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# Informality, Public Employment and Employment Protection in Developing Countries

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# Informality, Public Employment and Employment Protection in Developing Countries *

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**Abstract**

This paper proposes an equilibrium matching labor market model for developing countries where the interaction between public, formal and informal sectors is considered. Theoretical analysis shows that labor markets' liberalization reforms can be evicted by shifts in public employment. Since the public sector accounts for a substantial share of employment in developing countries, this approach is crucial to understand their labor market outcomes. Wage offers to public sector employees increase the outside option value of workers during their bargaining processes in the formal and informal sectors. It becomes more profitable for workers to search on-the-job to access more attractive and stable jobs. The public sector acts as an additional tax imposed on private firms. Using workers flows data from Egypt, we show that labor markets' liberalization plays against informal employment by increasing formal jobs' profitability, but is evicted by the increase of public sector wages observed at the same time.

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# 1 Introduction

Policy prescriptions for developing countries struggling to raise their income levels are often contradictory. Although providing more employment should alleviate poverty, there is no clear consensus regarding the best policies for expanding employment opportunities in these economies. Labor market regulations are necessary to protect the rights of workers and to improve their working conditions. Yet, they might discourage firms from hiring workers and would thus have unintended consequences of harming the people they are designed to protect. Public sector employment policies and conditions can also contradict these regulations where workers would willingly queue for the more attractive and more stable public sector jobs. Fiscal realities, however, make it impossible for these government jobs to absorb all those queuing job seekers. Moreover, in developing countries, massive non-compliance is the norm and labor market regulations could simply encourage the expansion of a non-regulated informal market, where wages are lower, employment is more flexible and working conditions are worse. The aim of this paper is to provide a new theoretical model of the labor market where the interactions between public, formal and informal sectors can be analyzed as an equilibrium outcome. It also provides empirical support to these theoretical implications by using data on Egypt, which provide an interesting natural experiment where policies directed towards the private and public employment sectors have changed at the same time.

Since the flow approach to labor markets has become the basic toolbox to modern labor macroeconomics, this paper proposes an equilibrium matching model à la Diamond-Mortensen-Pissarides (DMP). We extend the textbook model in order to take into account the interaction between the public, the formal private and the informal[1] private employment sectors, as well as the job-to-job mobilities. A worker's employment/non-employment choices are therefore based on the comparisons between his/her expected job values in the current or all the prospective jobs i.e in any of the three employment sectors. There have been recent attempts to include within the DMP model an informal sector (such as Albrecht et al. (2009), Meghir et al. (2015), Bosch and Esteban-Pretel (2012), Charlot et al. (2013, 2014) and Charlot et al. (2015)) or a public sector and an unsegmented private sector (such as Burdett (2012) , Postel-Vinay et al. (2016)). In this paper, we aim to add both an informal and a public sector to the Mortensen and Pissarides (1994) model, with job-to-job transitions. These extensions are crucial to understand the economic mechanisms resulting in the

[1]The informal sector in this paper is defined as the wage employment that is not taxed or controlled by any form of government. The lack of a contract and social insurance identify informal wage workers in our dataset.

labor market outcomes of developing countries, which are characterized by large proportions of their employment being in the informal and the public sectors.

How can these interactions between sectors be illuminating? First, the workers' occupational choices between sectors imply that their outside options depend on opportunities in all sectors: when they bargain their wages in a particular sector, they integrate their potential opportunities in other sectors. Hence, if the formal sector becomes more profitable, the threat point of the employees in each sector goes up, leading to wage pressures in the informal sector. If the latter does not observe changes in its profitability, workers move to the formal sector, which will be the most able to support these high wages. The interaction between the private (formal and informal) sector and the public sector is also interesting. Indeed, if the public sector provides high wages, it is profitable for the employees to search on-the-job, in order to move to these types of jobs. Hence, the public sector can act as an additional tax imposed on the private firms: they pay an opening cost in order to hire workers, but during the duration of the contract, some of these workers will choose to move to a more stable better paid opportunity, in the public sector. The model built in this paper also takes into consideration the fiscal realities faced by the public sector. It's true that the public sector can increase its wages but given its budgetary constraint, it is likely to decrease the rate at which it hires employees. This could be done by rationing public sector vacancies for instance.

In this paper, we use available data on labor market flows in Egypt, from the Egypt Labor Market Panel Survey (ELMPS) rounds in 1998, 2006 and 2012, between the different employment sectors and unemployment as an application to our model. Egypt is a Middle East and North Africa (MENA) country with a substantial unregulated informal private sector, that counts up to 40% of wage work, and a sizable public sector employer. Egypt has long been ranked as a country with very rigid labor laws[2]. According to different labor regulations indices it was ranked among the most rigid MENA region countries, which are themselves the most restrictive developing countries, after the Latin American region (see (Veganzones-Varoudakis and Pissarides, 2007) and (Campos and Nugent, 2012)). The importance of a more flexible labor market was therefore recognized by the Egyptian Government in 2003,

[2]According to WorldBank (2014), this has stemmed from the time when virtually all industrial employment was public sector and heavily unionized. In 1990, the private sector accounted at most for 23 percent of Egypt's manufacturing sector output, and 25 percent of its employees. Very bureaucratic rules were established. Fear of social costs of privatization may have kept these rules rigid, especially the costs of paying off fired workers. The crisis of the beginning of the nineties, compelled the government to look to the International Monetary Fund (IMF), World Bank and the Paris Club for support, where Egypt was required to undergo a structural adjustment package as a counterpart to receiving a stand-by credit. The result was an increase in economic activity, and strong growth in private-sector manufacturing. By 2003, the share of the Egyptian total industrial value added reached 70 percent and employment increased substantially to 60 percent.

as they introduced the new labor law (No.12). The law came to action in 2004 aiming at increasing the flexibility of the hiring and firing processes in Egypt. It directly addresses the right of the employer to terminate an employee's contract and the conditions in which it performs under. With such a reform, should an employer need to go out of business, he gets the right to lay off all workers. In case of economic necessity, an employer has the right to lay off workers or modify contracts given that he provides a certain notice period(see WorldBank (2014) for more details).

Theoretically, the liberalization of the labor market, modeled through the introduction of reduced firing taxes in a conventional one-sector Mortensen and Pissarides (1994) job search model, leads to the increase of both job creation and job destruction. Empirical findings in Langot and Yassin (2015) suggest however that the 2004 Egyptian labor market reform increased significantly the separation rates and had no significant impact on the job finding rates[3]. We use the proposed 3-sector job search model to offer an explanation to this empirical paradox. Even though the policy is directed to the formal private sector, it surely affects the interaction and the flow of workers between the different employment sectors, which is what the conventional aggregate Mortensen and Pissarides (1994) model fails to explain.

Our main findings suggest that introducing flexible employment protection rules, modeled as reduced firing taxes, favors a more proportionate increase in the job separations of the private formal sector than the increase in job creations of the same employment sector. These effects can themselves be evicted by changes in the wage policy of the public sector. We also show that the liberalization of the labor market increases job separations in the informal sector and decreases workers finding in informal jobs. Hence, introducing flexibility into developing countries' labor markets is important to scale down the difference between formal and informal jobs. Such a reform causes a shift of employment from informal jobs, which are very flexible by definition given that they are not controlled by any institutional regulations, to formal work. However, if at the same time, the wages offered by the public sector are increased, this creates a crowding out effect: the new surpluses created by the labor market reform are more than compensated by the new costs of worker mobility induced by the increase in the attractiveness of the public sector. We show that this result is robust, even if the introduction of reduced firing taxes decreases the proportion of on-the job search towards the public sector of both workers in the formal and informal sectors. This paper therefore supports the view that since reducing firing taxes in Egypt has been accompanied simultaneously by an increase

[3]These rates represent the overall labor market flows. There is no distinction made between the three employment sectors to calculate the separation and job finding rates in Langot and Yassin (2015).

in the real wages of public sector workers[4], formal and informal workers are encouraged to search more on-the-job to move to the public sector: this tends to cancel out the positive effect on the private formal sector's job creation, and may even reduce it. The net effect of the reform would therefore be an increase in the unemployment rates since job separations in all cases are enhanced, but job findings remain unchanged or even dampened.

In this paper, we choose to focus on exploring the effects of firing taxes and public sector wage policies on job creation, job destruction, on-the-job search and employment. It is worth noting however that the model developed in this paper can be used to explore the effect of changes of many other parameters such as subsidies, cost of maintaining jobs and productivity shocks on labor market outcomes. For the purpose of this paper, we limit the analysis to firing taxes and public sector wage policies. The model can therefore provide main guidelines to how developing countries need to design their future employment policies, whether public or private, in order to obtain the most efficient labor market outcomes.

The rest of the paper is divided as follows. In section 2, we extend a theoretical job search equilibrium model a la Mortensen and Pissarides (1994) showing the interaction between the three typical wage employment sectors in a developing nation, namely (public, formal and informal), and the non-employment state. We calibrate the model in section 3 and provide simulations for the impact of structural reforms that can take place in such economies, such as the 2004 Labor law in Egypt and the change in the wage and hiring policies of the public sector. Section 4 shows supporting evidence from available data on labor market flows in Egypt, between the employment sectors and unemployment, before and after the 2004 reform. We then conclude in section 5.

# 2 A Model with Formal, Informal and Public Sectors

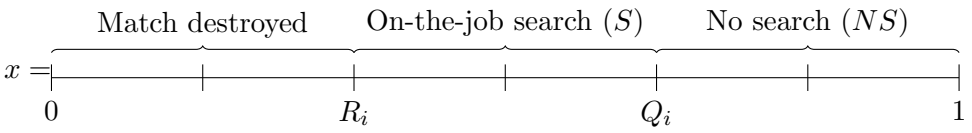
## 2.1 Setting the Model

**Matching.** Job and worker matching in the private sector is viewed as a production process. The function $m_i(v_i, u)$ represents the matching rate in sector $i = F, I$ associated with every possible vacancy in that sector and unemployment pair. Based on evidence from Petrongolo and Pissarides (2001), constant returns is considered a convenient assumption, such that for

[4] The increase of the public sector wages is more proportionate than than the increase in the wages of private sector workers. Said (2015) shows that over the period 1998-2006, i.e. from a point in time before the reform to a point in time after, there has been a 40% increase in the median real monthly wages of government employees, a 26% increase in the median real monthly wages of public firm' employees and only a 9% increase in the median real wage of the private sector.

$i = F, I$, we have $m_i(v_i, u) = m_i(1, \frac{u}{v_i}) \equiv q_i(\theta_i)$, where $\theta_i = \frac{v_i}{u}$, is the labor market tightness in sector $i$ i.e. the ratio of vacancies in that specific sector to the overall unemployment. These are endogenous variables and are determined by the model. In either the formal or the informal private sector, a vacant job is taken by a worker at the rate $q_i(\theta_i)$. The rate at which workers find jobs is $\theta_i q_i(\theta_i)$. Given that the matching functions are assumed to be concave, homogeneous and linear, $q_i(\theta_i)$ decreases in $\theta_i$, while $\theta_i q_i(\theta_i)$ increases in $\theta_i$.

**Job heterogeneity.** The output of a job in sector $i$ is the product of two components $p_i$, a common productivity of all jobs in a particular skill group in sector $i$, and $x$, the idiosyncratic component taking values on the unit interval and arriving from time to time at the Poisson rate $\lambda_i$. Given an arrival of an idiosyncratic shock, $x$ is distributed according to the c.d.f. $F(x)$. The sequence of shocks is independently and identically distributed (i.i.d.). In a specific sector, an existing match is destroyed if the idiosyncratic productivity shock falls below an endogenous reservation threshold $R_i$ specific to each sector. The average rate of transition from employment in sector $i$ to unemployment is therefore $\lambda_i F(R_i)$, which increases with the reservation threshold. Since certain workers take the private sector (whether formal or informal) as an intermediary till they get their appointment in the public sector (Yassin, 2015), we allow for these types of transitions among a productivity level ($x$) below a certain qualification threshold ($Q_i$). Offers from the public sector arrive at an exogenous poisson rate $\lambda_{iG}$, with $i = F, I$ depending on where the worker receiving the offer is hired. In simple words, when it's a good/high productivity job, there is no interest to search for another and when it's a bad/low productivity job, it's only an intermediate step till the public sector's appointment arrives. In each of the private sectors, formal ($F$) and informal ($I$), there are therefore 3 values: *(i)* the initial value (0) of the match as it starts, when $x$ is at its highest i.e. $x = 1$ , *(ii)* the no-search value ($NS$) when $Q_i < x \leq 1$, and *(iii)* the on-the-job search value ($S$), when $R_i \leq x \leq Q_i$.




**Public employment.** The public sector is added as an exogenous player. Wages, as well as the employment strategy are determined by the policy maker and should not be determined by the Nash bargaining rule. The exogenous wages and number of individuals hired in the public sector are however constrained by a government budget $D$. Workers within the public

sector are neither hit by productivity reallocation shocks nor get laid off. In all sectors, workers retire at an exogenous rate $\delta$.

**Hiring and firing costs.** The flow cost of recruiting in each sector is $c_i p_i$. Applications in each sector begin arriving at a hazard rate $q_i(\theta_i)$. Only in the formal sector, the firm is required to pay a set-up cost $p_F C$. This includes the cost of hiring in terms of legal formalities, training and other forms of match specific investments. The informal sector being not controlled by any form of government is assumed not to incur any of these costs. If $x$ falls below some reservation level $R_i(p_i)$, job destruction takes place. Only formal firms in that case pay a firing cost $p_F T$. This is an implicit firing tax imposed by employment protection regulations.

## 2.2 Private Firms' Behavior

### 2.2.1 Formal Firms

The initial value of an occupied job in the formal sector is given by the equation :

$$\begin{aligned}(r+\delta)J_F^0(1) &= p_F - w_F^0 + \tau + \lambda_F \int_{R_F}^{1} \left[\max\{J_F^{NS}(z), J_F^S(z)\} - J_F^0(1)\right] dF(z) \\ &+ \lambda_F F_F(R_F)[V_F - p_F T - J_F^0(1)] \qquad (1)\end{aligned}$$

$r$ and $\tau$ represent respectively the risk free interest rate and a payroll tax. $V_F$ is the value of a vacancy in the formal private sector. Since the idiosyncratic component of a new job is $x = 1$, and due to the existence of job creation costs $p_F C$ and policy parameters, $p_F H$ and $p_F T$, we define $J_F^0(1)$ as the expected profit of a new match to the employer, given an initial formal sector wage $w_F^0$.

A continuing match has a specific productivity $x$. However, as explained in the previous section, we define two intervals: *(i)* no search and *(ii)* on-the-job search. If it's a good (high productivity) job i.e $x > Q_F$, the workers will not be looking for a job in the public sector i.e. no on-the-job search ($NS$), and the capital value of the job to the employer $J_F^{NS}(x)$ therefore solves the following asset pricing equation for each $p_F$,

$$\begin{aligned}(r+\delta)J_F^{NS}(x) &= p_F x - w_F^{NS}(x) + \tau + \lambda_F \int_{R_F}^{1} \left[\max\{J_F^{NS}(z), J_F^S(z)\} - J_F^{NS}(x)\right] dF(z) \\ &+ \lambda_F F_F(R_F)[V_F - p_F T - J_F^{NS}(x)] \qquad (2)\end{aligned}$$

given the wage $w_F^{NS}(x)$ and where the match can end if a new match specific shock $z$ is less

than some reservation threshold $R_F$.

If it's a bad (low-productivity) job $x \leq Q_F$, the workers are looking for better options in the public sector (on-the-job search $S$). This decreases the capital value of the job to the employer. In the asset pricing equation, an outside option being the transition of the worker from the formal sector to the public sector is added. This becomes an additional possibility to why the match can end in the future. Given the wage $w_F^S(x)$, the asset pricing equation for each $p_F$ is:

$$\begin{aligned}(r+\delta)J_F^S(x) &= p_F x - w_F^S(x) + \tau + \lambda_F \int_{R_F}^{1} \left[\max\{J_F^{NS}(z), J_F^S(z)\} - J_F^S(x)\right] dF_F(z) \\ &+ \lambda_F F_F(R_F)[V_F - p_F T - J_F^S(x)] + \lambda_{FG}(V_F - J_F^S) \qquad (3)\end{aligned}$$

Given the definitions of the policy parameters described in the setting of the model, the present value of an unfilled vacancy for a formal firm, $V_F$, is:

$$rV_F = -p_F c_F + q_F(\theta_F)(J_F^0(1) - p_F(C-H) - V_F) \qquad (4)$$

Free entry requires that new vacancies are created until the capital value of holding one is driven to zero i.e. $V_F = 0$. The free entry condition for formal jobs can therefore be formalized using the equation:

$$\frac{p_F c}{q_F(\theta_F)} + p_F(C-H) = J_F^0(1) \qquad (5)$$

The free entry condition therefore equates the cost of recruiting and hiring a worker to the expected discounted future profit stream.

### 2.2.2 Informal Firms

The logic behind the behavior of the informal firms is similar to that of the formal firms except that any form of government regulation or policy parameter is being excluded. It follows that, in the informal sector, there will neither be firing costs nor setting up costs. The initial job value with an idiosyncratic productivity $x = 1$ in that case would be exactly equal to the capital value of a job in a continuing match over the no search interval i.e. if $Q_I < x \leq 1$, we formally have $J_I^0(1) = J_I^{NS}(1)$. $Q_I$ is the skill threshold that determines whether workers are on the job-search or not.

In the case of a high-productivity job i.e. $x > Q_I$, the only way the match can end is

if a new match with a specific shock $z$ arrives, and this shock is lower than the reservation threshold $R_I$. With a wage $w_I^{NS}(x)$, the expected profit of the job to the employer is:

$$\begin{aligned}(r+\delta)J_I^{NS}(x) &= p_I x - w_I^{NS}(x) + \lambda_I \int_{R_I}^{1} \left[\max\{J_I^{NS}(z), J_I^{S}(z)\} - J_I^{NS}(x)\right] dF_I(z) \\ &+ \lambda_I F_I(R_I)[V_I - J_I^{NS}(x)] \end{aligned} \tag{6}$$

When it's a bad low-productivity job, i.e. $x \leq Q_I$, on-the-job search towards the public sector becomes an outside option and threatens the match to end. The capital value to an employer $J_I^S(x)$ is therefore the solution of the asset-pricing equation:

$$\begin{aligned}(r+\delta)J_I^{S}(x) &= p_I x - w_I^{S}(x) + \int_{R_I}^{1} max\{J_I^{NS}(z), J_I^{S}(z)\} - J_I^{S}(x) dF_I(z) \\ &+ \lambda_I F_I(R_I)(V_I - J_I^{S}(x)) + \lambda_{IG}(V_I - J_I^{S}(x)) \end{aligned} \tag{7}$$

In the informal sector there are no policy parameters, the value of a vacant job is therefore:

$$rV_I = -p_I c + q_I(\theta_I) J_I^{NS}(1) \tag{8}$$

The free entry condition for informal firms therefore equates the cost of recruiting and the anticipated profit of the match to the employer:

$$\frac{p_I c}{q_I(\theta_I)} = J_I^{NS}(1) \tag{9}$$

### 2.3 Workers' Behavior

An employed worker can be either employed in the formal or the informal sector $i = F, I$ respectively. According to the level of productivity $x$, the worker decides whether to search on-the-job for better options in the public sector or not. The initial job value of a worker, $W_i^0(1)$, in sector $i = F, I$ is when the idiosyncratic component is at its highest value i.e. $x = 1$. This is expressed by the equation:

$$(r+\delta)W_i^0(1) = w_i^0(1) + \lambda_i \int_{R_i}^{1} \left[\max\{W_i^{NS}(z), W_i^{S}(z)\} - W_i^0\right] dF_i(z) + \lambda_i F(R_i)(U - W_i^0(1)) \tag{10}$$

For a continuing match, as the specific productivity $x$ is below the on-the-job search threshold of the sector, $Q_i$, the worker will be searching for better options in the public sector with an exogenous poisson rate of arrival of public sector offers $\lambda_{iG}$. The rate at which the public

sector hires workers is therefore specific to the sector $i$ where the worker is employed as he/she receives the offer. The worker's value $W_i^S(x)$ in that case solves the following asset pricing equation:

$$\begin{aligned}(r+\delta)W_i^S(x) &= w_i^S(x) + \lambda_i \int_{R_i}^{1} \left[\max\{W_i^{NS}(z), W_i^S(z)\} - W_i^S(x)\right] dF_i(z) \\ &+ \lambda_i F_i(R_i)(U - W_i^S(x)) + \lambda_{iG}(W_G - W_i^S(x)) \end{aligned} \tag{11}$$

If the specific productivity $x$ exceeds the threshold $Q_i$, the only outside option for the worker becomes unemployment. No on-the-job search takes place in that case. The worker's value over the no search interval is expressed by:

$$\begin{aligned}(r+\delta)W_i^{NS}(x) &= w_i^{NS}(x) + \lambda_i \int_{R_i}^{1} \left[\max\{W_i^{NS}(z), W_i^S(z)\} - W_i^{NS}\right] dF_i(z) \\ &+ \lambda_i F_i(R_i)(U - W_i^{NS}(x)) \end{aligned} \tag{12}$$

Being unemployed in this economy, the individual receives an imputed income $b > 0$. In the future, the unemployed can get hired by one of the three sectors, private formal, private informal or public. The following bellman equation therefore solves for the value of being unemployed, $U$:

$$(r+\delta)U = b + \theta_F q_F (W_F^0(1) - U) + \theta_I q_I (W_I^0(1) - U) + \lambda_{UG}(W_G - U) \tag{13}$$

By arriving to the public sector, the workers in our model are content with their jobs. In the model, the government employees are assumed not to be searching for jobs in the private sector[5]. Moreover, transitions from employment to unemployment are very rare among public sector workers and are therefore set to zero. Given that the public sector wage policy (offering a wage $w_g$) is assumed to be determined according to the government's exogenous budget, the value of an employed worker in the public sector is $W_G$, where

$$(r+\delta)W_G = w_g \tag{14}$$

[5]Evidence from the Egypt Labor Market Panel Survey for instance, in Assaad et al. (2016), has shown that transitions from the public sector to other sectors including the private sector (whether formal or informal) and non-wage work are very few, sometimes nil.

## 2.4 The Separation Rule

In the formal sector, given a match product shock $z$, a firm decides to destroy a job, whether within the on-the-job search or the no search interval, if and only if the value of holding it as a vacancy exceeds its value as a continuing job plus the firing costs $p_F T$. In other words, $V_F^j > J_F^j(z) + p_F T$, where $j = NS, S$. Similarly, a worker in the private sector prefers to stay unemployed if and only if $U > W_F^j(z)$. Since, under the wage rule, and as we will show below, $J_F^j(z)$ and $W_F^j(z)$ are increasing, separation occurs when a new value of the shock arrives and falls below a reservation threshold $R_F$. This reservation productivity $R_F$ is defined as $max\{R_{eF}, R_{wF}\}$, where $W_F^j(R_{wF}) = U$ and $J_F^j(R_{eF}) = V_F - p_F T$. The separation rule in our case, a bilateral bargain, should be jointly optimal in the sense that it maximizes the total wealth. The necessary and sufficient condition for this joint optimization is therefore $R_F = R_{eF} = R_{wF}$ implying that $J(R_F) + W(R_F) = V_F - p_F T + U$.

Similarly, the same reasoning applies to come up with the reservation threshold and the necessary and sufficient condition for the joint optimization in the informal sector. The only difference is that no firing costs should be paid by the employer as jobs are destroyed. It therefore follows that $R_I$ is defined as $max\{R_{eI}, R_{wI}\}$, where $W_I^j(R_{wI}) = U$ and $J_I^j(R_{eI}) = V_I$, with $j = S, NS$. The necessary and sufficient condition for the joint optimization would be $R_I = R_{eI} = R_{wI}$ leading to $J(R_I) + W(R_I) = V_I + U$.

## 2.5 On-the-job Search

After deriving the value of the surplus in every sector, as shown in appendix A, it becomes possible to determine the threshold at which workers would decide to search on-the-job or not. In the formal sector, the productivity threshold $Q_F$ is defined when the surplus obtained from a job with on-the-job search is equal to the surplus obtained from one with no search, such that $S_F^{NS}(Q_F) = S_F^S(Q_F)$. By doing so, one obtains

$$\lambda_{FG} S_F^S(Q_F) = \lambda_{FG}[p_F T + (W_G - U)] \tag{15}$$

which allows us to derive a unique value for $Q_F$, only if $\lambda_{FG} > 0$. If $\lambda_{FG} = 0$, the threshold $Q_F$ can not be defined. Using equations 15 and 46, the expression for $Q_F$, the on-the-job threshold in the formal sector, when $\lambda_{FG} > 0$ is :

$$Q_F = R_F + (r + \delta + \lambda_F + \lambda_{FG}) \left( T + \frac{W_G - U}{p_F} \right) \tag{16}$$

Similarly in the informal sector, the productivity threshold $Q_I$ is defined when the surplus obtained from an informal job with on-the-job search is equal to the surplus obtained from one with no search, such that $S_I^{NS}(Q_I) = S_I^S(Q_I)$. By doing so, one obtains

$$\lambda_{IG} S_I^S(Q_I) = \lambda_{IG}(W_G - U) \tag{17}$$

As in the formal sector, the $Q_I$ threshold is only defined if $\lambda_{IG} > 0$ and is consequently expressed as follows:

$$Q_I = R_I + (r + \delta + \lambda_I + \lambda_{IG})\frac{W_G - U}{p_I} \tag{18}$$

### 2.6 Nash Bargaining and Wage Determination

The wages are bargained, with $\beta$ being the worker's bargaining power and $1 - \beta$ the employer's, and $V_i = 0$ $(i = F, I)$ is set according to the free-entry condition. By using the definitions and expressions of surpluses derived in appendix A, we are able to build up the first order conditions of the standard wage optimization problem for each sector $i = F, I$, during the absence and presence of on-the-job search. For the initial wage of a job in the formal sector, we obtain

$$\beta(J_F^0(1) - V_F - p_F(C - H)) \quad = \quad 1 - \beta(W_F^0(1) - U) \tag{19}$$

For a continuing job in the formal sector, we derive the following equations:

$$\beta(J_F^S(x) - V_F - p_F T) \quad = \quad 1 - \beta(W_F^S(x) - U) \quad \text{for } x \leq Q_F \tag{20}$$

$$\beta(J_F^{NS}(x) - V_F - p_F T) \quad = \quad 1 - \beta(W_F^{NS}(x) - U) \quad \text{for } x > Q_F \tag{21}$$

Recalling that the initial wage in the informal sector is the same as the wage of a no-search job when $x = 1$, i.e. $w_I^0(1) = w_I^{NS}(1)$, the first order condition for an informal job is

$$\beta(J_I^{NS}(x) - V_I) \quad = \quad 1 - \beta(W_I^{NS}(x) - U) \quad \text{for } x > Q_I \tag{22}$$

$$\beta(J_I^S(x) - V_I) \quad = \quad 1 - \beta(W_I^S(x) - U) \quad \text{for } x \leq Q_I \tag{23}$$

Using the free entry conditions for the formal and informal sectors $\frac{p_F c}{q_F(\theta_F)} + p_F(C - H) = J_F^0(1)$ and $\frac{p_I c}{q_I(\theta_I)} = J_I^{NS}(1)$ respectively, we can re-write $(W_F^0(1) - U) = \frac{\beta}{1-\beta}\frac{p_F c}{q_F(\theta_F)}$ and

$(W_I^{NS}(1) - U) = \frac{\beta}{1-\beta}\frac{p_I c}{q_I(\theta_I)}$. This implies[6]:

$$(r+\delta)U = \frac{r+\delta}{r+\delta+\lambda_{UG}}(b + \frac{\beta c}{1-\beta}(\theta_F p_F + \theta_I p_I)) + \frac{\lambda_{UG}}{r+\delta+\lambda_{UG}} w_G \tag{24}$$

Introducing these results in the wage equations, we obtain the expressions for the initial wages and wages in continuing jobs in both the formal and informal sectors.

**Formal Sector.** The initial wage expression in the formal sector therefore becomes:

$$\begin{aligned} w_F^0(1) &= \beta\left[p_F + \tau - (r+\delta+\lambda_F)p_F(C-H) - \lambda_F p_F T + \frac{r+\delta}{r+\delta+\lambda_{UG}} c(\theta_F p_F + \theta_I p_I)\right] \\ &+ (1-\beta)\left[\frac{r+\delta}{r+\delta+\lambda_{UG}} b + \frac{\lambda_{UG}}{r+\delta+\lambda_{UG}} w_G\right] \end{aligned} \tag{25}$$

For the wages of jobs occupied by workers who are looking out for outside options in the public sector, i.e. $x \leq Q_F$

$$\begin{aligned} w_F^S(x) &= \beta\left[p_F x + \tau - (r+\delta+\lambda_{FG})p_F T + \frac{r+\delta+\lambda_{FG}}{r+\delta+\lambda_{UG}} c(\theta_F p_F + \theta_I p_I)\right] \\ &+ (1-\beta)\left[\frac{r+\delta+\lambda_{FG}}{r+\delta+\lambda_{UG}} b + \frac{\lambda_{UG}-\lambda_{FG}}{r+\delta+\lambda_{UG}} w_G\right] \end{aligned} \tag{26}$$

For a continuing match, when workers are not searching on the job, $x > Q_F$, we have:

$$\begin{aligned} w_F^{NS}(x) &= \beta\left[p_F x + \tau - (r+\delta)p_F T + \frac{r+\delta}{r+\delta+\lambda_{UG}} c(\theta_F p_F + \theta_I p_I)\right] \\ &+ (1-\beta)\left[\frac{r+\delta}{r+\delta+\lambda_{UG}} b + \frac{\lambda_{UG}}{r+\delta+\lambda_{UG}} w_G\right] \end{aligned} \tag{27}$$

As in the conventional Mortensen and Pissarides (1994) model, the wages of the formal sector depend on the policy parameters. By introducing the informal sector in the model, these wages not only depend on the labor market tightness in the formal segment of the market, but also on the labor market tightness in the informal sector. As the tightness $\theta_i$ increases in any of the sectors, the net share of match product obtained by the employer increases. Adding the public sector increases the bargained share of the worker. This is valid at the start of the job since now the outside option is not only being unemployed and receiving an imputed income $b$. It is now possible for an unemployed worker to get hired by the public sector and this therefore adds to his/her net share of the bargained wage. Moreover, the on-the-job search

[6]The expression of $W_G - U$ is obtained using the public sector worker's value function $(r+\delta)W_G = w_g$, allowing us to obtain $W_G - U = \frac{w_G - b - \frac{\beta c}{1-\beta}(\theta_F p_F + \theta_I p_I)}{r+\delta+\lambda_{UG}}$.

possibility acts as a liability to the employer. It therefore strengthens the worker's hand in the wage bargain.

**Informal Sector.** Similarly in the informal sector, the wages depend on the labor market tightness in both segments of the private sector, $\theta_I$ and $\theta_F$. Since the informal sector represents any form of employment that is not regulated by the government, the wages in this sector do not depend by any means on policy parameters. The outside option of getting hired by the public sector, however, strengthens the worker's bargain and acts as a tax or liability to the employer. The informal wage in a continuing match in the informal sector, when workers are searching on-the-job, i.e. $x \leq Q_I$, becomes:

$$w_I^{NS}(x) = \beta\left[p_I x + \frac{r+\delta}{r+\delta+\lambda_{UG}} c(\theta_F p_F + \theta_I p_I)\right] + (1-\beta)\left[\frac{r+\delta}{r+\delta+\lambda_{UG}} b + \frac{\lambda_{UG}}{r+\delta+\lambda_{UG}} w_G\right] \quad (28)$$

When, there is no on-the-job search, $x > Q_I$, the wage equation is defined as:

$$w_I^{S}(x) = \beta\left[p_I x + \frac{r+\delta+\lambda_{iG}}{r+\delta+\lambda_{UG}} c(\theta_F p_F + \theta_I p_I)\right] + (1-\beta)\left[\frac{r+\delta+\lambda_{iG}}{r+\delta+\lambda_{UG}} b + \frac{\lambda_{UG}-\lambda_{iG}}{r+\delta+\lambda_{UG}} w_G\right] \quad (29)$$

## 2.7 Equilibrium

**Definition 1** *The labor market equilibrium is defined by the labor market tightness in each segment of the private sector, $\theta_F$ and $\theta_I$, the reservation productivity threshold for each sector, $R_F$ and $R_I$, and the on-the-job search threshold in each sector, $Q_F$ and $Q_I$:*

$$\frac{p_F c_F}{q_F(\theta_F)} = (1-\beta)[\frac{p_F(1-R_F) - \lambda_{FG} p_F T - \lambda_{FG}(W_G - U)}{r+\delta+\lambda_F} - p_F(C - H + T)] \quad (30)$$

$$\frac{p_I c_I}{q_I(\theta_I)} = (1-\beta)[\frac{p_I(1-R_I) - \lambda_{IG}(W_G - U)}{r+\delta+\lambda_I}] \quad (31)$$

$$p_F R_F = (r+\delta)U - \tau - \lambda_F \int_{R_F}^{1} S_F(z) dF_F(z) - (r+\delta+\lambda_{FG}) p_F T - \lambda_{FG}(W_G - U) \quad (32)$$

$$p_I R_I = (r+\delta)U - \lambda_I \int_{R_I}^{1} S_I(z) dF_I(z) - \lambda_{IG}(W_G - U) \quad (33)$$

$$p_F Q_F = p_F R_F + (r+\delta+\lambda_F+\lambda_{FG})(p_F T + W_G - U) \quad (34)$$

$$p_I Q_I = p_I R_I + (r+\delta+\lambda_I+\lambda_{IG})(W_G - U) \quad (35)$$

*with* $(r+\delta)U = \frac{r+\delta}{r+\delta+\lambda_{UG}}(b + \frac{\beta c}{1-\beta}(\theta_F p_F + \theta_I p_I)) + \frac{\lambda_{UG}}{r+\delta+\lambda_{UG}} w_G$ *and* $W_G - U = \frac{w_G - b - \frac{\beta c}{1-\beta}(\theta_F p_F + \theta_I p_I)}{r+\delta+\lambda_{UG}}$. *See appendix A for the derivation of the expected surpluses.*

Using the wage equations (25)-(29), we plug them into the asset value equations, the job

creation, job destruction and on-the-job search conditions, in order to derive the overall market equilibrium.

The job destruction conditions (Equations (32) and (33)) suggest that at the worst possible surplus, whether for the formal or informal sector, the reservation productivity does not only depend on the possible gains from the match in the sector itself. It depends as well on the potential gains one could have from passing on eventually to a job in the public sector after being for a while in the formal or the informal sector. A worker might prefer having a low salary in the private sector i.e. a low reservation productivity $R_i$, whether formal or informal $i = F, I$, knowing that eventually he/she can access the public sector via this job. The Equations (34 and (35) show that the gaps between the two thresholds $R_i$ and $Q_i$ for $i = F, I$, are increasing functions of the surplus $(W_G - U)$ that a worker will obtain if he/she finds a job in the public sector.

**Steady-state Stocks.** Using definition 1 we can deduce the steady-sate labor market stocks. The entire Population of the economy, $Pop$, is sub-divided into four sub-populations: the unemployed $u$, the public sector employees $n_G$, the formal private sector wage workers $n_F$ and the informal private sector wage workers $n_I$:

$$1 = n_F + n_I + n_G + u \qquad (Pop) \tag{36}$$

Since the model is assumed to be in steady-state, for each sub-population, inflows are equal to outflows. This can be formalized by the following equations [7]

$$\delta n_G = \lambda_{UG} u + \lambda_{FG} n_F + \lambda_{IG} n_I \qquad (NG) \tag{37}$$

$$f_F u = \lambda_F F_F(R_F) n_F + \lambda_{FG} n_F \qquad (NF) \tag{38}$$

$$f_I u = \lambda_I F_I(R_I) n_I + \lambda_{IG} n_I \qquad (NI) \tag{39}$$

Given the above relationships, the number of workers hired in the public sector is given by the equation:

$$n_G = \frac{\lambda_{UG}}{\delta + \lambda_{UG}} + \frac{\lambda_{FG} - \lambda_{UG}}{\delta + \lambda_{UG}} \frac{f_F}{\lambda_F F_F(R_F) + \lambda_{FG}} u + \frac{\lambda_{IG} - \lambda_{UG}}{\delta + \lambda_{UG}} \frac{f_I}{\lambda_I F_I(R_I) + \lambda_{IG}} u$$

[7] $f_F$ and $f_I$ are the job finding rates in the formal and the informal sectors respectively. Formally, $f_F = \theta_F q_F(\theta_F)$ and $f_I = \theta_I q_I(\theta_I)$.

Finally the steady-state unemployment rate is obtained:

$$u = \frac{\delta(\lambda_I F_I(R_I) + \lambda_{IG})(\lambda_F F_F(R_F) + \lambda_{FG})}{\left[\begin{array}{c}(\lambda_I F_I(R_I) + \lambda_{IG})(\lambda_{FG} + \delta) f_F + (\lambda_F F_F(R_F) + \lambda_{FG})(\lambda_{IG} + \delta) f_I \\ +(\lambda_I F_I(R_I) + \lambda_{IG})(\lambda_F F_F(R_F) + \lambda_{FG})(\lambda_{UG} + \delta)\end{array}\right]} \tag{40}$$

**Policy.** It's important to note at this point that due to fiscal realities, even though the hiring and wage policies in the public sector are determined by the policy maker, they are limited and constrained by the government's budget. This is defined as $D$ such that

$$D = n_G(\lambda_{UG}, \lambda_{FG}, \lambda_{IG}) \times w_G \tag{41}$$

# 3 A Numerical Analysis of the Model

One of the main aims of this paper is to explain how the labor market equilibrium, particularly job creations and job destructions, in developing countries react as flexible employment protection is introduced in their markets, in a context where the share of public wage employment is substantially large to evict the impact of such labor market reforms. We use the case study of the Egyptian labor market as an application to demonstrate these effects. The introduction of the 2004 Labor Law [8] is modeled by a reduction of the firing taxes $T$, whereas the observed increase in the median real wages of the public sector employees (see Said (2015)) is modeled by an increase in $w_G$ and is compensated by a decline in the public sector hiring over the same period in order to take into account the budget constraint of the government[9]. We then show that our model is sufficient to explain the puzzle of the Egyptian labor market: building up on the empirical results of Langot and Yassin (2015), section 4 shows that as the firing taxes were reduced, only separations increased significantly, while job creations remained unchanged.

We present computed solutions to the model that provide some numerical feel for its policy implications. Parsimonious functional forms are assumed. We set some baseline parameters at reasonable values, as per previous literature as shown in table 1. Other baseline

[8] The Egypt labor law came to action in 2004 aiming at increasing the flexibility of the hiring and firing processes in Egypt. The law provides comprehensive guidelines for recruitment, hiring, compensation and termination of employees. It directly addresses the right of the employer to terminate an employee's contract and the conditions in which it performs under.

[9] Assaad (2014) show how the public sector hiring has been declining over the past decade in Egypt given the fiscal constraints faced by the government and hence the inability of the government jobs to absorb the queuing masses of job seekers.

parameters are structurally estimated, using transitions data moments (table 2) obtained from the ELMPS datasets [10], and by applying a simulated method of moments to match unemployment spell durations, the oversized share of the public sector and incidences typically experienced by the Egyptian workers in the different sectors.[11]

### 3.1 Calibrations

Following Mortensen and Pissarides (2001), the matching function of sector $i = F, I$ is log-linear. Formally, $q_i(\theta_i) = \chi_i \theta_i^{-\eta_i}$ where $\chi_i$ denote the scale parameter of the matching function and $\eta_i$ is the constant elasticity of each sector's matching function with respect to unemployment. The distribution of the idiosyncratic shock to match productivity is uniform over the interval $[\gamma_i, 1]$. We therefore have $F_i(x) = \frac{x-\gamma_i}{1-\gamma_i}$. The baseline parameter used for the policy cases under study are presented in Table 1.[12] This table also justifies the choice of the value of the exogenous baseline parameters. This could be chosen following previous search equilibrium literature, inspired by the data or modified to fit results that match the economy in question. The analysis considers only the case of an efficient equilibrium solution to the model, where $\beta = \eta$. Without any information on observed productivity and associated wages, we choose to normalize the productivity $\{p_F, p_I\} = \{1, 0.9\}$ and the outside option values $\{w_g, b\} = \{0.8, 0.7\}$. This calibration satisfies the intuitive ranking $p_F > p_I > w_g > b$.

We then use the labor market transitions data moments before the reform (table 2) as well as the the budget constraint which the government faces (as per the model described in section 2) and their equilibrium counterparts generated by the theoretical model to estimate the baseline parameters. More precisely, we estimate the baseline parameters that minimize a function of the difference between a chosen set of transitions moments from the data $\psi$ and data simulated with these values of structural parameters and the steady state solution of the model $\psi(\widetilde{\Theta})$. With $\Theta = \{\lambda_F, \lambda_I, \lambda_{FG}, \lambda_{IG}, \lambda_{UG}, \chi_F, \chi_I\}$ and $x^{SS} = \{\theta_F^{SS}, \theta_I^{SS}, R_F^{SS}, R_I^{SS}, Q_F^{SS}, Q_I^{SS}\}$,

[10] The ELMPS 1998, 2006 and 2012 are the first, second and third rounds of a periodic longitudinal survey that tracks the labor market and demographic characteristics of households and individuals in Egypt, interviewed in 1998. The households selected in the contemporaneous panel data are national-representative and randomly selected. Longitudinal annual retrospective panels are extracted to be able to compute the transition rates of male workers, ages 15-49, between the different employment and/or non-employment sectors, over the period 1999-2011. The recall and design bias, which these retrospective panels suffer from (Assaad et al., 2016), is corrected by using the markovian structure of these transitions by applying a simulated method of moments, as proposed by Langot and Yassin (2015).

[11] Section 4 provides empirical evidence on the labor market transition probabilities in the Egyptian labor market over the period 1999-2011 (i.e before and after the reform). Yassin (2015) also provides detailed descriptive statistics in the labor market transition probabilities, sectors' shares and unemployment rates obtained from the Egypt Labor Market Panel Survey, fielded in 2012. Some of these descriptive statistics provide guidelines in our numerical analysis to choose the baseline parameters.

[12] Because these policy tools are not relevant for the Egyptian case, we set $H = \tau = 0$.

| Parameters | Benchmark | Reason for setting this value |
|---|---|---|
| Worker Bargaining power $\beta$ | 0.5 | To obtain an efficient equilibrium solution |
| Interest rate $r$ | 0.09 | Average interest rate in Egypt over the studied period of time |
| Cost of maintaining a vacant formal job $c_F$ | 0.3 | Mortensen and Pissarides (2001) |
| Cost of maintaining a vacant informal job $c_I$ | 0.3 | Mortensen and Pissarides (2001) |
| Cost of Setting up a job in the formal sector $C$ | 0.3 | Mortensen and Pissarides (2001) |
| Government's budget $D$ | 0.23 | Average share of public sector $\times$ public sector wage |
| Duration Elasticity (Formal Sector) $\eta_F$ | 0.5 | Petrongolo and Pissarides (2001) |
| Duration Elasticity (Informal Sector) $\eta_I$ | 0.5 | Petrongolo and Pissarides (2001) |
| Firing Tax $T$ | 1.6 | 2 years of the average wage |
| Lower productivity shock support (Formal) $\gamma_F$ | 0 | assumed nil |
| Lower productivity shock support (Informal) $\gamma_I$ | 0 | assumed nil |
| Exit rate from participation $\delta$ | 0.033 | 30 years as average duration of a worker in the job market |

Table 1: Exogenous Baseline parameters

we obtain $\hat{\Theta} = \text{argmin}_{\Theta}||g(x^{SS}, \widetilde{\Theta})||$, where

$$g(x^{SS}, \Theta) = \left\{ \begin{bmatrix} JFR_F \\ JFR_I \\ JSR_F \\ JSR_I \\ JTJ_F \\ JTJ_I \\ JFR_G \\ D \end{bmatrix} - \begin{bmatrix} \theta_F^{SS}\widetilde{\chi}_F(\theta_F^{SS}) \\ \theta_I^{SS}\widetilde{\chi}_I(\theta_I^{SS}) \\ \widetilde{\lambda}_F F_F(R_F^{SS}) \\ \widetilde{\lambda}_I F_I(R_I^{SS}) \\ \widetilde{\lambda}_{FG} F_F(Q_F^{SS}) \\ \widetilde{\lambda}_{IG} F_I(Q_I^{SS}) \\ \widetilde{\lambda}_{UG} \\ n_G(\widetilde{\lambda}_{UG}, \widetilde{\lambda}_{FG}, \widetilde{\lambda}_{IG}) \times w_G \end{bmatrix} \right\} \equiv \left[\psi - \psi\left(\widetilde{\Theta}\right)\right] \quad (42)$$

and such that $x^{SS}$ is the steady state solution of the model's job creation, destruction and on-the-job search conditions given by the equations 30, 31, 32, 33, 34 and 35 respectively. The results are reported in table 2.

| Type of Transition ($\psi$) | Average rate over 1999-2003 | Parameters ($\Theta$) | Estimated values |
|---|---|---|---|
| $JFR_F$ | 0.0105 | Reallocation Shock (Formal) $\widehat{\lambda}_F$ | 0.0216 |
| $JFR_I$ | 0.0597 | Reallocation Shock (Informal) $\widehat{\lambda}_I$ | 0.0464 |
| $JSR_F$ | 0.0110 | Transition from Formal to Public $\widehat{\lambda}_{FG}$ | 0.0124 |
| $JSR_I$ | 0.0360 | Transition from Informal to Public $\widehat{\lambda}_{IG}$ | 0.0126 |
| $JTJ_F$ | 0.0127 | Transition from unemployment to Public $\widehat{\lambda}_{UG}$ | 0.0150 |
| $JTJ_I$ | 0.0110 | Matching Efficiency (Formal) $\widehat{\chi}_F$ | 0.0695 |
| $JFR_G$ | 0.0163 | Matching Efficiency (Informal) $\widehat{\chi}_I$ | 0.1671 |

1. $JFR_i$ refers to the empirical job finding rate, $JSR_i$ refers to the empirical job separation rate, where $i = F, I, G$, and $JTJ_j$ refers to the rate of transition from sector $j$, where $j = F, I$, to the public sector ($G$).

2. The table reports the average corrected annual transition rates over the period 1999-2003, i.e. before the reform came to action. These are calculated by the authors using a retrospective longitudinal panel obtained from the ELMPS 1998,2006 and 2012.

3. We consider non-employment state (i.e. both unemployment and inactivity) to obtain these data moments.

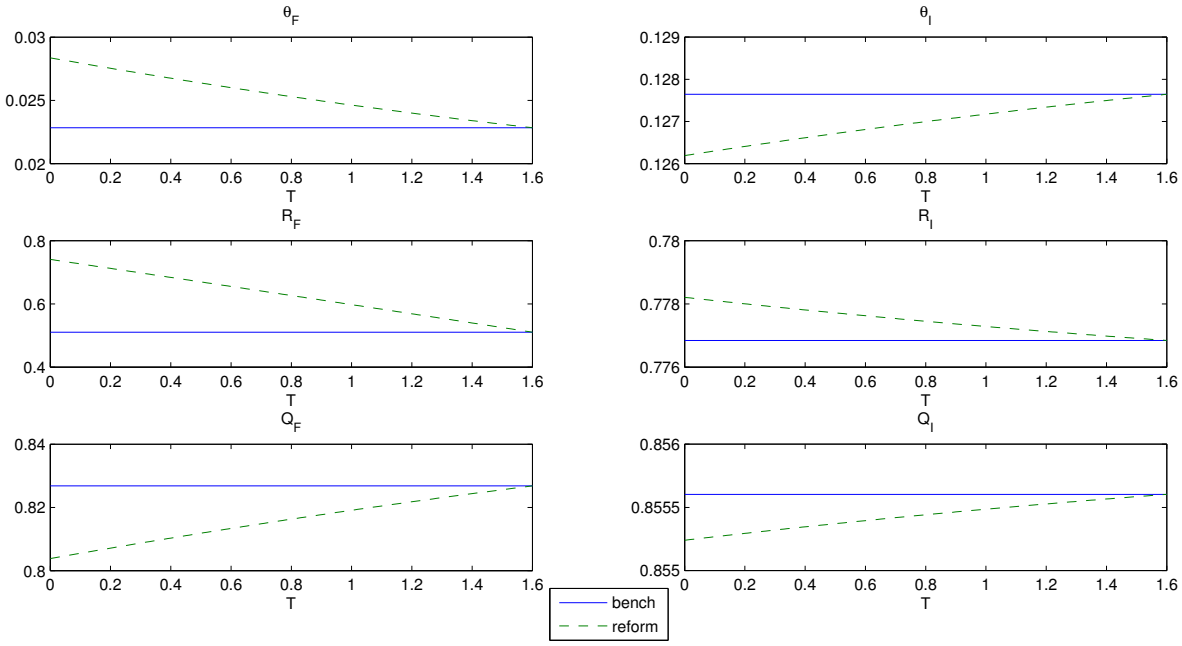
Table 2: Data Moments obtained from ELMPS datasets

## 3.2 The quantitative impacts of the reforms

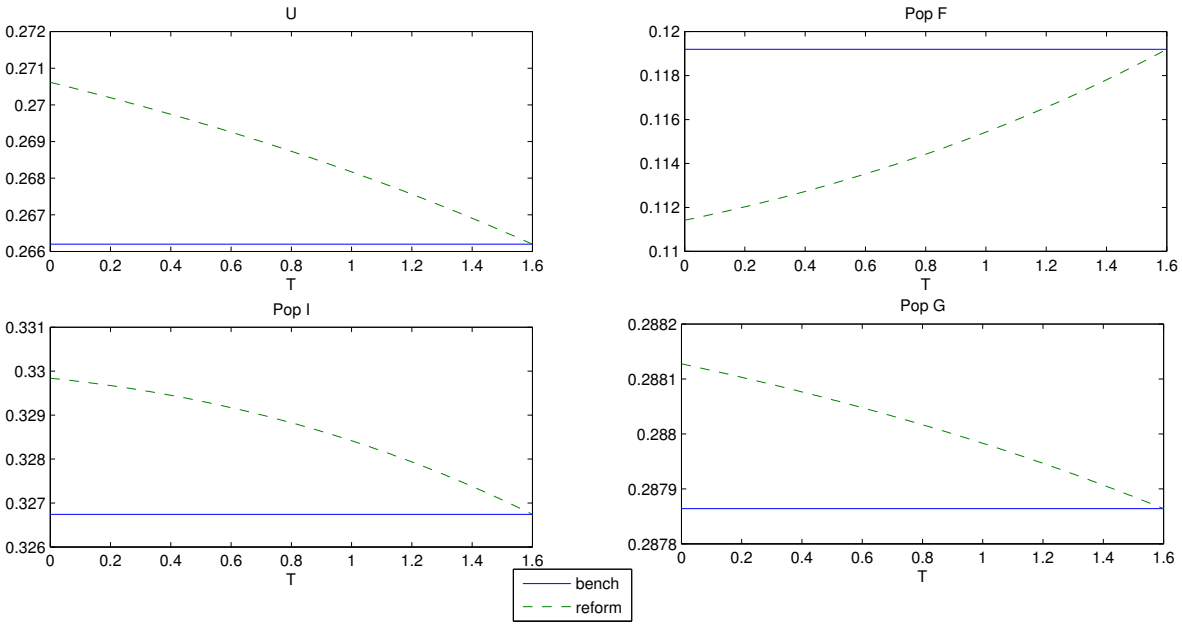
### 3.2.1 The impact of the liberalization of the labor market

The Egypt Labor Law, implemented in 2004, introduced lower levels of employment protection in the Egyptian Labor market. This is modeled as a reduction in the firing tax $T$. In Figure 1, we show the impact of decreasing the firing taxes on the steady-state labor market outcomes. The blue solid lines represent the reference economy obtained with $T = 1.6$.

We note that both separations in the formal and informal sectors increase, since both $R_F$ and $R_I$ (the reservation productivity levels) shift upwards after the reform. The increase in separations is proportional in magnitude to the decrease in the firing taxes, i.e the larger the reduction in Taxes, the larger the increase in job destruction. For the job creations, the story is different. As suggested by the conventional Mortensen and Pissarides (1994) model, the decrease in the firing tax leads to an increase in the job creations of the formal sector. This is the direct effect, corresponding to the shift of the job creation curve in the plane (labor market tightness, reservation productivity) which always dominates the reduction of the employment duration implied by the increase in the separation (the shift of the job destruction curve in the plane (labor market tightness, reservation productivity)). Extending the model to include the informal sector, shows that such a reform decreases the job creations in the informal sector: the new opportunities in the formal sector push up the real wages in all sectors, and hence reduces the hiring in the sector where this increase of labor costs is not over-compensated by a reduction of tax (the firing taxes in the formal sector). The reform, therefore scales down the difference between the formal and informal sector by shifting employment and favoring the formal sector. Moreover, our simulations show that decreasing firing taxes reduces substantially the on-the-job search of private formal workers towards the public sector jobs. It is shown that if the decrease in $T$ is huge, the share of workers on-the-job search in the formal sector, described by the difference between $Q_F$ and $R_F$, might be very small. This is mainly driven by the combined effect of the small decrease in the on-the-job search threshold $Q_F$ along with a substantial increase in the reservation productivity $R_F$ for a given $dT$. In the informal sector, on-the job search towards the public sector almost remains unchanged or slightly decreases, following a relatively small increase in the reservation productivity $R_I$ and almost no change in the on-the-job search threshold $Q_I$. Figure 1 also shows that following the reduction in firing taxes, overall steady-state unemployment shifts upwards.




(a) Steady State Outcomes (Before and After Reform)




(b) Labor market stocks (Before and After Reform)

Figure 1: Impact of reducing firing Taxes, keeping all other baseline parameters constant

### 3.2.2 The crowding-out impact of the wage policy in the public sector

Evidence from Said (2015) has shown, however, that during the period 1998-2006, i.e. during the time period where the reform came into action, there has been a relatively higher increase in the median real wages of public sector employees. Said (2015) shows that there has been a 40% increase in the median real monthly wages of government employees and a 26% increase in the median real monthly wages of public firms' employees, as opposed to only a 9% increase in the median real wage of the private sector.

**New hiring policy of the Government.** The government is constrained by a budget ($D$) that does not change after the decision to increase the wages of the public sector employees. In order to calibrate the necessary changes in its hiring policy allowing to keep its expenditures constant after the wage increase, we assume that *(i)* this constraint is satisfied ex ante and *(ii)* all the contact rates from government are changed in the same proportions $\lambda'_{iG} = \kappa\lambda_{iG}$, for $i = F, I, U$. Thus, we deduce that:

$$\begin{aligned} n'_G &= \frac{\lambda_{UG}}{\delta + \kappa\lambda_{UG}} + \left( \frac{\lambda_{FG} - \lambda_{UG}}{\delta + \kappa\lambda_{UG}} \frac{JFR_F}{JSR_F + \kappa\lambda_{FG}} + \frac{\lambda_{IG} - \lambda_{UG}}{\delta + \kappa\lambda_{UG}} \frac{JFR_I}{JSR_I + \kappa\lambda_{IG}} \right) \kappa u' \\ \text{with} \quad u' &= \frac{\delta(JSR_I + \kappa\lambda_{IG})(JSR_F + \kappa\lambda_{FG})}{\left[ \begin{array}{c} (JSR_I + \kappa\lambda_{IG})(\kappa\lambda_{FG} + \delta)JFR_F + (JSR_F + \kappa\lambda_{FG})(\kappa\lambda_{IG} + \delta)JFR_I \\ +(JSR_I + \kappa\lambda_{IG})(JSR_F + \kappa\lambda_{FG})(\kappa\lambda_{UG} + \delta) \end{array} \right]} \end{aligned}$$

Given these constraints and the ex-ante information of $\{JFR_F, JFR_I, JSR_F, JSR_I\}$, the parameter $\kappa$ is estimated using $D = n'(\kappa)w'_G$. Hence, this estimated value for $\kappa$ is obtained using the labor market flows before the liberalization and before the increase of the wage of the public sector employees: its value depends only on the choice of $w_G$. The results and the evolution of $\lambda_{iG}$, for $i = F, I, U$, as the public sector wage increases, are reported graphically in figure 2.

**Implications for the labor market.** In figures 3, we show how the steady-state labor market outcomes vary in response to only a variation in the public sector wages. The blue lines therefore represent the reference economy obtained using the baseline parameters. In order to better explain the mechanisms at work, we first remove the firing tax $T = 0$, reflecting a case where the market has been totally liberalized by the reform. Interestingly, the increase in public sector wages shows opposite effects to the decrease in firing costs on the reservation productivity levels of both sectors $R_F$ and $R_I$: they both decrease.

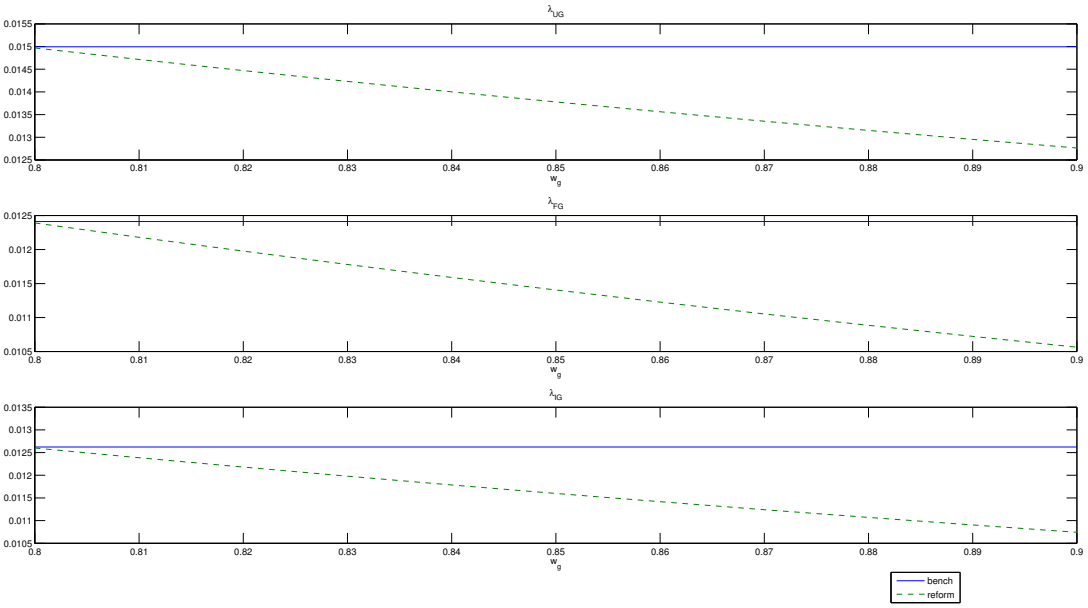
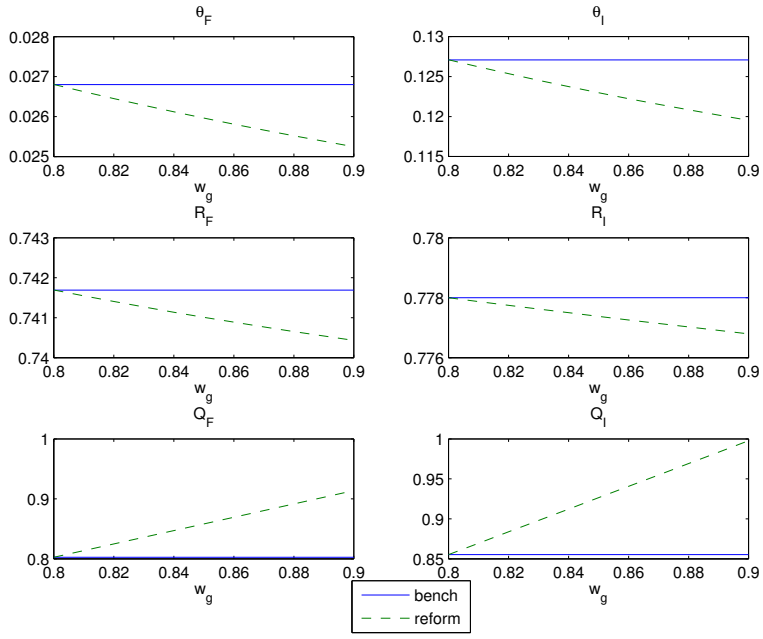


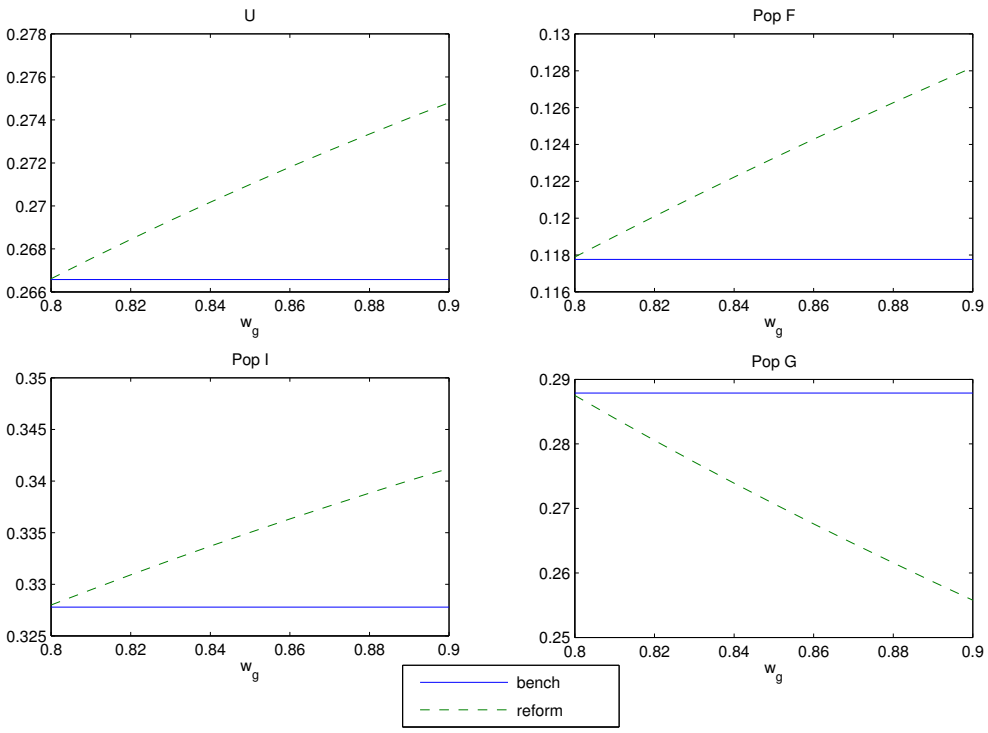

Figure 2: Evolution of $\lambda_{iG}$, $i = F, I, U$ as $w_G$ increases

As has been explained in the theoretical model, when the public sector jobs become more attractive, the reservation productivities $R_F$ and $R_I$ are pushed downwards. Consequently, increasing the public sector's wages while keeping all other parameters constant, separations are dampened in both sectors. It is interesting for workers to stay temporarily in these private sector jobs knowing that eventually there are potentials to move to the public sector. It is worth noting that it might be possible however, that even if the public sector wages increase, in case the hiring rate encounters a substantial relative decrease, in other words $\lambda_{iG}$ is very elastic, there exists less potential to move to public sector jobs. In that case the reservation productivities might on the contrary increase or remain unchanged. Figure 4 shows an example to this possible phenomenon. This shows the response of the steady-state labor market outcomes to only a variation in the public sector wages at a higher level of firing tax $T = 1.6$ i.e. a more rigid formal employment sector.

Figures 3 and 4 also show that job creations in both private formal and informal sectors are discouraged. Indeed, following the rise of $w_G$, it becomes more attractive for all workers to search for better options and potential jobs in the Public sector: the expected employment duration is reduced, leading to a lower incentive for private firms to post vacancies. This decrease is non-linear depending on the way job finding rate in the public sector decreases. Generally, by raising its attractiveness, the public sector reduces the expected employment duration of each job, and hence the expected surplus. This implies that $\theta_F$ and $\theta_I$ decrease.

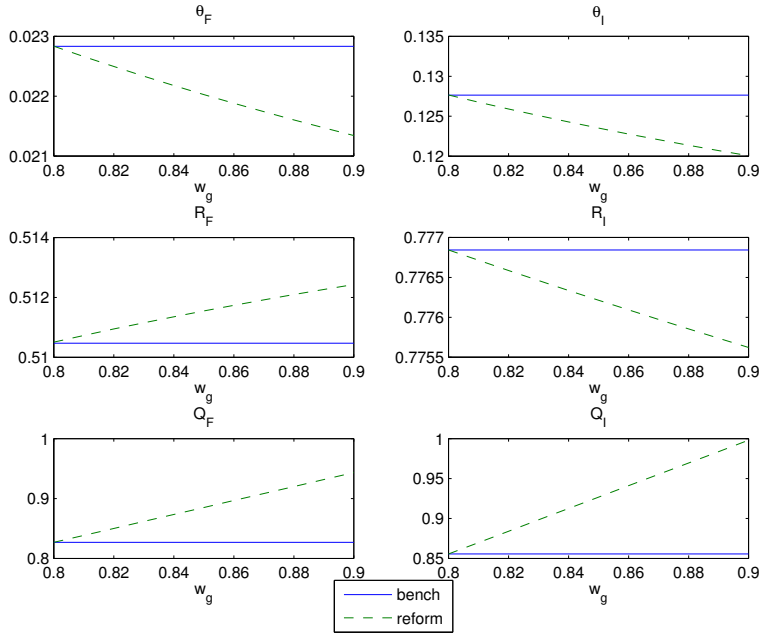



(a) Steady State Outcomes (Before and After Reform)

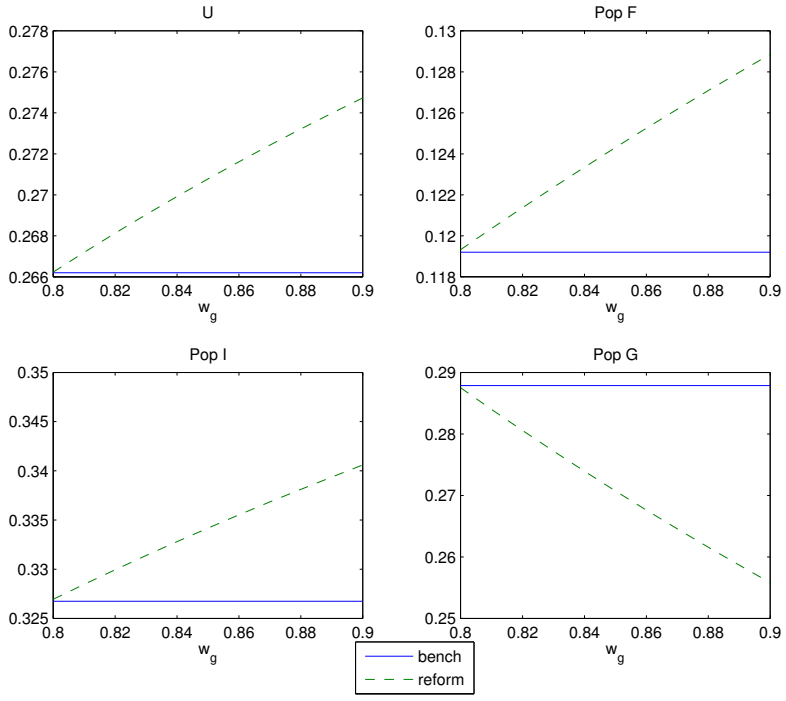



(b) Labor market stocks (Before and After Reform)

Figure 3: Impact of an increase in public sector wages, after the market has been totally liberalized ($T = 0$), keeping all other baseline parameters constant




(a) Steady State Outcomes (Before and After Reform)




(b) Labor market stocks (Before and After Reform)

Figure 4: Impact of an increase in public sector wages, in a market with rigid regulations ($T = 1.6$), keeping all other baseline parameters constant

On-the-job search in both sectors also increases, given that workers can now gain more with higher wages in the public sector.

### 3.2.3 The impact of a simultaneous change in $T$ and $w_g$

Figures 5 and 6 show results using a three-dimensional display of the impact of simultaneous variations of firing taxes and public sector wages on steady-state outcomes. The main results of these simulations can be summarized as follows: if the government liberalizes the formal labor market and, at the same time, raises the wages of the public sector employees, it reduces a tax on one hand and increases another, on the other hand. Hence, nothing changes in the economy, except the job separation rate of the formal jobs, which is directly impacted by the decrease in $T$.

For the match surplus the net effect of these opposite policies is ambiguous: by reducing the firing taxes, the surplus and consequently the incentive to hire rise, but at the same time the increased attractiveness of the public sector reduces the time horizon of a new job, and thus the incentive to create it. Figure 5 shows that the positive effects on job creations resulting from the liberalization of the labor market, are dampened by an increase in the public sector wage. Indeed, the on-the-job search towards the public sector is encouraged in both sectors the formal and informal, thanks to the rise in $w_G$. This is obvious in figure 5, showing the large increases in $Q_F$ and $Q_I$. Overall for the formal sector's separations, i.e. $R_F$ (Figure 5), there has been a substantial increase following the simultaneous decrease in the firing tax and the increase in public sector wage. This is however mainly driven by the introduction of flexible regulations. The increase in the public sector wage, accompanied by a decrease in the public sector hiring had almost no effect, possibly a very slight decrease, on the reservation productivity in the formal sector.

Overall, separations in the informal sector almost remain unchanged or slightly increase. Job creations in the informal sector are reduced, given the combined effect of both the liberalization reform and the increase in the public sector wage. Nevertheless the decrease is only substantial, because the two policies (the reduction of the firing tax, and the increase of the wages of the public sector employee) act in opposite directions.

These theoretical mechanisms possibly provide an explanation to the empirical results obtained on the aggregate level in (Langot and Yassin, 2015) showing that although the Egypt labor law came into action in 2004, overall job findings remain unchanged afterwards (Figure 7). In all cases, steady-state unemployment increases after the change in both parameters.

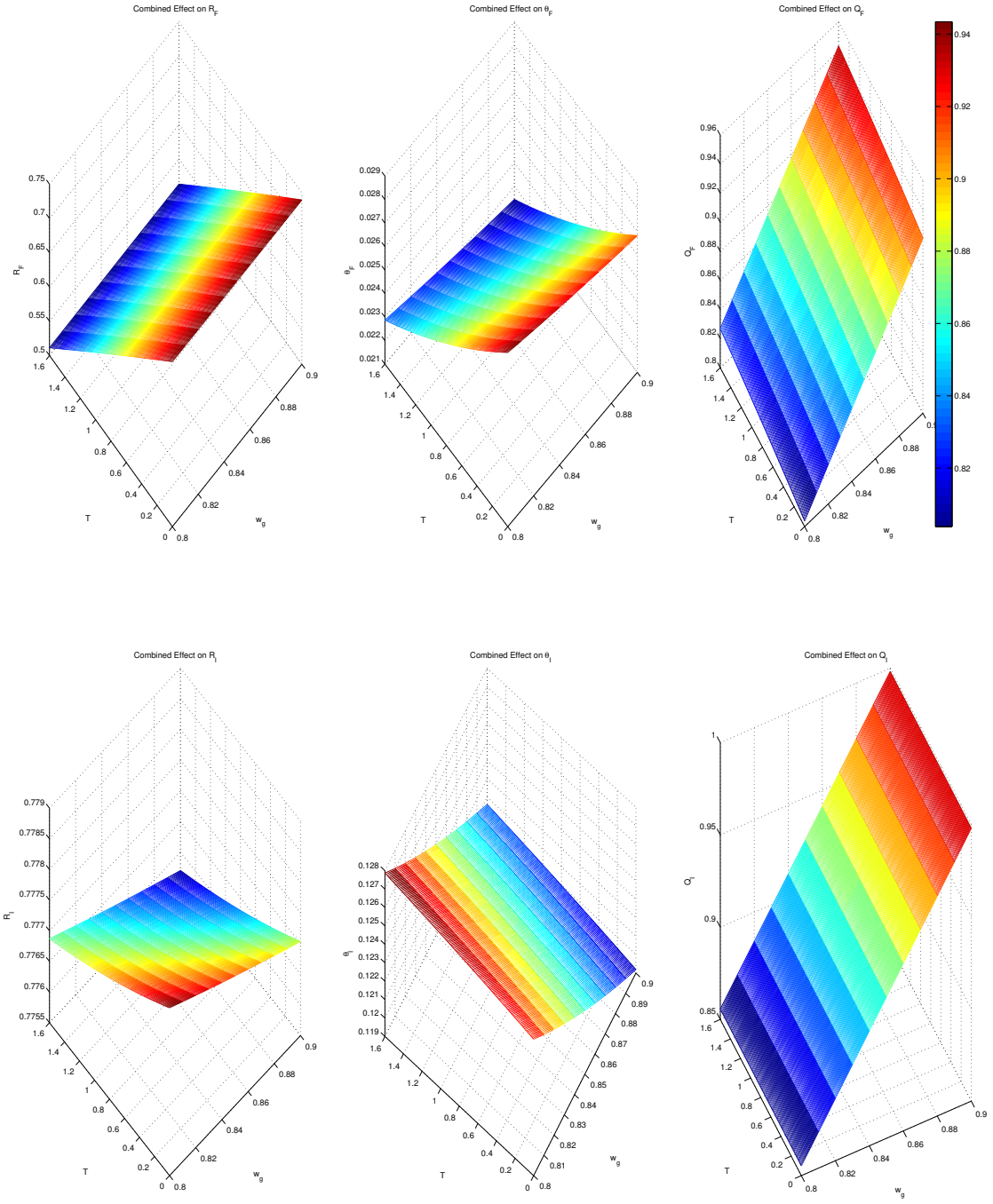



Figure 5: Impact of changing $T$ and $w_G$ on Steady-state outcomes

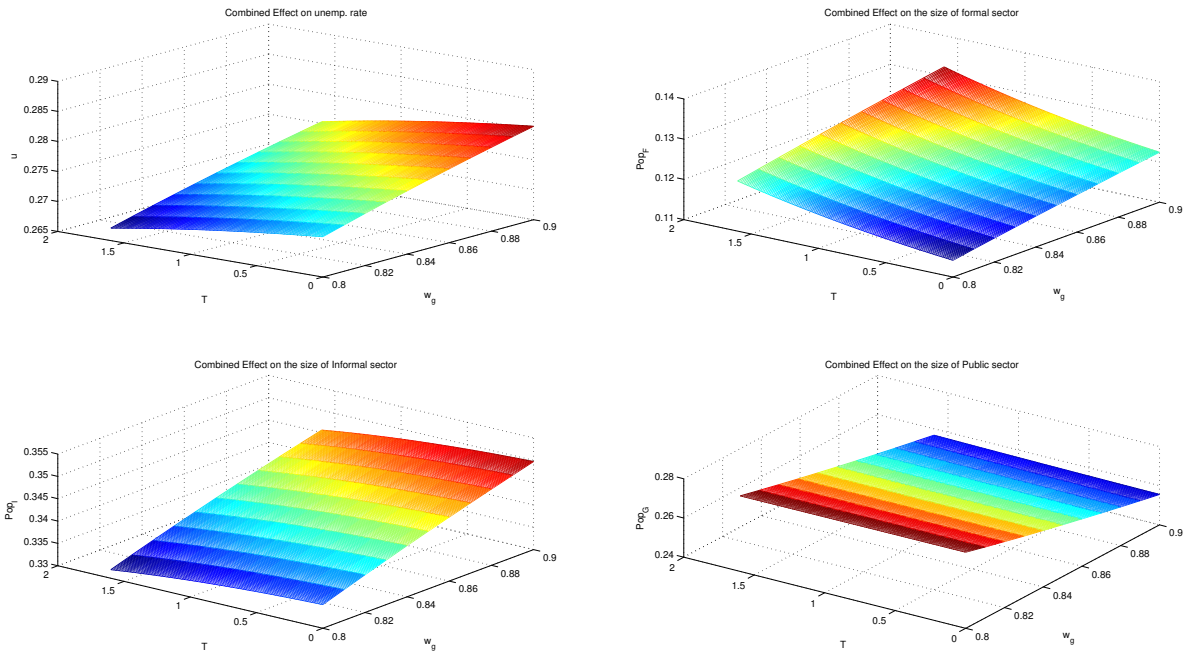
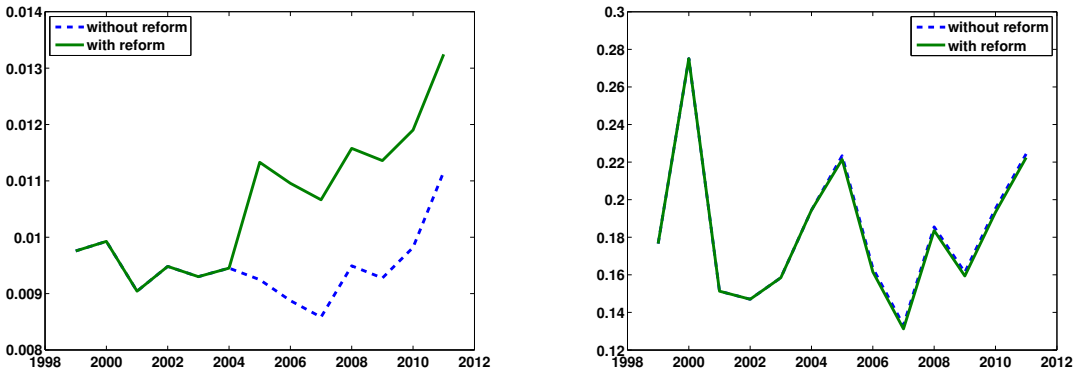



Figure 6: Impact of changing $T$ and $w_G$ on Steady-state outcomes




(a) Separation rate

(b) Job finding rate

Figure 7: Job Finding and Separation Rates with and without the new labor market reform in 2004, courtesy of Langot and Yassin (2015)

# 4 Empirical Evidence from Egypt

In this section, we use the Egypt Labor Market Panel Survey, fielded in 2012 to extract a longitudinal retrospective panel for the period 1998-2011. This allows us to construct the time series for the labor market flows before and after the reform. The data also allows us to categorize employed workers by sector of employment namely, public, formal and informal wage work[13]. Given these flows, we use the econometric methodology described in Langot and Yassin (2015) to purge the time series of each type of transition from the the macroeconomic trend. The reform is then detected as a structural break in the series. This estimation allows us to construct the counterfactual time series if the reform has not been implemented in 2004. To be able to estimate the impact of the reform on each type of flow, it would be necessary to use a regression such as $x_t - x_t^\star = \alpha(y_t - y_t^\star) + \beta + \epsilon_t$, for $x = s_F, s_I, f_F, f_I, \lambda_{FG}, \lambda_{IG}$ and where $x_t$ and $x_t^\star$ represent the current values and the natural rates of the labor market flows (whether job finding $f_i$, separation $s_i$ or transitions towards the public sector $\lambda_{iG}$, for $i = F, I$). $y_t$ is the log of the observed output and $y_t^\star$ is the log of the potential output. The left-hand side term represents the flow gap, whereas $y_t - y_t^\star$ captures the output gap (the difference between the observed and potential real GDP, which captures the cyclical component of the output). Likewise, the difference between the observed and natural rate of job finding and the job separation represent the cyclical rate of worker flows. We approximate $y_t - y_t^\star$ by the first difference of the observed output $\Delta y_t$ and we assume that the natural rates of the different labor market transitions are constant over time, i.e. $x_t^\star = x^\star$, $\forall t$. This leads us to use the following regression:

$$x_t = \alpha \Delta y_t + b + \mathbb{I}_a \gamma + \epsilon_t \quad \text{for } x = s_F, s_I, f_F, f_I, \lambda_{FG}, \lambda_{IG} \tag{43}$$

with $b = \beta + x^\star$ and where the instability of the natural rate of labor market transition implied by the reform is captured by $\gamma$, given that $\mathbb{I}_a$ indicates the year of the reform.

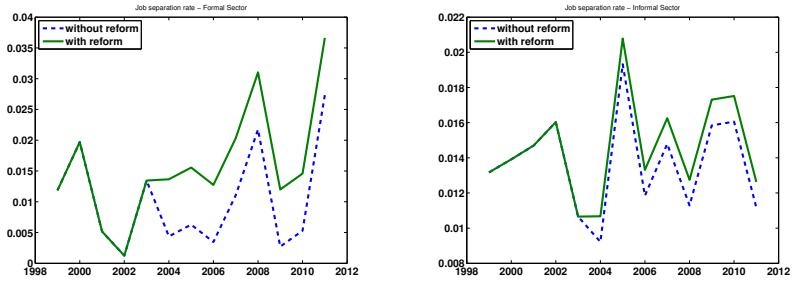
The estimations reported in table 3 show the results of running the regressions of equation (43), which allow us to test for the impact of the policy change in 2004 on the natural rate of worker flows. The figures 8, 9 and 10 display the time series of the labor market flows and

[13] It has been shown in Assaad et al. (2016) and Langot and Yassin (2015) that the retrospective panel extracted from the ELMPS 2012 suffer from a recall and design bias. Moreover, Assaad et al. (2016) and Yassin (2016) show that the characteristics of the sample are not kept random as we go back in time. Following the correction methodology based on matching population moments, from other rounds in 2006 and 1998, (Langot and Yassin, 2015) and creating differentiated weights (Yassin, 2016), we are able to reconstruct corrected flows between the employment sectors as well as unemployment. See Yassin (2015) for the raw labor market flows obtained form the ELMPS12 dataset. The regressions in this section use the corrected flows.

| | $s_F$ | $s_F$ | $s_I$ | $s_I$ | $f_F$ | $f_F$ | $f_I$ | $f_I$ | $\lambda_{FG}$ | $\lambda_{FG}$ | $\lambda_{IG}$ | $\lambda_{IG}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\alpha$ | 0.116 | -0.250 | 0.065 | 0.022 | 0.628 | 0.307 | -0.363 | 0.143 | -0.064 | -0.082 | -0.025 | -0.041 |
| $b$ | 0.016*** | 0.010** | 0.024*** | 0.014*** | 0.044*** | 0.052*** | 0.010*** | 0.010*** | 0.010*** | 0.011*** | 0.009*** | 0.009*** |
| $\gamma$ | | 0.009* | | 0.002 | | -0.011 | | -0.000174 | | -0.002 | | 0.001 |

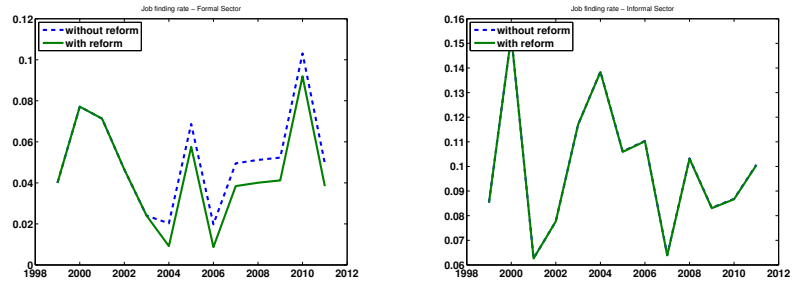
Table 3: OLS regression results showing the impact of Egypt 2004 New Labor Law on Labor market flows

their counterfactual counterparts.




(a) Formal Sector (b) Informal Sector

Figure 8: Impact of Egypt 2004 New Labor Law on Separations of the Formal and Informal Sector

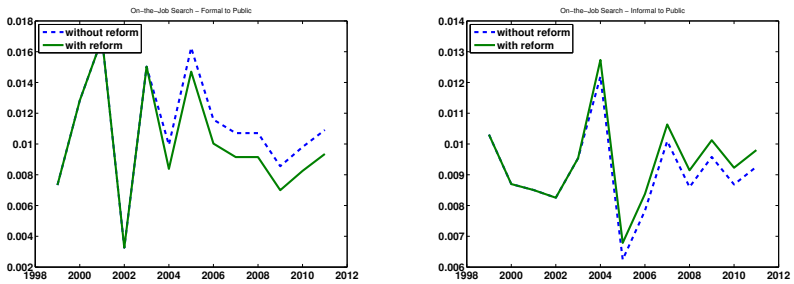



(a) Formal Sector (b) Informal Sector

Figure 9: Impact of Egypt 2004 New Labor Law on Job Findings of the Formal and Informal Sector

The results of these regressions using the ELMPS 2012 show that only the separations in the formal sector increased significantly after the reform. The impact on all other flows are insignificant[14]. These results are however in accordance with the theoretical model. Indeed, the direction of change in the natural rates of these flows is coherent with the theoretical model presented in the previous section. Separations in both sectors increased showing that the effect of the reduced firing taxes has dominated in that case. Findings in both sectors

[14]This can be due to the fact that we're over exploiting the data by detailing the transitions between the different employment sectors, given the structure of the dataset and the samples' sizes discussed in Yassin (2015) and Assaad et al. (2016).




(a) Formal to Public (b) Informal to Public

Figure 10: Impact of Egypt 2004 New Labor Law on the On-the-Job Search towards the Public Sector

remain constant or slightly retreated. For the informal sector, this is due to both the decrease in the firing taxes as well as the increase in the public sector wages. For the formal sector, it shows that the job creations were still taxed by the increase in the public sector wage even though the hiring has declined. Workers considering on-the-job search are now more than before. Interestingly however, this was not followed by more people really moving to the public sector. On the contrary, actual transitions occurring to the public sector from the formal sector decreased. This comes however from the two contradicting forces acting in two different directions: where decreasing firing taxes discouraged transitions to the public sector while increasing public sector wage encouraged them. Since the firing taxes do not have any effect on the on-the-job search towards the public sector in the informal jobs, these increased following the rise in the public sector wage.

# 5 Conclusion

The segmented nature of labor markets in developing countries in general, and in the MENA region in particular, plays an important role in their lack of dynamism. High levels of public sector employment are also used as part of the authoritarian bargain, where public employment has always been exchanged for political acquiescence under authoritarian regimes (Assaad, 2014). With an aim to portray the nature of labor markets in developing countries, we extend the Mortensen-Pissarides model to add to the conventional private formal sector, both a public and an informal wage employment sectors. The public sector is added as an exogenous player where wage and employment policies are decided exogenously by the policy maker. These are however constrained by the government's budget. The model shows the different interactions between the sectors, and particularly endogenizes job creations, job

destructions as well as on-the job search towards public employment, in both the formal and the informal sectors.

One example of a reform attempting but struggling to encourage dynamism in the MENA labor markets is observed in the case of Egypt. In Egypt, a new labor law (Law 12 of 2003) was enacted with the goal of increasing the dynamism of the private sector by making hiring and firing workers easier. Nevertheless, in the data, only separations increased significantly while job findings hardly change. Our model is able to explain this partial failure of the reform, by modelling the particular nature of a labor market of a developing country such as Egypt, due to the existence of informal sectors and taking into account the strategies of the public employer. Firstly, we show that a liberalization of the private formal sector, leading to an increase in the formal job creations accompanied by a decrease in the informal job creations, would result in an ambiguous impact on the aggregate job creations depending on the magnitude of each variation. Secondly, we show that the increase in the public sector wages tends to nullify the positive effects on the private formal sector's job creations induced by the liberalization of the formal sector. It might even reduce it, even if this has been accompanied by less hiring in the public sector, due to fiscal realities. Hence, our model explains the empirical paradox of the Egyptian case: after the liberalization of the labor market, only job separations increase and job findings remain unchanged. The 2004 reform achieves its mission in liberalizing the market by favoring the formal sector against the informal, boosting both its job creations and separations. But, these positive effects, and particularly the increase in job creations, have been nullified and even dampened by raising the levels of the public sector wages at the same time. The increase in the public sector wages acts as an extra taxation to the job creations in the private (formal and informal) sector.

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# A Deriving the Market's Surplus

## A.1 Formal Sector

The initial surplus in the formal sector is defined as $S_F^0 = J_F^0 - V_F - p_F(C-H) + W_F^0(1) - U$, while the continuing job surplus is $S_F(x) = max\{J_F^{NS}(x) + p_F T - V_F + W_F^{NS}(x) - U, J_F^S(x) + p_F T - V_F + W_F^S(x) - U\}$.

At the time of the hiring, when the idiosyncratic component is at its highest value $x = 1$, the initial match surplus in the formal sector is therefore :

$$\begin{aligned}(r+\delta+\lambda_F)S_F^0(1) &= p_F + \tau + \lambda_F \int_{R_F}^{1} S_F(z)dF_F(z) - (r+\delta)(U+V_F) \\ &- (r+\delta+\lambda_F)p_F(C-H) - \lambda_F p_F T \end{aligned} \tag{44}$$

For a continuing match, and in case on-the-job search takes place i.e. if $x \leq Q_F$, the surplus of the job, $S_F^S(x)$ solves the following equation:

$$\begin{aligned}(r+\delta+\lambda_F+\lambda_{FG})S_F^S(x) &= p_F x + \tau + \lambda_F \int_{R_F}^{1} S_F(z)dF_F(z) + (r+\delta+\lambda_{FG})p_F T \\ &- (r+\delta)(V_F+U) + \lambda_{FG}(W_G - U) \end{aligned} \tag{45}$$

If $x > Q_F$, the workers do not search on-th-job for better options in the public sector. The only outside option in this case is the destruction of the job and the worker becoming unemployed. The surplus, $S_F^{NS}(x)$, in this case solves the following equation:

$$(r+\delta+\lambda_F)S_F^{NS}(x) = p_F x + \tau + \lambda_F \int_{R_F}^{1} S_F(z)dF_F(z) - (r+\delta)(V_F - p_F T + U)$$

Since the separation rule has to maximize the total wealth in a bilateral agreement, we know that $J(R_F) + W(R_F) = V_F - p_F T + U$ , where $j = S, NS$. It follows that $S_F^j(R_F) = 0$. This allows us to derive $S_F^S(x)$ as

$$S_F^S(x) = \frac{p_F(x - R_F)}{r+\delta+\lambda_F+\lambda_{FG}} \tag{46}$$

and $S_F^{NS}(x)$ as

$$S_F^{NS}(x) = \frac{p_F(x - R_F) - \lambda_{FG}p_F T - \lambda_{FG}(W_G - U)}{r+\delta+\lambda_F} \tag{47}$$

Using all the above we can therefore conclude that the total surplus of the formal sector

is:

$$\begin{aligned}
\int_{R_F}^{1} S_F(z)dF_F(z) &= \int_{R_F}^{Q_F} S_F^S(z)dF_F(z) + \int_{Q_F}^{1} S_F^{NS}(z)dF_F(z) \\
&= \frac{p_F}{r+\delta+\lambda_F+\lambda_{FG}} \left\{ -(Q_F - R_F)(1 - F_F(Q_F)) + \int_{R_F}^{Q_F} [1 - F_F(x)]dx \right\} \\
&+ \frac{p_F}{r+\delta+\lambda_F} \left\{ (Q_F - R_F)(1 - F_F(Q_F)) + \int_{Q_F}^{1} [1 - F_F(x)]dx \right\} \\
&- \frac{\lambda_{FG} p_F T - \lambda_{FG}(W_G - U)}{r+\delta+\lambda_F}(1 - F_F(Q_F)) \qquad (48)
\end{aligned}$$

## A.2 Informal Sector

The expressions for the surplus in the informal sector are derived in a similar way to that adopted for the formal sector. However, due to the absence of policy paramters in the informal sector, the initial surplus is the same as the surplus of a continuing match, when there is no on-the-job search and when the productivity is at its highest level, $x = 1$, i.e. $S_I^0(1) = S_I^{NS}(1)$. When there is no on-the-job search, i.e. $x > Q_I$, the value of the surplus, $S_I^{NS}(x)$, is given by the equation:

$$(r+\delta+\lambda_I)S_I^{NS}(x) = p_I x + \lambda_I \int_{R_I}^{1} S_I(z)dF_I(z) - (r+\delta)(V_I + U) \qquad (49)$$

whereas for $x \leq Q_I$, when workers are searching on-the-job for positions in the public sector, we have

$$\begin{aligned}
(r+\delta+\lambda_I+\lambda_I G)S_I^S(x) &= p_I x + \lambda_I \int_{R_I}^{1} S_I(z)dF_I(z) - (r+\delta)(V_I + U) \\
&+ \lambda_{IG}(W_G - U) \qquad (50)
\end{aligned}$$

Since $S_I^S(R_I) = 0$, subtracting $S_I^S(R_I)$ from $S_I^S(x)$ allows us to obtain:

$$S_I^S(x) = \frac{p_I(x - R_I)}{r+\delta+\lambda_I+\lambda_{IG}} \qquad (51)$$

and subtracting $S_I^S(R_I)$ from $S_I^{NS}(x)$ gives:

$$S_I^{NS}(x) = \frac{p_I(x - R_I) - \lambda_{IG}(W_G - U)}{r+\delta+\lambda_I} \qquad (52)$$

Using all the above we can therefore conclude that the total surplus in the informal sector

is derived as follows:

$$\begin{aligned}
\int_{R_I}^{1} S_I(z)dF_I(z) &= \int_{R_I}^{Q_I} S_I^S(z)dF_I(z) + \int_{Q_I}^{1} S_I^{NS}(z)dF_I(z) \\
&= \frac{p_I}{r+\delta+\lambda_I+\lambda_{IG}} \left\{ -(Q_I - R_I)(1 - F_I(Q_I)) + \int_{R_I}^{Q_I} [1 - F_I(x)]dx \right\} \\
&+ \frac{p_I}{r+\delta+\lambda_I} \left\{ (Q_I - R_I)(1 - F_I(Q_I)) + \int_{Q_I}^{1} [1 - F_I(x)]dx \right\} \\
&- \frac{\lambda_{IG}(1 - F_I(Q_1))}{r+\delta+\lambda_I}(W_G - U) \qquad (53)
\end{aligned}$$