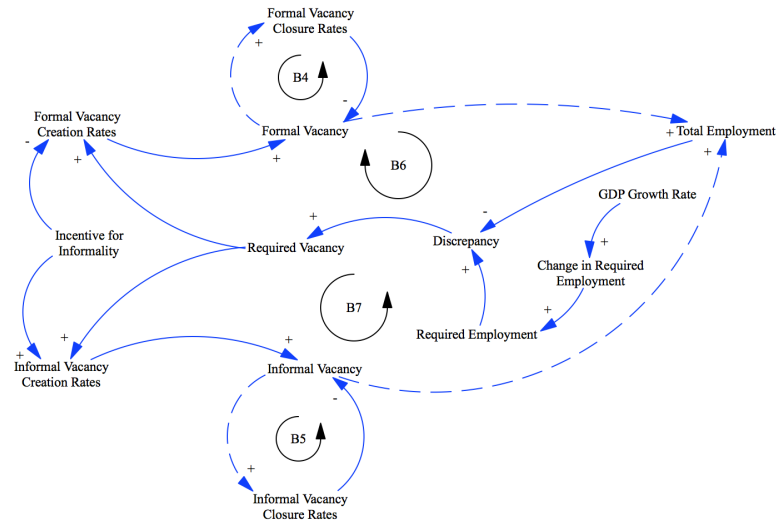


Figure 5.17. Simplified causal loop diagram of the labor demand sector.

As mentioned earlier, required vacancy values are determined according to the discrepancy between current and required employment. Required vacancy values are distributed to the formal and informal sectors via incentive for informality. There are certain factors (i.e. cost gap ratio between sectors, government enforcement and peer pressure) on this incentive level, as mentioned in the previous section. Incentive for informality affects informal vacancy positively via informal vacancy creation rates whereas affects formal vacancy negatively via formal vacancy creation rates. Then, these vacancies positively affect total employment. In addition to these causal relationships, now we present feedback loops as following;

- **Balancing Feedback Loops 4 and 5 (B4 and B5):** As explained before, job opportunities are closed with the hiring rates. As known, vacancy increases hiring rates via the probability functions. The higher hiring rates mean the higher closure rates. This indirect relation between the vacancy and closure rate is shown with the dotted arrow in the diagram (Figure5.17). Finally, the higher closure rates cause a decrease in the vacancies. This process is identical for both formal and informal sectors.

- **Balancing Feedback Loops 6 and 7 (B6 and B7):** In addition to the dotted arrows between vacancy and closure rate, the dotted arrows from the vacancy to total employment represent indirect relationships between them. With the growing vacancy, the formal/informal employment grows via the formal/informal hiring rates. Thus, total employment grows, which decreases the discrepancy between the required employment and total employment. Then, the required vacancy decreases and this decrease has a negative effect on the formal/informal vacancy. So that there are balancing loops between the formal/informal vacancy and total employment variables for both formal and informal sector. By the way, even though the formal/informal vacancy is negatively affected by the formal/informal vacancy creation rates, this does not mean the decreasing vacancy creation rates cause a decrease in the formal/informal vacancy since the vacancy creation rates are inflow of the formal/informal vacancy.

5.3.4. Description of the Structure

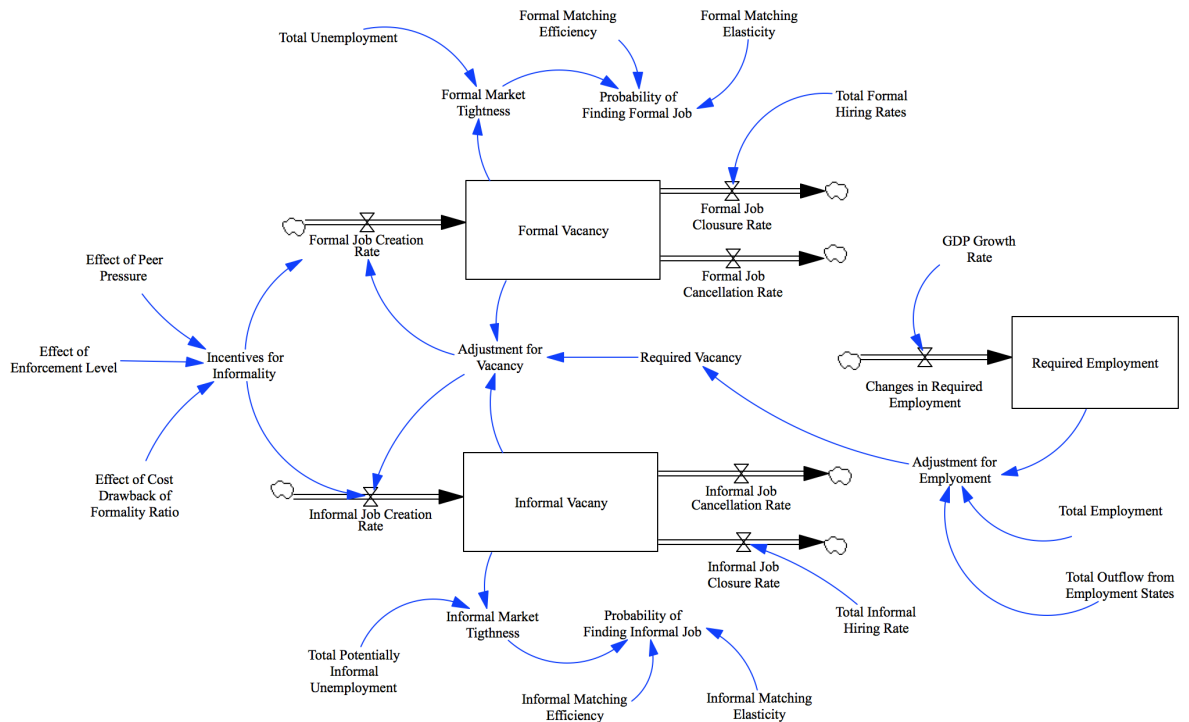


Figure 5.18. Simplified stock-flow diagram of the labor demand sector.

Before the detailed explanations for each stock variable, the general stock-flow diagram of the labor demand sector is shown in Figure 5.18 ⁴ .

5.3.4.1. Required Employment (RE). The required employment stock represents required amount of employment at a given time. Basically, growth or recession in an economy alters a labor market size. A growing economy requires new workers, for example. So with the GDP growth ratio converter, the bi-flow, required employment rate changes the stock over time.

As a reference, we use the quarterly percentage changes of seasonally and calendar adjusted gross domestic product with chain linked volume index (2009=100) between 2000-2017 in the Turkish economy (Figure 5.20; TurkStat) [51]. We set these quarterly growth ratios by dividing them in related months. These monthly growth ratios are used by multiplying with a constant adjustment fraction which is called employment elasticity in the literature. Employment elasticity (which is called 'GDP Adjustment fraction' in the model) represents a percentage change of in employment associated with a 1 percentage point change in an economic growth [52]. In other words, this fraction represents an ability of creating vacancies from an economic growth. There is no estimation for the Turkish labor market, so that this constant parameter is determined by considering logical market tightness and job finding probability dynamics in the model.

By the way, we will discuss the exogenous and time-dependent GDP growth ratio parameter in the model validation chapter. The model outputs with varying parameters will be compared to the model outputs with constant parameters. In order to observe effects of the time-dependent parameters on the model dynamics, we will apply this comparative test. Additionally, the model sensitivity to the GDP adjustment fraction (employment elasticity) parameter is tested. As expected, the model is sensitive to this parameter, which is normal since the required employment is determined by this fraction and the real GDP growth ratio. However, as mentioned above, we try to

⁴In Figure 5.18, adjustment time variables and some converters are excluded for the sake of simplicity. For the full structure, see Appendix B.

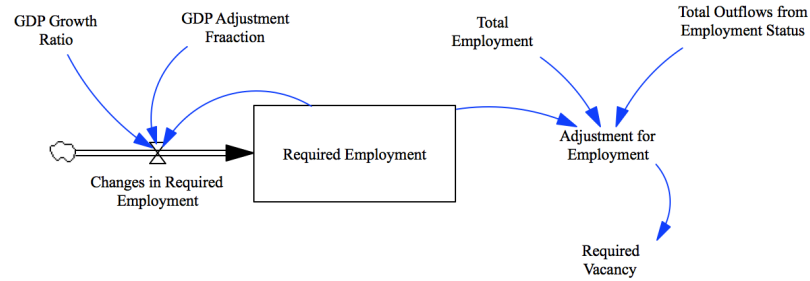


Figure 5.19. Simplified stock-flow diagram related to required employment.

find acceptable and logical value for this parameter and while doing this, we consider market tightness and probability function dynamics.

$$\begin{aligned} \text{RequiredEmployment}(t) = & \text{RequiredEmployment}(t - dt) \\ & + (\text{ChangesinRequiredEmployment}) \times dt \end{aligned} \quad (5.45)$$

$$\begin{aligned} \text{ChangesinRequiredEmployment} = & \text{RequiredEmployment} \times \text{GDPGrowthRate} \\ & \times \text{GDPAdjustmentFraction} \end{aligned} \quad (5.46)$$

$$\text{GDPAdjustmentfraction} = 0.4 \quad (5.47)$$

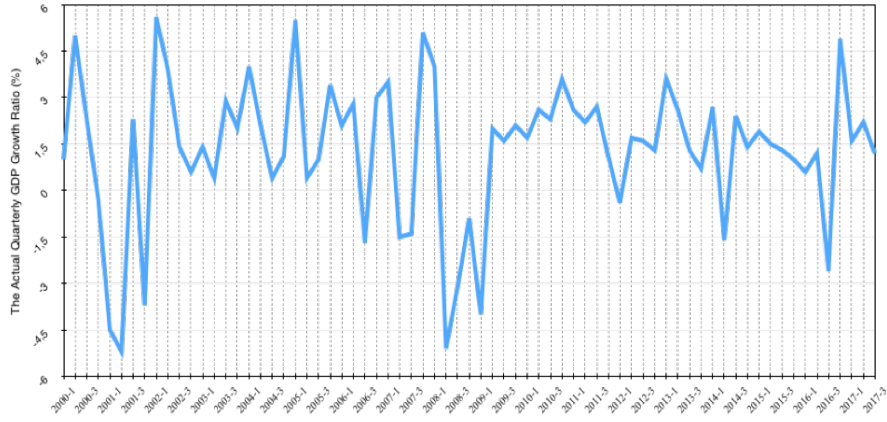


Figure 5.20. Quarterly changes of seasonally and calendar adjusted GDP with chain linked volume index (2009=100).

$$\begin{aligned}
 \text{AdjustmentforEmployment} &= \text{RequiredEmployment} \\
 &\quad - \text{TotalEmployment} \\
 &\quad + (\text{TotalOutflowsfromEmploymentStatus} \\
 &\quad \times \text{AdjustmentTimeforTotalOutflows} \quad (5.48)
 \end{aligned}$$

$$\begin{aligned}
 \text{TotalOutflowsfromEmploymentStatus} &= \text{FormalFiringRatetoUF} \\
 &\quad + \text{InformalFiringRatetoUFI} \\
 &\quad + \text{InformalFiringRatetoUI} \\
 &\quad + \text{AgingRatefromEI} + \text{RetirementRate} \\
 &\quad + \text{DeathRatefromEF} \\
 &\quad + \text{DeathRatefromEI} \quad (5.49)
 \end{aligned}$$

$$\text{AdjustmentTimeforTotalOutflows} = 1 \quad (5.50)$$

We add total outflow rates of formal and informal employment to a discrepancy between the required and current employment, in order to immediately capture em-

ployment needs emerging from these outflow rates.

$$\text{RequiredVacancy} = \text{MAX}(0, \text{AdjustmentforEmployment}) \quad (5.51)$$

When the adjustment for employment converter is below zero, this means there is an employment surplus in the system. Then the system fixes this surplus of employment by using firing processes. The system equally increases the three firing rates (formal firing rate to UF, informal firing rate to UFI and informal firing rate to UI) by one third of the amount of this converter.

5.3.4.2. Formal and Informal Vacancy (FV and IV). Vacancy creation, cancellation and closure processes are same for the formal and informal sectors. After determining required vacancy values, a discrepancy (adjustment for vacancy) between a required and current vacancy is calculated (Figure 5.21). When this discrepancy is greater than zero, then it determines the amount of new vacancy creation. When the discrepancy is below zero then it determines the amount of vacancy cancellation. After that process, a distribution process will be active while determining this vacancy creation and cancellation decisions as happening in the formal or informal sectors. This distribution process will be explained in the next subsection.

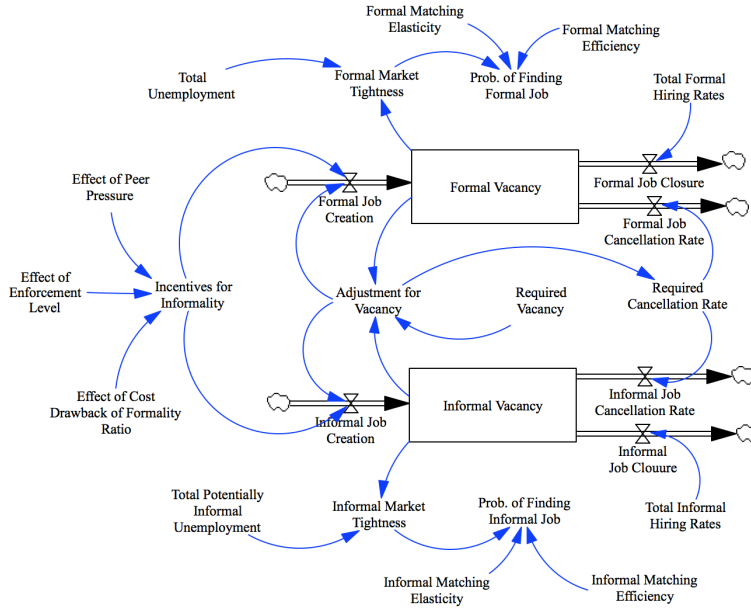


Figure 5.21. Simplified stock-flow diagram related to formal and informal vacancies.

$$\begin{aligned} \text{AdjustmentforVacancy} &= \text{RequiredVacancy} \\ &\quad - \text{FormalVacancy} - \text{InformalVacancy} \end{aligned} \quad (5.52)$$

$$\begin{aligned} \text{FormalVacancy}(t) &= \text{FormalVacancy}(t - dt) \\ &\quad + (\text{FormalJobCreationRate} \\ &\quad - \text{FormalJobCancellationRate} \\ &\quad - \text{FormalJobClosureRate}) \times dt \end{aligned} \quad (5.53)$$

$$\begin{aligned} \text{FormalJobCreationRate} &= \text{MAX}(0, \\ &\quad \text{AdjustmentforVacancy} \\ &\quad / \text{Adj.TimeforVacancyCreation} \\ &\quad \times (1 - \text{IncentiveforInformality})) \end{aligned} \quad (5.54)$$

$$\text{AdjustmentTimeforVacancyCreation} = 1 \quad (5.55)$$

$$\begin{aligned} \text{FormalJobCancellationRate} = & \text{RequiredCancellationRate} \\ & / \text{Adj.TimeforVacancyCancellation} \\ & \times \text{IncentiveforInformality} \end{aligned} \quad (5.56)$$

$$\text{AdjustmentTimeforVacancyCancellation} = 1 \quad (5.57)$$

$$\text{FormalJobClosureRate} = \text{TotalFormalHiringRates} \quad (5.58)$$

$$\begin{aligned} \text{TotalFormalHiringRates} = & \text{FormalHiringRatefromUF} \\ & + \text{FormalHiringRatefromUFI} \end{aligned} \quad (5.59)$$

If a job seeker and a vacancy are matched, then the system closes this vacancy. So vacancy closure rates are determined according to the total hiring rates.

As mentioned above, vacancy creation, cancellation and closure processes of the informal sector is identical to the formal sector.

5.3.5. Parameter Estimation and Assumptions

We set the initial stock values as seen in the Table 5.3. The initial value of the required employment (RE) stock is determined according to the initial total employment by leaving a margin. In order to capture logical market tightness and probability values, it is assumed that there are extra 100000 required people for $t = 0$ (in the year, 2000). Similarly, initial values of the formal and informal vacancy stocks are determined.

5.3.5.1. Incentive for Informality. As mentioned above, the vacancy distribution process occurs after determining a total amount of vacancy creation or cancellation. The incentive for informality variable represents firms'/employers' general tendency to be

Table 5.3. Initial values of the labor demand sector stocks.

In 2000 (t=0)	RE	FV	IV
Initial Values	20428	100	500

informal. At a macro level, vacancy shares of formal and informal sectors are decided according to this incentive level, and so formal and informal sectors take their own shares from total vacancy creation or cancellation rates.

$$\begin{aligned}
 \text{IncentiveforInformality} &= \text{InitialIncentive} \\
 &\times \text{DelayedEffectofGovernmentEnforcement} \\
 &\times \text{EffectofPeerPressure} \\
 &\times \text{EffectofAverageCostDrawbackofFormalityRatio} \quad (5.60)
 \end{aligned}$$

Since there is no empirical study on these factors for the Turkish case of the informal employment problem, it is assumed that the incentive for informality is determined by these effects, as seen in Equation 5.60. Additionally, it is assumed that initial incentive value is equal to 0.45, which is close to the initial reference ratio of informal employment to total employment [10].

There are three main effects on this informality incentive level. We firstly show the effect of a government enforcement level. Governments suffer from tax and contribution evasions due to informality. So they want to control labor markets. In this study, we just consider varying informal control levels according to the amount of informal employment in the market. For example, with growing amount of informal workers, a government responds to this negative situation by rising its own enforcement level on a market. So under strictly controlled market conditions, it is hypothesized that an incentive for informality is affected negatively (Figure 5.22). If this helps to relieve

more evasions (such as tax, contribution etc.), an enforcement level turns back to the previous level. It is assumed that the effects of government enforcement on incentive for informality is delayed about six months. While doing this, we use the third order information delay which is represented by the ‘Smooth3’ notation which is a formulation in the used software.

$$\text{EffectofGovernmentEnforcement} = f\left(\frac{\text{EmployedInformal}}{\text{InitialEmployedInformal}}\right) \quad (5.61)$$

$$\begin{aligned} \text{DelayedEffectofGovernmentEnforcement} &= \text{SMOOTH3} \\ &(\text{EffectofGovernmentEnforcement}, 6) \end{aligned} \quad (5.62)$$

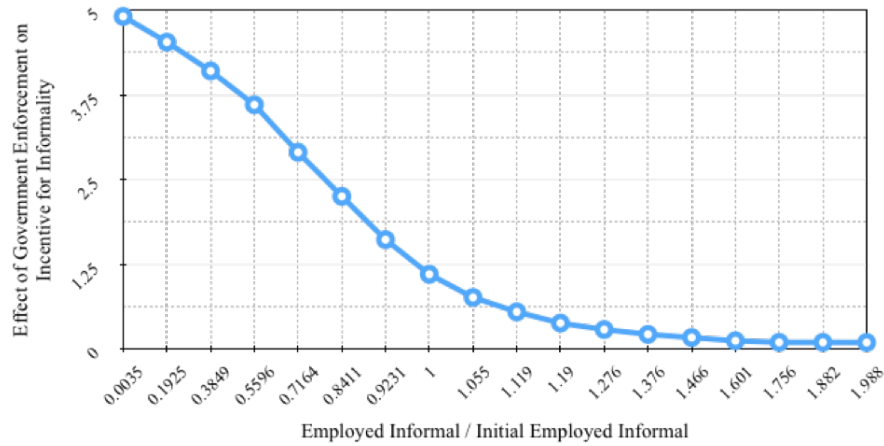


Figure 5.22. Effect of government enforcement on incentive for informality.

Secondly, we accept a peer pressure factor as a significant effect on the informality incentive level. The effect function is shown in Figure 5.23). Employers are influenced by dynamic formal/informal worker ratios in the market. Growing informal worker density causes an increase in a tendency for informal vacancy creation since informal employment has become common so it is assumed that suppliers benefit from this emerging opportunity. Similarly, a growing formal worker density affects a market to concentrate on formal job creations.

$$\text{Effect of Peer Pressure} = g\left(\frac{\text{Informal Employment Ratio}}{\text{Initial Informal Employment Ratio}}\right) \quad (5.63)$$

$$\text{Informal Employment Ratio} = \left(\frac{\text{Employed Informal}}{(\text{Employed Formal} + \text{Employed Informal})}\right) \quad (5.64)$$

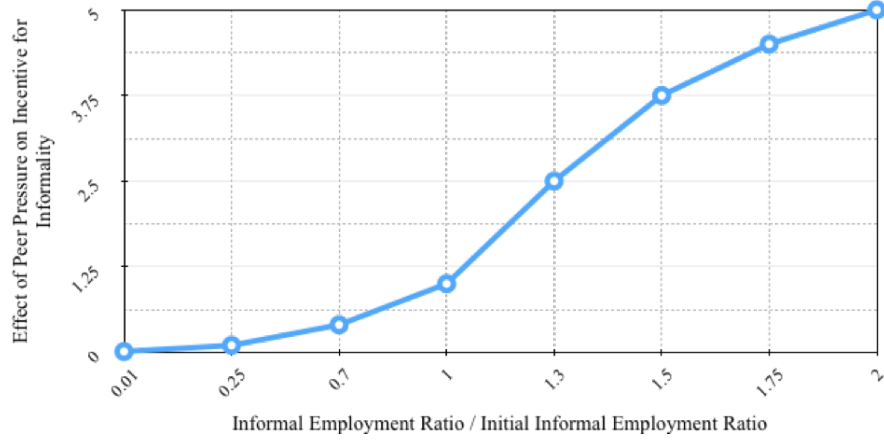


Figure 5.23. Effect of peer pressure on incentive for informality.

Lastly, we assume cost gaps between formal and informal employment to have an effect on the incentive for informality level. In the micro-level labor force statistics (TurkStat, 2000-2017), we gather data about wage/salary of formal and informal employees over the period of 2002 to 2016 [10]. At first, we include labor tax and contribution rates on an annual average net wage of formal employees in order to compute formal labor costs. As there are no such tax and contribution costs for informal employment, we take an annual average net wages of them. Then, we find annual ratios, called average cost drawback of formality ratio, of the formal labor costs to their informal counterparts (Figure 5.24). We use this statistical data as an input. With this input data, the effect function of the average cost drawback of formality ratio is shown in Figure 5.25.

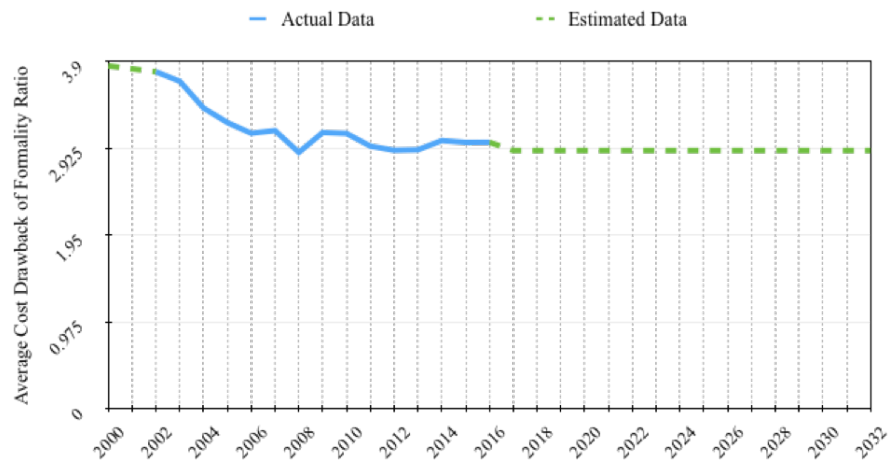


Figure 5.24. Average cost drawback of formality ratio over time (TurkStat, between 2002-2016).

EffectofAvg.CostDrawbackofFormalityRatio =

$$h\left(\frac{\text{Avg.CostDrawbackofFormalityRatio}}{\text{InitialCostDrawbackofFormalityRatio}}\right) \quad (5.65)$$

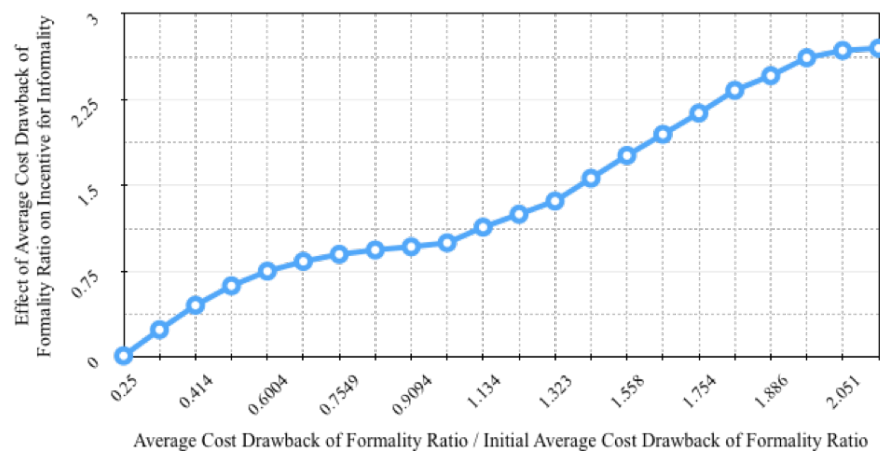


Figure 5.25. Effect of average cost drawback of formality ratio on incentive for informality.

Initial cost drawback of formality ratio is calculated by the model according to related initial conditions in the model.

In order to give a clear picture about these effects, the causal loop diagram and explanations of related causal loops are given below (Figure 5.26);

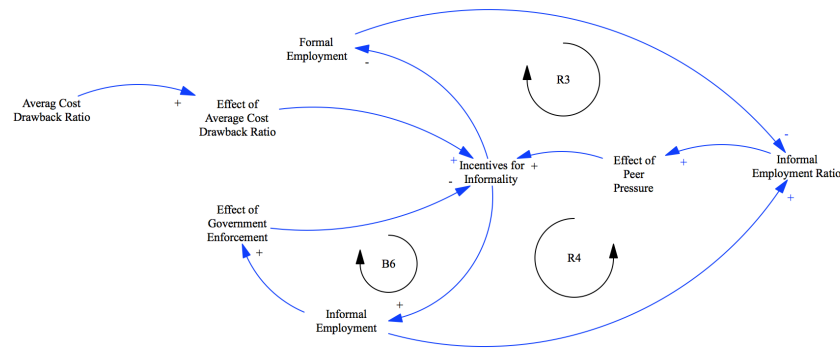


Figure 5.26. Simplified causal loop diagram of the effects on the incentive for informality.

- **Balancing Feedback Loop 6 (B6):** There is a balancing loop which starts at the effect of government enforcement. Increasing (decreasing) enforcement makes incentive for informality less (more). With reduced (raised) incentive, informal employment goes down (goes up) whereas formal employment goes up (goes down). After reaching a target, a government control reverts to normal stage. So a government tries to hold the informality at a certain point.
- **Reinforcing Feedback Loops 3 and 4 (R3 and R4):** As mentioned above, informality tendency is affected by the informal employment ratio in the market. The more informal employment there have been in the market the more informality tendency there have seen in the market players. If market players (e.g. employers, self-employed workers) are familiar to informality, then they are inclined to be informal while making new decisions. However, if the formal sector starts to dominate the market with growing rates, then they will reduce informality tendencies according to a current situation. Long story in short, these players always

try to adapt themselves to market conditions mainly due to economic factors.

5.3.5.2. Probability Function. At a given time, probability of finding job for a job seeker is calculated by considering a labor matching function. We use the Cobb-Douglas form of a matching function with constant returns to scale (CRS), which gives the amount of matches as a function of the number of vacancy and the number of job seeker [53, 54]. A probability of finding a job is calculated as following:

$$m_t = \mu v_t^\alpha u_t^\beta \quad (5.66)$$

$$\alpha + \beta = 1 \quad (5.67)$$

$$m_t = \mu v_t^\alpha u_t^{1-\alpha} \quad (5.68)$$

$$q = \frac{v_t}{u_t} \quad (5.69)$$

$$p = \frac{m_t}{u_t} = \mu q^\alpha \quad (5.70)$$

Where;

m_t : Number of matches per unit of time t .

v_t : Number of vacancy at a given time t .

u_t : Number of unemployed at a given time t .

q : Market tightness.

p : Probability of finding a job.

μ : Matching efficiency.

α : Matching elasticity.

β : Constant parameter.

According to the probability function, the model equations are following (see Equations 5.71, 5.72, 5.73);

$$\text{ProbabilityofFindingFormalJob} = \text{MIN}(\text{FormalMarketTightness}^{\text{MatchingElasticity}} \times \text{MatchingEfficiency}, 1) \quad (5.71)$$

$$\text{FormalMarketTightness} = \text{FormalVacancy} / \text{TotalUnemployment} \quad (5.72)$$

$$\text{TotalUnemployment} = \text{UnemployedFormal} + \text{UnemployedFormalandInformal} \quad (5.73)$$

Kanik *et al.* examine unemployment and vacancy relationships of the Turkish labor market for the period from 2005 to the middle of 2013. Additionally, they make estimations about the matching function and matching elasticity by taking monthly vacancy data from the private recruitment website, Kariyer.net and the Turkish Public Employment Agency (TEA). With Kariyer.net data, matching elasticity is equal to 0.46 yet in the other estimation it is equal to 0.80. In the short time period, they just consider a non-agricultural labor market and incomprehensive vacancy data [55]. Even though this approach is useful for qualitatively interpretations on the market, estimations are so different so we do not take these results in the model. Rather, it is assumed that the matching elasticity parameter is equal to 0.5, which is moderate and between these two estimations. Additionally, matching efficiency is assumed to be equal to 0.3. While setting these values, we aim to capture logical market tightness and probability of finding job dynamics. Additionally, we will examine these parameter values in the sensitivity and scenario analysis parts. The behavior of the probability function as a dependent variable of market tightness is shown in Figure 5.27. As seen in the graph, the probability function seems to be able to be higher than 1. We solve this problem by adding an extra constraint to equations (see Equation 5.71 and Equation 5.76).

$$\text{MatchingElasticity} = 0.5 \quad (5.74)$$

$$\text{MatchingEfficiency} = 0.3 \quad (5.75)$$

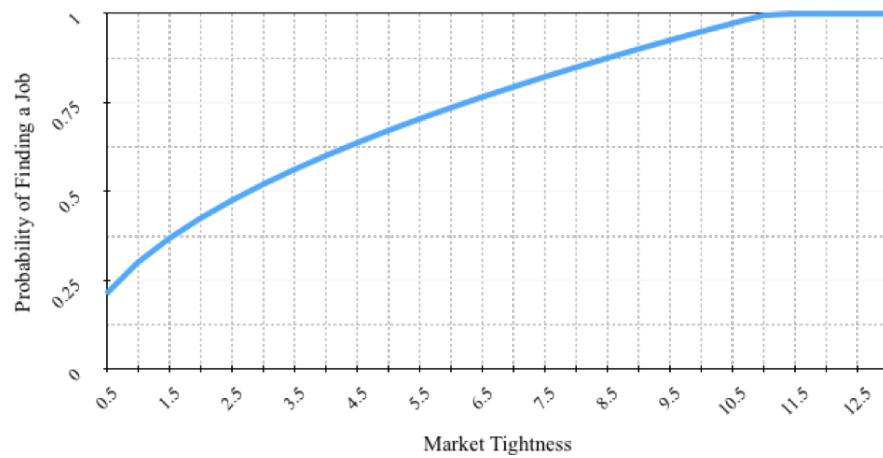


Figure 5.27. Probability of finding a job function with dependent market tightness variable.

The informal probability function and related parameters are identical to the formal sector. About the matching efficiency and elasticity parameters, we avoid making an extra assumption for the informal sector and use the same parameter values.

$$\begin{aligned} \text{Probability of Finding Informal Job} = \text{MIN}(\text{Informal Market Tightness}^{\text{Matching Elasticity}} \\ \times \text{Matching Efficiency}, 1) \end{aligned} \quad (5.76)$$

$$\begin{aligned} \text{Informal Market Tightness} = \text{Informal Vacancy} \\ / \text{Total Potentially Informal Unemployment} \end{aligned} \quad (5.77)$$

$$\begin{aligned} \text{Total Potentially Informal Unemployment} = \text{Unemployed Informal} \\ + \text{Unemployed Formal and Informal} \end{aligned} \quad (5.78)$$

6. VALIDATION AND ANALYSIS OF THE MODEL

In order to test whether the model sufficiently simulates the real dynamics with respect to the problem of interest, model validity is tested [56]. This process has two stages; firstly structural and then behavioral validation tests are applied to the model.

6.1. Structural Validity

Structural validity tests are applied to the model in order to check if the model is able to describe the actual relations existing in the problem of interest within the model boundary. Structural validity analysis consists of direct structure and structure-oriented behavior tests [56].

6.1.1. Direct Structure Test

By directly testing the model with knowledge about the real system, the validity of the structure is tested. The direct structure test process consists of parameter and variable confirmation tests, dimensional consistency tests and direct extreme conditions tests [56]. The sectors, variables and relationships have a meaning in the real labor market and compatible with available knowledge.

6.1.2. Structure Oriented Behavior Tests

In order to examine the validity of the model indirectly, we make extreme condition and sensitivity tests as structure oriented behavior tests.

6.1.2.1. Extreme Condition Tests. Extreme conditions tests (ECTs) are used to understand if the model is reliable under extreme conditions. The model behaviors should be consistent with what it is to be expected independently from applying extreme policies [56]. Three examples of performed ECTs are given below;

Extreme Condition Test 1 (ECT 1): Firstly, we set the incentive for informality of employers/firms to zero, which means the labor demand side does not create informal jobs any more. In this condition, the informal employment pool should decline and become approximately empty over time due to the absence of informal job vacancies. As shown in Figure 6.1, the model behaves as expected. So the model is valid under the extreme condition where the incentive for informality level is zero.

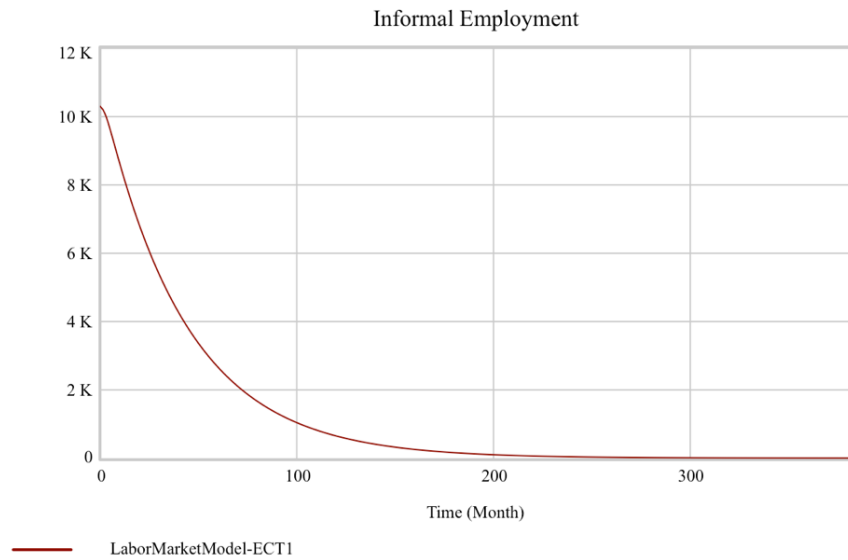


Figure 6.1. The number of informally employed people under the first extreme condition test.

Extreme Condition Test 2 (ECT 2): Now, we again look at the informal employment behaviors under the extreme condition where there are no people to seek informal jobs. This means, the labor demand side creates informal vacancies whereas nobody can be found to be filled these vacancies. In this condition, the informal employment pool should decline and become approximately empty over time due to the absence of the labor supply for informal vacancies. As expected, the employed informal stock approaches to zero over time in the model (Figure 6.2). So the model is valid under the extreme condition where there is no labor supply for the informal working conditions.

Extreme Condition Test 3 (ECT 3): Lastly, we set maturation rate to zero. This means, people who are older than 14 year-old, do not enter the labor supply sector

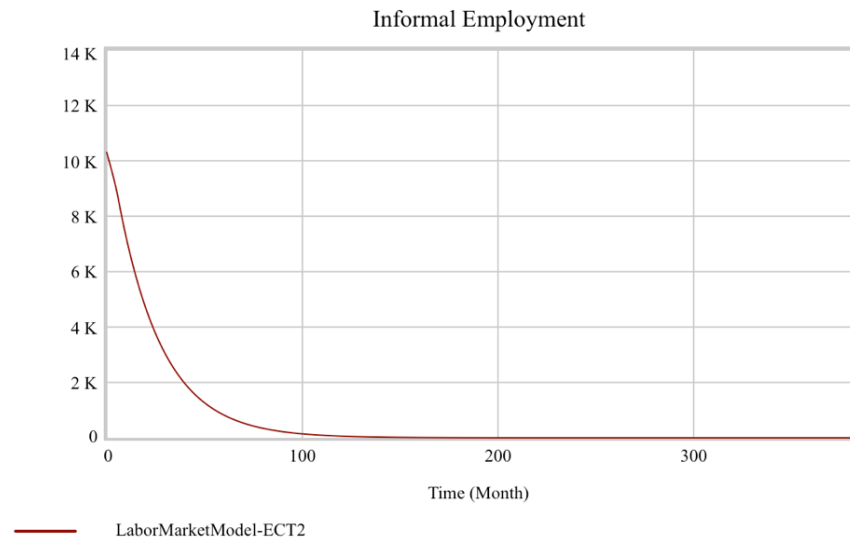


Figure 6.2. The number of informally employed people under the second extreme condition test.

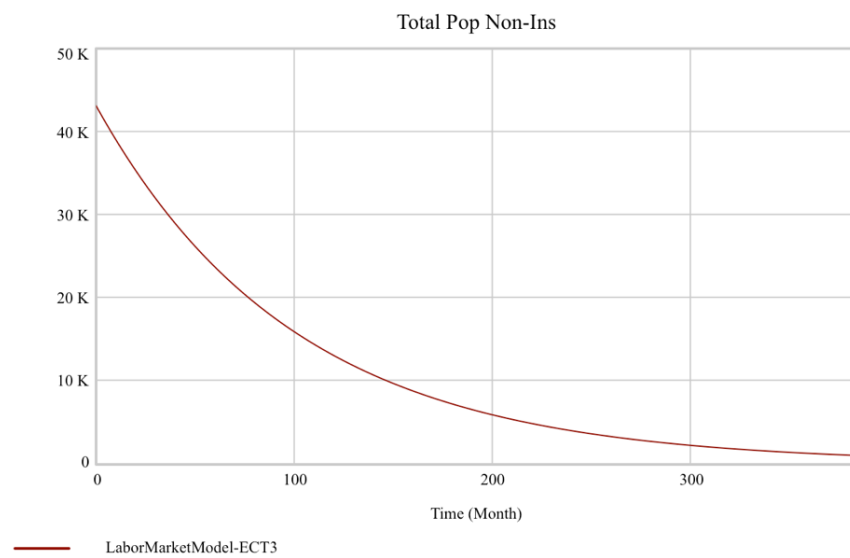


Figure 6.3. Population under the third extreme condition test.

anymore. Additionally, the death fraction is assumed to be increased dramatically. In this condition, the population should decrease and become approximately empty over time. As shown in Figure 6.3, the model population are getting down over time, as expected. So the model is valid under these extreme conditions.

Under extreme conditions, we perform various behavioral tests on the structure. We separately examine robustness of each sector under extreme conditions. Briefly, three examples of these tests are shown. As seen in these examples, the model is valid under these three extreme condition tests. In addition to these shown tests, similar extreme condition tests are applied to the probability, incentive for informality, vacancy and informality accepting functions. The model is also valid under these additional extreme conditions.

6.1.3. Sensitivity Analysis

In order to understand whether the model is highly sensitive to parameters or not, the model is examined by behavioral sensitivity tests [56]. We apply these sensitivity analyses to the parameters which are not calibrated based on the actual data. Here, we present three examples of sensitivity tests (Table 6.1); As mentioned in the model

Table 6.1. Parameter values under the sensitivity test.

Parameters	Base run	Sensitivity Analysis
Retiree Willing to Work Fraction	0.4	0.1 - 0.9
Formal and Informal Firing Fraction	0.02	0.005 - 0.05
Formal and Informal Matching Efficiency	0.3	0.1 - 0.9

description section, there is no difference between formal and informal firing fractions and between formal and informal matching efficiency in the base model. Similarly, in the sensitivity analyses, formal and informal values of these parameters are equal.

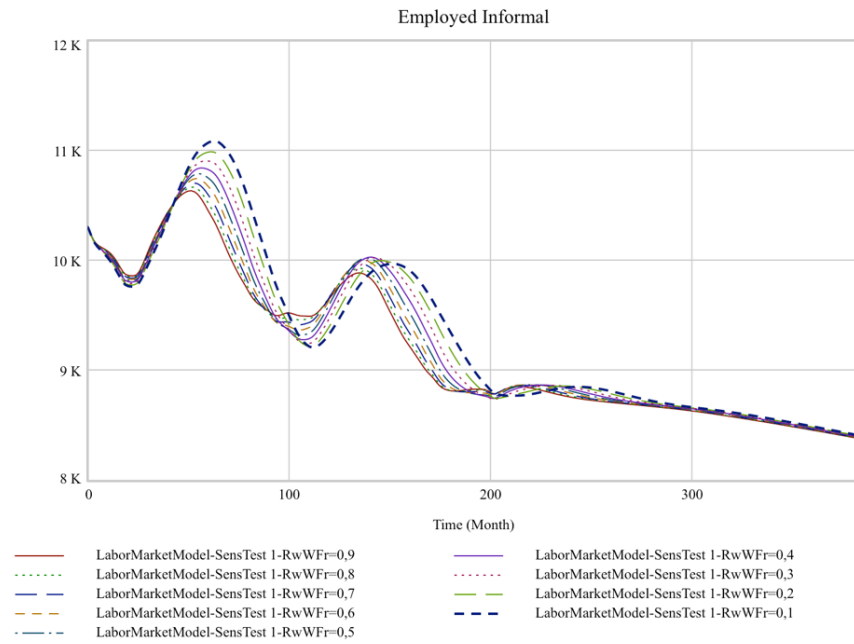


Figure 6.4. Sensitivity result for retiree willing to work fraction.

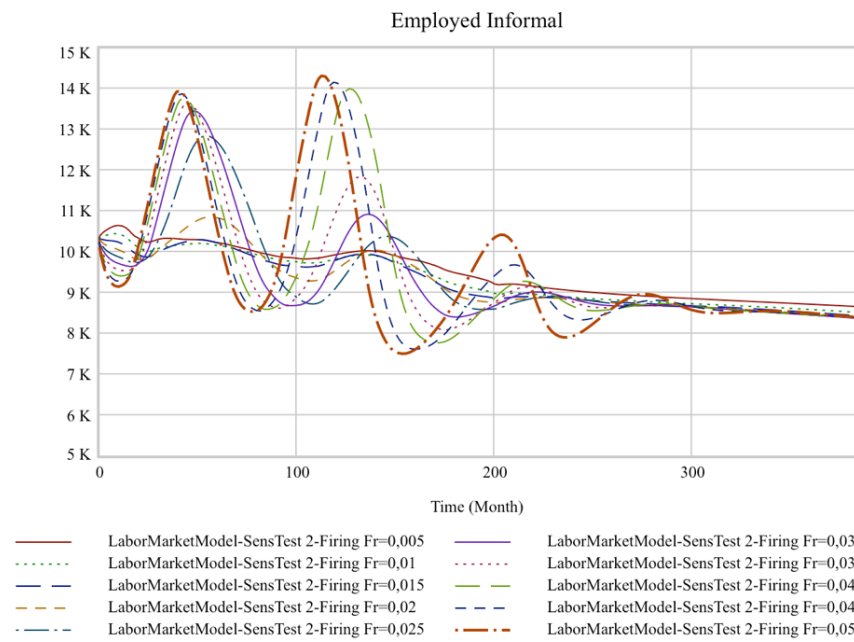


Figure 6.5. Sensitivity result for formal and informal firing fractions.

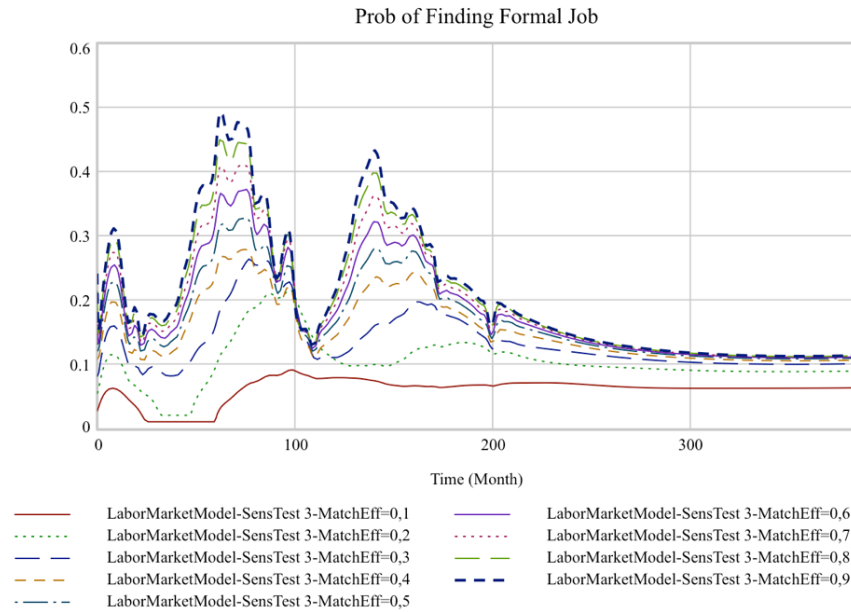


Figure 6.6. Sensitivity result for matching efficiency.

In conclusion, the employed informal stock is not strongly sensitive to retiree willing to work fraction (Figure 6.4). However, Figure 6.5 shows that this stock is strongly sensitive to formal and informal firing fractions. Actually, a firing process varies according to a current economic state in the real labor market. Additionally, changes in firing rates significant affect the real labor market dynamics, as known. So that the real informal employment is also sensitive to the firing fraction parameter. Additionally, even though we do not accept the estimation of firing fraction made by Sengul since her model does not include the whole labor market, our assumption about firing fraction is rather close to this estimation [49].

Moreover, the probability of finding job function is sensitive to the matching efficiency parameter, as seen in Figure 6.6. While determining this parameter value, we consider logical market tightness dynamics and probability of finding formal and informal job dynamics. Additionally, we set the matching efficiency parameter to different values and examine results in the scenario analysis section. Additional sensitivity tests are also applied by changing matching elasticity and GDP adjustment fraction (employment elasticity) parameter values (for result of sensitivity test, see Appendix C).

The model is sensitive to these parameters. While determining these parameter values, similarly logical market tightness and probability dynamics are considered.

6.2. Behavioral Validity

In order to check the model dynamics with the actual labor market dynamics, we use the micro-level labor force statistics, yearly provided by TurkStat [10]. As mentioned in the model description section, there are six time-dependent parameters (i.e. maturation rate, participation fraction, retirement fraction, cost drawback of formality ratio, job seeker poverty ratio and GDP growth ratio) in the model. We directly use the real data for the cost drawback of formality ratio, job seeker poverty ratio, GDP growth ratio parameters. Moreover, we set the others (i.e. maturation rate, participation fraction, retirement fraction) according to the dynamics of the real labor market states. However, before analyzing the calibrated model dynamics with these varying parameters, we provide the calibration results of the model outputs by making these parameters' values constant in order to clarify effects of these varying parameters. In table 6.2, the two different conditions with constant and varying parameters are shown.

Table 6.2. Calibrated model conditions.

Parameters	Constant Parameter Conditions	Time- Dependent Parameter Conditions
Maturation Rate	120000	115000 - 140000
Participation Fraction	0.0045	0.003 - 0.0056
Retirement Fraction	0.0025	0.002 - 0.004
Avg Cost Drawback of Formality Ratio	3	2.8 - 3.9
Job Seeker Poverty Ratio	0.25	0.2 - 0.3
GDP Growth Ratio	0.0045	-0.02 - 0.02

6.2.1. Calibrated Model with Constant Parameters

Firstly, it is assumed that the maturation rate, participation fraction, retirement fraction, cost drawback of formality ratio, job seeker poverty ratio and GDP growth ratio parameters do not vary during the simulation. We set these parameters logical constant values as seen in table 6.2.

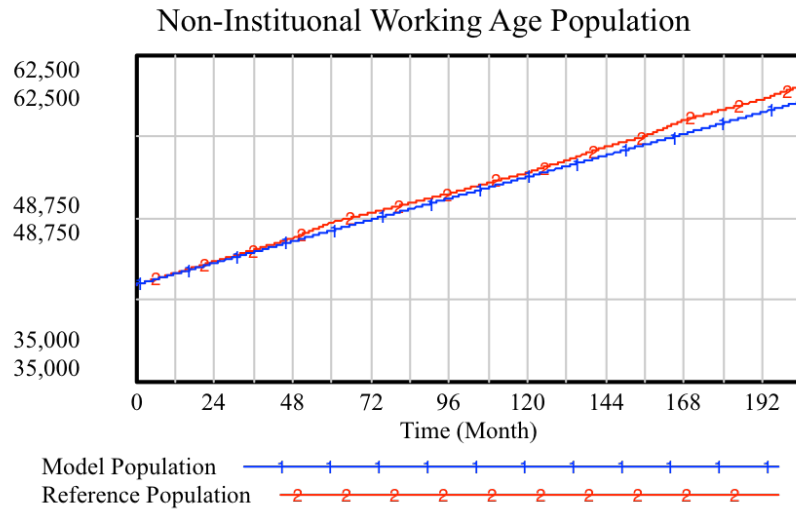


Figure 6.7. Non-institutional working age population under constant parameter conditions.

Non-institutional working age population represents the total number of people in the model. With the constant maturation rate (120000 people per month), the model population can capture the trend seen in the statistical data (Figure 6.7). However, the increase happening after 2004, and also fluctuations cannot be imitated with the constant maturation rate. These differences in the population dynamics have considerable direct and indirect effects on the labor force states. For example, the non-labor force stock becomes less than the real non-labor force when the population cannot capture a growth in the real population. In order to avoid these effects, the maturation rate parameter should be varying over time according to the real population dynamics.

As mentioned above, the differences in the model and real population dynamics directly affect the non-labor force dynamics. Additionally, the constant participation

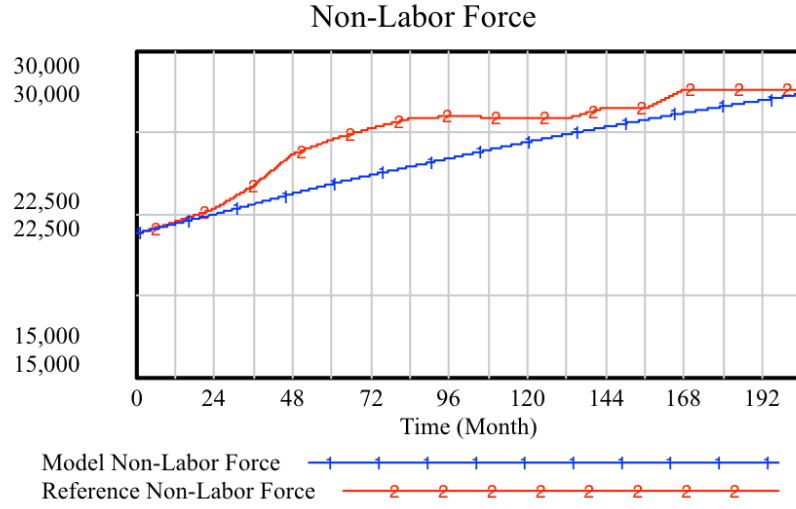


Figure 6.8. Non-labor force under constant parameter conditions.

fraction makes the non-labor force stock inflexible. Despite these deficiency, the model can capture the trend seen in the statistical non-labor force data (Figure 6.8).

Moreover, the model can more or less capture the real dynamics of the number of formally and informally employed people with constant parameters, (Figure 6.9; Figure 6.10). This means, the endogenous structure of the model can create similar dynamics to the real dynamics without considering significant exogenous effects (i.e. GDP growth ratio, cost drawback of formality ratio and poverty ratio) on the labor market. With the incentive for informality variable in the model, which is determined by the effect functions (on employers' informality tendency) and their feedback mechanisms, the formal and informal employment dynamics can be generally imitated.

Furthermore, the unemployment dynamics in the real labor market can captured with some deficiencies (Figure 6.11). Even though a boom and bust cycle between 2008 and 2011 cannot be imitated by the endogenous structure of the model, behaviors are similar. This similarity can be succeeded despite the constant GDP growth ratio. As mentioned in the previous chapter, the GDP growth ratio directly affect vacancy creation processes so a balance between hiring and firing rates is affected by this ratio. This balance plays a crucial role in both employment and unemployment dynamics.



Figure 6.11. Unemployed people under constant parameter conditions.

As a general interpretation about the model outputs under constant parameter conditions, the model can create logical and acceptable behaviors without the help of significant exogenous effects and varying parameters. It is concluded that the endogenous causal relationships of the model are relatively enough to represent the labor market.

6.2.2. Calibrated Model with Time-Dependent Parameters

The model dynamics can be created more accurate by taking the significant exogenous drivers into consideration and making some parameters as varying during time. Firstly, we consider the real GDP growth ratio dynamics rather than taking it as constant. Then, the effect of poverty ratio on the informality accepting rate of job seekers are taken into consideration by using the statistical poverty ratio over time. Additionally, the effect of cost gap ratio on the incentive for informality level of the labor demand side is taken into consideration according by using related statistical observations. Furthermore, we set the maturation rate, participation and retirement fractions according to the related labor force states' data. So that the model is enriched by using statistical data and logical varying parameters in order to capture more accurately the real dynamics.

- Non-Institutional Working Age Population: According to the statistical population data, we set the maturation rate parameter as varying over time. So the real dynamics can be accurately captured (Figure 6.12).

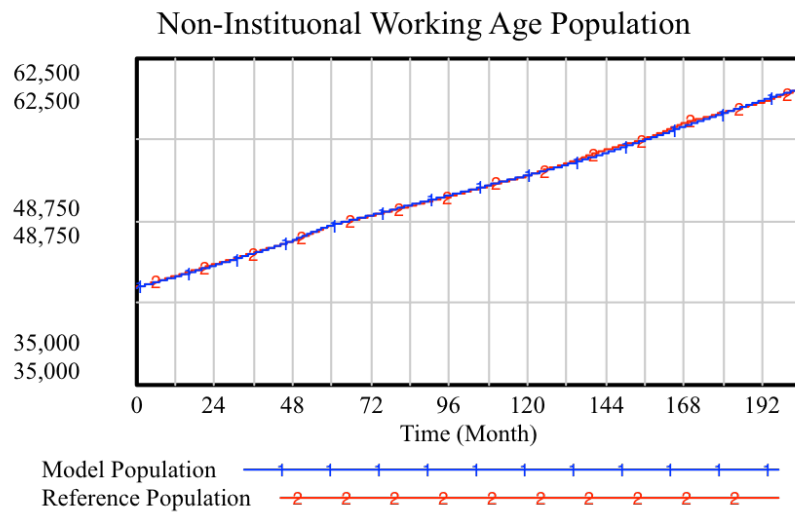


Figure 6.12. Calibrated non-institutional working age population.

- Non-Labor Force: The graph shows that the real dynamics of non-labor force is successfully captured by the model (Figure 6.13). Non-labor force generated by the model, makes a goal-seeking behavior in the period from 2000 to 2017. About this behavior, we can briefly say that; firstly, non-labor force grows with the inflows, especially with the maturation rate. On the other side, job seeker rate, the outflow of non-labor force, grows with growing non-labor force and also growing participation fraction. There is a balancing loop between non-labor force and job seeker rate, as seen in Figure 6.14. So that non-labor force increases at a decreasing rate. Additionally, some slight fluctuations can be seen in the behavior due to varying maturation rate and the other varying inflows (retirement and leaving rates).
- Participation Ratio: We also compare the participation ratio output (a ratio of labor force to population) to the real participation ratio dynamics. As seen in the Figure 6.15, the model behavior can capture general tendency and switches. This

result so far gives an idea about the correctness of flow rates from non-labor force to labor force. In the participation ratio dynamics, an exponential decay is seen until 2006. In that period, the inflow of the non-labor force stock, maturation rate is higher than the participation rate in labor force. However, the difference between these rates is rapidly decreasing with an increase in job seeker rate (due to growing non-labor force and participation fraction). In the second period, exponential growth starts after the participation in labor force becomes higher than the participation in non-labor force. The difference between these growth rates is increasing over time so the participation ratio increases exponentially (Figure 6.14).

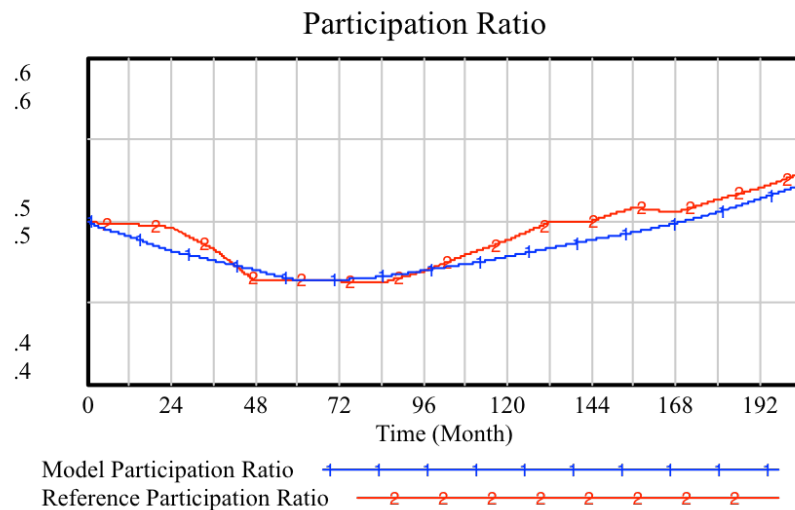


Figure 6.15. Calibrated participation ratio.

- **Formal Employment:** The Figure 6.16 shows that the employed formal stock which mainly depends on formal hiring/firing rates, has successfully imitated the real formal employment dynamics. In the first four years, an exponential decay is seen in the formal employment dynamics, which means the net flow (basically the difference between formal hiring rates and formal firing rate) of the employed formal stock is negative. Interestingly, this decline happens despite the generally growing economy during these years. An insufficiency in the formal hiring rates come from the higher incentive for informality variable. With the

- **Informal Employment:** As seen in the Figure 6.17, the model generally behaves like the real informal employment dynamics. During the first four years, we cannot successfully capture the dynamics since some specific factors which are out of our model boundary are determinant at these times. In the first two years, the informal employment goes down since mainly the total informal hiring rates are lower than the total firing rates. The insufficient informal hiring rates stem from the lower informal vacancy. In that period, the informality incentive level significantly increases due to a decrease in the enforcement level. With the decreasing informal employment, the enforcement level decreases. Nevertheless, this increasing incentive level cannot increase the informal employment. As mentioned above, the employment dynamics depends on both incentive level and GDP growth ratio. This time, the informal employment dynamics are mainly determined by the GDP growth ratio. Thus, the increasing incentive level cannot immediately increase the informal employment. However, after the first two year, the informal employment starts to grow with the delayed effect of the increasing incentive level. With the growing informality, the enforcement level starts to increase. Also in that period, the cost drawback of formality ratio decreases. Despite the positive effect of the peer pressure, these two negative effects dominate the incentive dynamics so that the incentive level starts to go down while the informal employment continues to grow. With the decreasing incentive level, the informal employment growth stops and it starts to go down. As seen in the formal employment, the incentive level dynamics affect the informal employment dynamics with some delay. The decrease in the incentive level continues with the three negative effects. With the decrease in the informal employment ratio, the peer pressure also affects the incentive level negatively. However, the negative effect of the governmental control is getting over and even it starts to affect positively. Since the significant decrease in the number of informally employed people, the governmental control goes down. Also the negative effect of the cost gap ratio decreases. With these positive effects, the incentive level starts to increase. Meanwhile, the informal employment continues to decrease but the decrease rate becomes slower over time due to the increasing incentive level. Finally, the in-

creasing incentive level changes the informal employment behavior. So that the number of the informally employed people starts to grow despite the economic growth seen in that period. However, after this growing behavior during the four years, the informality again is inclined to go down. It is concluded that the endless fight between the effect functions and the incentive for informality level creates these fluctuations in the incentive level. Increases in the dynamics are followed by decreases and vice versa. And these fluctuations mainly determine the informal employment dynamics with some delay. Additionally, the GDP growth ratio plays a role in these dynamics yet these dynamics can be contradictory to the economic dynamics. By the way, despite fluctuations there is an overall decrease in the informal employment dynamics which can be seen over the years. The overall decrease in the cost drawback of formality ratio and plus the peer pressure effect (there is a reinforcing loop between the peer pressure effect and the incentive level), and finally plus the total economic growth create this trend in the number of informally employed people over the period from 2000 to 2017. In addition to these effects, the negative effect of the probability of finding formal job variable on the informal employment by decreasing the informal unemployment pool (via both inflow and outflow of the unemployed formal and informal stock) also plays a significant role in this trend.

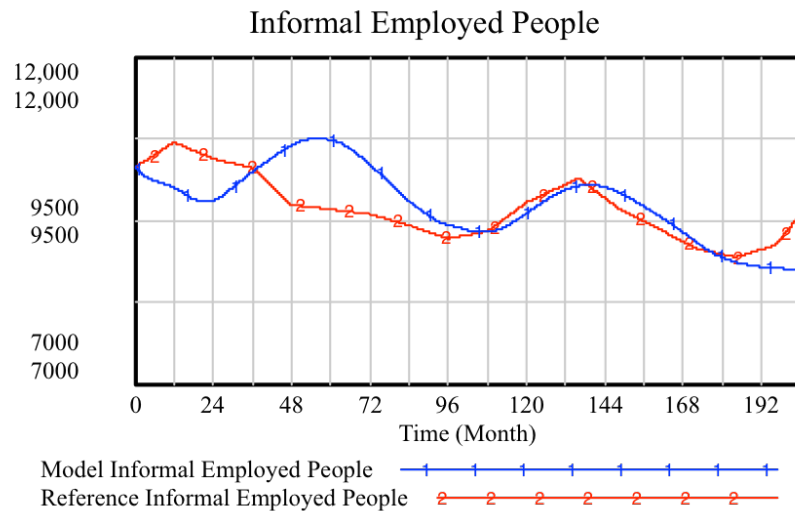


Figure 6.17. Calibrated informal employment.

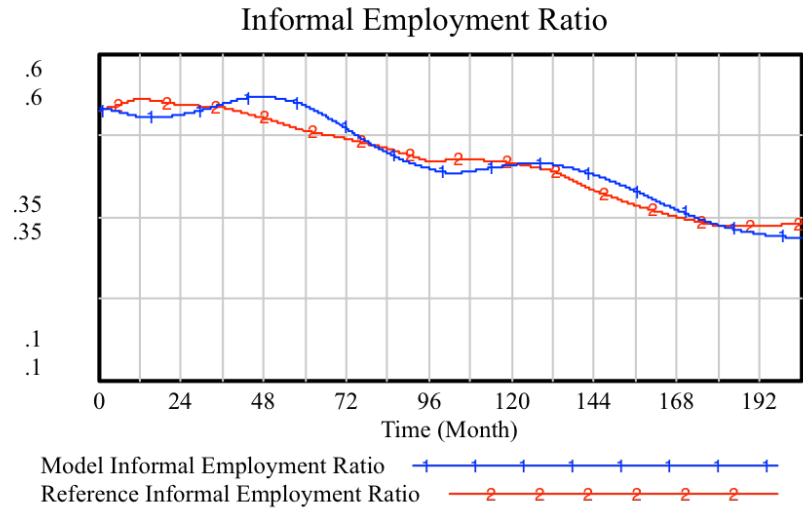


Figure 6.18. Calibrated informal employment ratio.

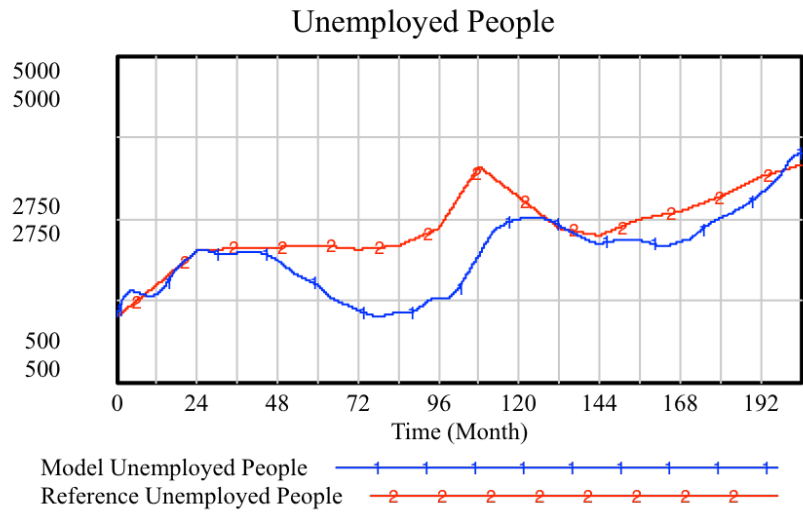


Figure 6.19. Calibrated unemployment.

- **Informal Employment Ratio:** In addition to the calibrations of formal employment and informal employment separately, we compare the model outputs to the real dynamics by considering formal and informal employment values together. The graph shows that the model behavior truly image the reality except in the first three years (Figure 6.18).
- **Unemployment:** Additionally, we check the model in terms of unemployed people which play a significant role in our structure. Although there are differences in exact points, the real behaviors are satisfactorily represented by the model (Figure 6.19). With the constant parameter values, the unemployed people dynamics are generally captured as seen in the previous section. Now by considering the real GDP growth ratio dynamics, the switches can be captured more successfully as seen between 2008 and 2014. However, some errors also emerge with the using statistical data. For example, after the 48th month, the decrease in the unemployment dynamics stem from the significant economic growth seen in that period.

7. THE BASE MODEL

In the base model, we aim to have a general overlook of the informal employment problem and also of the general labor market for the future. We set the parameter and variables as seen in Table 7.1. While setting the time-dependent variables for the future, we consider their historical dynamics between 2000-2017. For the period of 2017 and 2032, main outcomes of the base model are following;

Table 7.1. Calibrated model conditions.

Parameters	Base Model Conditions (2017-2032)
Maturation Rate	120000
Participation Fraction	0.0056 - 0.0065
Retirement Fraction	0.0015 - 0.002
Avg Cost Drawback of Formality Ratio	2.9
Job Seeker Poverty Ratio	0.166 - 0.2
GDP Growth Ratio	0.00432

- **Non-Institutional Working Age Population:** Under the base run conditions, the non-institutional working age population reaches a total of 73 million people in 2032. Actually, the official projections about older than 14-year-old population are about 66 and 78 million for the years 2023 and 2050, respectively (TurkStat) [57]. So the increasing population dynamics under the base run conditions are acceptable (Figure 7.1).
- **Non-Labor Force:** In spite of the significant rise in the population, the amount of people who do not participate in labor force starts to go down after 2017 (Figure 7.2). As seen in the previous section, the non-labor force was growing at a decreasing rate. Then this trend ends and the non-labor force starts to

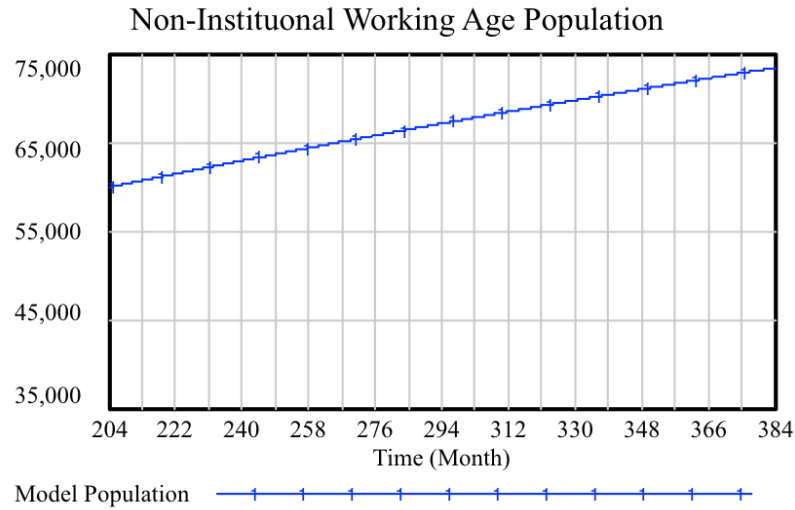


Figure 7.1. Total population generated by the model.

decrease because people, entering the system, are less than people, participating in the labor market (for further explanations, see the previous section).

- **Participation Ratio:** Since 2006, the trend, seen in the participation ratio dynamics, still continues (Figure 7.3). The labor force density in the population grows. However, the growth rate starts to decrease slightly because of the decreasing difference between job seeker rate and leaving/retirement rates.
- **Formal Employment:** The quarterly GDP growth ratio fluctuates over time in the real economy. We accept the real GDP growth ratio for the years 2000-2017. Averagely, this real ratio is equal to 1.3 percent. Thus, we accept this average ratio as a constant growth ratio for the future. So, with the stable economic growth (i.e. quarterly 1.3 percent or yearly about 5.3 percent), the number of formally employed people increases linearly in between 2018-2032 (from the 210th month to the 384th month), as seen in Figure 7.4. The growth in the labor force affects the formal employment positively. The growth in the labor force means an increase in the unemployed people. The growing unemployed pool affects the formal employment both positively and negatively. The probability of finding a

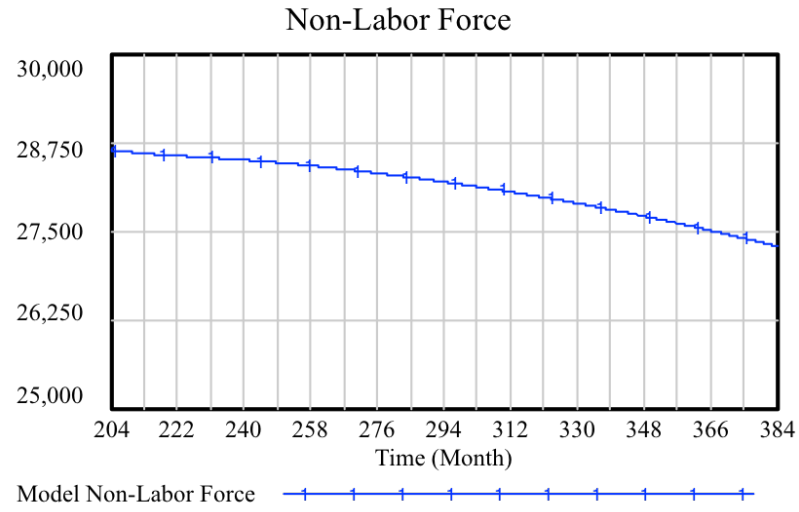


Figure 7.2. Non-Labor force generated by the model.

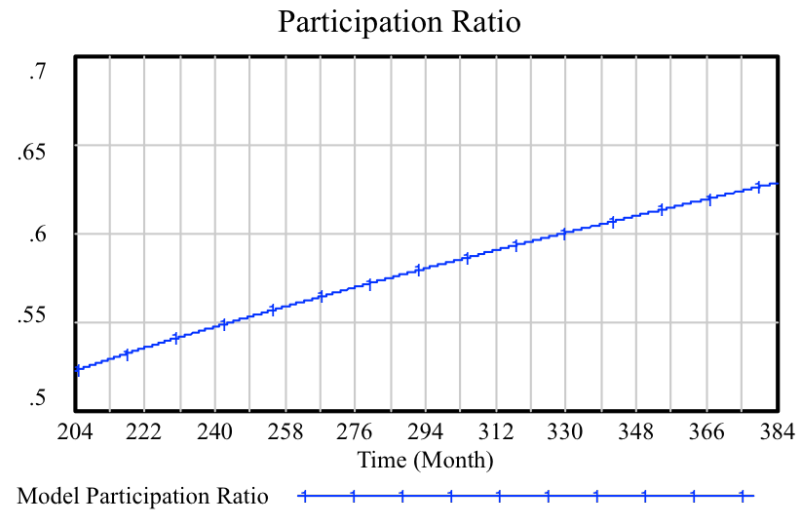


Figure 7.3. Participation ratio generated by the model.

job for a job seeker goes down with the higher unemployment. However, the hiring rates are inclined to go up with the higher unemployment. Among these two effects, the latter dominates the system and so the formal employment increases.

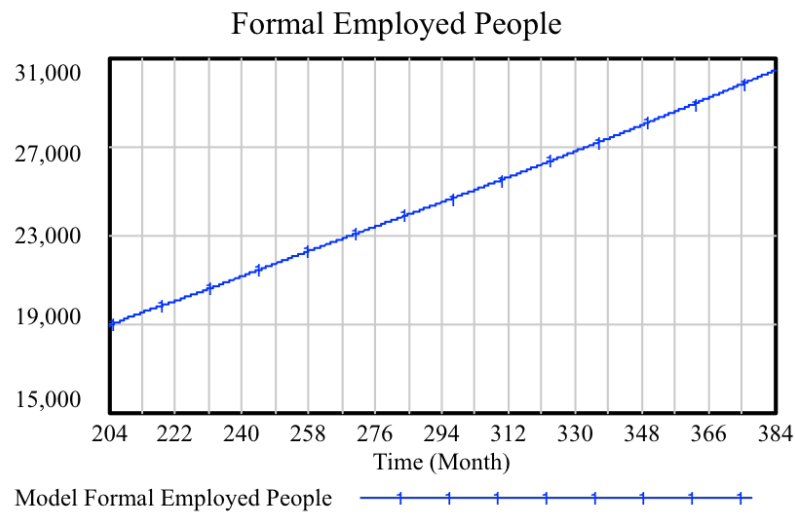


Figure 7.4. The number of formally employed people generated by the model.

- **Informal Employment:** As explained in the previous section, the informally employed people dynamics make fluctuations mainly with the reinforcing and balancing loops seen among the effect functions on the incentive for informality variable. One of these fluctuations is seen between 2017-2021 (Figure 7.5). Before that, a similar fluctuation is seen in the incentive level so this behavior determines the informality dynamics with some delay. With the decrease in the informally employed people before 2017, the governmental control decreases and affects positively yet the peer pressure affects negatively since it decreases with the decreasing informal employment ratio. Additionally, the cost drawback ratio firstly increases yet then, decreases in that period. Among these three effects, the positive effects of the enforcement and cost gap ratio dominate the system and so the incentive start to go up. With the growing incentive level, the informal employment goes up. It is interesting that the informal employment increases despite the growing economy. However, the growing incentive level stops with the decrease in the cost gap ratio and also with the peer pressure effect. So the

incentive level goes down. In addition to these effects, the growing informality triggers the balancing loop between the enforcement effect and the incentive level. With these three consistent effects, the incentive decreases significantly. Until the end of the simulation period, this trend in the incentive level does not change despite the balancing loop of the enforcement. This effect cannot dominate the system just causes slight fluctuations in the incentive level and so in the informal employment dynamics. Thus, the informally employed people go down until the end of the simulation period.

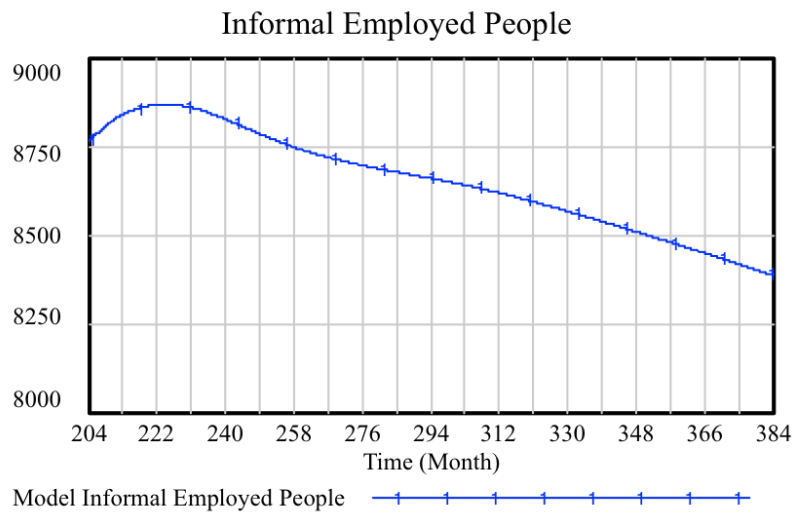


Figure 7.5. The number of informally employed people generated by the model.

- **Informal Employment Ratio:** With an informal employment ratio measurement (a ratio of informal employment to total employment), we are able to have clear interpretations on the share of informality in the labor market. According to Figure 7.6, it is concluded that the informal employment ratio continuously goes down with the increasing formal employment and decreasing informal employment. At the end of the simulation period (2032), it decreases below 21 percent. According to our structure and base run assumptions, the government target, to decrease the informal employment ratio down to 15 percent, cannot be realized for the future 15 years.

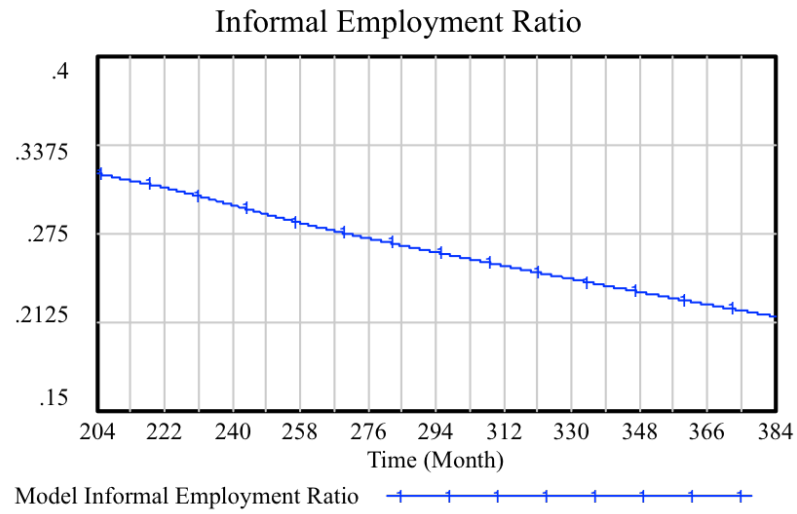


Figure 7.6. Informal employment ratio generated by the model.



Figure 7.7. The number of unemployed people generated by the model.

- Unemployment: As seen in the participation ratio dynamics, the number of people in the labor force increases. This increase causes a significant increase in the number of unemployed people (Figure 7.7). According to the graph, it is concluded that the economic growth ratio (quarterly 1.3 percent) becomes insufficient to meet this growing demand for jobs.

In conclusion, under the base run conditions, for the period from 2017 to 2032, it is suggested that the labor market faces a significant unemployment problem. The unemployment ratio increases from 12 percent to about 16 percent. On the other hand, the informal employment ratio decreases from nearly 32 percent to 21 percent. However, this result is not satisfying and the governmental target to decrease the informality ratio to 15 percent seems all but impossible under these base run conditions.



Figure 7.8. Unemployment ratio generated by the model.

8. SCENARIO AND POLICY ANALYSIS

In this section, at first the labor market dynamics are analyzed under four different scenario conditions. Secondly, we evaluate four different policies by taking specific demand and supply side policies into consideration separately and also together. Finally, there are two scenario-policy combinations in this section.

In the model, the people and vacancy units are thousand people and vacancies to present information in a useful manner. In other words, each thousand people and vacancies are represented by one person and one vacancy, respectively.

8.1. Scenario Analysis

Basically, we focus on factors which have potentials to change the labor market situations dramatically. So we consider different economic growth and matching efficiency scenarios. Besides these scenarios, the Syrian immigration facts are considered in the labor market.

8.1.1. Scenario 1 - Economic Growth

Firstly, we perform experiments under different economic growth conditions in order to observe the informal employment dynamics.

8.1.1.1. Scenario 1a - Strong and Stable Economic Growth. We set the GDP growth ratio variable to 3,5 percent per quarter (yearly about 15 percent) for the next 15 years, as seen in Table 8.1. Actually, this economic growth ratio is the government's target for 2018 [58]. So in that assumption, we try to observe the labor market dynamics over time.

month). The negative effects on the unemployed formal and informal stock are stronger than the positive effect on the informal vacancy so an exponential collapse happens in the informal employment dynamics (Figure 8.2). The results show that if the economy strongly and continuously grows, then the informal employment ratio can be reduced to 12 percent (Figure 8.3). Under these scenario conditions, it is concluded that the government's target, reducing the informal employment ratio down to 15 percent, can be reached in the strong and continuous economic growth (yearly about 15 percent) assumption, over 15 years.

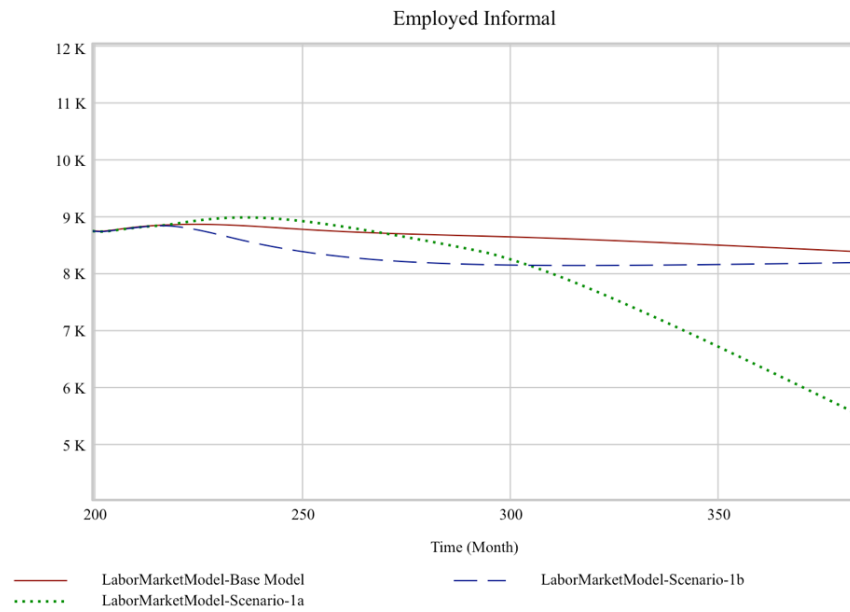


Figure 8.2. Informally employed people under the scenarios 1a and 1b.

On the other hand, the economic recession negatively affects the number of formally employed people (Figure 8.4). Interestingly, the informally employed people in this case are less than the informally employed people in the base run. At the beginning, the employed informal stock decreases by making an exponential decline since the informal vacancy decreases due to the economic recession. So finding a job becomes more difficult even in the informal sector (Figure 8.2). Thus, the number of people who accept informal working conditions increase via the inflow of the unemployed formal and informal stock, informality accepting rate. The increase in the unemployed formal

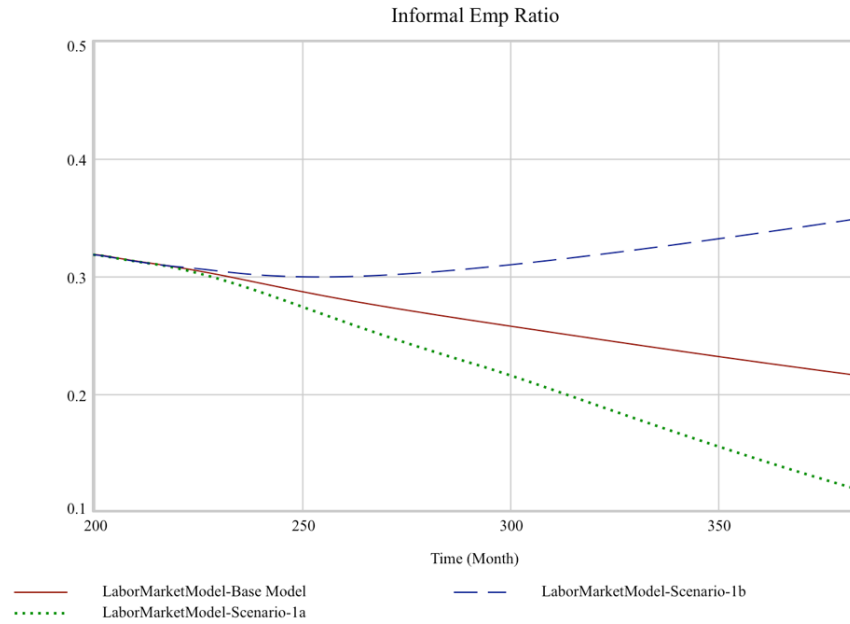


Figure 8.3. Informal employment ratio under the scenarios 1a and 1b.

and informal stock mainly stops the decrease in the employed informal stock. In addition to this effect, the incentive for informality level increases due to the peer pressure effect and enforcement effect. As explained in the model description section, the peer pressure effect depends on the ratio of informal employment to total employment, and there is a reinforcing loop between this effect and the incentive level. So as the informal employment ratio increases then the incentive for informality is inclined to increase exponentially with the peer pressure effect. Additionally, the government enforcement effect depends on the number of informally employed people and there is a balancing loop between this effect and the incentive level. So as the informally employed people decreases then the incentive for informality is inclined to increase (a goal-seeking behavior due to the balancing loop) with the enforcement effect. In other words, the incentive for informality increases with a decrease in the governmental control due to the decreasing number of informally employed people. With the growing incentive level, the informal vacancy continues to decrease (due to the economic recession) but with a decreasing decline rate (due to the increasing incentive level). Thus, with mentioned two positive effects (from the increasing unemployed informal and formal stock and increasing incentive for informality), the decrease in the employed informal stock stops

and even this stock slightly grows until the end of the simulation run.

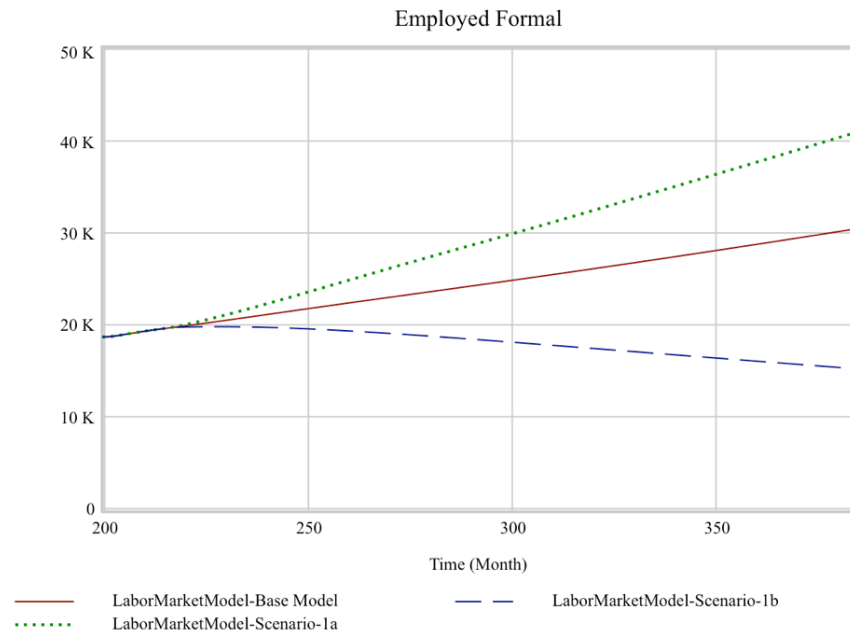


Figure 8.4. Formally employed people under the scenarios 1a and 1b.

Additionally, the informal employment ratio (ratio of informal employment to total formal and informal employment) is the highest (it reaches to 35 percent at the end) under the economic recession since the number of informally employed people increases whereas the number of formally employed people decreases (Figure 8.3; Figure 8.4).

As expected, the unemployment ratio decreases down to 3 percent under the strong economic growth whereas this ratio significantly increases up to 45 percent under the economic recession (Figure 8.5). While the unemployment ratio is shrinking at decreasing decline rate, the balancing loops between the employment stocks (employed formal and employed informal) and the unemployed stocks (unemployed formal, unemployed informal, unemployed formal and informal) dominate the system so that decline rates in the unemployment stocks decrease. Similarly, these balancing loops dominate the system under the economic recession so that the unemployment ratio makes a goal-seeking behavior.

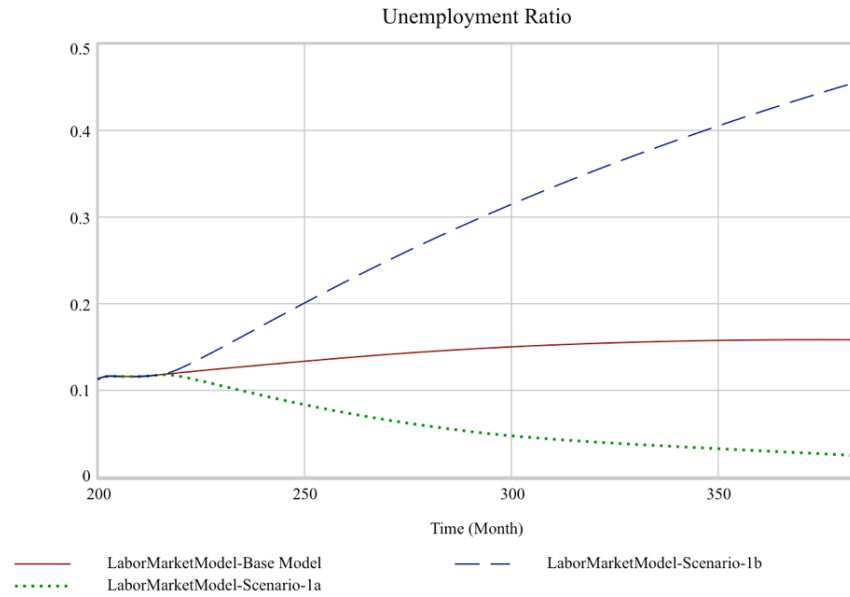


Figure 8.5. Unemployment ratio under the scenarios 1a and 1b.

8.1.2. Scenario 2 – Migrations

According to the United Nations (UN) report about registered Syrian refugees in Turkey (2018), more than 3.5 million people have migrated into Turkey, since 2012 (Figure 8.7) [59]. This dramatic event creates many social and economic problems in Turkey. One of them occur in the labor market by creating a new informal employment source. Refugees start to work as an informal self/paid employed in the market due to weak legislation in the refugee policy. As expected, employers profit from these situations by using the cheaper labor source. Now, we try to analyze effects of these situations on the labor market. In the model, it is assumed that refugees can find a job just in the informal sector. So refugees enter the unemployed informal stock via the labor refugee immigration from 2012 (144th Month) to the first quarter of 2018 (219th Month) (Table 8.2 and for the stock-flow diagram, see Figure 8.6). By using the data provided by UN, we consider real immigration waves over time (Figure 8.7 and for the refugee dynamics in the model, see Figure 8.8). It is assumed that 30 percent (labor refugee fraction) of these immigrants can be counted as workforce (Equation 8.2). There are no information and estimations about this workforce ratio.

Table 8.2. Scenario 2 settings (between 2012-2018).

	Base Model	Scenario 2
Syrian Refugee Immigration (People/Time)	0	143000 - 384000

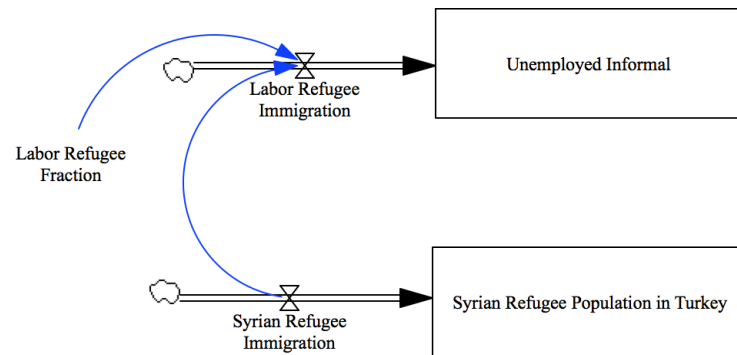


Figure 8.6. Stock-flow diagram of Syrian refugees.

$$\text{LaborRefugeeImmigration} = \text{SyrianRefugeeImmigration} \times \text{LaborRefugeeFraction} \quad (8.1)$$

$$\text{LaborRefugeeFraction} = 0.3 \quad (8.2)$$

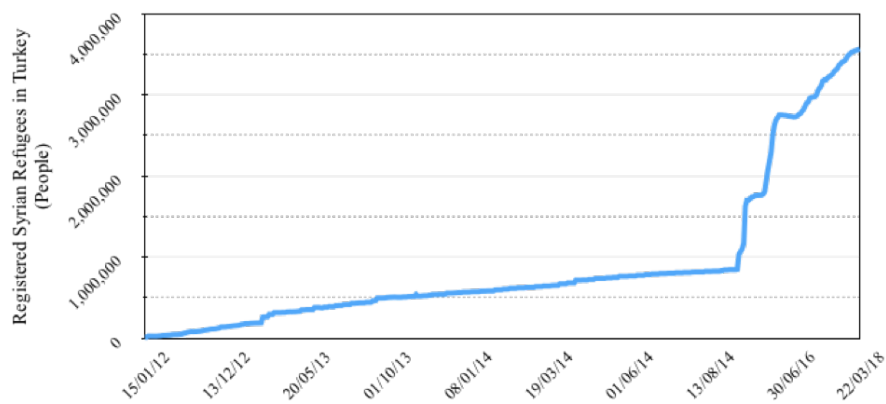


Figure 8.7. Registered Syrian Refugees in Turkey (UN, 2018).

The unemployed informal stock increases with the increase in Syrian informal job seekers (Figure 8.10). The increasing unemployed informal stock positively affects the informal hiring rate (informal hiring rate from unemployed informal), as seen in Figure (the circled No.1 effect). However, the probability of finding informal job for job seekers decreases with the increasing unemployed informal stock so that the increasing unemployed informal also negatively affects this informal hiring rate (the circled No.2 effect in the diagram). Among these two effects, the former is stronger than the latter so the informal hiring rate (informal hiring rate from unemployed informal) goes up. On the other side, the decreasing probability of finding informal job decreases the other informal hiring rate (informal hiring rate from unemployed formal and informal), as seen in the diagram (the circled No.3 effect).

In a summary, one of the informal hiring rate increases whereas the other one decreases. Because the increase in the first hiring rate is greater than the decrease

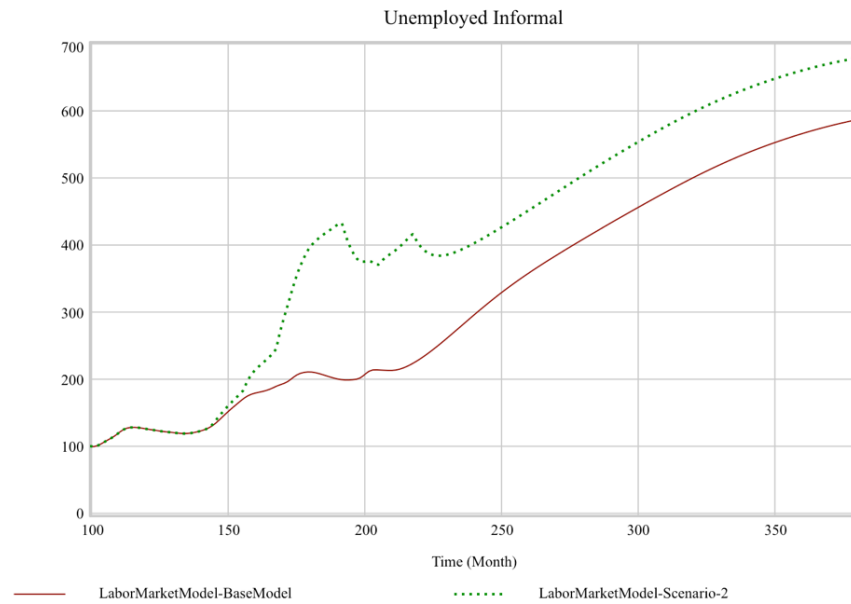


Figure 8.8. Under the scenario 2, the number of unemployed people who can find just informal jobs.

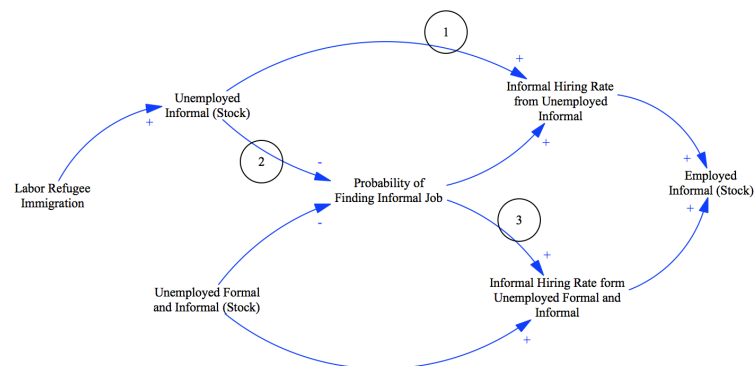


Figure 8.9. Simplified causal loop diagram related to the scenario 2.

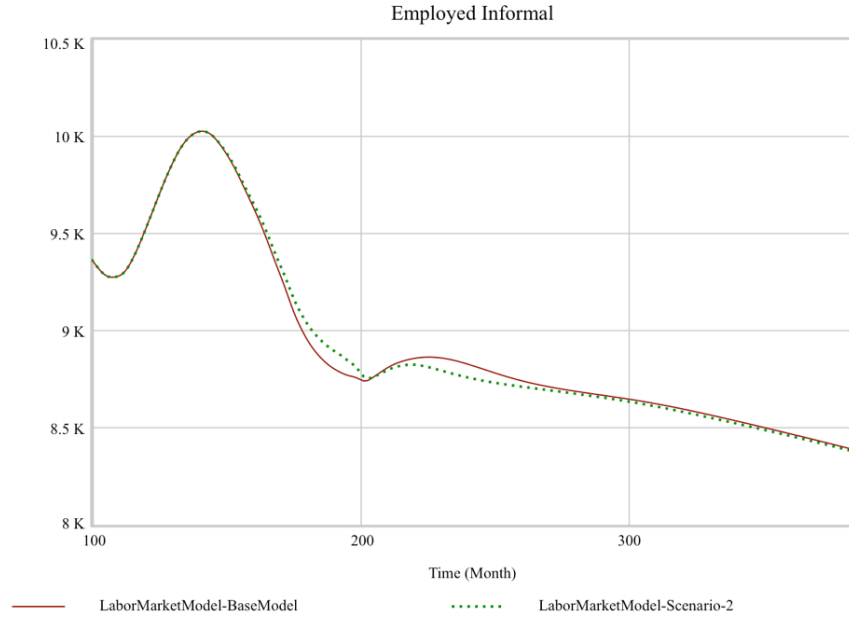


Figure 8.10. The number of informally employed people under the scenario 2.

in the second hiring rate, the informal employment becomes higher than the base run until the 200th month. Because of the decrease in the immigration wave, the decreasing second hiring rate dominates the system so that the informal employment becomes less than the base run after the 200th month (for the immigration dynamics see Figure 8.7 and Figure 8.8). Similarly, after that period the employed informal stock behaves according to the immigration waves. As mentioned, until 219th month, refugees continue to come. After that month, the decline rate in the probability of finding informal job decreases since the immigration waves stop. Then, the informal employment dynamics are gradually approaching the base run dynamics by making slightly increase with the growing probability of finding informal job.

Moreover, the unemployment ratio also rises because the employed informal stock is filled up by the exogenous source (refugees) so that for indigenous people, it becomes harder to find a job (Figure 8.11). Over the years, the official unemployment increases by more than 5 hundred thousand people due to about 1 million refugees in the labor market.

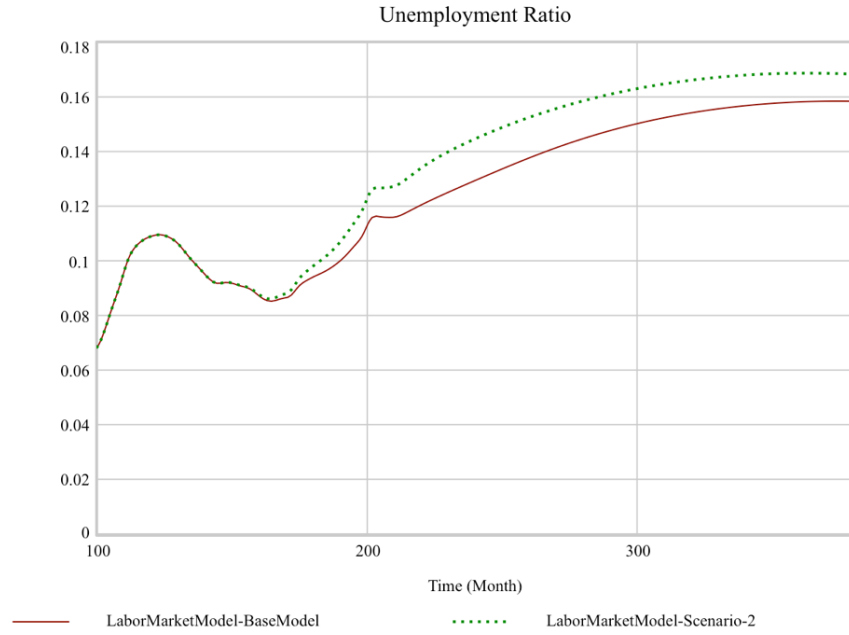


Figure 8.11. Unemployment ratio under the scenario 2.

8.1.3. Scenario 3 – More Efficient Labor Market

It is assumed that technological improvements, spreading widely social networks and new official platforms and canals have potentials to make matching processes more efficient. So with considering these positive factors on matching processes, we set the matching efficiency as seen in Table 8.3.

Table 8.3. Scenario 3 settings.

	Base Model	Scenario 3
Formal Matching Efficiency	0.3	Increasing up to 0.6

There are three direct affects on the probability functions, as seen in Figure 8.12. One of them is the number of unemployed people (the No.1 effect in the diagram). The second one is the number of vacancy and the last one is the matching efficiency (the No.2 and No.3 effects in the diagram). Firstly, the probability of finding formal job is inclined to increase if the matching efficiency is increased. With the higher

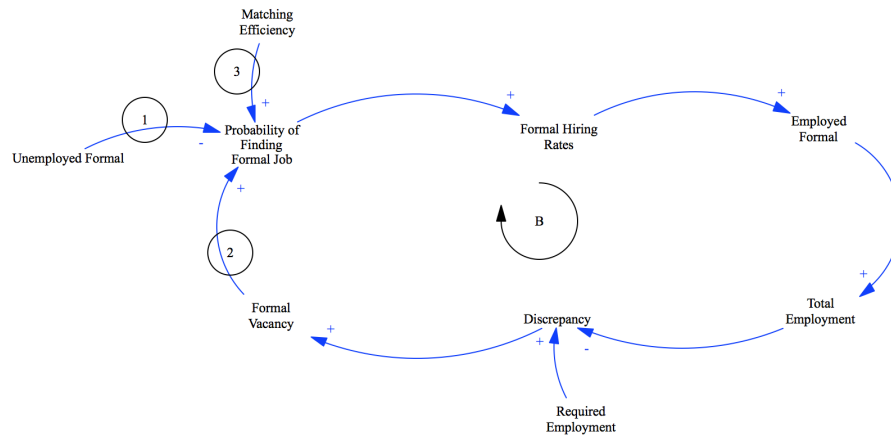


Figure 8.12. Simplified causal loop diagram related to the scenario 3.

probability, the formal hiring rate (hiring rate from unemployed formal) increases. On the other hand, the other formal hiring rate (hiring rate from unemployed formal and informal) decreases. Due to the growing probability of finding formal job, the unemployed formal and informal stock decreases via the decrease in the inflow of informality accepting rate. In other words, there have been less people to accept informal working conditions since they find formal jobs more easily. The increasing formal hiring rate dominates the system rather than the decreasing formal hiring rate so that the number of formally employed people grows (Figure 8.13). With the growing formal employment, the discrepancy between the required employment and current employment goes down. Actually, the total employment variable depends on both employed formal and informal stocks yet the employed formal stock dominates the variable in this scenario. So new vacancy decisions are reduced. This means a negative effect on the probability of finding formal job since the formal vacancy decreases (the No.2 effect). The positive effect of the higher matching efficiency is balanced by the negative effect of the lower vacancy. Besides these opposite effects, the unemployed formal stock decreases with the higher hiring rate (hiring rate from unemployed formal) and this effect increases the probability of finding formal job. Under these three effects, the probability of finding formal job eventually becomes slightly more than the probability of the base run.

Long story in short, the probability cannot grow significantly due to the higher matching efficiency since the balancing loop between the formal employment and new vacancy creation process decreases the expected positive effect of the higher matching efficiency (Figure 8.12). With the balanced effect, the informality cannot be affected significantly. The number of informally employed people becomes slightly less than the informality of the base run (Figure 8.14).

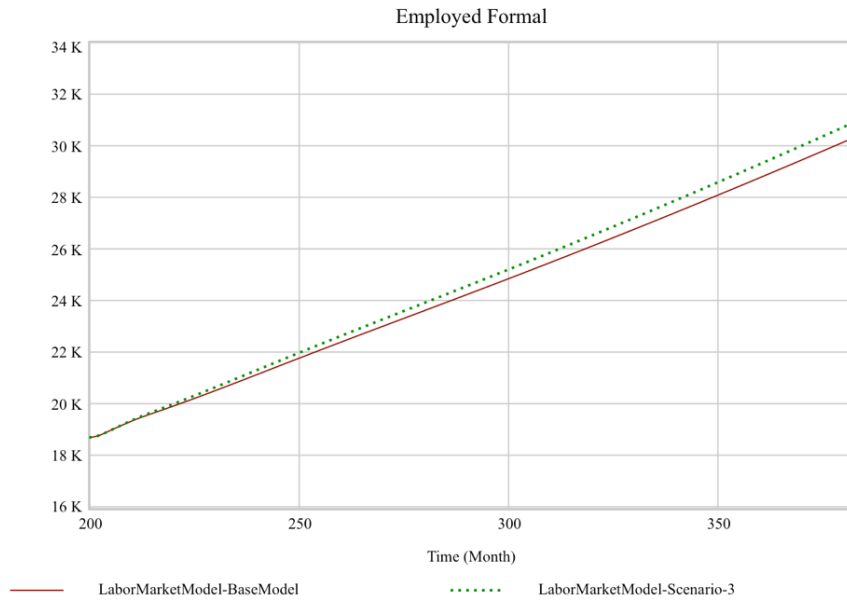


Figure 8.13. The number of formally employed people under the scenario 3.

Interestingly, more efficient formal labor sector cannot be solution for the informality problem. Even though the higher formal matching efficiency cannot significantly decrease the informally employed people, it can decrease the unemployment ratio more than 1 percent, which means, the number of unemployed people decreases by about 5 hundred thousand people (Figure 8.15).

As a conclusion, higher formal matching efficiency speeds formal hiring processes up and so makes labor market situations a bit better by decreasing unemployment and having relatively lower informality under the same economic conditions.

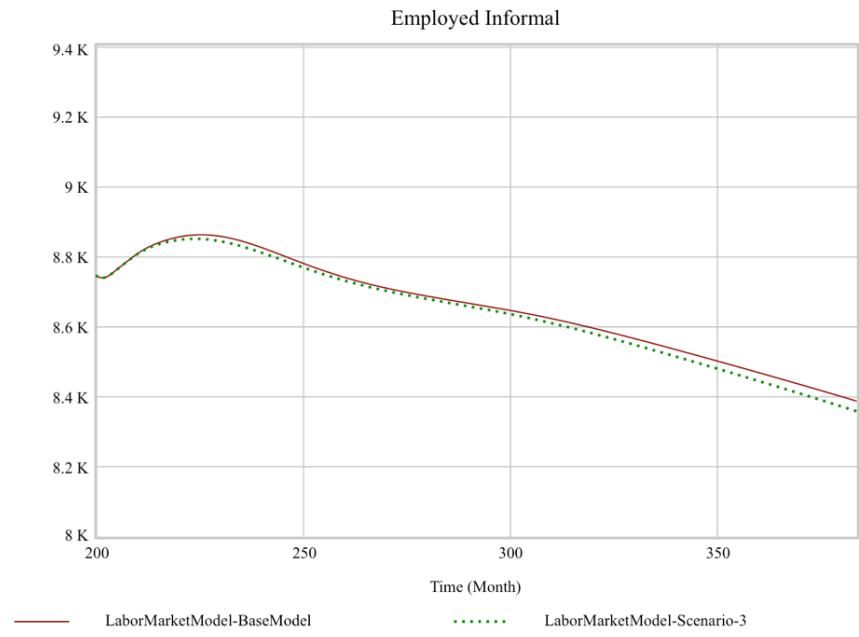


Figure 8.14. The number of informally employed people under the scenario 3.

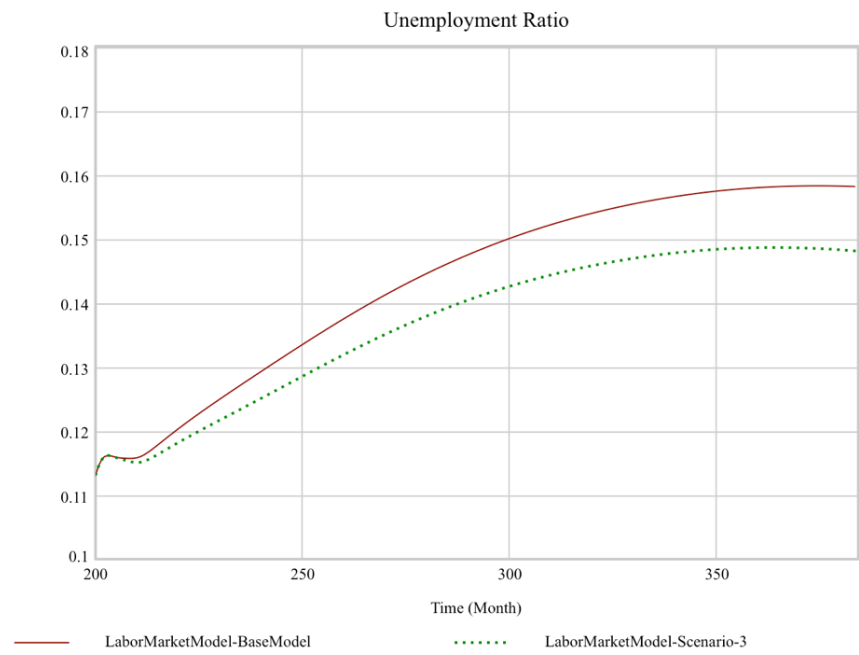


Figure 8.15. Unemployment ratio under the scenario 3.

8.2. Policy Analysis

In this section, the labor market dynamics are analyzed under four different policies by taking specific demand and supply side policies into consideration separately and also together.

8.2.1. Policy 1 – Regulatory Burdens on the Labor Demand Side

As mentioned in the previous chapter, creating a job in the formal sector has disadvantages in terms of labor costs such as tax and contribution rates. These cost drawbacks of the formal sector come from governmental regulations. Governments affect a labor market by making decisions on for example, tax/contribution rates or minimum wage levels. These governmental effects on a labor market are discussed in the studies as seen in the literature review chapter. Now we try to observe the labor market dynamics by making such governmental changes in the variable of cost drawback of formality ratio (Table 8.4).

Table 8.4. Policy 1a and 1b settings.

	Base Model	Policy 1a	Policy 1b
Avg Cost Drawback of Formality Ratio	2.9	Increasing up to 6	Decreasing down to 1

8.2.1.1. Policy 1a - Gradually Increasing Regulatory Burdens. In this policy, it is assumed that the cost drawback of formality ratio is gradually increasing over time until an average formal labor cost will be equal to six times as many as an average informal one. In other words, a firm can informally hire six people rather than formally hiring a single person with same costs.

8.2.1.2. Policy 1b - Gradually Decreasing Regulatory Burdens. It is assumed that the cost drawback of formality ratio is gradually decreasing over time until an average formal labor cost will be equal to an average informal one. This means, in both formal and informal sectors, there is no an extra labor cost except a net wage.

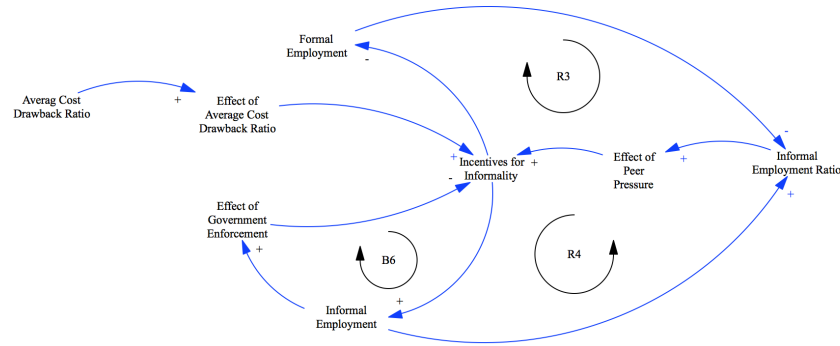


Figure 8.16. Simplified causal loop diagram related to the effect functions on the incentive for informality.

Rising formal costs (due to such as increasing labor tax/contribution rates) increase the average cost drawback ratio. The growing cost drawback of formality ratio positively affects the incentive for informality of the labor demand side (Figure 8.16). As seen also in the diagram, there are three effects on the incentive for informality. In addition to the positive effect of the growing cost gap ratio, the enforcement and the peer pressure effects try to determine the behavior of the incentive level. At the beginning, the enforcement and the peer pressure negatively affect the incentive level and these effects dominate the system. The incentive level slightly decreases at a decreasing decline rate. This decline cannot decrease the employed informal stock. This stock seems almost stable (even slightly increase) at the beginning (Figure 8.17). However, then, the gradually increasing cost gap effect becomes stronger than the other effects and the incentive for informality level starts to go up but with a decreasing growth rate (due to the other negative effects). With the growing incentive level, the decrease in the informal vacancy stops. With the higher informal vacancy, the employed informal stock grows significantly which is consistent with the incentive level dynamics. Under the three opposite effects, the incentive for informality dynamics make slight fluctu-

ations depending on changing dominants effects. Slight fluctuations in the informal employment dynamics come from these changes.

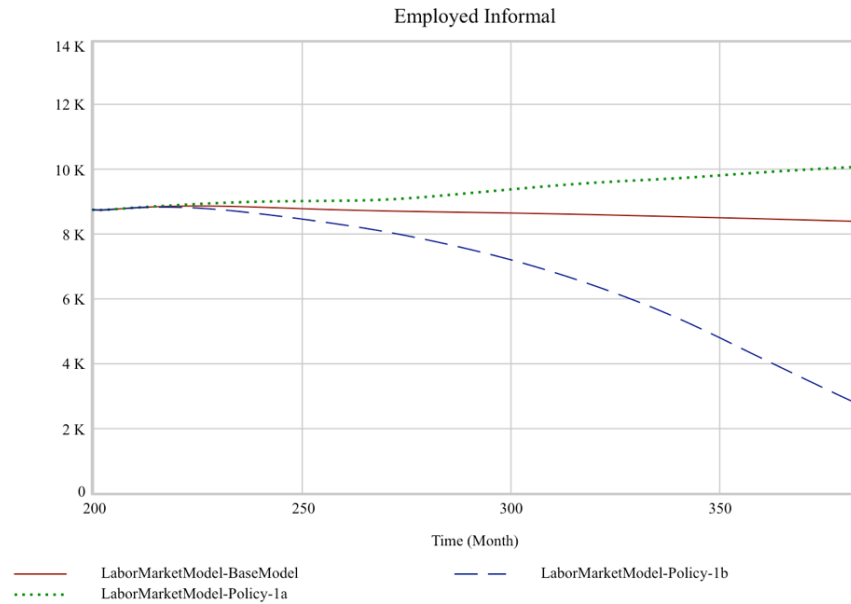


Figure 8.17. The number of informally employed people under the policy 1a and 1b.

While the cost drawback of formality ratio is gradually decreasing, then the informally employed people also decreases (Figure 8.17). With the lower cost gap ratio, the labor demand side is inclined to create formal vacancy. As seen in the graph, the number of informally employed people dynamics make an exponential collapse because of the gradually decreasing cost gap. Additionally, the reinforcing loop between the peer pressure effect and the incentive level also decreases the informal employment despite the positive effect of the decreasing enforcement level.

As a conclusion, the growing cost drawback of formality ratio increases the informality and the number of informally employed people reaches 10 million. The positive effect of the growing cost gap ratio is decreased by the governmental control so that the informality cannot increase dramatically.

On the other hand, the decreasing cost drawback of formality ratio significantly decreases the number of informally employed people down to 3 million. The informal

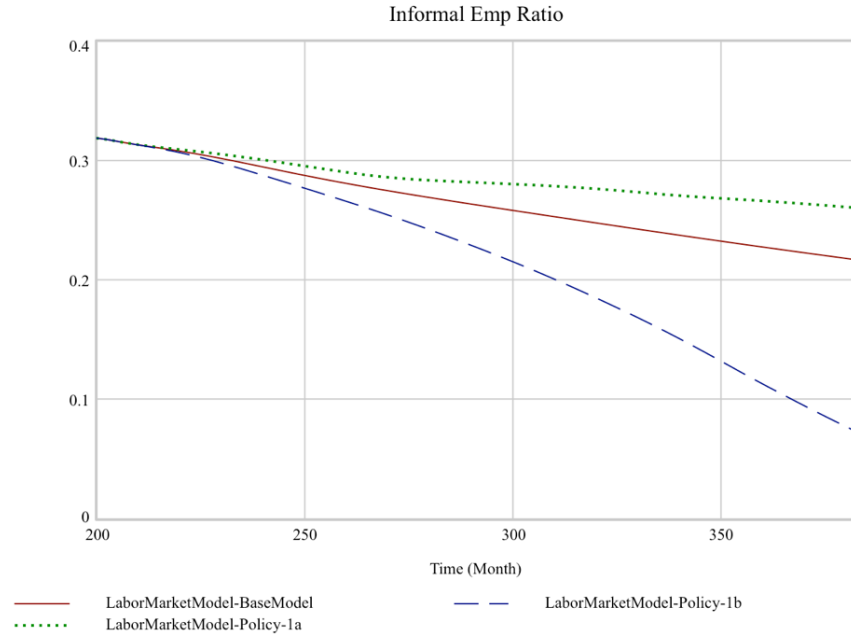


Figure 8.18. The informal employment ratio under the policy 1a and 1b.

employment ratio can be decreased down to 7 percent under the policy where there is no labor cost gap between the formal and informal sectors at the end of the period (Figure 8.18).

8.2.2. Policy 2 - Regulations on Firing Processes

Another governmental effect on the labor market is making labor protection legislation (e.g. severance pays) which mainly regulates firing processes in the formal sector. In the matching efficiency scenario, we analyzed the effect of increasing hiring rates on the labor market. Now, we try to observe effects of increasing and decreasing firing rates on the labor market by considering easy and strict labor protection legislation.

8.2.2.1. Policy 2a - Gradually Decreasing Regulations on Formal Firing Processes. It is assumed that labor protection legislation is easy so that firing decisions are made more common in the formal sector. We set formal firing fraction as gradually increasing in order to observe labor market dynamics while firing rates are growing (Table 8.5).

8.2.2.2. Policy 2b - Gradually Increasing Regulations on Formal Firing Processes. It is assumed that labor protection legislation is strict so that making firing decision becomes harder. We set the formal firing fraction as gradually decreasing as seen in the Table 8.5.

Table 8.5. Policy 2a and 2b settings.

	Base Model	Policy 2a	Policy 2b
Formal Firing Fraction	0.02	Increasing up to 0.05	Decreasing down to 0.01

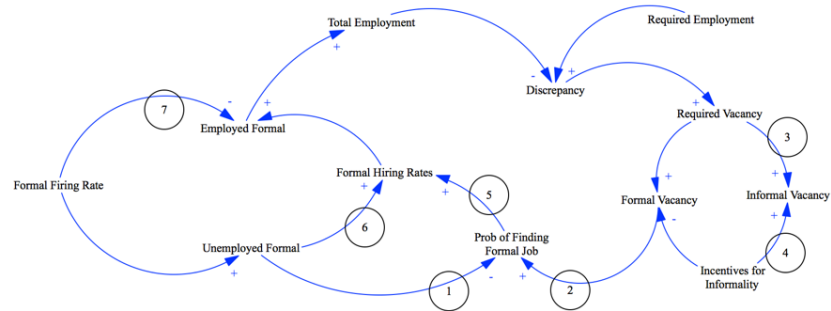


Figure 8.19. Simplified causal loop diagram related to the policy 2a and 2b.

Easy labor legislation causes an increase in the formal firing rate. With the growing formal firing rate, the employed formal stock goes down whereas the unemployed formal stock goes up (for the causal loop diagram see Figure 8.19 and for the related graphs see the Figure 8.20 and Figure 8.21). At the beginning, the probability of finding formal job dynamics make an exponential decay with the growing unemployed formal stock (Figure 8.22). However, the decreasing employed formal stock decreases the total employment. So with the decreasing total employment, the discrepancy between required and current employment increases. Therefore, the system tries to make new vacancies in order to meet this emerging employment need. There have been many vacancies in the labor market so job finding probabilities are inclined to go up in both

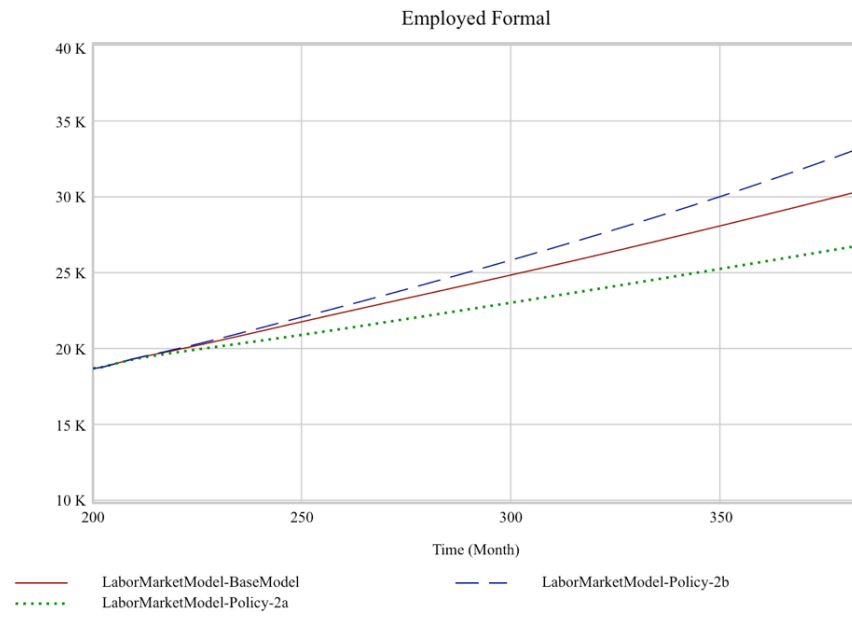


Figure 8.20. The number of formally employed people under the policy 2a and 2b.

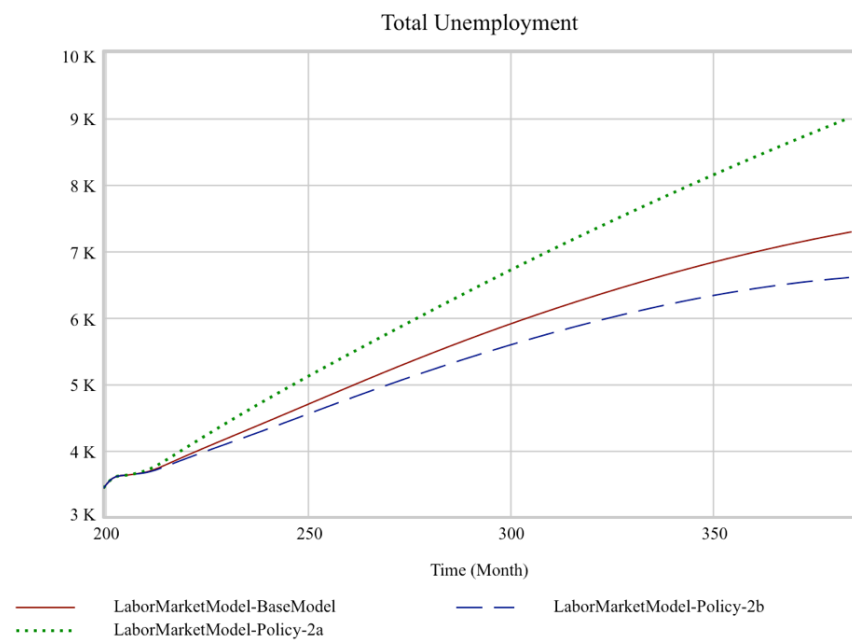


Figure 8.21. Total unemployment under the policy 2a and 2b.

formal and informal sectors as seen in Figure 8.22 and Figure 8.23. In addition to the growing vacancy effect, the incentive for informality plays a significant role in the probability levels. The incentive level goes down due to the growing enforcement level (the negative effect of the enforcement is stronger than the positive effect of the peer pressure under this scenario) against the growing informality. Then, with both positive effects of the higher vacancies and lower informality incentive level, the probability of finding formal job increases. Long story in short, the probability of finding formal job firstly makes an exponential decay since the negative effect of the growing unemployed formal stock dominates the system (the No.1 effect in Figure 8.19). Then, the probability starts to increase since the positive effects of the growing vacancies dominate the system for the following years (the No.2 effect in the diagram). On the other hand, the probability of finding informal job dynamics continue to make an exponential decay with the positive effect of the higher required vacancies and the negative effect of the lower incentive level (the No.3 and No.4 effect in the diagram, respectively). As seen in the diagram, the No.5 effect (represents the positive effect of the growing probability of finding formal job on formal hiring rates) increases the formal hiring rates. Additionally, the growing unemployed formal stock also increases the formal hiring rate from unemployed formal (the No.6 effect). However, these two effects seem to be not enough to cease the negative effect of the higher firing rates (the No.7 effect). Finally, the employed formal stock goes down.

Besides the growing unemployed formal stock, the unemployed formal and informal stock goes up since there have been more people who accept informal working conditions. The unemployed formal and informal stock makes goal-seeking behavior since there is a balancing loop between this stock and the informality accepting flow. With the higher unemployed formal and informal stock and higher probability of finding informal job (the probability of finding informal job is higher than the probability under the base run despite it decreases), the informally employed people increase at a decreasing growth rate (Figure 8.24). So these causal relations are beneficial for the informal employment so that more than 10 million people will be informal in 2032, while the formal firing rate is increasing.

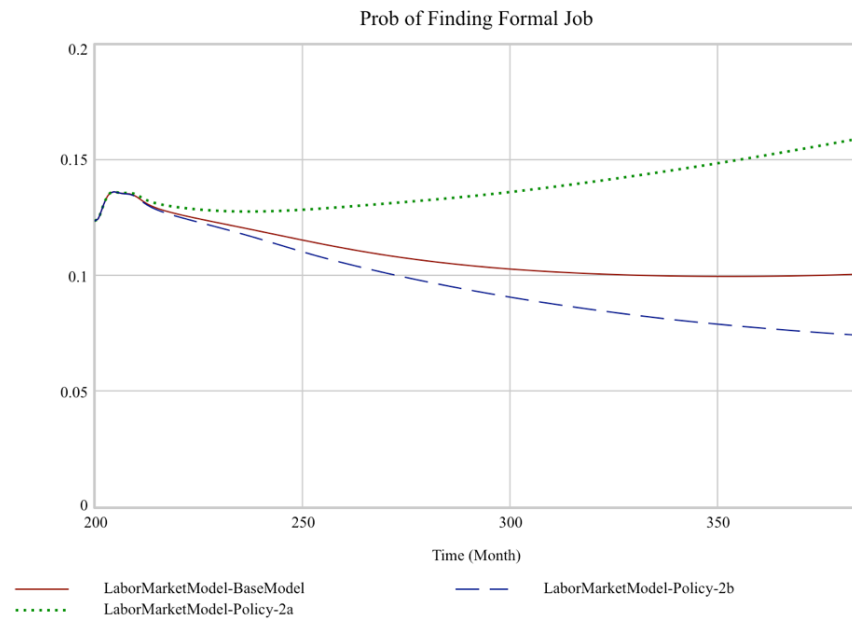


Figure 8.22. Probability of finding formal job under the policy 2a and 2b.

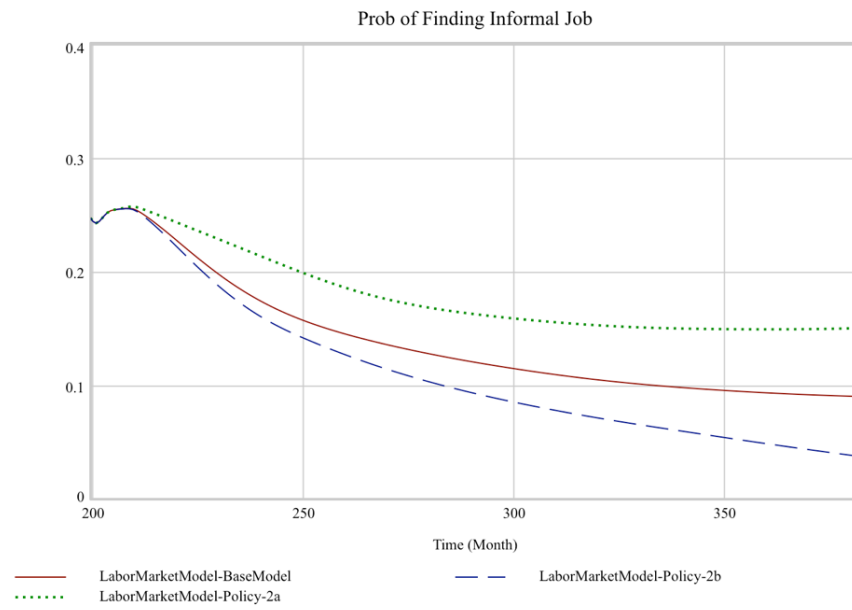


Figure 8.23. Probability of finding informal job under the scenario 2a and 2b.

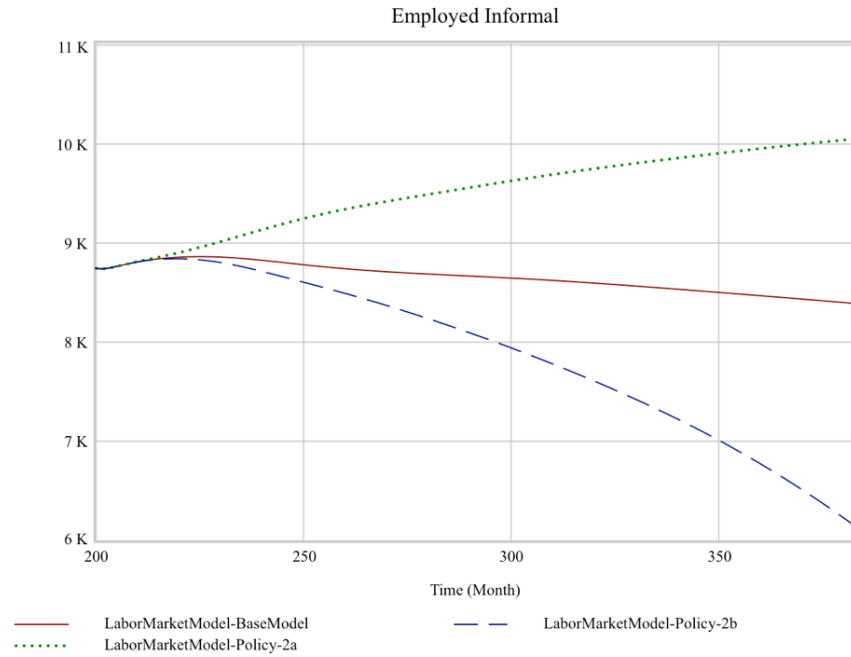


Figure 8.24. The number of informally employed people under the policy 2a and 2b.

On the other hand, in the strict labor protection condition, the number of informally employed people is decreasing while the number of formally employed people is increasing (Figure 8.24, Figure 8.20). At the end of the simulation period, the informal employment difference between the easy and hard regulation conditions is about 4 million people. It is suggested that protecting labors with strict legislation against firing decisions seems to be useful to solve the informality problem for the labor market.

Finally, it is concluded that hiring rates become insufficient when a market requires rapid labor exchanges with higher firing rates. In a labor market where hiring rates occur slowly, easy labor protection regulations contribute to the informality and unemployment problem.

8.2.3. Policy 3 - More Burdens and Harder Regulations

As a governmental decision, protecting labor against a firing process with legislation can be useful for the informality and unemployment problems as discussed in the

second policy experiments (see Policy-2b). Furthermore, as a governmental decision, making more burdens (such as increasing contribution rate) on the business side can exacerbate these problems as discussed in the first policy (see Policy-1a). Now in this policy, we try to examine these two contrary policies' joint effects on the market.

Table 8.6. Policy 3 settings.

	Base Model	Policy 3
Avg Cost Drawback of Formality Ratio	2.9	Increasing up to 6
Formal Firing Fraction	0.02	Decreasing down to 0.01

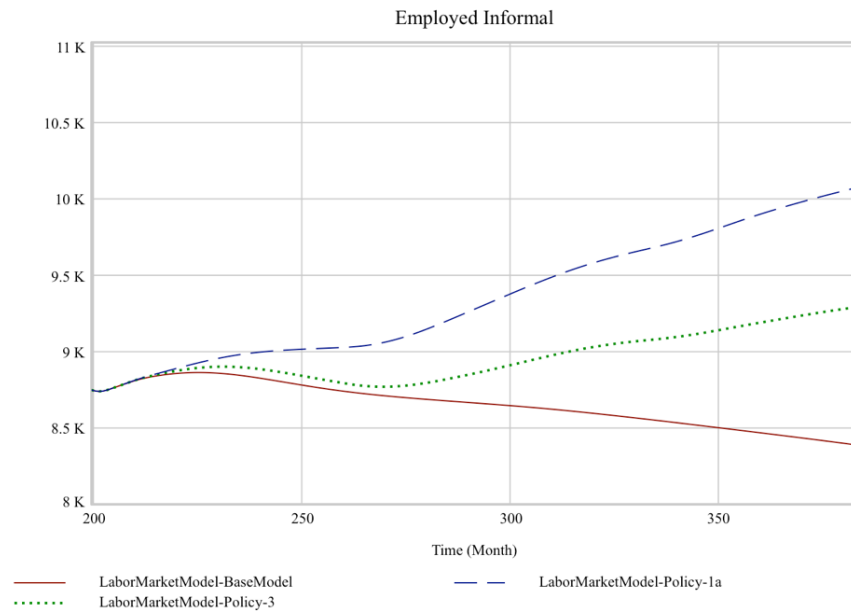


Figure 8.25. The number of informally employed people under the policy 3.

By comparing the Policy 3 to the Policy 1a, the results are analyzed as following; in the Policy 3, the formal firing rate is lower than the Policy 1a. So that the employed formal stock is more than the formal stock in the Policy 1a. As explained in some of the previous scenario and policy analyzes, there is a balancing loop between the formal employment and vacancy creation process. With the lower vacancy due to the

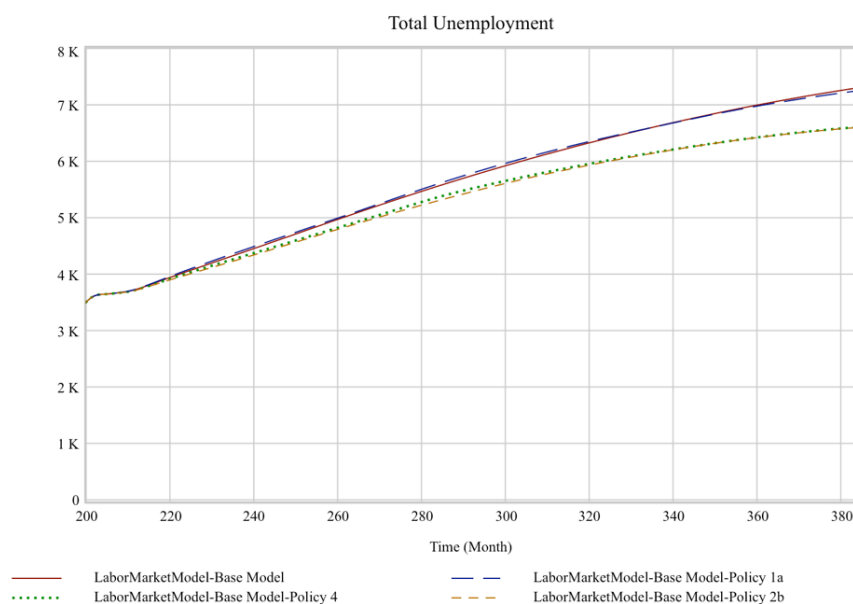


Figure 8.26. The number of unemployed people under the policy 3.

higher formal employment, the probability of finding informal job is lower than the probability in the Policy 1a. Additionally, the number of unemployed is lower in the Policy 3 due to the lower firing rate. Under these two effects (lower probability and lower unemployment), the informal hiring rates become less than the informal hiring rates in the Policy 1a. So the employed informal stock cannot grow as much as the employed informal stock in the Policy 1a (Figure 8.25). However, as seen in the graph, the dynamics of the two policies look similar, just one of them is higher than the other (for more information about these dynamics, see the policy 1 section).

As a result, it is suggested that the Policy 3 creates better results than the Policy 1a in terms of the informality and unemployment problems (Figure 8.25; Figure 8.26). By making positive improvement in the labor labor demand side (with harder labor protection legislation), the negative effect of the growing cost gap ratio is partially reduced. However, the Policy 3 results are worse than the base run results. The positive policy in the labor supply side cannot be enough to totally decrease the damage of the negative policy in the labor demand side. So it is concluded that the labor demand side is more stronger than the labor supply side to dominate the labor market dynamics.

Interestingly, it is suggested that this approach gives governments a way to decrease undesirable effects of increasing governmental incomes (via burdens). By making strict regulations on firing processes, they can protect the labor market against the informality which is inclined to rise significantly due to these burdens.

8.2.4. Policy 4 – Improvements with Moderate Changes

As a best policy, a government should make decisions in a favor of both demand and supply sides, as widely known. The positive effect of decreasing regulatory burdens on the labor market are analyzed in the Policy 1b. Additionally, the positive effect of harder labor protection legislation on the labor market are analyzed in the Policy 2b. In this policy, firstly, we want to consider these positive effects with moderate improvements. Secondly, we want to consider an effect of the retirement system.

Table 8.7. Policy 4 settings.

	Base Model	Policy 4
Avg Cost Drawback of Formality Ratio	2.9	Decreasing down to 2
Formal Firing Fraction	0.02	Decreasing down to 0.015
Retirement Fraction	Decreasing down to 0.015	Decreasing down to 0.010
Retiree Willing to Work Fraction	0.4	Decreasing down to 0.1

A bad retirement system makes people retiree early and provides them insufficient pensions. These retired people have to find jobs again. Furthermore, a government cannot efficiently profit from their labours in this system. Moreover, the system has to pay pensions to them for longer terms. The Turkish retirement system can be given as an example of a bad retirement system. According to president of the Turkish

SSI, Dr. Bagli, an average retirement age is about 52 in 2017 [60]. Besides this low retirement age, the pension payments are not satisfactory for retirees. On the other hand, providing appropriate environments for working people until they get older or lose working abilities and plus effectively profiting from their labours during these times seem a correct approach for a government. Additionally, with this approach, retired people are paid sufficiently. In order to observe a positive effect of this approach, retirement fraction and retiree willing to work fraction are assumed to be significantly decreasing as if it represents increases in retirement age and pensions. Additionally, we moderately decrease the cost gap ratio and formal firing fraction parameters in order to observe all these positive effects' jointly (Table 8.7).

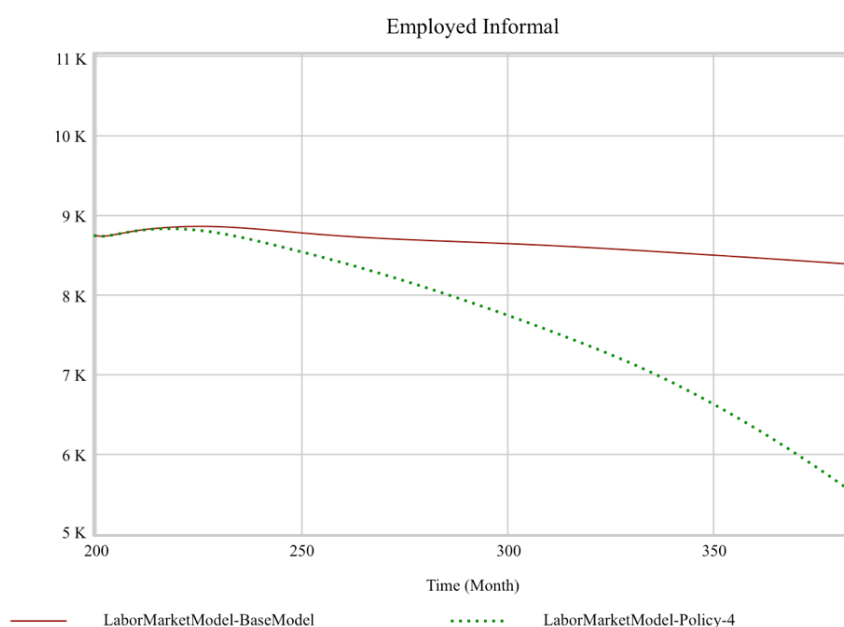


Figure 8.27. The number of informally employed people under the policy 4.

Making relatively modest and applicable changes significantly contributes to fighting the informality problem. The informal employment decreases by about 3 million people over the 15 years (Figure 8.27). The informal employment ratio decreases below 15 percent, which is the government's informality target (Figure 8.28). So it is concluded that the government target can be reached with making relatively acceptable changes in the medium-term.

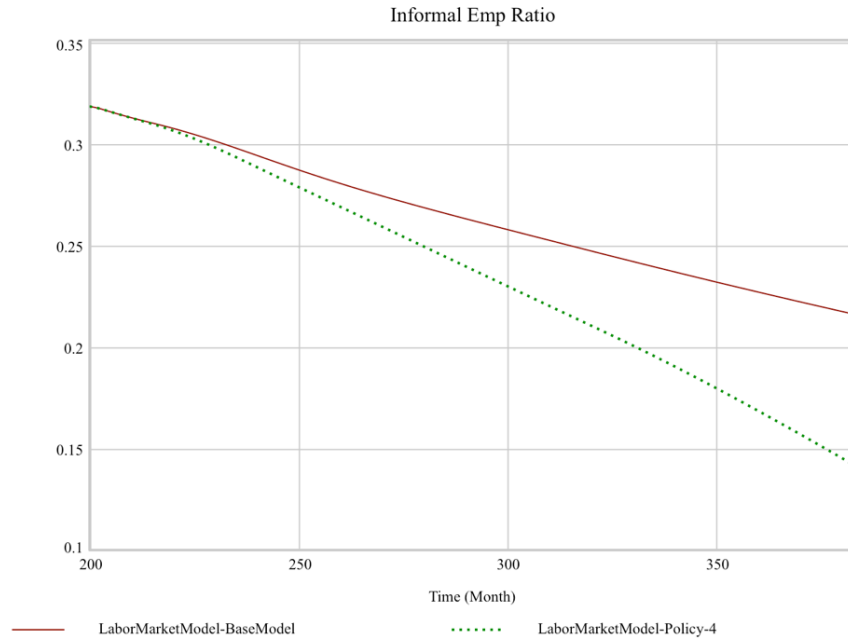


Figure 8.28. Informal employment ratio under the policy 4.

By the way, this approach seems having a contradiction with governmental interest in terms of a budget balance. To be more clear, decreasing contribution rates and taxes may affect a social security budget negatively. With decreasing governmental incomes, a pension system may not be enhanced in order to diminish retirees, willing to re-enter workforce. Maybe, this dilemma can be solved by exogenous sources for a social security budget. However, there is a debate on whether this solution will be sustainable or not. Despite these discussions, this policy seems to be the best viable plan in the short and medium-terms among other policies.

8.3. Scenario - Policy Combination 1 - Strict Labor Protection Legislation under the Economic Recession

In the policy 2, we analyzed possible effects of the regulations on firing processes and it is concluded that strict labor protection legislation on firing processes can be useful for the informality problem. In the scenario-policy combination section, we focus on this positive effect of the strict regulations on the labor market while the economy

is continuously shrinking. We try to answer the question whether the strict regulations can be a solution or not when the labor market is negatively affected by the economic recession. By assuming that the formal firing rate is decreasing with the strict labor protection legislation while the GDP growth ratio is negative over the following 15 years (Table 8.8).

Table 8.8. Scenario-policy combination 1 settings.

	Base Model	Scenario-Policy Combination 1
Formal Firing Fraction	0.02	Decreasing down to 0.01
GDP Growth Ratio	0.013	-0.01

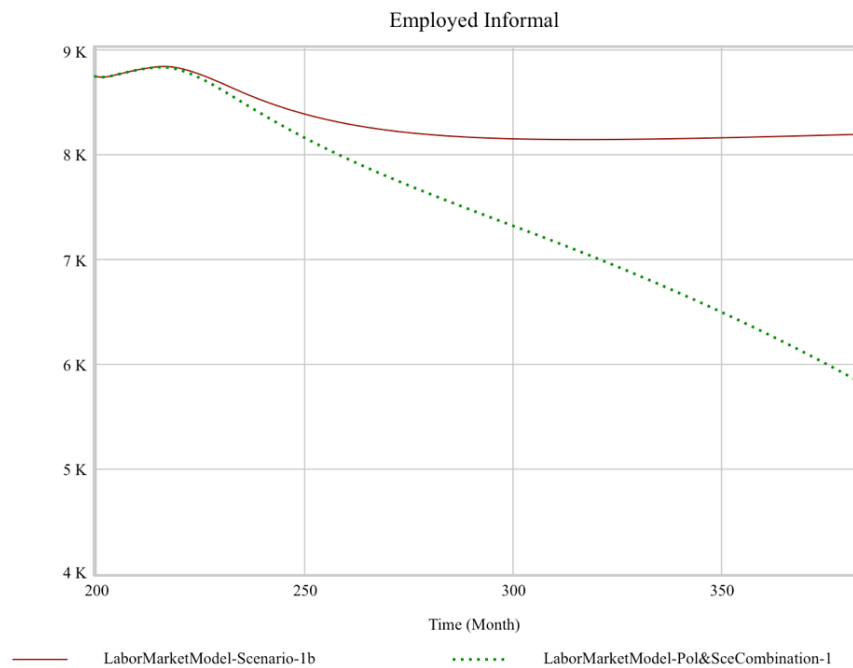


Figure 8.29. The number of informally employed people under the scenario-policy combination 1.

By comparing results to the Scenario 1b (economic recession scenario), it is concluded that the strict labor protection legislation can be useful for the informality

problem even under the economic recession conditions (Figure 8.29). As known, the required employment decreases and so the required vacancy decreases under the economic recession. Additionally, with the lower formal firing rate, the current employment becomes more and so that the discrepancy between the current employment and required employment decreases. With the more current employment and less required employment, the required vacancy becomes the lowest in the scenario and policy combination conditions. Thus, the probability of finding informal job significantly decreases. With the decreasing probability of finding informal job, the number of informally employed people decreases, naturally. So the informality problem can be decreases due to the lower firing rate under the economic recession.

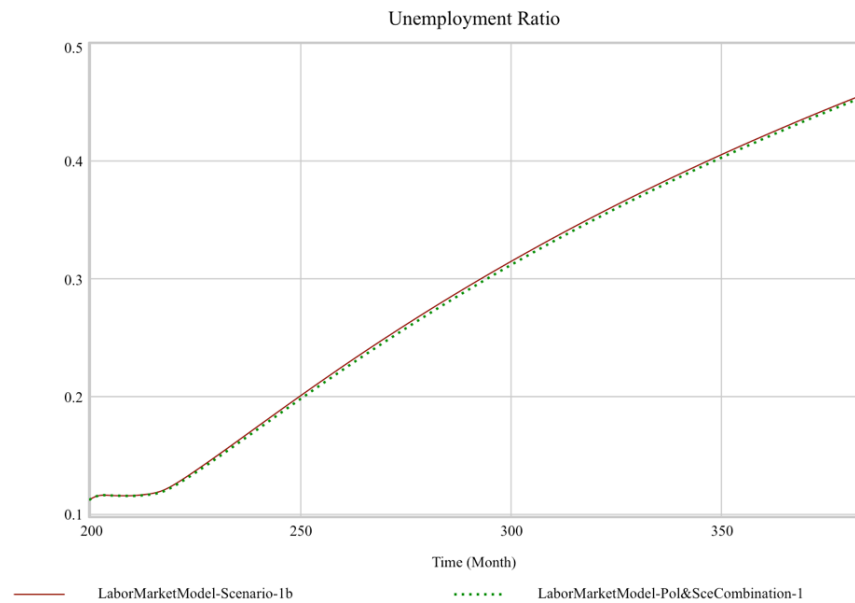


Figure 8.30. Unemployment ratio under the scenario-policy combination 1.

On the other hand, the unemployment problem happens under these conditions. While decreasing the informal employment, the unemployment increases due to the insufficient vacancy opportunities for the growing labor force participants. However, this unemployment problem mainly comes from the economic recession. The strict labor protection legislation does not significantly contribute to this problem, as seen in Figure 8.30.

As a conclusion, the harder regulations to protect labors from the firing risks can be useful for the informality problem under the economic recession. The number of informally employed people decreases by more than 2 million by applying the harder regulative policy. This policy gives a government a way to decrease the informality without making additional damages to the unemployment problem while the economy goes wrong.

8.4. Scenario - Policy Combination 2 - More Burdens under the Aggressive Economic Growth

In the Scenario 1, we analyzed possible effects of the regulative burdens (tax or contribution rates) on the labor demand side and it is concluded that an increase in regulative burdens creates bad results for solving the informality problem. In this scenario and policy combination, we focus on this negative effect of more burdens on the labor market while the economy is growing significantly. We try to analyze whether governmental incomes can increase (by increasing tax, contribution rates) without making additional damages to the informality problem, when the economy continuously grows. It is assumed that the cost drawback of formality ratio increases with higher tax/contribution or other regulative burdens while the GDP growth ratio is positive over the following 15 years.

Table 8.9. Scenario-policy combination 2 settings.

	Base Model	Scenario-Policy Combination 2
Avg Cost Drawback of Formality Ratio	2.9	Increasing up to 6
GDP Growth Ratio	0.013	0.035

This scenario-policy combination is compared to the Scenario 1a (while the economy is growing) and the base model (Figure 8.31). With the higher cost gap ratio,

the informal employment becomes more than the informal employment in the Policy 1a. The higher cost gap ratio affects the incentive for informality level positively so that the incentive level becomes more than the incentive level in the Policy 1a. As explained in the policy 1 section, at the beginning the informality benefits from the growing economy with the more informal vacancy creations. Similarly, the informal employment more benefits from this situation with the higher incentive level in this scenario-policy combination. Then, the decrease in the unemployed formal and informal stock (which is the unemployed people source for the informal employment) since the higher probability of finding formal job affects the employed informal stock negatively. With the increasing probability of finding formal job (due to the economic growth), the inflow of the unemployed formal and informal stock decreases and plus the outflow of this stock increases. With the decreasing unemployed people source, the informality starts to decrease (for more information, see the scenario 1 section). Unlike the informal employment dynamics in the policy 1a, the informal employment makes a reverse s-shape behavior in this scenario and policy combination. As mentioned above, with the decreasing unemployed formal and informal stock, an exponential collapse is seen in the informal employment dynamics. However, there are balancing loops firstly between the unemployed formal and informal stock and its growing outflow and secondly between the probability effect and its inflow. So the decreasing rate in the unemployed formal and informal stock decreases. This affects the informality positively. Additionally, the incentive for informality level goes up with the growing cost gap ratio. These two positive effects make decreases slow in the informal hiring rates. Then, the decrease rate in the informal employment dynamics is decreasing over time. Thus, the informal employment behavior changes and makes an exponential decay at the second period of the reverse s-shape curve.

Meanwhile, the unemployment ratio, in this scenario-policy combination, becomes more than the unemployment ratio under the Scenario 1a, especially after 2025 (Figure 8.32). As mentioned above, the incentive for informality levels increases with some delay due to the positive effect of the higher cost gap ratio. With the growing incentive level, the formal vacancy cannot grow as much as the growth rate in the Policy 1a. The formal vacancy dynamics make a goal-seeking behavior with the increasing incentive

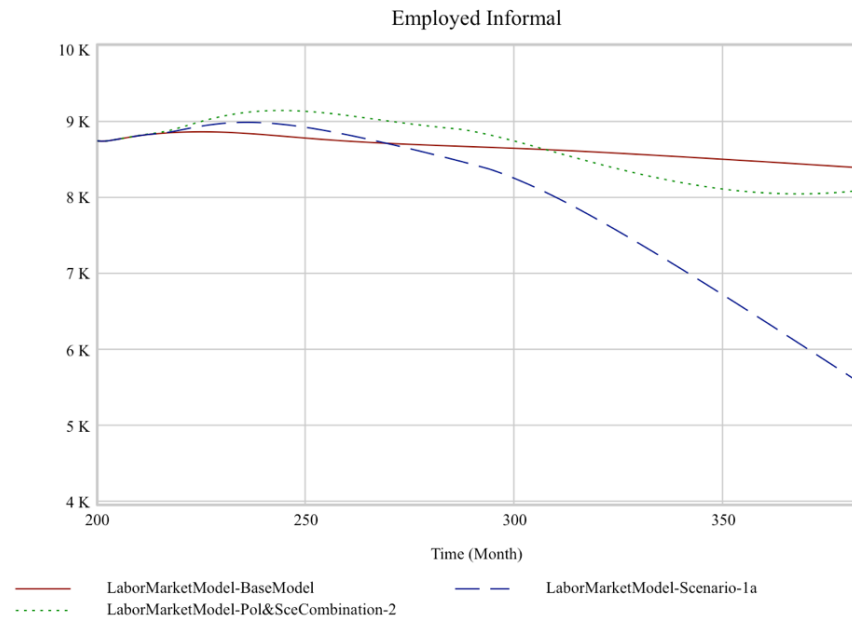


Figure 8.31. The number of informally employed people under the policy-scenario combination 2.

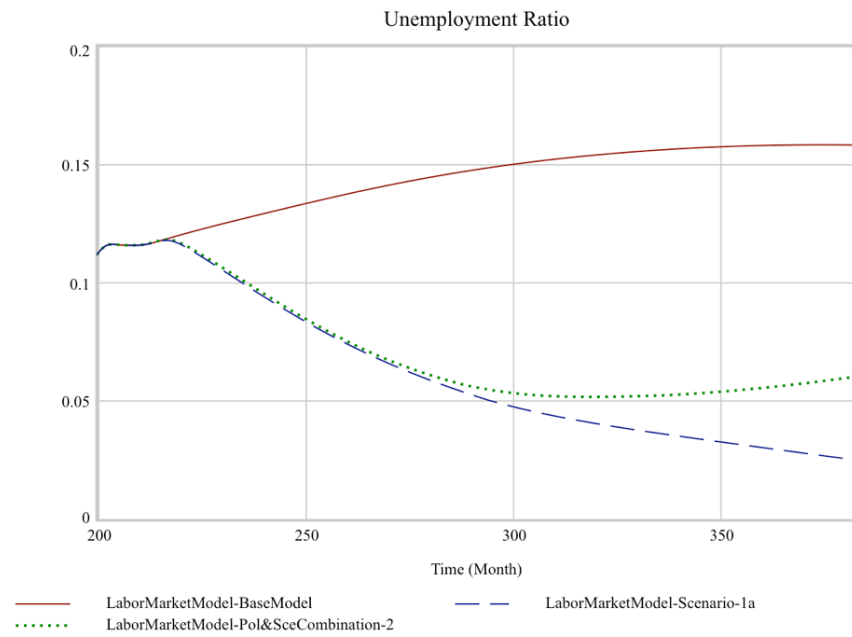


Figure 8.32. Unemployment ratio under the policy-scenario combination 2.

level so that the probability of finding formal job makes similar behavior. Thus, the formal hiring rates cannot make an exponential growth. In this behavior, the balancing loops, as mentioned above, play roles. With these formal hiring rates, the unemployed people cannot be decreased as much as decline rates in the Policy 1a.

As a conclusion, governmental income rates can be increased via more burdens without increasing the informality up to the base run level. However, the negative effect of higher regulative burdens is still active so that the informality problem cannot be decreased significantly under the aggressive economic growth.

8.5. Comparison of All Policies

In this section, we compare the informal employment results under the all scenario and policy conditions. Firstly, it is concluded that the Policy 1 which is about the labor cost gap ratio between the formal and informal sectors causes significant changes in the number of informally employed people (Figure 8.33). With the decreasing cost gap ratio (Policy 1b), the number of informally employed people can be decreased below 3 million which is the lowest level in the model. Additionally, the informal employment ratio can be decreased down to 7 percent (Figure 8.34). On the other hand, the number of informally employed people reaches to 10 million, the highest level, while this cost gap ratio is growing (due to higher tax/contribution rates and entry costs or other regulative burdens etc.). Additionally, the number of informally employed people also reaches 10 million with easy labor protection legislation on formal firing processes (Policy 2a).

Furthermore, making improvements in both labor demand and supply sectors with moderate changes can be the best solution for the informality problem. With relatively moderate changes, the informal employment ratio can be decreased below 15 percent over the 15 years. It is the best solution since the other policies (Policy 1b and Policy 2b) which also decrease the ratio below 15 percent, require radical changes for example, making labor costs of the formal and informal sector equal.

The governmental target, 15 percent, will be reached by applying the Policy 1b, Policy 2b and Policy 4. Additionally, the target can be reached with the current (real) policy under the Scenario 1a, where the economy aggressively grows over the following 15 years.

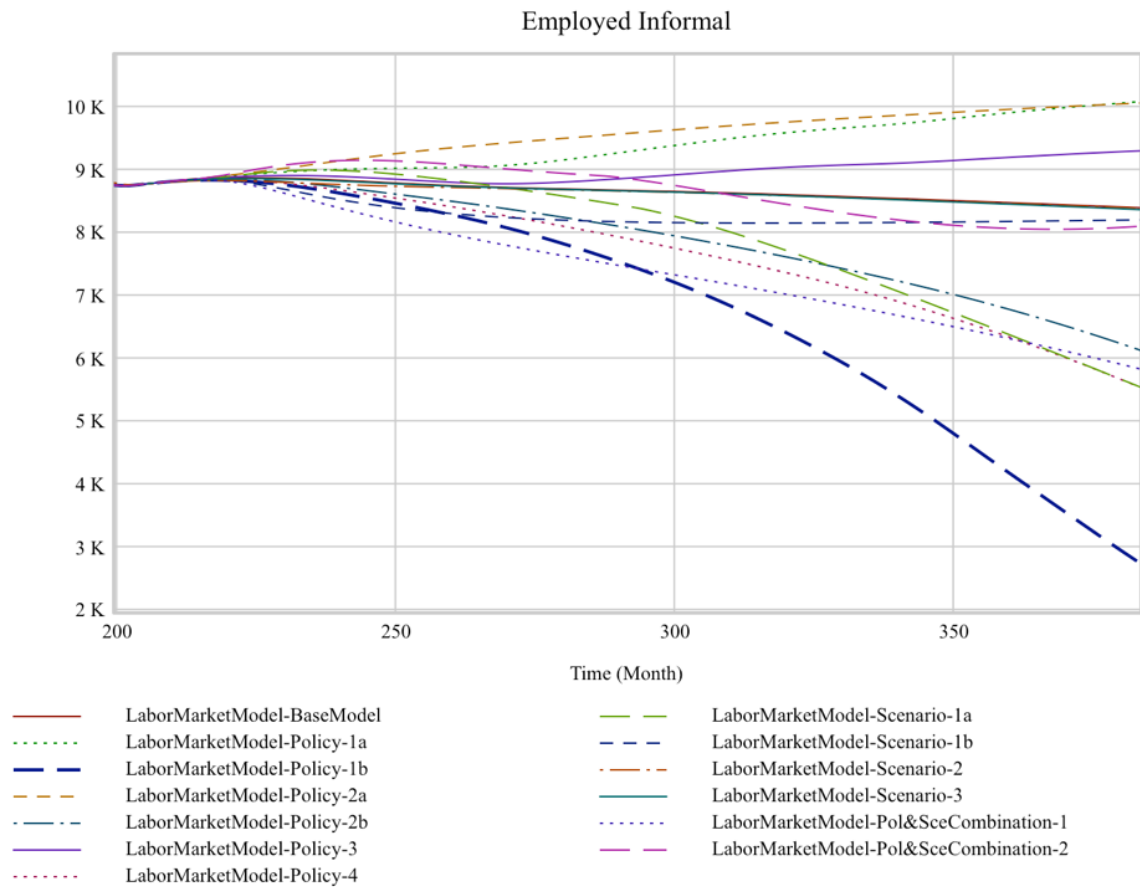


Figure 8.33. The number of informally employed people under all scenario and policy conditions.

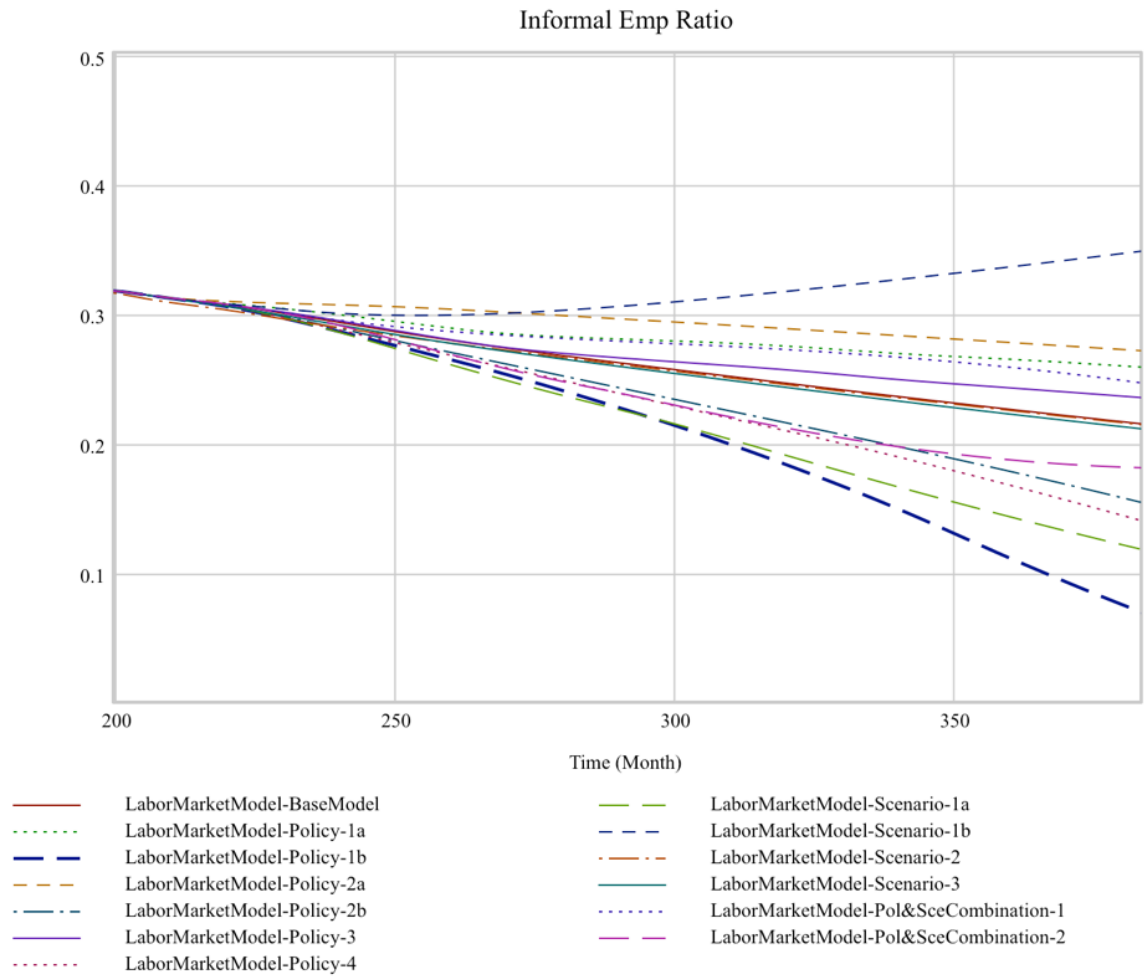


Figure 8.34. Informal employment ratios under all scenario and policy conditions.

9. CONCLUSION

Informal employment problem exists with varying degrees around the world. Especially in developing countries, the extent of the problem is worrisome. Similarly, for the Turkish labor market, the problem has not been solved even though improvements have taken place recently.

Informal employment is a part of the total labor market. In order to clearly understand the problem, dynamics of the whole market should be considered unlike the studies conducted in this field. The non-labor force state and many transitions between the labor market states such as participation, retirement and distinct formal/informal hiring and firing rates are not considered in the literature. Additionally, these market dynamics should be taken into consideration over time. Moreover, while building a model, making assumptions about dynamics (e.g. being at an equilibrium state or eventually accessing to this state etc.) cause deficiencies in capturing real behaviors. Therefore, in order to successfully analyze the informality problem without these deficiencies, we used the System Dynamics method while seeking answers to the following research questions; firstly, what could be the driving mechanisms of the informal employment problem in Turkey? Then, could the official target about reducing the informal employment rate down to 15 percent be achieved? Finally, what could be alternative policies to decrease informal employment rate in Turkey?

The main purpose of the study is to capture the Turkish labor market dynamics over time. By doing this, the informality problem can be clearly analyzed. After identifying main causes and related relationships about the problem, we construct a model by using the SD methodology. Then, this constructed model is validated with a series of structural and behavioral credibility tests. We use the labor force statistic data (TurkStat) while calibrating the model in the simulation period between 2000 and 2017. As a conclusion of these tests, the model satisfactorily represents the historical labor market patterns.

In the base run, it is assumed that the economy grows by 5.3 percent per year and the poverty ratio decreases from 20 percent to 16 percent over the following 15 years from 2017 to 2032. Additionally, the average cost gap ratio between the formal and informal sectors is assumed to be constant since there has not been significant changes in this cost gap from 2006 to 2017. Moreover, labor force participations and retirement rates are assumed to be consistent with their original trends, seen in the model. In these base conditions, it is observed that the informal employment is decreasing slightly. The amount of informally employed people decreases by about 5 hundred thousand over 15 years. Nevertheless, the informal employment ratio continuously falls to 21 percent under these conditions since the number of formally employed people is increasing while the number of informally employed people is decreasing. Despite the decrease in the informality ratio, it is concluded that the informality cannot be totally solved under the rather possible conditions in the medium-term. Our observations contradict the governmental target to reduce the informal employment ratio to 15 percent. Besides the informality result, the unemployment ratio reaches 16 percent in the labor market due to the growing participation assumption. Under the base run conditions, the labor market faces significant an unemployment problem.

Throughout the scenario analysis part, firstly in the scenario where the economy consistently and aggressively grows by 15 percent per year, it is observed that the informal employment ratio falls below 15 percent in 2032. So it is concluded that a strong economic growth seems to be useful to reach the governmental target under the given base conditions.

Secondly, in the scenario where the formal labor market is more efficient with higher formal matching efficiency, it is concluded that there is no significant improvement in the informality problem. Since the positive effect of the higher formal matching efficiency is decreased by the balancing loop between the employment and vacancy creation process, the informality is not affected significantly.

Finally, we consider the dramatic Syrian refugee fact as one of the scenario cases starting from 2012 to 2018. Syrian refugees are assumed to be informal sources and

they enter the informal unemployment pool with the specific labor fraction. It is observed that the informality increases during the immigration waves. Moreover, the unemployment ratio is increasing due to an increase in the regular unemployed people while Syrians are filling up the informal vacancies.

Throughout the policy analysis stage, at first we analyze the policies and their possible effects on the labor demand side. For that purpose, firstly cost gap ratio between formal and informal sectors is assumed to vary over time. The results show that the difference between the number of informally employed people of increasing and decreasing cost gap policies reaches to 7 million at the end of the 15 years. The informal employment ratio decreases down to 7 percent while the cost gap ratio is gradually decreasing until a cost of employed formally and informally being equal.

Moreover, policies which target the labor supply side are examined. It is suggested that labor protection legislation on the formal firing process plays a significant role in the labor market. With easy labor protection legislation, it is assumed that the formal firing rate increases. However, hiring rates cannot keep pace with this faster firing rate in the market. So this results in an increase in the number of unemployed people. More unemployed people mean more potential unemployed people for the informality. So with the increasing informality source, the number of informally employed people goes up. On the other hand, with the strict labor protection, the informal employment is decreasing while the formal employment is increasing. Thus, the informal employment ratio decreases down to 15 percent. So it is suggested that protecting formal labors against a firing risk seems to be an alternative solution to solve the informality problem for the labor market.

Additionally, policies which directly manipulate both labor supply and demand sides are analyzed by assuming that an authority increases burdens (via tax / contribution rates etc.) on the labor demand side while it protects the labor supply side interests by making harder legislation. The results show that the informal employment is higher than the base run's informality. The positive effects of increasing burdens on the informality are stronger than the negative effects of harder legislation on the

informality. Thus, it is concluded that the labor demand side dominates the informal employment dynamics under these policy conditions. On the other hand, this approach gives governments a way to decrease undesirable effects of increasing governmental incomes (due to increasing contribution/tax rates). By making strict regulations on firing processes, they can protect the labor market against the informality which is inclined to rise significantly due to these growing burdens.

Furthermore, the policy which positively focus on both labor supply and demand sides and make improvements with relatively moderate changes can be suggested as the best policy. By making cost gap ratio as gradually decreasing until the acceptable level, and making strict labor protection legislation, and finally making improvements in the retirement system with higher retirement age and pensions, the informality problem can be reduced down to 15 percent over 15 years. So the governmental target can be reached by applying this policy.

In the model, we have to make assumptions on certain variables due to lack of empirical data about the Turkish labor market. With real data on the labor demand side variables such as on vacancy, matching efficiency, job creation ability or on the labor supply side variables such as on firing rates, informality accepting tendency etc., the labor market and informality analyses give more accurate results. Furthermore, the economic growth and poverty ratio is considered as exogenous variables and independent from the changes in employment whereas the economy, poverty and employment have intense relationships with each other in the real market. As future research, these variables may be turn into endogenous variables with a good extension of the model. Moreover, we do not consider the under-declaration part of the informality problem. Even though analyzing this part seems to be very hard, considering it makes the picture very clear. Finally, analyzing economic dynamics is quite hard since there are potential factors which may change a story in a specific time period such as subsidies, regulations, minimum wages as in public policy or inflation rates, interest rates and even currency values as in monetary policy. Additionally, competitive global markets can be counted as an external factor on the dynamics. In addition to economic factors, socio-cultural factors such as informality perception, religion, trust in government may

have an effect on the problem. For the Turkish case, it will be useful to elaborately focus on such possible economic and social factors in order to explain the problem more accurately.

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APPENDIX A: MODEL EQUATIONS

All equations in the model are given below;

Accepting Fr Yealy= MIN(Normal IAFr*Effect of Finding Formal Job Prob*
Effect of JS Poverty,1)

Adjustment for Employment= Required Employment-Total Employment +(To-
tal Outflows from The Employment Status *Adjustment Time for Total Outflows)

Adjustment for Vacancy= Required Vacancy -Formal Vacancy-Informal Vacancy

Adjustment Time for Job Creation=1

Adjustment Time for Total Outflows=1

Adjustment Time for Vacancy Cancellation=1

Aging Fraction = WITH LOOKUP (Time,([(0,0)-(385,0.01)],(0,0.002583)
, (204,0.002583)))

Aging Rate from EI= Employed Informal*Aging Fraction

Aging Rate from UF= Aging Fraction*Unemployed Formal

Aging Rate from UFI= Aging Fraction*Unemployed Formal and Informal

Change in Prob= Probability of Finding Formal Job/Normal FFJP

Changes in Required Employment= GDP Growth Rate*Required Employment
*GDP Adjustment Fraction

Cost Drawback of Formality Ratio = WITH LOOKUP (Time,[(0,2)-(408,4)],
 (0,3.85),(24,3.785) ,(36,3.677),(48,3.377),(60,3.214),(72,3.094) ,(84,3.124),(96,2.879),
 (108,3.1),(120,3.092) ,(132,2.95),(144,2.903) ,(156,2.908),(168,3.011),(180,2.991) ,
 (192,2.992),(204,2.9),(384,2.9)))

Death Rate from EI= Death Fraction*Employed Informal

Death Fraction = WITH LOOKUP (Time,[(0,0)-(384,0.001)],(0,0.001005)
 ,(204,0.00075),(384,0.00075)))

Death Rate form UFI= Death Fraction*Unemployed Formal and Informal

Death Rate from EF= Death Fraction*Employed Formal

Death Rate from NLF= Death Fraction*Non Labor Force

Death Rate from UF= Death Fraction*Unemployed Formal

Death Rate from UI= Death Fraction*Unemployed Informal

Delayed Enforcement Effect= SMOOTH3
 (Effect of Government Enforcement, 6)

Discrepancy= Required Employment-Total Employment

Effect of Average Cost Drawback of Formality Ratio = WITH LOOKUP (Cost
 Drawback of Formality Ratio/Initial Cost Drawback of Formality Ratio
 ,([(0.25,0)-(2.1,3)],(0.25,0.0142181) ,(0.321283,0.241706),(0.413951,0.454976)
 ,(0.513747,0.625592),(0.600407,0.753555),(0.687067,0.838863),(0.754888,0.9)
 ,(0.826477,0.938389) ,(0.909369,0.966825),(1,1),(1.13391,1.137) ,(1.22301,1.25)
 ,(1.32281,1.36493),(1.44756,1.56398) ,(1.55804,1.76303),(1.67566,1.94787)
 , (1.75407,2.1327),(1.82536,2.33175),(1.88595,2.45972) ,(1.93941,2.55924),

(1.99644,2.61611),(2.05102,2.63033) ,(2.1,2.63033)))

Effect of Finding Formal Job Prob = WITH LOOKUP (Probability of Finding Formal Job/Normal FFJP, ([(0,0)-(12.5,3)],(0.001,1.75),(0.0625,1.55) ,(0.125,1.4) ,(0.25,1.3),(1,1),(6,0.5) ,(12.5,0.1)))

Effect of Government Enforcement = WITH LOOKUP(Employed Informal/ Normal Informal Emp,([(0,0)-(2,5)],(0.00356415,4.90521) ,(0.192464,4.52607) ,(0.384929,4.09953) ,(0.559572,3.6019),(0.716395,2.9) ,(0.841141,2.25), (0.923116,1.61137),(1,1) ,(1.05499,0.758294),(1.11914,0.545024) ,(1.19043,0.379147), (1.27597,0.28436) ,(1.37576,0.21327),(1.4664,0.165877) ,(1.60081,0.118484), (1.7556,0.0710902) ,(1.88187,0.0947866),(1.98778,0.0947866)))

Effect of JS Poverty = WITH LOOKUP (Job Seeker Poverty Ratio/Initial Job Seeker Poverty Ratio,([(0,0)-(3.5,4)],(0.00610998,0.0853081) ,(0.158859,0.156398) ,(0.366599,0.312796) ,(0.586558,0.52),(0.805499,0.77),(1,1) ,(1.20367,1.33649) ,(1.42566,1.74882) ,(1.58859,2.03318),(1.78921,2.27488) ,(1.98574,2.47393), (2.21487,2.6872) ,(2.48676,2.8436),(2.71283,2.95735) ,(2.97251,3.03318), (3.25051,3.07109) ,(3.48574,3.07109)))

Effect of Peer Pressure = WITH LOOKUP (Informal Employment Rate / Normal Informal Emp Rate, ([(0,0)-(2,5)],(0.01,0.01),(0.25,0.1),(0.7,0.4) ,(1,1) ,(1.3,3), (2,5)))

Employed Formal= INTEG (Formal Hiring Rate from UF +Formal Hiring Rate from UFI -Death Rate from EF -Formal Firing Rate to UF-Retirement Rate, 20128-10305)

Employed Informal= INTEG (Informal Hiring Rate from UFI +Informal Hiring Rate from UI-Death Rate from EI -Informal Firing Rate to UFI -Informal Firing Rate to UI-Aging Rate from EI, 10305)

FINAL TIME = 384 Units: Month The final time for the simulation.

Firing Adjustment= MAX(0,-Adjustment for Employment)

Formal Firing Fr=0.02

Formal Firing Rate to UF= (Employed Formal*Formal Firing Fr)+(Firing Adjustment/3)

Formal Hiring Rate from UF= Unemployed Formal*Probability of Finding Formal Job

Formal Hiring Rate from UFI= Probability of Finding Formal Job*Unemployed Formal and Informal

Formal Job Cancellation Rate= Required Cancellation Rate/Adjustment Time for Vacancy Cancellation*Incentive for Informality

Formal Job Closure Rate= Total Formal Hiring Rate

Formal Job Creation Rate= MAX(0,Adjustment for Vacancy/Adjustment Time for Job Creation*(1-Incentive for Informality))

Formal Market Tightness= MAX(Formal Vacancy/Total Unemployment, 0.0001)

Formal Vacancy= INTEG (Formal Job Creation Rate-Formal Job Cancellation Rate-Formal Job Closure Rate,100)

GDP Adjustment Fraction=0.4

GDP Growth Rate = WITH LOOKUP (Time,([(0,-0.02)-(384,0.07)],
(0,0.0034),(3,0.0164) ,(6,0.008),(9,-0.0011),(12,-0.015),(15,-0.0175) ,(18,0.008),

(21,-0.012),(24,0.018),(27,0.0127) ,(30,0.0048),(33,0.002),(36,0.0048),(39,0.0014),
 (42,0.01),(45,0.007),(48,0.013),(51,0.007) ,(54,0.0014),(57,0.004),(60,0.018),
 (63,0.0014),(66,0.0035),(69,0.0112),(72,0.007),(75,0.0093) ,(78,-0.006),(81,0.01),
 (84,0.0116),(87,-0.005) ,(90,-0.00),(93,0.017),(96,0.013),(99,-0.017) ,(102,-0.01),
 (105,-0.003),(108,-0.013),(111,0.007) ,(114,0.005),(117,0.007),(120,0.006),
 (123,0.009),(126,0.008),(129,0.012),(132,0.009),(135,0.007) ,(138,0.009),(141,0.004),
 (144,-0.002) ,(147,0.006),(150,0.006),(153,0.0045),(156,0.012) ,(159,0.009),
 (162,0.0045),(165,0.0025),(168,0.009),(171,-0.006),(174,0.008),
 (177,0.0048) ,(180,0.0065),(183,0.005),(186,0.0045),(189,0.0035),(192,0.002),
 (195,0.004),(198,-0.0086),(201,0.016) ,(204,0.006),(207,0.0075),(210,0.004),
 (213,0.00432)))

INormal= Informal Employment Rate/Normal Informal Emp Rate

INormal Rate= Employed Informal/Normal Informal Employment

Incentive for Informality= MIN(Initial Incentive*Delayed Enforcement Effect
 Effect of Peer Pressure*Effect of Average Cost Drawback of Formality Ratio,1)

Informal Emp Ratio= Employed Informal/Total Employment

Informal Employment Rate= Employed Informal/(Employed Formal+
 Employed Informal)

Informal Firing Fraction=0.02

Informal Firing Rate to UFI= (Employed Informal*Informal Firing Fraction*
 0.75) +(Firing Adjustment/3)

Informal Firing Rate to UI= (Informal Firing Fraction*Employed Informal*
 0.25) +(Firing Adjustment/3)

Informal Hiring Rate from UFI= Probability of Finding Informal Job*
Unemployed Formal and Informal

Informal Hiring Rate from UI= Probability of Finding Informal Job*
Unemployed Informal

Informal Job Cancellation Rate= Required Cancellation Rate/
Adjustment Time for Vacancy Cancellation*(1-Incentive for Informality)

Informal Job Closure Rate= Total Informal Hiring Rates

Informal Job Creation Rate= MAX(0,Adjustment for Vacancy /
Adjustment Time for Job Creation*Incentive for Informality)

Informal Market Tightness= MAX(Informal Vacany/Total Potentially Informal
Unemployment,0.0001)

Informal Matching Efficiency=0.3

Informal Vacany= INTEG (Informal Job Creation Rate-
Informal Job Cancellation Rate-Informal Job Closure Rate,500)

Informal/Formal= Employed Informal/Employed Formal

Informality Accepting Rate= Monthly Accepting Fr*Unemployed Formal

Initial Cost Drawback of Formality Ratio=3.85

Initial Incentive=0.45

Initial Job Seeker Poverty Ratio= 0.3

INITIAL TIME = 0 Units: Month The initial time for the simulation.

Job Seeker Poverty Ratio = WITH LOOKUP (Time,([(0,0)-(384,0.35)],(0,0.3),
(24,0.27) ,(36,0.285),(48,0.275),(60,0.28),(72,0.254),(84,0.234) ,(96,0.241),(108,0.243),
(120,0.238),(132,0.229) ,(144,0.227),(156,0.224),(168,0.218),(180,0.219),(192,0.212),
(384,0.166)))

Labor Force= Employed Formal+Employed Informal+Total Unemployment

Labor Refugee Fraction=0

Labor Refugee Immigration= Syrian Refugee Immigration*
Labor Refugee Fraction

Matching Efficiency=0.3

Matching Elasticity=0.5

Maturation Rate = WITH LOOKUP(Time,([(0,0)-(408,250)],(0,117),
(47.9,135) ,(48,170),(59,145),(60,115),(120,115),(156,140) ,(167,140),
(168,140),(205,130),(384,120)))

Month Adj=12

Monthly Accepting Fr= Accepting Fr Yealy/12

Non Labor Force= INTEG (Maturation Rate+Aging Rate from EI +
Aging Rate from UFI+Aging Rate from UF +Retirement Rate-
Death Rate from NLF-Participation Rate-Retiree Willing to Work Rate,
21574-300)

Normal FFJP= 0.0802932

Normal IAFr= 0.75

Normal Informal Emp= 10305

Normal Informal Emp Rate= 0.511973

Participation Fraction = WITH LOOKUP (Time,([(0,0)-(384,0.01)],
(0,0.003),(205,0.0057) ,(384,0.0065)))

Participation Rate= Non Labor Force*Participation Fraction

Participation Ratio= (Total Pop NonIns-Total Non Labor Force)/
Total Pop NonIns

Probability of Finding Formal Job= MIN((Formal Market Tightness
Matching Elasticity) *Matching Efficiency,1)

Probability of Finding Informal Job= MIN((Informal Market Tightness
Matching Elasticity) *Informal Matching Efficiency,1)

Ref Death = WITH LOOKUP (Time,([(0,400)-(210,600)],(0,520),(84,503)
,(96,505),(108,503),(120,490),(132,501),(144,503) ,(156,494),(168,516),(180,530)
,(192,547),(204,547)))

Ref Death Month= Ref Death/Month Adj

Ref Formal Emp = WITH LOOKUP (Time,([(0,0)-(85,20000)],(0,9822),
(12,9426),(24,9583),(36,9601),(48,9678),(60,10401),(72,10830),(84,11315),(96,11975),
(108,11950),(120,12822),(132,13972) ,(144,15136),(156,16143),(168,16864),
(180,17684),(192,18094),(204,18597)))

Ref Informal Emp = WITH LOOKUP (Time,([(0,0)-(85,11000)],(0,10305),

(12,10690) ,(24,10440),(36,10298),(48,9732),(60,9666),(72,9592),(84,9423),
 (96,9219),(108,9328),(120,9772),(136,10140),(148,9685),(160,9379),(172,9068),
 (184,8936) ,(196,9110),(204,9585)))

Ref Informal Emp Ratio = WITH LOOKUP (Time,([(0,0)-(204,10)],
 (0,0.512),(12,0.5314) ,(24,0.5214),(36,0.5175),(48,0.5014),(60,0.4817) ,(72,0.4697),
 (84,0.4544),(96,0.435),(108,0.4384) ,(120,0.4325),(132,0.4205),(144,0.3902),
 (156,0.3675),(168,0.3497),(180,0.3357),(192,0.3349),(204,0.34)))

Ref Non Labor Force = WITH LOOKUP (Time,([(0,20000)-(85,30000)],
 (0,21574),(12,22119) ,(24,22716),(36,23783),(48,25239),(60,25904) ,
 (72,26423),(84,26879),(96,26967),(108,26938) ,(120,26901),(132,26867),
 (144,27385), (156,27337),(168,28200),(180,28176),(192,28185) ,(204,28186)))

Ref Participation Ratio = WITH LOOKUP (Time,([(0,0.45)-(210,0.55)],
 (0,0.499),(12,0.498) ,(24,0.496),(36,0.483),(48,0.463) ,(60,0.464),(72,0.463),
 (84,0.462),(96,0.469) ,(108,0.479),(120,0.488),(132,0.499) ,(144,0.5),(156,0.508),
 (168,0.505),(180,0.513) ,(192,0.52),(204,0.529)))

Ref Pop Month= Ref Pop NonIns/Month Adj

Ref Pop NonIns = WITH LOOKUP (Time,([(0,0)-(108,60000)],(0,43098),
 (12,44075) ,(24,45053),(36,46031),(48,47009),(60,48358) ,(72,49174),(84,49994),
 (96,50772),(108,51686) ,(120,5541),(132,53593),(144,54724),(156,55608),
 (168,56986),(180,57854),(192,58720),(204,59894)))

Ref Retirement Rate = WITH LOOKUP (Time,([(0,25)-(210,50)],(0,40),
 (84,26.4),(96,34.8) ,(108,35.6),(120,29.4),(132,39.9),(144,30.5) ,(156,27.8),
 (168,30.3),(180,41.5),(192,35.8) ,(204,35.8)))

Ref Unemployment = WITH LOOKUP (Time,([(0,0)-(85,4000)],(0,1396),
 (12,1838),(24,2310),(36,2346),(48,2358),(60,2388),(72,2328) ,(84,2377),(96,2611),

(108,3471),(120,3046) ,(132,2615),(144,2518),(156,2747) ,(168,2849),(180,3056),
(192,3328),(204,3489)))

Required Cancellation Rate= MAX(0,-Adjustment for Vacancy)

Required Employment= INTEG (Changes in Required Employment,
20428)

Required Vacancy= MAX(0,Adjustment for Employment)

Retiree Willing to Work Fraction= 0.4

Retiree Willing to Work Rate= Retirement Rate*
Retiree Willing to Work Fraction

Retirement Fraction = WITH LOOKUP (Time,([(0,0)-(385,0.01)],
(0,0.004) ,(204,0.002),(384,0.0015)))

Retirement Rate= Employed Formal*Retirement Fraction*0.7

Syrian Refugee Immigration = WITH LOOKUP (Time,([(0,0)-(384,120)],
(0,0),(143,0) ,(144,10),(155,10),(156,35),(167,35),(168,91),(179,91),(180,85),
(191,85),(192,18),(204,18),(205,48),(216,48),(217,48),(218,0),(384,0)))

Syrian Refugee Population in Turkey= INTEG (Syrian Refugee Immigration,
9)

Total Death= Death Rate from NLF+Death Rate from EF+
Death Rate from UF+Death Rate from UI+Death Rate form UFI+
Death Rate from EI

Total Employment= Employed Formal+Employed Informal

Total Formal Hiring Rate= Formal Hiring Rate from UF+
Formal Hiring Rate from UFI

Total Informal Hiring Rates= Informal Hiring Rate from UFI+
Informal Hiring Rate from UI

Total Non Labor Force= Non Labor Force+Unemployed Informal

Total Outflows from The Employment Status= Aging Rate from EI+
Death Rate from EI+Death Rate from EF+Formal Firing Rate to UF+
Informal Firing Rate to UFI+Informal Firing Rate to UI+Retirement Rate

Total Pop NonIns= Employed Formal+Employed Informal+
Non Labor Force+Unemployed Formal+Unemployed Formal and Informal+
Unemployed Informal

Total Potentially Informal Unemployment= Unemployed Formal and Informal
+Unemployed Informal

Total Unemployment= Unemployed Formal+Unemployed Formal and Informal

Unemployed Formal= INTEG(Formal Firing Rate to UF+
Participation Rate-Death Rate from UF-Formal Hiring Rate from UF
-Informality Accepting Rate -Aging Rate from UF,1396-650)

Unemployed Formal and Informal= INTEG(Informal Firing Rate to UFI+
Informality Accepting Rate-Death Rate form UFI -
Formal Hiring Rate from UFI -Informal Hiring Rate from UFI-
Aging Rate from UFI ,650)

Unemployed Informal= INTEG (Labor Refugee Immigration+Informal Firing
Rate to UI+Retiree Willing to Work Rate -Death Rate from UI-

Informal Hiring Rate from UI,300)

Unemployment Ratio= Total Unemployment/(Total Unemployment+
Total Employment)

APPENDIX B: SIMULATION MODEL

The stock-flow diagram of the labor demand sector is given below (Figure B.1);

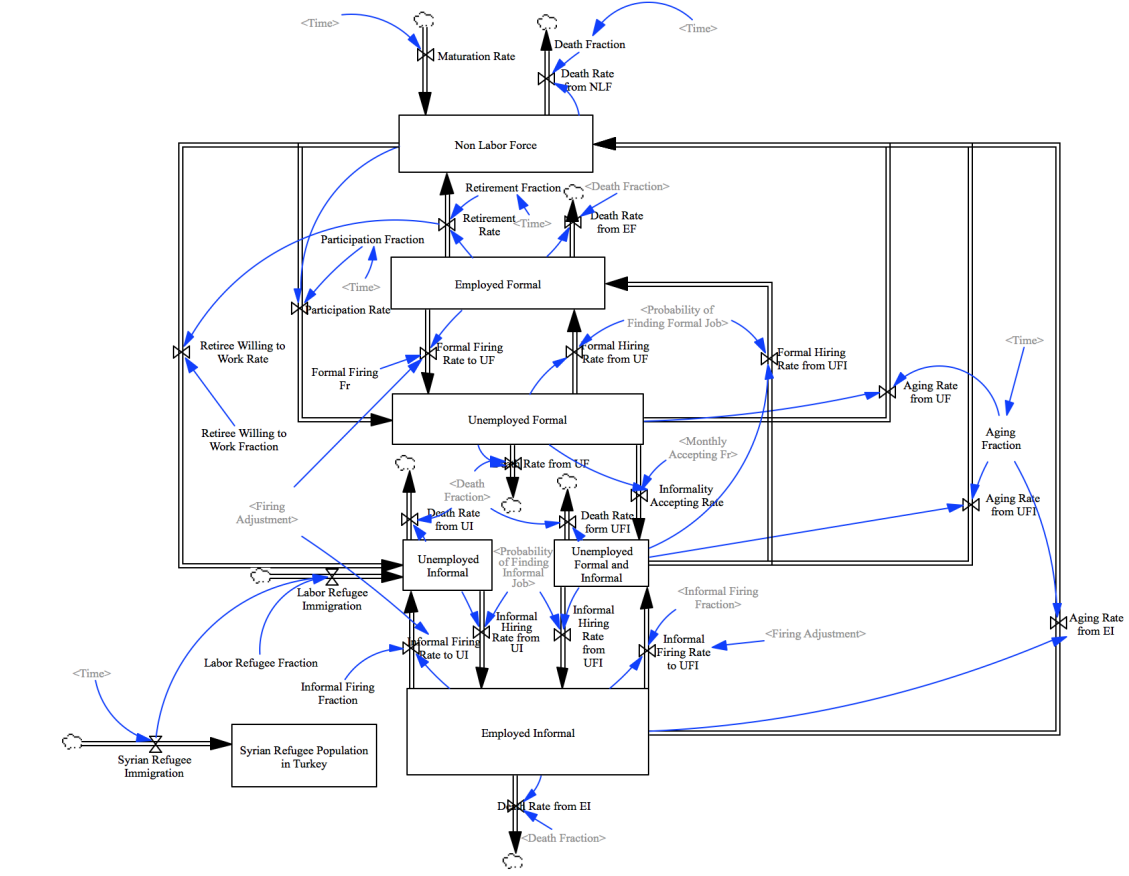


Figure B.1. Stock-flow diagram of the labor demand sector.

The stock-flow diagram of the labor supply sector is given below (Figure B.2);

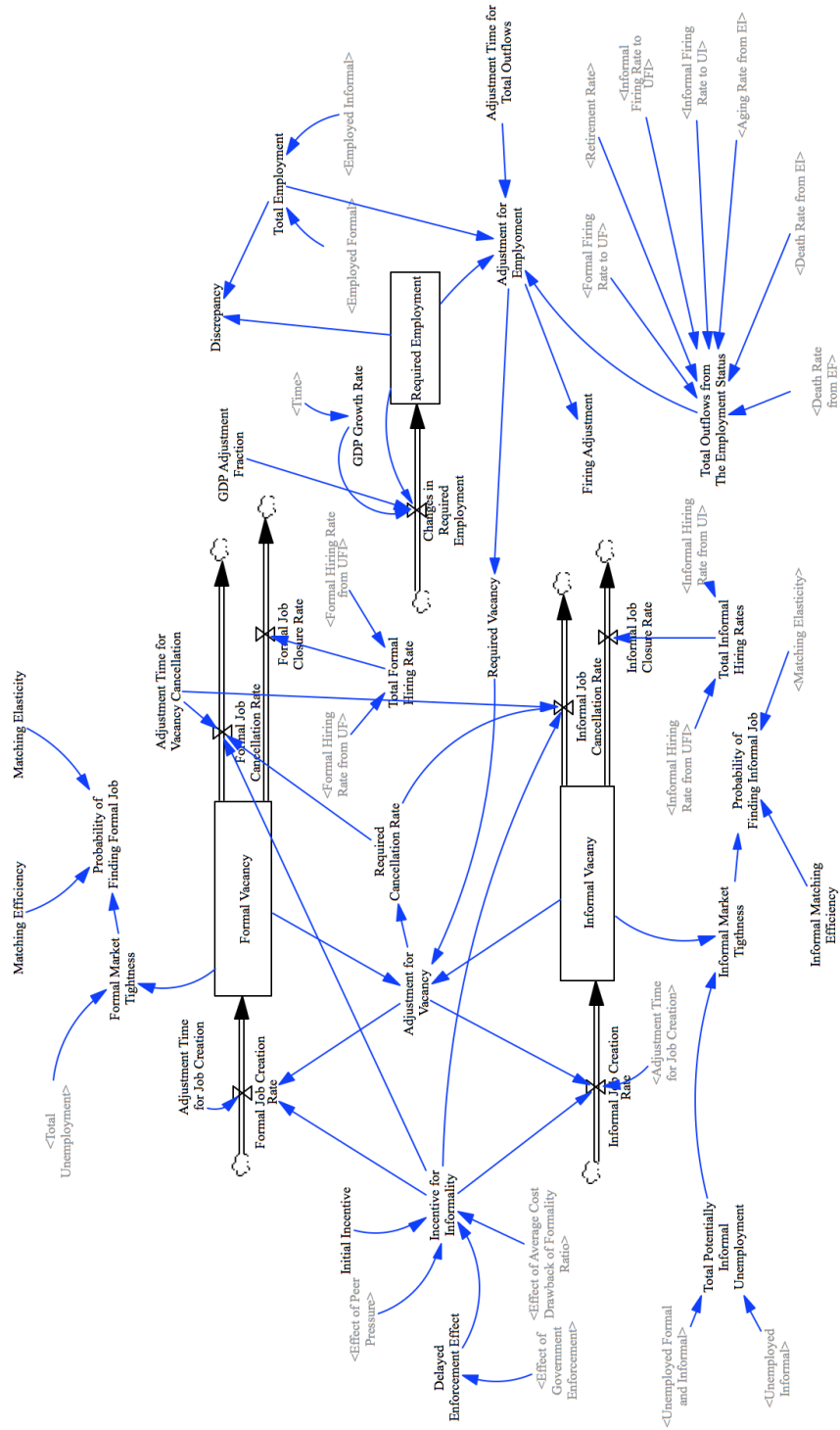


Figure B.2. Stock-flow diagram of the labor supply sector.

APPENDIX C: RESULT OF SENSITIVITY TESTS

Additional model sensitivity tests are applied by considering matching elasticity and GDP adjustment fraction (employment elasticity) parameters.

In the Figure C.1, changes in the employed informal stock is shown with different GDP adjustment values.

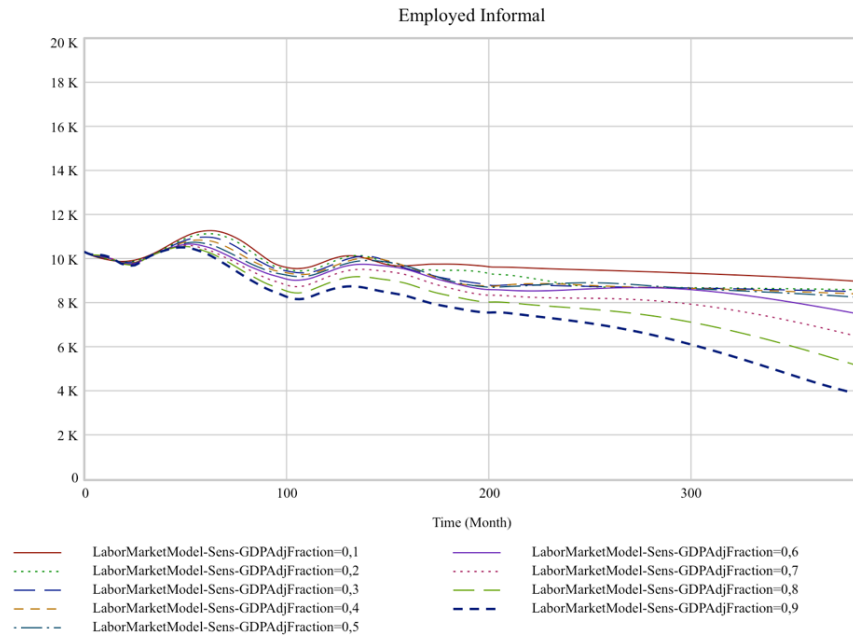


Figure C.1. Sensitivity result for GDP adjustment fraction.

In the Figure C.2 , changes in the probability of finding formal job is shown with different matching elasticity values.

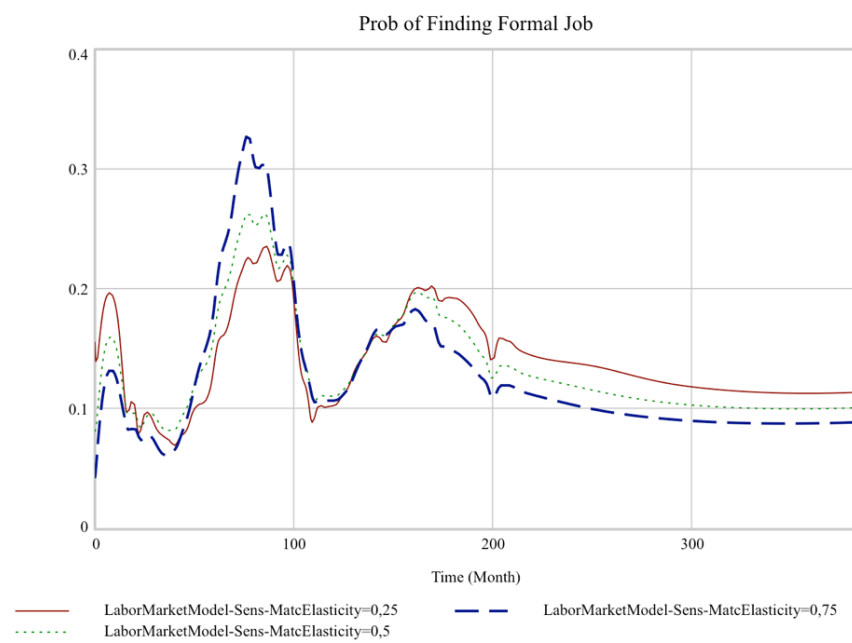


Figure C.2. Sensitivity result for matching elasticity.