Labour Market Policies and the Informal Sector:
A Segmented Labour Markets Analysis

Dürdane Şirin Saracoğlu

Department of Economics, Middle East Technical University, Ankara, Turkey
E-mail: ssirin@metu.edu.tr
Phone: + (90) 312 210 2058

LABOUR MARKET POLICIES AND THE INFORMAL SECTOR: A SEGMENTED LABOUR MARKETS ANALYSIS[*]

Dürdane Şirin SARAÇOĞLU

Middle East Technical University, Department of Economics, Ankara, Turkey
Üniversiteler Mahallesi, Dumlupınar Bulv.,
No.1 Ankara, Turkey 06800
Office tel: +90 (312) 210 2058
Office fax: +90 (312) 210 7964
E-mail: ssirin@metu.edu.tr

Abstract

In this paper we develop a dynamic model of a multi-sector economy with an informal sector and segmented labour markets first to demonstrate how informal production and employment decline in transition towards the steady state, and second to analyse the impact of various labour market policies at the steady state. Our results primarily indicate that informal employment share increases with minimum wage, and decreases with reductions in the payroll taxes, moreover, reducing the tax imposed on employer is more effective in reducing the informal employment share, while reducing the tax imposed on employee is more effective in increasing consumer felicity.

JEL Classification codes: C61; J42; O17; O41
Keywords: Segmented labour markets, informal employment, payroll taxes, minimum wage, dynamic modelling

1 Introduction

Informality in employment and production activities remains to be a prevalent issue especially in developing economies. Co-existence of strict labour market policies as well as costly and time-consuming bureaucratic processes along with insufficient or lacking enforcement of the rules and regulations increases the attractiveness of informal activities. For a producer, informality implies non-compliance with the government regulations and bureaucratic procedures with the possible consequence of official penalties when caught by the government if there is any serious enforcement, in addition to poor access to public services, including limited protection by law and order (Loayza, 1996; Sookram & Watson,

2008; Ulyssea, 2010). From the point of view of a worker, on the other hand, the costs associated with being formal entails taxes that relate to formal labour contracts, such as income taxes and social security contributions, while being informal involves lack of social security benefits and job protection, high turnover rates in the informal labour market, and is related to ineffective government institutions (Ulyssea, 2010; Jonasson, 2012). From the government's perspective, existence of informality brings about significant tax losses and limits the ability to efficiently apply tax policies as well as administer social security legislation (Fortin, Marceau, & Savard, 1997). Tax losses, in return, undermine the ability of the government to provide public goods, including law and order, healthcare, education, efficient tax and regulatory institutions, and a well-functioning and incorruptible public administration (Johnson, Kaufman, & Shleifer, 1997).

A considerable body of research has concentrated on the positive relationship between the tax burden, strict labour market policies and regulations, and the size of the informal sector. Using an endogenous growth model, Loayza (1996) shows that an excessive tax burden and regulations with weak enforcement result in a large informal sector, which further lead to a reduction in the rate of economic growth. In a CGE model with firm heterogeneity in which formal and informal firms emerge endogenously, Fortin et al. (1997) assess that a rise in the tax rate on firm profits, in the payroll tax, and in the government determined wage rate all lead to an increase in the significance of the informal sector. Johnson et al. (1997), focusing on the transition economies of Eastern Europe and former Soviet Union, argue that economies with relatively unfair taxes, relatively excessive regulation, low tax collection, and relatively poor public goods, experience a higher share of unofficial activity and slower economic growth than otherwise. Building on the theoretical model established in Johnson et al. (1997), and introducing endogenous decision to work in the informal sector, Ihrig and Moe (2004) determine that increased degree of enforcement and/or a reduction in tax rate will prompt an agent to shift labour from the informal sector to the formal sector, reducing the size of the informal sector. Additionally they find that the degrees by which these two policy changes impact the size of the informal sector differ.

Within the framework of a search and matching model, Albrecht, Navarro, and Vroman (2009) show that the labour market policies that are administered only in the formal sector also impact the size and composition of employment in the informal sector; in particular, an increase in payroll tax significantly increases the size of the informal sector and the number of workers accepting jobs in this sector. On the other hand, developing a two-sector matching

model and applying the model to Brazilian data, Ulyssea (2010) finds that reducing payroll taxes and increasing unemployment benefits prove to be ineffective in reducing informality while decreasing formal sector entry costs are associated with a lower informal empoyment. In the same vein, within the framework of a dynamic matching model, Fugazza and Jacques (2003) determine that rather than applying a deterrence policy, policies geared towards increasing the individuals' benefits of joining the formal sector prove to be more effective in reducing the size of the informal or irregular sector.

In addition to the literature exploring the impact of taxation and enforcement policies on the informal sector and employment, there is also a separate strand of literature which deals with the impact of changing minimum wage laws, which indirectly affect informal activity. In that context, for the case of Brazil, Fajnzylber (2001) finds that the impact of the changes in the minimum wage is not restricted only to those earning a minimum wage in the formal sector, but the impact appears to be present across the whole range of wage distribution, including those earning informal wage. As for employment impacts, he establishes that the increase in minimum wage leads to a decrease in informal employment or self-employment as the increase in the minimum wage renders formal employment more attractive. Conversely, for the case of Indonesia, Suryahadi, Widyanti, Perwira, and Sumarto (2003) argue that the increase in the minimum wage highly negatively impact the vulnerable groups in the formal sector, such as the females, the young, and the less educated, who lose jobs in the formal sector and have to relocate to the informal sector under low wage and poor working conditions. Lemos (2009), on the other hand, using data from Brazil, does not find any significant employment effect of the changes in minimum wages in either the formal or the informal sector.

Guided by the implications drawn from the previous literature, in this paper we build a dynamic model of a small-open developing economy including a formal sector, an informal sector, and an agricultural sector. Our objective is first to examine the path of transition of each sector's output and employment as the economy grows through time, and secondly to analyse the effects of certain labour market policies on sectoral output, employment, and wages. The labour market is segmented in the sense that the informal sector and the agricultural sector hire unskilled labour from a perfectly flexible, competitive labour market at market-determined wages while the formal sector hires unskilled labour at the government-determined minimum wage and skilled labour at an above-equilibrium efficiency wage. Absence or lack of enforcement of government laws and regulations can be considered to be a

4

prevalent attribute in developing economies. Correspondingly, one defining feature of our model economy is that in the formal sector, minimum wage laws as well as labour tax laws are perfectly enforced, while the informal sector and the agricultural sector evade these laws.

The model's initial equilibrium is fit to data from the Turkish economy, which, as of 2013,[1] has an informal or unrecorded employment share of 37 percent. Nevertheless, this share has declined from as high as 60 per cent in the 1980s after reaching a plateau around 50 per cent in the 1990s and early 2000s. The share of informal employment in non-agricultural employment, on the other hand, has shown an increasing trend in the late 1990s and early 2000s up to as high as 34 per cent, eventually declining after 2006. This outcome attests to the circumstance that labour exiting the agricultural sector has been more heavily employed in the non-agricultural informal sector rather than in formal sector in the late 1990s to early 2000s, but after 2006, non-agricultural labour has become increasingly more formal. Turkey, being a developing economy with a considerable but recently declining informal employment share, and a payroll tax burden on wages persistently higher than the OECD average (OECD, 2007), presents a viable and interesting case to study the theoretical model's transition and steady state equilibrium implications.

Results from the simulation of the baseline economy show that as the economy accumulates capital and grows with capital accumulation in transition, the share of informal employment in total employment and in non-agricultural employment gradually declines, while the share of unskilled workers in the formal sector gradually increases. That is, as agriculture loses labour to non-agricultural sectors in the transition and growth process, relatively more labour is reallocated in the formal sector as unskilled labour under fixed minimum wages than in the informal sector as unskilled labour under flexible wages. This outcome concurs with the declining informal employment share in total and also in non-agricultural employment in Turkey after 2006. Labour market policy experiments at the steady state equilibrium of our economy show that increases in minimum wages as well as increases in payroll taxes (both by the employer and the employee) lead to an increase in the share of informal employment. The fundamental contribution of our study is to consider the relative impact of each tax policy change on the economy's main aggregates. When we focus on the relative effectiveness of each policy, especially the payroll tax policies, understanding the policymaker's objective becomes essential. If the policymaker's objective is to reduce the share of informal employment in the economy, then reducing the payroll tax rate imposed on the formal producer from its baseline value takes precedence over reducing the payroll tax imposed on

the employee, that is, reducing the payroll tax rate on the employer is more effective in reducing the informal employment share than reducing the payroll tax rate on the employee. On the other hand, if the government's objective is to increase consumer felicity, then a policy designed to decrease the payroll tax rate imposed on the employee and to simultaneously increase the payroll tax on employer up to a certain extent takes priority. Increasing the payroll tax imposed on the employer too much in order to augment transfers eventually becomes detrimental with respect to consumer felicity, as well.

In what follows, we present the framework of the theoretical model, introducing the production sectors, the behaviour of households, and the labour market structure. Competitive equilibrium is defined and characterized in this section; steady state and transition path equilibria are also determined. Section 3 presents the data and the quantitative analysis of the baseline economy. Section 4 conducts comparative statics analysis of the impact of various labour market policy changes at the steady state, including changes in the minimum wage, and changes in the social security tax rates imposed on employer and employee. Finally Section 5 concludes the study.

2 The model environment and methodology

This section introduces the model environment, defines the competitive equilibrium, and presents the characterization of the competitive equilibrium. A small open economy with three production sectors is described. The production sectors included in the model economy are the agricultural sector, the informal sector, and the formal sector. The linkages between these three sectors materialize through the labour market. In the model economy, in addition to three production sectors, there are three types of economic agents: the producers, the household and the government. Production takes place using four factors of production: capital, skilled labour, unskilled labour, and land. The household owns all production factors, and generates income from renting or supplying them. The formal sector utilizes capital, unskilled labour and skilled labour in production, and produces a traded good which is both an investment and a consumption good. Since this is a small open economy, the price of the traded formal good is taken exogenously at the world price.

The informal sector uses capital and unskilled labour in production, and produces a non-traded consumption good. The informal good is a home-good and the informal goods market clears domestically, therefore the price of the informally produced good is determined in the

domestic economy endogenously. The agricultural sector rents land and hires unskilled labour in production, and produces a traded pure consumption good. The price of agricultural good is also taken exogenously at the world price. Although foreign trade of goods are allowed in the model, there is no international mobility in labour and capital. Within the economy, capital is perfectly mobile across all sectors, and all sectors are subject to the same economy-wide rental rate for capital. On the other hand labour market is segmented implying that different sectors may hire labour from different labour markets under different wages. Land can be rented in and out only within the agricultural sector and the rents from land accrue to the household. Finally, the government only serves to collect taxes and distribute transfers, and has no particular consumption and investment behaviour. The government collects payroll taxes from the formal sector producer and formal sector labour: formal sector producer pays a labour tax on each unit of labour hired and the household pays a labour tax on wages earned in the production of formal sector output. One can think of these taxes as the contributions of the employer and the employee towards the social security and unemployment insurance funds of the employee, as they are fully paid as a transfer to the employee (or, the household) by the government in the consumer's lifetime.

One important feature of the theoretical model is that the labour market is segmented. The literature on segmented labour markets has gained momentum especially with Mazumdar (1983), and subsequently has focused on the formal versus informal labour markets analysis. In the present study, in modelling the labour markets, we follow the structure introduced in Agenor and Aizenman (1999). In the model, two types of labour are defined: skilled and unskilled. Skilled labour is employed only in the formal sector, while unskilled labour is employed in all production sectors. In segmented labour markets, distinct wages arise. The wage of the unskilled labour employed in informal and agricultural sectors is determined in a fully competitive labour market (that is, an informal and flexible labour market), and is fully based on demand and supply conditions. On the other hand, unskilled labour employed in the formal sector is paid a legally determined minimum wage. Lastly, skilled labour employed in the formal sector earns an efficiency wage above the market equilibrium wage. Once the formal sector decides on how much skilled and unskilled labour to hire, any labour that is not hired by the formal sector is absorbed by the informal labour market (to be employed in the informal and agricultural sectors). The skilled-unskilled labour market structure is also similar to that in Sargent (1987) in the sense that any labour not hired in the skilled labour market at the minimum wage is hired in the unskilled labour market at competitive wages. As a

consequence, there is no unemployment in the model. Since any skilled labour that is not hired in the formal sector can also be seeking employment in the informal labour market, there may well emerge an inefficient allocation of labour. In this model environment, one can define a competitive equilibrium as the follows:

Definition. A competitive equilibrium for this economy is a list of sequences of output prices, consumption levels, wage rates, capital and land rental rates, and production plans for each of the sectors, such that

   (i) given output and factor prices, the representative household maximizes the present value of her discounted intertemporal utility;

   (ii) given output and factor prices, representative firms in each sector maximize profits;

   (iii) non-tradeable (informal) goods market clears;

   (iv) capital market and the informal labour market clear;

   (v) skilled labour is indifferent between shirking (not showing any effort) and not shirking on the job, as such, skilled labour wage depends on the equilibrium effort;

   (vi) non-arbitrage condition holds between capital and land assets;

   (vii) total taxes collected by the government equal total transfers paid by the government, i.e. government budget balances every period;

   (viii) Walras' Law holds.

2.1   Production sectors

   As mentioned above, production takes place in three sectors. Producers in all three sectors have a similar motive: minimize costs and maximize profits. Below we elaborate on the production activities and profit maximizing behaviour in each sector.

2.1.1   Formal sector

Production in the formal sector follows a constant returns to scale technology:

$$Y_F = B_F (\varepsilon L_S)^{\delta_1} L_{U,F}^{\delta_2} K_F^{\delta_3}$$

where Y_F is the formal sector production volume, L_S is the formal sector skilled labour demand, $L_{U,F}$ is the formal sector unskilled labour demand, K_F is the formal sector capital

demand, ε is the skilled worker effort coefficient, and B_F is a scaling constant, $B_F \equiv b_F \delta_1^{-\delta_1} \delta_2^{-\delta_2} \delta_3^{-\delta_3}$. Here, $(\delta_1, \delta_2, \delta_3) \in (0,1)$ and $\delta_1 + \delta_2 + \delta_3 = 1$.

Skilled worker effort The skilled worker effort analysis in this study follows that in Agenor and Aizenman (1999). Skilled labour has a preference between showing an effort of ε and working, thus earning an after-tax wage of $(1 - \iota)\omega$, and not working (or, showing an effort of only $1 - \varepsilon$), summarized by the utility function $u(\omega, \varepsilon)$:

$$u(\omega, \varepsilon) = \ln\{[(1 - \iota)\omega]^\gamma (1 - \varepsilon)^{1-\gamma}\}$$

where $0 < \gamma < 1$. Assume that with probability $0 < \phi < 1$, a skilled worker in the formal sector is caught shirking on the job. If the skilled worker is caught shirking on the job with probability ϕ, then the worker will be fired from the formal sector job paying wage ω_S and will be compelled to look for a job in the informal labour market with wage ω_I. Accordingly, the total expected utility that the worker gains by showing effort ε and earning an after-tax wage of $(1 - \iota)\omega_S$ must be at least as much as the total expected utility gained by not showing any effort and shirking on the job (that is, $\varepsilon = 0$):

$$\gamma \ln[(1 - \iota)\omega_S] + (1 - \gamma)\ln(1 - \varepsilon) \geq \phi\gamma \ln\omega_I + (1 - \phi)\gamma \ln[(1 - \iota)\omega_S]$$

In equilibrium, the worker is indifferent between showing or not showing any effort:

$$\gamma \ln[(1 - \iota)\omega_S] + (1 - \gamma)\ln(1 - \varepsilon) = \phi\gamma \ln\omega_I + (1 - \phi)\gamma \ln[(1 - \iota)\omega_S]$$

which implies that

$$(1 - \varepsilon)^{1-\gamma} = \left(\frac{\omega_I}{(1 - \iota)\omega_S}\right)^{\phi\gamma}$$

or,

$$\varepsilon = 1 - \left(\frac{\omega_I}{(1 - \iota)\omega_S}\right)^\beta; \beta = \frac{\phi\gamma}{1 - \gamma} > 0 \tag{1}$$

This equation indicates that the effort that skilled worker shows in equilibrium increases with formal sector skilled worker wage, decreases with informal labour market wage and the payroll tax rate.

Formal sector producer analysis Representative producer in the formal sector chooses the allocation of capital, skilled and unskilled labour amounts, along with the wages to be paid to

the skilled worker that minimize total costs. The formal sector producer hires skilled labour, unskilled labour and rents capital, and pays labour tax in the form of contribution towards the employee's social security and unemployment insurance premiums ($0 < \tau < 1$) which raises the unit cost of labour in the formal sector. Accordingly, the cost minimization problem of the formal sector producer is given by

$$\min_{\omega_S, L_S, L_{U,F}, K_F} (1+\tau)\omega_S L_S + (1+\tau)\omega_M L_{U,F} + rK_F$$

subject to
$$Y_F \leq B_F (\varepsilon L_S)^{\delta_1} L_{U,F}^{\delta_2} K_F^{\delta_3}$$
$$0 \leq L_S, L_{U,F}, K_F$$

where the formal sector producer takes the minimum wage ω_M and the unit cost of capital, or the interest rate, r as given. After replacing (1) for ε in the formal producer's cost minimization problem above, from the first order conditions we obtain

$$\frac{\omega_I}{(1-\iota)\omega_S} = \frac{1}{\sigma}, \sigma = (1+\beta)^{1/\beta} \tag{2}$$

Then with (1) and (2), the equilibrium level of skilled worker effort is found as

$$\varepsilon = \frac{\beta}{1+\beta}$$

That is, in equilibrium, skilled worker effort ε is constant, and is a function of ϕ, the probability of getting caught when shirking, and γ, the share of utility gained by working and earning a wage.

Under profit maximization condition of the formal firm, unit price of the formal sector good is equalized to the marginal cost,

$$p_F = MC_F = \frac{1}{b_F} \left[\frac{(1+\tau)\omega_S}{\varepsilon} \right]^{\delta_1} \left[(1+\tau)\omega_M \right] \delta_2 r^{\delta_3} \tag{3}$$

2.1.2 Informal sector

Using a constant returns to scale production technology, the informal sector firm produces output

$$Y_I = B_I L_{U,I}^{\eta} K_I^{1-\eta}$$

where $L_{U,I}$ is the informal sector labour demand, K_I is the informal sector capital demand, $0 < \eta < 1$, and $B_F > 0$ is a scaling constant, $B_F \equiv b_F \eta^{-\eta} (1-\eta)^{-(1-\eta)}$. Let p_I is the unit price of the informal good, then profit maximization in the informal sector requires equalization of unit price in informal sector to the marginal cost:

$$p_I = MC_I = \frac{1}{b_I} \omega_I^{\eta} r^{1-\eta} \tag{4}$$

2.1.3 Agricultural sector

Agricultural sector uses technology

$$Y_A = B_A L_{U,A}^{\alpha_1} K_A^{\alpha_2} Z^{\alpha_3}$$

where Y_A is the agricultural output, $L_{U,A}$ is the agricultural labour demand, K_A is the capital demand in agriculture, Z is the fixed land factor, $B_A > 0$ is a scaling constant, $B_A \equiv b_A \alpha_1^{-\alpha_1} \alpha_2^{-\alpha_2} \alpha_3^{-\alpha_3}$ with $\alpha_1 + \alpha_2 + \alpha_3 = 1$ and $\alpha_1, \alpha_2, \alpha_3 \in (0,1)$. Since land is a fixed factor, returns to scale in labour and capital in agriculture are diminishing. As in the informal sector, agricultural sector employees labour at flexible wage ω_I. Optimal agricultural output under cost minimization is found to be

$$Y_A^* = B_A^{1/\alpha_3} p_A^{\frac{\alpha_1+\alpha_2}{\alpha_3}} (\frac{\alpha_1}{\omega_I})^{\alpha_1/\alpha_3} (\frac{\alpha_2}{r})^{\alpha_2/\alpha_3} Z$$

Given that the unit world price of agricultural product is p_A, indirect agricultural profits (or land rents) are found as

$$\begin{aligned}
\pi_A^* &= p_A Y_A^* - (\omega_I L_{U,A}^* + r K_A^*) \\
&= b_A^{1/\alpha_3} p_A^{1/\alpha_3} \omega_I^{-\alpha_1/\alpha_2} r^{-\alpha_2/\alpha_3} Z
\end{aligned}$$

2.2 Household behaviour

There is a representative household who consumes and realizes expenditures on all three types of goods: an agricultural traded good, a formally produced traded good, and an informally

produced non-traded good. The representative household has a two-stage consumption choice problem: intertemporally, the representative household decides how much to save and how much to spend on aggregate consumption, and within each period she chooses how to allocate aggregate spending among three different consumption items. The instantaneous composite consumption function, or intra-temporal felicity of the representative household is given as

$$c' = B_C c_A^{\lambda_1} c_F^{\lambda_2} c_I^{\lambda_3} \tag{5}$$

where c_A is the consumption of agricultural good, c_F is the consumption of formally produced good, and c_I is the consumption of informally produced good. Here $\lambda, \lambda_2, \lambda_3 \in (0,1)$ and $\lambda_1 + \lambda_2 + \lambda_3 = 1, B_C > 0$ is a scaling constant and $B_C \equiv \lambda_1^{-\lambda_1} \lambda_2^{-\lambda_2} \lambda_3^{-\lambda_3}$. Expenditure minimization in every period implies minimum total expenditures per period

$$E = p_A^{\lambda_1} p_F^{\lambda_2} p_I^{\lambda_3} c'$$

Intertemporally, the representative household maximizes the present value of discounted intertemporal utility,

$$\int_0^\infty \frac{c'(t)^{1-\theta} - 1}{1 - \theta} e^{-\rho t} dt$$

Subject to an intertemporal budget constraint, non-negativity and initial asset constraints, and the transversality constraint,

$$\dot{a}(t) = \Omega(t) + r(t)a(t) + T(t) - E(t)$$
$$c'(t) \geq 0$$
$$a(0) \leq a_0$$
$$\lim_{t \to \infty} \int_0^\infty a(t)\vartheta(t) = 0$$

In the intertemporal budget constraint, a represents household assets, $\dot{a}$ the accumulated assets; Ω represents after-tax income from all types of labour, ra is the return on all assets owned, T is transfers from the government, E is aggregate expenditures on consumption, $\rho > 0$ is a constant denoting the rate of time preference, and finally $(1/\theta)$ is the elasticity of intertemporal substitution. There is no population growth. With the prices of goods subject to

international trade are taken as given, $\dfrac{\dot{p}_F(t)}{p_F(t)} = \dfrac{\dot{p}_A(t)}{p_A(t)} = 0$, solution to the intertemporal problem of the representative household yields the Ramsey rule for optimal saving:

$$\frac{\dot{c}'(t)}{c'(t)} = \frac{1}{\theta}\left[r(t) - \rho - \lambda_3 \frac{\dot{p}_I(t)}{p_I(t)} \right] \tag{6}$$

2.3 Characterization of competitive equilibrium

In equilibrium, we have stated that profit maximization in formal and informal sectors implies

$$MC_F(\omega_S, \omega_M, r) = p_F \equiv 1$$
$$MC_I(\omega_I, r) = p_I$$

Above, the price of the formal sector good is set at 1 as it is assumed to be the numeraire, while p_I is endogenously determined within the model. In addition, we have found that in equilibrium, formal sector skilled labour wages are a multiple of the flexible informal labour wages:

$$\omega_S = \frac{\sigma}{1-\iota}\omega_I \tag{7}$$

Using these three equilibrium conditions, we can express r and ω_I as functions of $(p_I, \tau, \iota, \omega_M)$:

$$r = r(p_I; \tau, \iota, \omega_M)$$
$$\omega_I = \omega(p_I; \tau, \iota, \omega_M)$$

As mentioned before, there are two types of labour in the economy: skilled and unskilled. We denote skilled labour supply by L_S^s, and unskilled labour supply by L_U^s. If economy-wide labour supply is L, it must be that

$$L_S^s + L_U^s = L$$

In the formal sector, skilled labour demand is $L_S^d = \dfrac{\partial MC_F}{\partial \tilde{\omega}_S} Y_F$, and unskilled labour demand is

$L_U^d = \dfrac{\partial MC_F}{\partial \tilde{\omega}_M} Y_F$, where $\tilde{\omega}_S \equiv (1+\tau)\omega_S$ and $\tilde{\omega}_M \equiv (1+\tau)\omega_M$. By construction of the labour

market, we know that whoever is not hired in the formal sector, either as skilled or unskilled labour, will be absorbed as unskilled labour in the informal labour market, under wage ω_I. Then,

$$L_S^s - L_S^d + L_U^s - L_S^d = L_U^d$$

where

$$
\begin{aligned}
L_U^d &= L_{U,A}^d + L_{U,I}^d \\
&= -\frac{\partial \pi_A^*}{\partial \omega_I} + \frac{\partial MC_I}{\partial \omega_I} Y_I
\end{aligned}
$$

Then,

$$
L_S^s - \frac{\partial MC_F}{\partial \tilde{\omega}_S} Y_F + L_U^s - \frac{\partial MC_F}{\partial \tilde{\omega}_M} Y_F = -\frac{\partial \pi_A^*}{\partial \omega_I} + \frac{\partial MC_I}{\partial \omega_I} Y_I
$$

or,

$$
\begin{aligned}
-\frac{\partial \pi_A^*}{\partial \omega_I} + \frac{\partial MC_F}{\partial \tilde{\omega}_M} Y_F + \frac{\partial MC_F}{\partial \tilde{\omega}_S} Y_F + \frac{\partial MC_I}{\partial \omega_I} Y_I &= L_U^s + L_S^s \\
&= L
\end{aligned}
$$

Similarly, capital market clearing condition is given by

$$
-\frac{\partial \pi_A^*}{\partial r} + \frac{\partial MC_F}{\partial r} Y_F + \frac{\partial MC_I}{\partial r} Y_I = k
$$

We note that labour market clearing and capital market clearing conditions are linear in both Y_F and in Y_I. Substituting for ω_I and for r in labour market and capital market clearing conditions, one can solve for functions of output Y_F and Y_I in terms of p_I and k (and the relevant exogenously given variables and parameters of the model):

$$Y_F = y_F(p_I, k)$$
$$Y_I = y_I(p_I, k)$$

The last step in characterization involves deriving the $\dot{k}$ and $\dot{p}_I$ equations in terms of (p_I, k) and the other relevant exogenous variables and parameters of the model. As the economy is closed to international capital flows, the intertemporal budget constraint of the representative household can be expressed as the rule of capital accumulation[2]

$$\dot{k}(p_I, k) = \Omega(p_I, k) + r(p_I)k + \pi_A^*(p_I) + T(p_I, k) - E(p_I, k)$$
$$= f_1(p_I, k) \tag{8}$$

On the other hand, imposing market clearing in the informal goods market, i.e. $c_I = y_I(p_I, k)$, we have

$$p_A^{\lambda_1} p_F^{\lambda_2} p_I^{\lambda_3} c' = \frac{p_I y_I(p_I, k)}{\lambda_3} \tag{9}$$

Total time differentiating both sides of (9), we get

$$\lambda_3 p_A^{\lambda_1} p_F^{\lambda_2} p_I^{\lambda_3} c' \left[\frac{\dot{c}'}{c'} + \lambda_3 \frac{\dot{p}_I}{p_I} \right] = \dot{p}_I y_I(p_I, k) + p_I \left[\frac{\partial y_I(p_I, k)}{\partial p_I} \dot{p}_I + \frac{\partial y_I(p_I, k)}{\partial k} \dot{k} \right]$$

Replacing for $\frac{\dot{c}'}{c'}$ and $\dot{k}$ and solving for $\dot{p}_I$, the resulting differential equation in terms of (p_I, k) can be obtained:

$$\dot{p}_I(p_I, k) = f_2(p_I, k) \tag{10}$$

The reduced system of two differential equations (8) and (10) along with an initial condition for capital k_o and the transversality condition characterize the competitive equilibria in our model.

2.4 Steady state equilibrium and the transition path

In the long-run equilibrium of this economy, all endogenous variables are constant for all t, under the assumption that $\dot{k} = 0$. Such an equilibrium will be called the steady state equilibrium. At the steady state equilibrium, in particular,

$$\dot{k} = 0$$

$$\frac{\dot{c}'}{c'} = 0$$

$$\dot{p}_I = 0$$

Then, from the Ramsey rule for optimal saving, $r_{ss} = \rho$ must be true at the steady state, where r_{ss} denotes the steady state value of capital rental rate. With r_{ss} and $\dot{k} = 0,$ the intertemporal budget constraint of the consumer can be rewritten at the steady state as

$$0 = \Omega(p_{I,ss}, k_{ss}) + r_{ss}k_{ss} + \pi_A^*(p_{I,ss}) + \text{T}(p_{I,ss}, k_{ss}) - \text{E}(p_{I,ss}, k_{ss}) \tag{11}$$

where $p_{I,ss}$ and k_{ss} are the steady state values of informal good price and capital stock, respectively. Using the equilibrium condition $r = r(p_I; \tau, \iota, \omega_M)$, and setting $r_{ss} = \rho = r(p_{I,ss}; \tau, \iota, \omega_M)$, one can solve for the steady state value $p_{I,ss}$. Replacing $p_{I,ss}$ in equation (11) and solving for the unknown k_{ss} yields the steady state of this economy.

Given the steady state values ($p_{I,ss}, k_{ss}$), differential equations (8) and (10) along with an initial condition for capital k_0, the Time-Elimination Method (under the Eigenvalues-Eigenvectors Approach) is adopted to numerically solve for the transition path equilibria (Mulligan and Sala-i-Martin, 1991; Barro and Sala-i-Martin, 2004).

3 Quantitative Analysis

To observe how the model behaves both in transition towards the steady state equilibrium, and at the steady state in response to various labour market policy experiments, we consider an example of a developing economy in transition with a relatively large informal employment base. To this end, the model's initial equilibrium is fit to data from the Turkish economy retrieved from the TurkSTAT National accounts, consumption and employment statistics database. The data were systematised by constructing a three-sector small open economy Social Accounting Matrix (SAM) for the year 2006 when non-agricultural informal employment (that is, employment that is not registered or recorded in the social security system) in Turkey has reached a turning point. Figure 1 shows that the share of informal employment in non-agricultural employment in Turkey has kept a downward trend after 2006 when it reached a peak. We are particularly interested in the behaviour of informal

employment in non-agricultural sectors, as agriculture already employs unrecorded workers to a large extent mostly in the form of unpaid family workers: the share of workers not registered to any social security institution in agriculture was as high as 87.4 percent in 2006 in Turkey. Within the scope of the model, we would like to understand the competitive market forces that drive the changes in informal versus formal employment as the country accumulates capital and increases income, and also examine the impact of changes in labour market policies on informal versus formal employment.
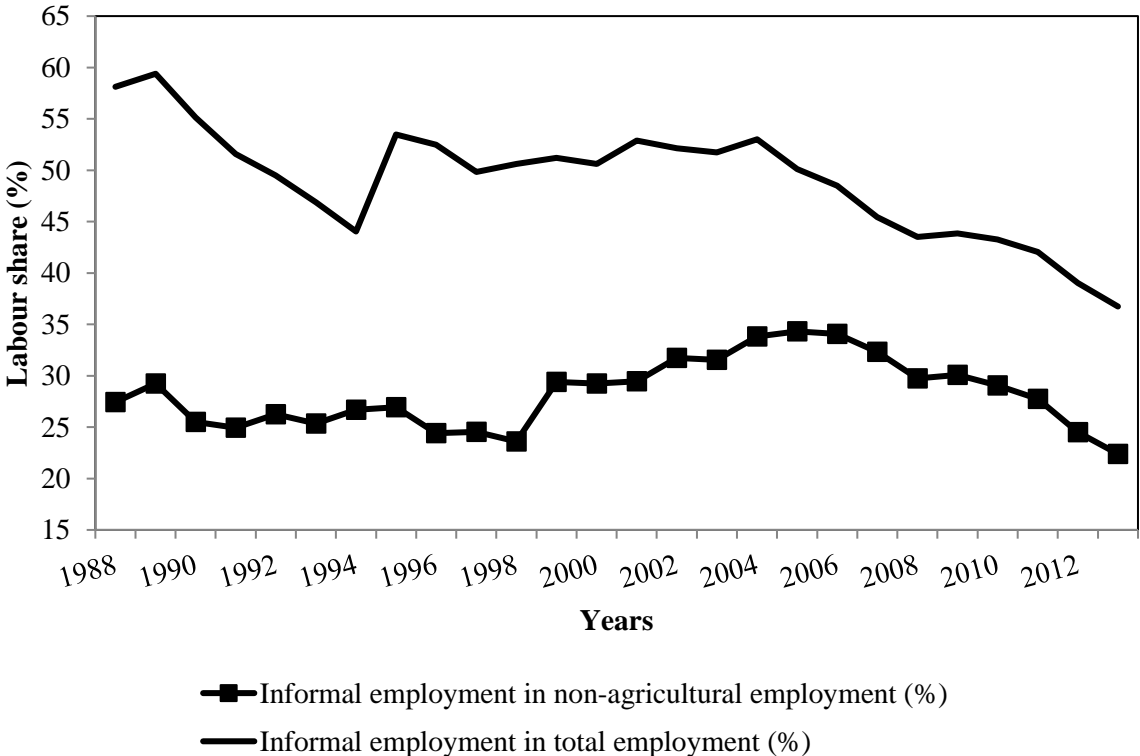
Source: TurkSTAT

Figure 1. Informal employment in Turkey

3.1 Data and the parameters of the model

To determine the size of the informal sector output, we followed the procedure introduced in Kelley (1994). As in Kelley, in order to maintain the internal consistency of the SAM constructed using the National Accounts, the non-agricultural value-added has been distributed between formal and informal sectors. Once formal and non-agricultural informal employment types have been specified, their respective output have been determined from their relative labour productivities. In our study, as a proxy for informal employment, we considered the uninsured employment which is not registered in any social security institution rather than unpaid self-employment as in Kelley. Accordingly, it is found that in 2006, 11.2

percent of total output is agricultural output, while about 28.4 percent of total output is produced by non-agricultural informal labour, about 60.5 percent of total output is produced by non-agricultural formal labour, both skilled and unskilled. Skilled workers are considered to be those with at least secondary school education, and unskilled workers those with elementary school education or less. In our measurement concerning the distribution of non-agricultural output into formal and informal sector output, we assumed that the skilled formal workers are about 1.9 times as productive as the unskilled informal workers, which is approximated by their wage, or as in our case, unit labour cost ratios. Aydın (2009) finds that the differences between formal and informal hourly wages in different regions of Turkey in 2006 range from a factor of 1.5 to 2.5. Similarly, he finds that the formal hourly wages in urban areas are about twice as much as the informal hourly wages in urban areas in 2006, while this factor is slightly above 1.5 in the rural areas.[3] Therefore, we believe that a factor of 1.9 is a reasonable approximation of the differences in formal versus informal worker marginal productivities.

Table 1 summarizes the factor elasticity parameters in each sector. Each factor elasticity represents the share of total payments to that factor in sectoral value added. These factor elasticities are such that agricultural production has the highest labour elasticity, and the formal sector production has the highest capital elasticity. The agricultural production labour elasticity is set at 0.45, and the land elasticity is assumed at 0.15, similar as in Saracoğlu (2008). As inclusion of imputed wages of agricultural unpaid family workers in agricultural labour cost leads to a very high labour elasticity in agriculture, they have been excluded from the agricultural and total workforce. With this adjustment, the share of agricultural labour in total becomes 20.1 per cent in the model. Agricultural and the informal sectors hire labour at the same competitive informal labour market wage, accordingly the labour elasticity in the informal sector production is determined at 0.29. Given that skilled labour in formal production costs 1.9 times as much as informal labour, and that the unskilled labour in formal sector is paid the minimum wage, the skilled labour and unskilled labour elasticities in formal sector production are determined as 0.21 and 0.07, respectively. In the model, non-agricultural GDP does not include government spending such as salaries and wages to government employees, accordingly we also exclude the employees in government services from total formal employment. As a result, formal skilled labour share is obtained as 26.3 per cent of the total, and formal unskilled labour share is obtained as 20.3 per cent of the total. Finally, the

share of informal or unrecorded labour employed in the non-agricultural informal production can be found as 33.3 per cent of the total.

Table 1. Factor elasticities in production

	Labour		Capital	Land
	Skilled	Unskilled		
Formal sector	0.21	0.07	0.72	
Informal sector		0.29	0.71	
Agriculture		0.45	0.40	0.15

In the formal sector, the labour cost to the producer includes the contribution of the employer towards the social security and unemployment insurance premiums of the worker, both skilled and unskilled. As given in Table 2, in 2006 this contribution was at 21.5 percent of the worker's earnings (19.5 percent as the contribution towards the worker's social security premiums, 2 percent as the contribution towards the unemployment insurance fund). Additionally, in the model's numerical solution, the contribution of the employee towards the social security and unemployment insurance premiums is at 15 percent of the employee's labour earnings, 14 percent as the contribution towards social security premiums, and 1 percent as the contribution towards the unemployment insurance fund.

Table 2. Baseline model parameters

	Symbol	Value
Taxes		
Payroll tax rate (employer)	τ	0.215
Payroll tax rate (employee)	ι	0.15
Consumption parameters		
Expenditure share of agricultural good	λ_1	0.29
Expenditure share of formally produced good	λ_2	0.36
Expenditure share of informally produced good	λ_3	0.35
Elasticity of intertemporal substitution	$1/\theta$	0.8
Time preference rate	ρ	0.042
Skilled worker		
Probability the worker is caught shirking on the job	ϕ	0.77
Share of utility gained by working	γ	0.9
Effort	ε	0.87

The consumption pattern in Table 2 reflects that 29 percent of total expenditures have been devoted to agricultural goods, 35 percent to informally produced goods, and 36 percent to

formally produced goods. The share of expenditures on agricultural goods comes from 2006 aggregate consumption data (concerning food and beverages), and the share of expenditures on informally produced goods is obtained by setting the household expenditures on informally produced goods equal to the value of output, as the informal goods market is assumed to clear domestically, and that this sector does not produce any capital or investment goods. Finally, the share of expenditures on formally produced goods is obtained as the residual. The elasticity of intertemporal substitution is chosen as 0.8, which produces a smooth transition towards the steady state equilibrium, and the time preference rate is set at 4.2 percent, which implies approximately 95 percent discount rate on behalf of the representative household.

Lastly, in the baseline numerical solution of the model, since we assume that the formal skilled unit labour cost is as 1.9 times as high as the informal unit labour cost, we set $\frac{\tilde{\omega}_S}{\omega_I} = \frac{(1+\tau)\omega_S}{\omega_I} = 1.9$, which implies $\frac{\omega_S}{\omega_I} = 1.58$ with $\tau = 0.215$. In the formal sector producer's equilibrium, we have established in equation (2) that $\frac{(1-\iota)\omega_S}{\omega_I} = \sigma$ where $\sigma \equiv (1+\beta)^{1/\beta}$ and $\beta \equiv \frac{\phi\gamma}{1-\gamma}$. Setting $\iota = 0.15$ and assuming $\gamma = 0.9$, in equilibrium, the probability of the skilled worker getting caught shirking on the job can be determined as $\phi = 0.77$. These parameters imply an equilibrium skilled worker effort ε of 87 percent.

In the model as well as the numerical simulations, we assume away any total factor productivity (TFP) growth or technological progress as per Atiyas and Bakış (2014), who establish that the Turkish economy has demonstrated a relatively poor performance in the period following 2006 compared to previous periods, with no TFP growth, or even negative TFP growth based on alternative measurements.

3.2 Baseline model simulation results

Table 3 below highlights some of the most salient outcomes from the baseline simulation of our model economy. According to the model results, over time the share of agricultural output in GDP falls from 11.2 per cent to a negligible 0.4 per cent, the share of formal sector output increases from 60.5 per cent to 65 per cent, while the share of informal sector output increases from 28.4 per cent to 34.7 per cent. Referring to the Rybczynski and the Stopler-Samuelson theorems, we first describe the transition and growth process driven by the competitive market forces. In transition, households are motivated to save as long as the returns to saving

remain above the time preference rate, $r(t) > \rho$. This saving behaviour allows for capital deepening, albeit at a decreasing rate towards the steady state. As capital deepening continues, Rybczynski-like effects cause formal sector output supply (whose production is most capital intensive) to increase, all else constant.

Table 3. Initial and steady state equilibrium outcomes from the baseline model

	Initial conditions	Steady-state outcome
Share in GDP (%)		
Agricultural output	11.2	0.4
Formal sector output	60.5	64.9
Informal sector output	28.4	34.7
Informal sector output in non-agricultural output (%)	31.9	34.9
Sectoral allocation of labour (%)*		
Agricultural labour share	20.1	0.6
Formal sector skilled labour share	26..3	20.8
Formal sector unskilled labour share	20.3	48.6
Informal sector labour share	33.3	30.1
Sectoral allocation of capital (%)		
Agricultural sector	6.6	0.2
Formal sector	63.9	65.3
Informal sector	29.6	34.5

*Initial sectoral labour shares exclude unpaid family workers and government employees

As income increases with capital accumulation, home-good (informal sector) prices increase relative to formal sector prices and agricultural prices, which are held constant at exogenous world prices. Although the informal sector uses a relatively less capital-intensive technology than the formal sector, as the relative price of the informal good increases, the informal sector is able to compete for capital with the formal sector. During transition with the accumulation of capital, the marginal productivity of labour in (flexible) informal labour market increases, hence the flexible wage rises over time. In fact, rising home-good prices cause a Stopler-Samuelson-like effect: the increase in the price of the relatively labour-intensive good comes with a rise in the price of the factor used intensively in its production. Rising flexible wages eventually lead to a decreased demand for labour in the informal sector. However still, the production in this sector rises and this increasing production is made possible by increasing the use of capital. On the other hand, labour cost in agriculture increases with the increase in flexible wages, and since the agricultural production is relatively more labour intensive compared to other sectors, agriculture loses labour to other sectors. Furthermore, since

agricultural prices are fixed at world prices, this sector cannot compete for capital with other sectors, and hence output declines over time. However since this sector involves a tradable good, any decrease in domestic production is compensated with imports to sustain consumption.

Recall that formal skilled labour wages are a fixed multiple of flexible wages, hence with the increase in flexible wages, there is also a proportional rise in skilled labour wages in the formal sector. Since unskilled labour (whose wages are held fixed at the minimum wage) is perfectly substitutable with skilled labour in the formal sector, producer will decrease the demand for skilled and increase the demand for unskilled labour. In the transition equilibria of the model as given in Figure 2, two features of the labour reallocation process stand out: first of all, during the transition process, labour exits from agriculture and is reallocated in the formal and informal sectors, and secondly as flexible wages and formal skilled worker wages increase relative to the fixed minimum wage of the formal unskilled labour, the share of formal unskilled labour in total employment steadily rises while the shares of the other labour types start to decline.
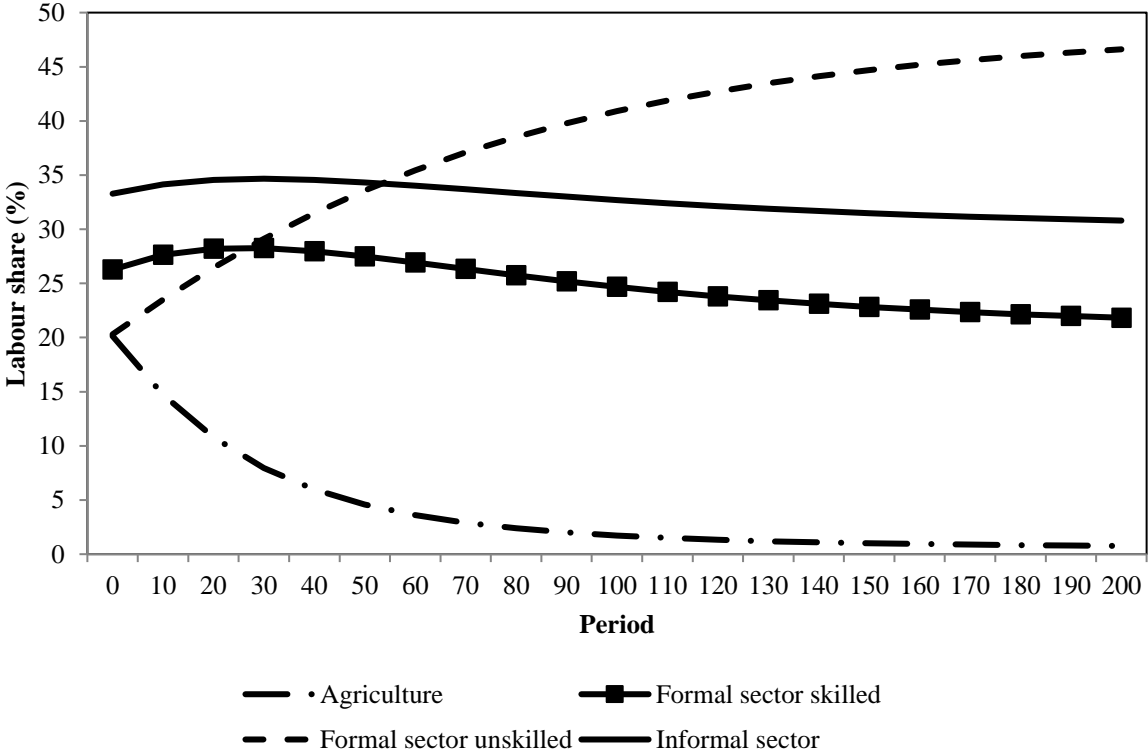

Figure 2. Time path of distribution of employment, baseline model

Lastly, Figure 3 depicts that as the economy accumulates capital and grows towards the steady state, the share of informal employment in total employment and in total non-

agricultural employment declines over time. In our model, since minimum wages are kept constant throughout the transition, they do not reflect the increases in labour productivity with capital accumulation, as the flexible labour market wages do. As long as the minimum wages do not keep up with the rise in flexible labour market wages, rendering formal unskilled labour relatively cheaper compared to labour hired under flexible wages, we observe an increase in demand for formal unskilled labour relative to labour hired with flexible wages, thus reducing the share of informally employed labour. Considering that the rate of economic growth is a proxy of the rate of change in marginal labour productivity with capital accumulation,[4] then if the rate of change in minimum wage is smaller than the rate of economic growth, it is also necessarily below the rate of change in marginal labour productivity in our model. In fact, 2015 Annual Report of the Ministry of Development of Turkey (2014) reveals that the rate of increase in minimum wages in real terms have remained below the real economic growth rate since 2005 in the Turkish economy (except in the crisis year of 2009 when the Turkish economy contracted by 4.7 per cent), therefore not reflecting the increases in marginal labour productivity, as our model postulates.
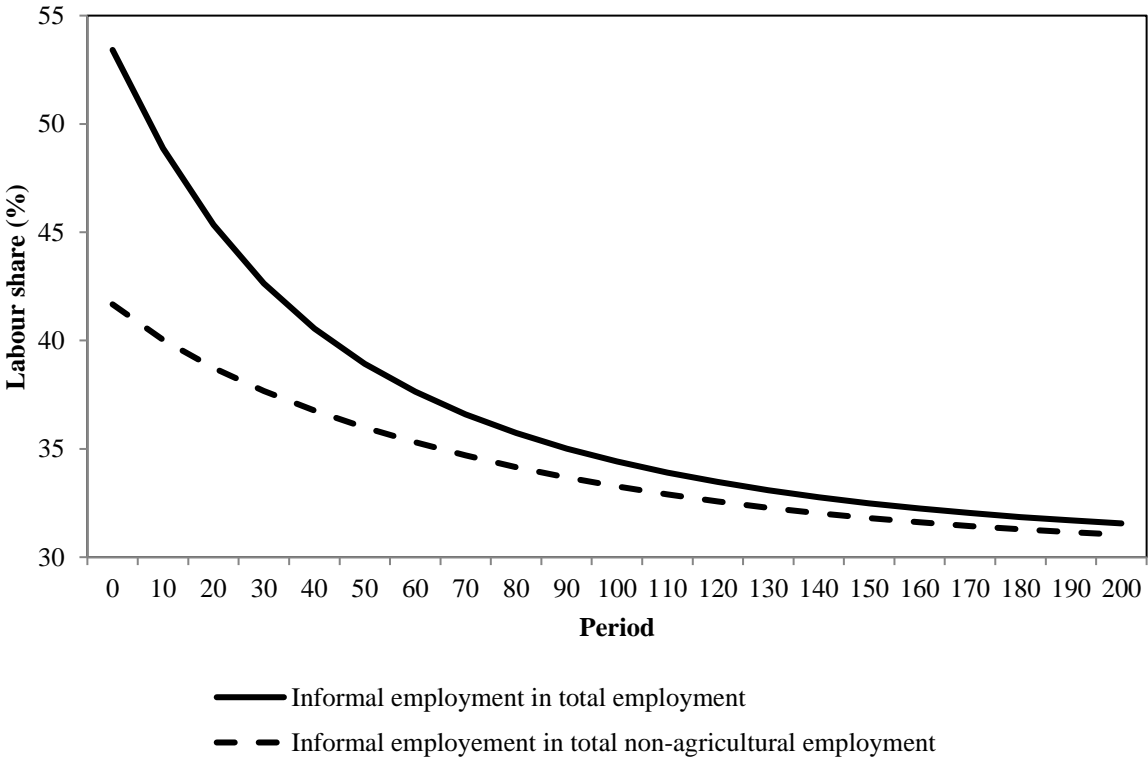

Figure 3. Time path of informal employment, baseline model

4 Labour market policy experiments at the steady state

After having established how the economy behaves in transition towards the steady state with economic growth under the baseline conditions, one can now determine how the economy would react to exogenous changes in various labour market policies at the steady state with respect to the economy's main variables. In this section we first examine the impact of gradual increases in the minimum wage paid to the formal sector unskilled labour, and then elaborate on the effects of changes in payroll taxes, first imposed on the employer, then imposed on the employee. Lastly, we compare and contrast the relative impact of these changes in payroll taxes on informal employment and household felicity as measured by the composite consumption at the steady state, and assess which policy change would create a larger impact on these aggregates at the steady state.

4.1 Changes in the minimum wage

The steady state equilibrium impacts of increasing the minimum wage in 10 per cent increments from its baseline value are presented in Table 4. Increasing the minimum wage steadily at 10 per cent increments at the steady-state equilibrium leads to a consistent decrease in home-good price at about 1 per cent, and in flexible labour market wage at about 3.3 per cent. An increase in the minimum wage will reduce the demand for unskilled labour in the formal sector, holding all else constant, and the producer will try to compensate for the fall in the unskilled labour with other factors of production. Unskilled labour released from the formal sector will seek jobs in the informal labour market, reducing equilibrium wages there. With the fall in informal labour wages, efficiency wages of the skilled labour will also decline. Some of the unskilled labour released from the formal sector will be hired in the informal sector, expanding output, and reducing unit prices, as marginal costs decline in this sector. Our conclusion regarding the impact of a change in the minimum wage on informal wage concurs with the findings of Agenor and Aizenman (1999), arguing that there will be a fall in informal labour market wages if there is a rise in minimum wage.

Table 4. Steady state comparative statics of a 10 per cent consecutive change in minimum wage from initial value (% changes)

Informal wage	Informal good price	Agricultural output	Formal sector output	Informal sector output	Informal sector labour	Composite consumption	GDP
-3.3	-0.9	29.1	2.6	3.7	6.2	3.1	2.8
-3.3	-0.9	29.2	2.2	3.3	5.7	2.6	2.4
-3.4	-0.9	29.1	1.8	2.9	5.4	2.2	2.0
-3.3	-0.9	29.1	1.3	2.4	4.9	1.8	1.6
-3.3	-0.9	29.0	0.9	2.0	4.5	1.4	1.3
-3.3	-1.0	29.2	0.5	1.6	4.2	1.0	1.0
-3.3	-1.0	29.1	0.1	1.3	3.7	0.6	0.7
-3.4	-1.0	29.1	-0.2	0.9	3.3	0.2	0.5
-3.3	-1.0	29.1	-0.6	0.5	3.1	-0.1	0.3
-3.3	-1.0	29.1	-0.9	0.2	2.6	-0.4	0.2
-3.3	-1.0	29.1	-1.3	-0.1	2.4	-0.7	0.3
-3.3	-1.0	29.1	-1.6	-0.4	2.1	-1.0	0.4
-3.3	-1.0	29.1	-1.9	-0.7	1.8	-1.3	0.7
-3.4	-1.0	29.1	-2.2	-0.9	1.5	-1.6	1.1
-3.3	-1.0	29.1	-2.5	-1.2	1.2	-1.8	1.8

As flexible wages decline, and as agricultural production is labour intensive, agricultural output increases monotonically at the steady state equilibrium. Formal sector output, on the other hand, first increases with the increase in minimum wages, and then decreases at high minimum wage levels. This behaviour of the formal sector output indicates that as formal skilled labour wages fall with the increase in minimum wage, initially the increase in formal skilled employment sustains the increase in formal sector output, but at a critically high minimum wage level, the increase in minimum wage is no longer favourable, that is, and the output loss with the reduction in unskilled labour overcomes the output gain with the increase in skilled labour, thus decreasing the formal sector output. Informal sector output, on the other hand, monotonically increases as flexible wages decline with minimum wages, making it profitable to hire labour in the informal sector. Figure 4 depicts the response of sectoral labour shares and the share of informal employment in non-agricultural employment to changes in minimum wage at the steady-state equilibrium. Accordingly, as minimum wage rises, the formal sector firm replaces unskilled labour with skilled labour, and the unskilled labour exiting the formal sector is employed in the informal sector, and in the agricultural sector, to some degree.[5] We can conclude that increasing the minimum wage leads to a definite increase in the share of informal labour in total non-agricultural labour.
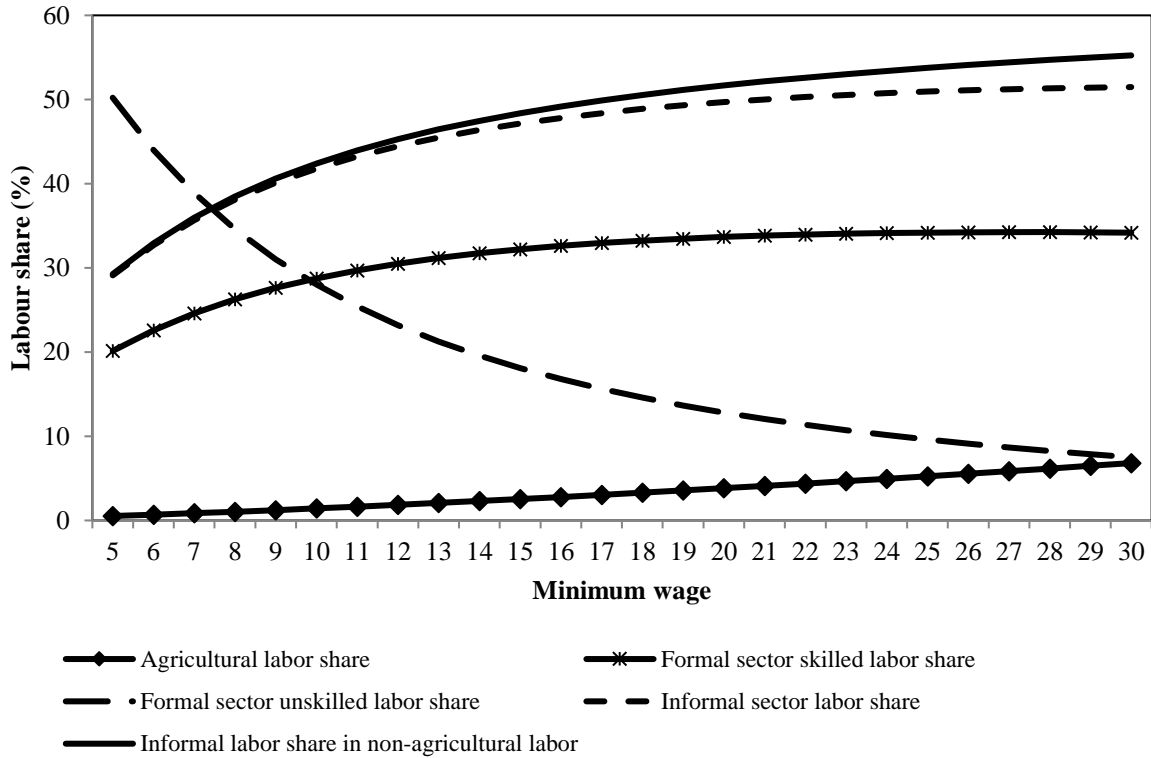
Figure 4. Steady state comparative statics of changes in minimum wage on sectoral labour shares

4.2 Changes in the payroll tax: Contribution by employer

Table 5 summarizes the steady state impacts of changing the rate of payroll tax paid by employer on selected variables of the model. As the rate of payroll tax paid by employer increases, the flexible wage decreases, and along with it, the efficiency wage of formal skilled labour declines. Since the minimum wage is held constant at the baseline value, the formal unskilled labour becomes relatively more costly with the rise in payroll tax rate, and hence the formal sector producer tries to replace unskilled labour with skilled labour, and additionally, some of the unskilled labour that exit the formal sector is employed in the informal sector and some in agriculture. For low enough tax rates (lower than the baseline of 21.5 per cent), an increase in tax rate, the ensuing decrease in efficiency wages and the increased employment of skilled labour compensates for the exit of unskilled labour, and thus leads to an increase in formal sector output, but for large enough tax rates, the opposite is observed: the exit of unskilled labour and the resulting loss of output cannot be overcome by hiring more skilled labour. This implies that at high tax rates, the producer is now more sensitive to the increase in the tax rate than to the decrease in formal skilled labour wage. In fact, it may even be the case that as the tax rate increases, the unit cost of skilled labour increases even though the

wage decreases. As labour shifts from the formal labour market to informal (flexible) labour market and is hired in informal and agricultural sectors, production in these other sectors experience growth.

Table 5. Steady state comparative statics of an increase in formal firm's payroll tax rate (% changes)

	Informal wage	Informal good price	Agricultural output	Formal sector output	Informal sector output	Informal sector labour	Composite consumption	GDP
0.05	-6.4	-1.9	22.0	0.8	2.9	7.7	1.6	0.9
0.1	-6.1	-1.8	20.8	0.5	2.5	7.2	1.3	0.6
0.15	-5.8	-1.7	19.8	0.3	2.1	6.5	1.0	0.4
0.2	-5.6	-1.7	18.9	0.0	1.8	6.1	0.7	0.1
0.215	-1.7	-0.5	5.1	0.0	0.5	1.8	0.2	0.0
0.25	-3.8	-1.1	12.3	-0.2	1.1	3.8	0.3	-0.1
0.3	-5.2	-1.5	17.3	-0.4	1.3	5.2	0.3	-0.3
0.35	-5.0	-1.5	16.6	-0.6	1.1	4.8	0.1	-0.4
0.4	-4.8	-1.4	15.9	-0.8	0.9	4.4	-0.1	-0.6
0.45	-4.6	-1.4	15.3	-0.9	0.7	4.0	-0.3	-0.7
0.5	-4.5	-1.3	14.8	-1.1	0.5	3.9	-0.4	-0.9

Note: Steady state equilibrium corresponds to the values in shaded cells.

4.3   Changes in the payroll tax: Contribution by employee

In the formal sector analysis, we have shown that skilled worker effort at the equilibrium is constant. Therefore, in order for the worker to exert constant effort, when there is a rise in the payroll tax on the worker, holding all else constant, there needs to be a compensating increase in the formal skilled worker wage. That is, holding the informal labour wage constant, formal skilled worker wage rises relative to informal labour wage. Holding the informal wage constant, formal skilled labour becomes relatively more expensive which reduces the demand for skilled workers in the formal sector. Workers released from the formal sector are employed in the informal sector and the agricultural sector, and as there is higher labour supplied in the informal labour market, informal labour market wages tend to decrease. Note that although informal sector labour increases, output in this sector decreases for tax rates higher than 15 percent, as this sector loses competitiveness to agricultural sector and loses capital as its relative price decreases. GDP continuously falls as the formal sector makes up for a large share of GDP. Similarly, as income falls, consumer felicity falls with increasing payroll tax rate on employee (that is, increasing transfers cannot make up for the decreasing wage income).

Table 6. Steady state comparative statics of an increase in worker's payroll tax rate
(% changes)

Tax rate	Informal wage	Informal good price	Agricultural output	Formal sector output	Informal sector output	Informal sector labour	Composite consumption	GDP
0.05	-5.0	-1.5	16.6	-1.5	0.1	3.8	-0.9	-1.4
0.1	-5.3	-1.6	17.6	-1.6	0.0	3.9	-1.0	-1.6
0.15	-5.6	-1.7	18.7	-1.8	-0.1	4.2	-1.1	-1.7
0.2	-5.9	-1.8	20.0	-2.1	-0.2	4.2	-1.3	-1.9
0.25	-6.3	-1.9	21.4	-2.3	-0.3	4.2	-1.5	-2.1
0.3	-6.7	-2.0	23.0	-2.7	-0.4	4.6	-1.7	-2.4
0.35	-7.1	-2.1	24.9	-3.1	-0.7	4.6	-2.1	-2.8
0.4	-7.7	-2.3	27.1	-3.8	-1.0	4.9	-2.5	-3.3
0.45	-8.3	-2.5	29.8	-4.6	-1.4	4.8	-3.0	-3.9
0.5	-9.1	-2.8	33.1	-5.9	-2.1	4.8	-3.8	-4.8

Note: Steady state equilibrium corresponds to the values in shaded cells.

4.4 Relative effectiveness of payroll tax rate changes

Figure 5 demonstrates the relative impact of changes in the rates of payroll tax paid by the employer and the employee on steady state informal employment as a share in non-agricultural employment. The vertical axis on Figure 5 stands for the partial derivatives of informal employment share in non-agricultural employment with respect to payroll tax rates levied on the employer and the employee. Accordingly, for low tax rates (lower than 29.5 per cent), the impact of changing the payroll tax paid by employer on the informal employment share is higher, while for relatively high tax rates, the impact of changing the payroll tax paid by the employee is higher. That is, if the policymakers decrease the payroll tax on employer at the steady state (holding all lese constant), the reduction in informal employment share would be higher compared to when policymakers reduce the payroll tax on employee. This implies that for tax rates below 29.5 per cent, decreasing the tax burden of the employer rather than the employee proves to be more effective in reducing the informal employment share by reducing the formal labour cost.
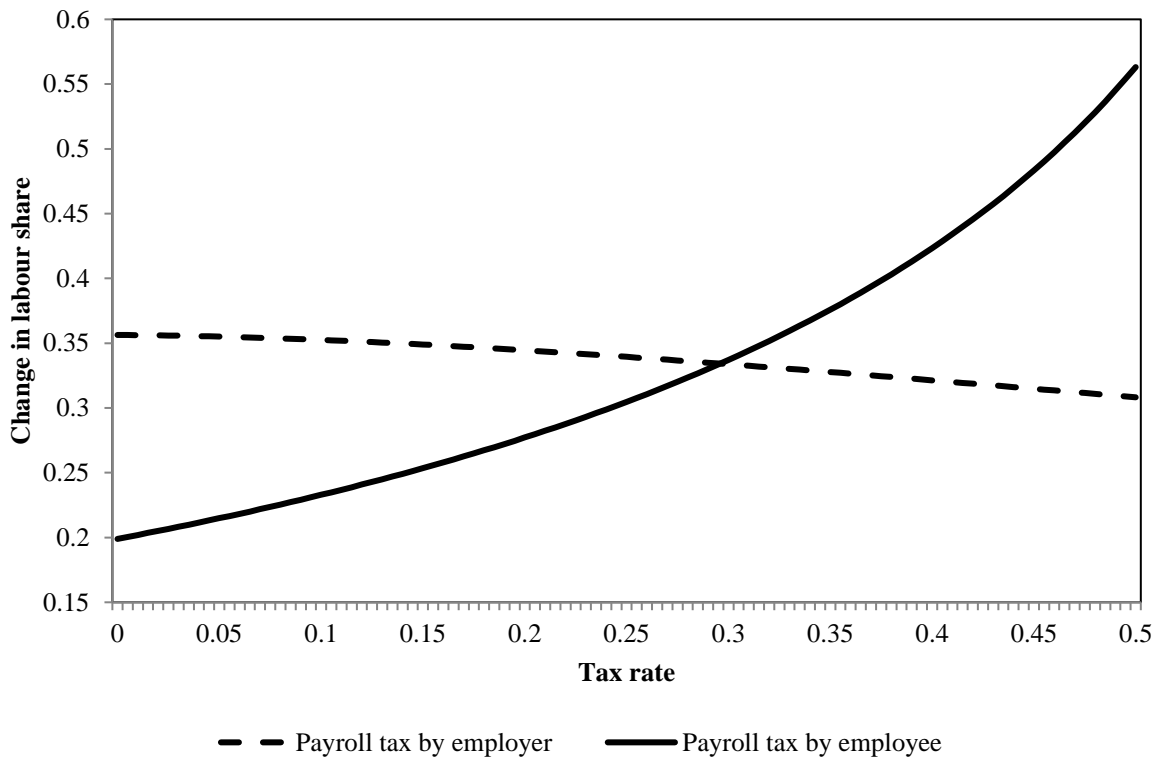
Figure 5. Steady state effects of payroll tax rate changes on the share of informal employment in non-agricultural employment

On the other hand if the objective is to increase the composite consumption, or the felicity of the consumer as given in equation (5), the policymakers could increase the rate of payroll tax on employer up to 35 per cent and thus increase consumer felicity, as shown in Figure 6. For payroll tax rates on employer above 35 per cent, consumer felicity starts to decline according to the model results. This outcome implies that at high tax rates on employer, the government loses the tax base and thus encounters a reduction in transfers to consumers, which reduces the disposable income and expenditures. Conversely, increasing the rate of payroll tax on employee consistently decreases consumer felicity (consumer felicity is always positive but diminishing with payroll tax on employee). If the objective of the policymakers is to increase the consumption composite or the consumer felicity, they should increase the payroll tax on employer from the baseline up to 35 per cent to increase transfers to the consumers and thus increase the disposable income and expenditures. Decreasing the payroll tax on employee from its baseline value monotonically increases consumer felicity, as the reduction of tax on wage income increases the consumer's disposable income directly, although there is a decrease in transfers. This result is notable in the sense that the increase in after-tax wage income overcomes any decrease in transfers due to the decrease in tax rate. At the steady state,

since savings are equal to zero, an increase in disposable income implies an equivalent increase in expenditures and thus in consumption composite.
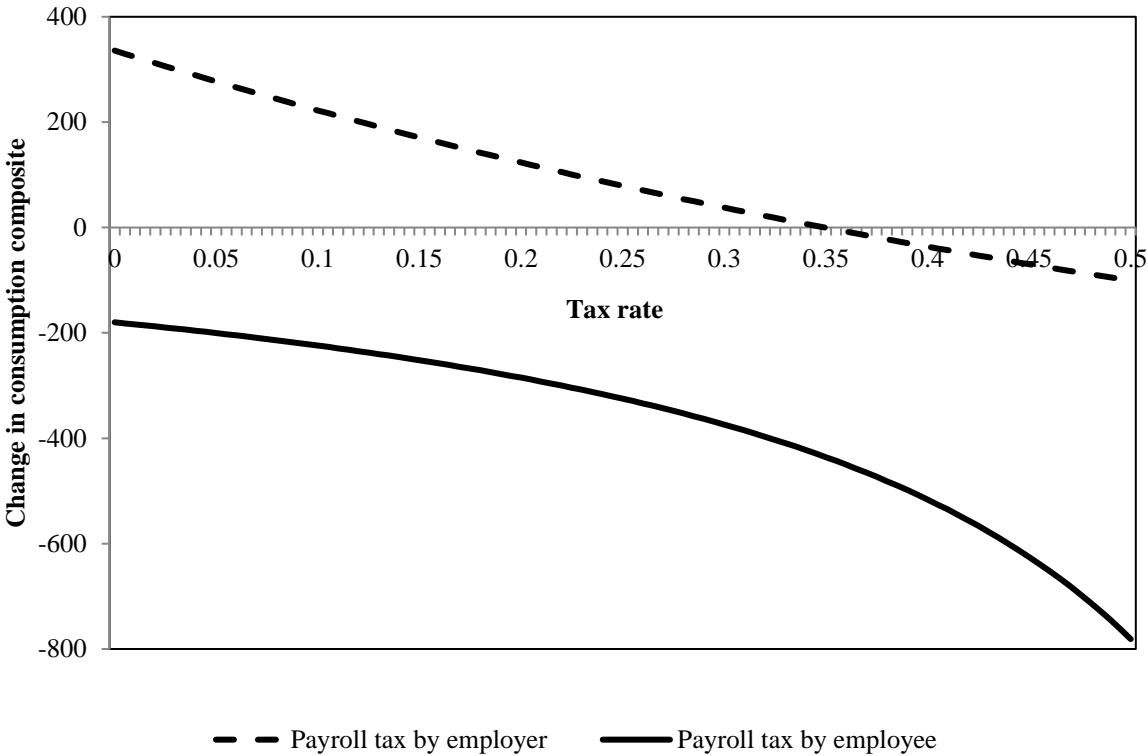

Figure 6. Steady state effects of payroll tax rate changes on composite consumption (per period felicity)

5 Conclusion

In this paper we build a multi-sector dynamic general equilibrium model of an economy with segmented labour markets and an informal sector to examine the evolution of the informal sector with the economy's transition towards the steady state with capital accumulation, as well as the impact of certain labour market policies on the size of the informal production and employment at the steady state. The model's initial equilibrium has been calibrated to the Turkish economy for the year 2006, when the share of informal employment in total non-agricultural employment has embarked on a downward trend. Baseline simulation results from our model corroborate this downward trend, particularly taking into account that the increase in minimum wages of the unskilled formal workers in Turkey have not kept up with labour productivity growth, or economic growth, after the mid-2000s, rendering unskilled formal workers relatively lower cost. Although the share of informal workers decline, which can be considered to be a positive outcome, we see that as

labour exits from agricultural sector with the growth in the economy, formal sector increasingly hires unskilled labour, getting locked into low-skilled production.

Within our model, we also show the steady state comparative statics of certain labour market policy changes, such as increases in minimum wage and changes in payroll tax rates imposed on the employer as well as the employee. Results from these comparative statics exercises have significant implications with respect to informal employment as well as household welfare at the steady state. For instance, increasing the minimum wage of the formal unskilled worker increases the informal employment, and at the same time increases household felicity, but only up to a point. That is, increasing the minimum wage too much reduces the formal tax base by discouraging the formal producer from hiring formal workers thus reduces the transfers to the household, and reduces consumption expenditures. Similarly, increasing the payroll tax rates by both the employee and the employer increases the informal employment, but their effects on household felicity are diverse. Our results show that the appropriate design and implementation of policy depends on the policymaker's ultimate objective: if the objective is to reduce informal employment, then decreasing the payroll tax rate imposed on employer takes priority, on the other hand if the objective is to increase consumer welfare at the steady state, decreasing payroll tax rate imposed on employee together with increasing payroll tax rate on employer (up to a certain extent) takes precedence.

Our paper from the outset assumes that there is duality or segmented labour markets in the economy where formal workers earn a legally determined minimum wage or an efficiency wage set above the competitive market-determined wage, and where informal workers earn the market determined flexible wage. There is a separate strand of literature which questions this dual labour market structure, and asserts that informal employment is a voluntary employment decision by workers as an alternative employment opportunity based on their income or utility maximization (for example, see Günther & Launov, 2012). In our model, although informal employment depends on formal labour market conditions and is involuntary to avoid unemployment, it still has benefits to the worker particularly with respect to immediate avoidance of formal payroll taxation. In this respect, the model does not leave out or overlook the advantages of being informal for a worker.

APPENDIX A

The function for capital accumulation is derived from the representative household's intertemporal budget constraint. Assuming that domestic capital markets are closed to international flows, total assets owned by the representative household are composed of capital holdings and land holdings as follows:

$$a = p_k k + p_Z Z$$

where p_k is the price of capital good, Z is the total land and p_Z is the price per unit of land (Roe et al., 2010). Capital good is produced in the formal sector, and the price of the good produced in the formal sector is uniform, hence we set $p_k = p_F$, which is the constant world price. Also we assume that land area is normalized to 1, $Z \equiv 1$. Then,

$$\dot{a} = p_F \dot{k} + \dot{p}_Z \tag{A1.1}$$

Moreover, with r as the return on household assets, $ra = p_F rk + rp_Z$.

Assuming that the household is in equilibrium with respect to the alternative asset returns, that is, the household indifference requires that the return on capital is equal to the return on land,

or, $r = \dfrac{\pi_A^*}{p_Z} + \dfrac{\dot{p}_Z}{p_Z}$ which yields,

$$ra = p_F rk + \pi_A^* + \dot{p}_Z \tag{A1.2}$$

Replacing (A1.1) and (A1.2) in the representative household's intertemporal budget constraint, we obtain,

$$p_F \dot{k} + \dot{p}_Z = \Omega + p_F rk + \pi_A^* + \dot{p}_Z + T - E$$

or,

$$\dot{k} = \frac{1}{p_F}(\Omega + p_F rk + \pi_A^* + T - E)$$

Assuming that the formal sector good is the numeraire and setting $p_F \equiv 1$, we obtain the economy's rule of capital accumulation, as given in equation (8).

APPENDIX B

Let $Y = F(K,L) = K^\beta L^{1-\beta}$ be some generic aggregate production function where we assume away any technological change or TFP growth, as we have in the model. This assumption is reasonable since Atiyas and Bakış (2014) show that for the period after 2006, TFP growth in Turkey has remained at 0 per cent, and even has turned negative according to some alternative measurements. Given this aggregate production function, the marginal productivity of labour is

$$MP_L = \frac{\Delta Y}{\Delta L} = (1-\beta)\frac{Y}{L}$$

And the change in the MP_L with respect to capital accumulation is

$$\frac{\Delta MP_L}{\Delta K} = \beta(1-\beta)\frac{Y}{KL} \text{ or } \Delta MP_L = \beta(1-\beta)\frac{Y}{L}\frac{\Delta K}{K},$$

Furthermore,

$$\frac{\Delta Y}{Y} = (1-\beta)\frac{\Delta L}{L} + \beta\frac{\Delta K}{K}. \text{ With } \frac{\Delta L}{L} = 0 \text{ as we assume in the model, and with capital}$$

accumulation as the main source of growth, $\frac{\Delta Y}{Y} = \beta\frac{\Delta K}{K}$. Then,

$$\Delta MP_L = \beta(1-\beta)\frac{Y}{L}\frac{\Delta K}{K} = \beta(1-\beta)\frac{Y}{L}\frac{\Delta Y}{Y}\frac{1}{\beta} = (1-\beta)\frac{Y}{L}\frac{\Delta Y}{Y}$$

Finally, with $MP_L = (1-\beta)\frac{Y}{L}$ or, $\frac{Y}{L} = \frac{MP_L}{1-\beta}$, one can rewrite $\Delta MP_L = (1-\beta)\frac{MP_L}{1-\beta}\frac{\Delta Y}{Y}$, or,

$$\frac{\Delta MP_L}{MP_L} = \frac{\Delta Y}{Y}.$$

Endnotes

1. 2013 is the latest year for which data on informal employment is available in the TurkSTAT database.

2. Details of the derivation are available in Appendix A.

3. Using standard Mincer earning regressions at the mean with ordinary least squares (OLS), Tansel and Kan (2012) establish the existence of informality penalty for the period 2006-2009 in Turkey, moreover, they show that formal-salaried workers are paid significantly higher than their informal counterparts. Taymaz (2009) also finds that there exists a significant productivity gap between informal and formal firms, and a wage gap between informal and formal workers, and that these findings are robust with respect to manufacturing and services sectors, as well as firm size and gender.

4. Please see Appendix B for an explanation.

5. Our results concur with those of Suryahadi et al. (2003) concerning the impact of increases in the minimum wage in the case of Indonesia in the early 2000s, that urban white collar workers benefit from an increase in the minimum wages while others, such as the females, the young and the less educated, are negatively affected. In particular, they state that those who lose their jobs in the formal sector face lower earnings and poorer working conditions in the informal sector.

References

Agénor, P.-R. & Aizenman, J. (1999). Macroeconomic adjustment with segmented labour markets. *Journal of Development Economics*, 58, 277--296.

Albrecht, J., Navarro, L. & Vroman, S. (2009). The Effects of Labour Market Policies in an Economy with an Informal Sector. *The Economic Journal* 119, 1105-1129.

Atiyas, İ. & Bakış, O. (2014). Türkiye'de Toplam ve Sektörel Toplam Faktör Verimliliği Büyüme Hızları: Bir Büyüme Muhasebesi Çalışması (Aggregate and Sectoral TFP Growth in Turkey: A Growth Accounting Exercise). *İktisat, İşletme ve Finans*, 29, 9-36.

Aydın, E. (2009). *Formel Ve Enformel Sektör Ücret Farklılıkları: Katmanlı İşgücü Piyasası Kuramının Türkiye Emek Piyasasına Uygulanması (Formal and Informal Sector Wage Differentials: An Application of the Segmented Labour Markets Theory to the Turkish Labour Market)*. Unpublished M.Sc. Thesis. İstanbul Technical University, Institute of Social Sciences.

Barro, R.J. & Sala-i-Martin, X. (2004). *Economic Growth, 2nd Edition*. Cambridge, MA: The MIT Press.

Fajnzylber, P. (2001). *Minimum wage effects throughout the wage distribution: Evidence from Brazil's formal and informal sectors* (Working Paper No. 151). Belo Horizonte – MG: Federal University of Minas Gerais, CEDEPLAR.

Fortin, B., Marceau, N. & Savard, L. (1997). Taxation, wage controls and the informal sector. *Journal of Public Economics* 66, 293-312.

Fugazza, M. & Jacques, J.-F. (2003). Labour market institutions, taxation and the underground economy. *Journal of Public Economics,* 88, 395-418.

Günther, I. & Launov, A. (2012). Informal employment in developing countries: Opportunity or last resort?. *Journal of Development Economics*, 97, 88-98.

Ihrig, J. & Moe, K.S. (2004). Lurking in the shadows: the informal sector and government policy. *Journal of Development Economics*, 73, 541-557.

Johnson, S., Kaufman, D. &Shleifer, D. (1997). The unofficial economy in transition. *Brookings Papers on Economic Activity,* 2, 159-239.

Jonasson, E. (2012). Government effectiveness and regional variation in informal employment. *The Journal of Development Studies*, 48, 481-497.

Kelley, B. (1994). The Informal Sector and the Macroeconomy: A Computable General Equilibrium Approach for Peru. *World Development*, 22, 1393-1411.

Lemos, S. (2009). Minimum wage effects in a developing country. *Labour Economics,* 16, 224-237.

Mazumdar, D. (1983). Segmented Labour Markets in LDCs. *The American Economic Review (Papers and Proceedings of the Ninety-fifth Annual Meeting of the American Economic Association),* 73, 254--259.

Mulligan, C.B., & Sala-i-Martin, X. (1991). A Note on the Time-Elimination Method for Solving Recursive Dynamic Models (Technical Working Paper No. 116). Cambridge, MA: NBER.

OECD (2007). *Taxing Wages 2006*. Paris: OECD Publishing. doi: http://dx.doi.org/10.1787/tax_wages-2006-en

Prado, M. (2011). Government policy in the formal and informal sectors. *European Economic Review*, 55, 1120-1136.

Roe, T.L., Smith, R.B.W. & Saracoğlu, D.Ş. (2010). *Multisector Growth Models: Theory and Application*. New York: Springer

Saracoğlu, D.Ş. (2008). The informal sector and tax on employment: A dynamic general equilibrium investigation. *Journal of Economic Dynamics & Control*, 32, 529-549.

Sargent, T.J. (1987). *Macroeconomic Theory*, San Diego: Academic Press.

Sookram, S. & Watson, P.K. (2008). Small-business participation in the informal sector of an emerging economy. *The Journal of Development Studies,* 44, 1531-1553.

Suryahadi, A., Widyanti, W., Perwira, D. & Sumarto S. (2003). Minimum wage policy and its impact on employment in the urban formal sector. *Bulletin of Indonesian Economic Studies*, 39, 29-50.

Tansel, A. & Kan, E.Ö. (2012). *The Formal/Informal Employment Earnings Gap: Evidence from Turkey* (Working Paper No. 1210). Istanbul: Koç University-TÜSİAD Economic Research Forum.

Taymaz, E. (2009). *Informality and Productivity: Productivity Differentials between Formal and Informal Firms in Turkey* (Working Paper No. 09/01). Ankara: METU-Department of Economics ERC.

T.C. Kalkınma Bakanlığı (2014). *2015 Yılı Programı* (2105 Annual Programme). Ankara: Ministry of Development of the Republic of Turkey. Retrieved from http://www.kalkinma.gov.tr

TurkSTAT (Turkish Statistical Institute) Database. http://www.tuik.gov.tr

Ulyssea, G. (2010). Regulation of entry, labour market institutions and the informal sector. *Journal of Development Economics* 91, 87-99.