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Informality, Public Employment and Employment Protection in Developing Countries

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ABSTRACT

Informality, Public Employment and Employment Protection in Developing Countries*

This paper proposes an equilibrium matching model for developing countries' labor markets where the interaction between public, formal private and informal private sectors are taken into account. Theoretical analysis shows that gains from reforms aiming at liberalizing formal labor markets can be annulled by shifts in the public sector employment and wage policies. Since the public sector accounts for a substantial share of employment in developing countries, this approach is crucial to understand the main labor market outcomes of such economies. Wages offered by the public sector increase the outside option value of the workers during the bargaining processes in the formal and informal sectors. It becomes more profitable for workers to search on-the-job, in order to move to these more attractive and more stable types of jobs. The public sector therefore acts as an additional tax for the formal private firms. Using data on workers' flows from Egypt, we show empirically and theoretically that the liberalization of labor markets plays against informal employment by increasing the profitability, and hence job creations, of formal jobs. The latter effect is however dampened or even sometimes nullified by the increase of the offered wages in the public sector 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 recipe 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. Removing employment protection legislations and liberalization reforms can therefore be encouraged to ensure healthy dynamic labor markets with both high job creations and job destructions. Public sector employment policies and conditions can still however contradict with these reforms by offering more attractive and more stable public sector jobs, or more precisely appointments, for which workers would be willing to queue for years. Unfortunately, fiscal realities will make it impossible though for these government jobs to absorb all those queuing job seekers. Moreover, since massive non-compliance is the norm in developing countries, 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 in a developing economy 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 workers' flows data from Egypt, which provides an interesting case study where policies directed towards the private and public employment sectors have changed at the same time. More specifically a liberalization reform, implemented in 2004, was concomitant to an increase in the compensation of the public sector.

Since the flow approach to labor markets has become the basic toolbox to modern labor macroeconomics, one would intuitively think of the conventional textbook job search model of Mortensen and Pissarides (1994) to provide a theoretical explanation of the empirical outcomes and adjustments of labor markets following a structural change such as a reform or a shock. Theoretically, a 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 creations and job destructions. 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[1]. In this paper, we propose a parsimonious 3-sector job search model sufficient to explain this empirical paradox, which the classic Mortensen and Pissarides (1994) model fails to explain unlike in the case of developed countries. In developing countries, particularly the MENA region [2], a sizeable public employer (Rodrik, 2000), that can count up to 30% of wage work in Egypt[3], presents a significant distortion to the dynamics of the labor markets, [4] especially if the wage or hiring policy of this sizeable employer changes. Consequently, the extension of the basic model to include a public sector seems primordial in the case of developing countries in general and in the Egyptian case in particular, where public sector wages have increased significantly and downsizing hiring strategies have been adopted concomitant to the liberalization reform (the Egypt labor law) that came into action in 2004. Moreover, even if such a policy can directly affect formal jobs, the share of the informal sector in private employment in developing countries is substantial and can not be ignored when considering the structure of these labor markets. Indeed, this informal sector represents an alternative option for workers for whom the relative evaluation of choices changes as these policies change[5].

The paper therefore proposes an extended equilibrium matching model à la Diamond-Mortensen-Pissarides (DMP) that takes into account the interaction between the public, the formal and the informal[6] private employment sectors, as well as the job-to-job mobilities towards the attractive public em-

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[1]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)

[2]Assaad (2014) shows that public sector employment shares in individual MENA countries are significantly higher than in a sample of comparable developing countries. According to data pulled from the World Bank on a sample of 12 MENA countries, government wage and salary expenditures average about 10 percent of GDP, which is higher than in any other world region, including OECD countries.

[3]Authours' own calculations using the Egypt Labor Market Panel Surveys (ELMPS 1998,2006 and 2012)

[4]See Barsoum (2016) for a sociological discussion of the attractiveness of the public sector in Egypt, where young people are actually willing to accept offers in the public sector even for a lower pay than in the private sector.

[5]Authours' own calculations using Egypt Labor Market Panel Surveys (ELMPS 1998,2006 and 2012) show that the informal sector reaches 54% of total wage employment in Egypt in 2010

[6]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.

ployer. A worker's employment/unemployment 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 towards the public sector[7]. These extensions are crucial to understand the economic mechanisms resulting in the 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. With no changes in the informal sector's profitability, workers accept more offers (i.e. more job creations) in 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 attractive 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 attractive stable opportunity, in the public sector. Another interesting point is how these new opportunities offered by the public sector

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[7]Since our main focus is to study the job creation and destruction processes in the market following the liberalization reform and the increase in the public sector's wages, transitions between the formal and informal sectors are not allowed. While adding on-the-job search between the formal and informal sector complexifies the model, it does not provide an extra economic mechanism. In other words, adding transitions between formal and informal sectors can change the elasticities but not the interactions, which is not inconvenient for our illustrative model. These transitions might however be crucial to study the formalization process of jobs and the way the quality of one's job is improving, which is beyond the scope of this paper.

are accessed. If it is easier for a worker to accept temporarily a job in the informal sector in order to search on-the-job for a public sector appointment (more formally the arrival rate of offers is higher than in the formal sector for instance), the indirect impact of the increase of the public sector wage could be a larger informal 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. While a higher proportion of workers in the private sector might be searching on-the-job for public sector jobs, the resulting actual job-to-job (Private to public) transitions to the public sector might decrease due to the downsizing hiring strategies of the public employer.

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. Our main findings suggest that introducing flexible employment protection rules, modeled as reduced firing taxes, favors a more than 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 dampened or even annulled 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 informal jobs. Hence, removing strict employment protection legislations in developing countries is important to scale down the difference in terms of flexibility between formal and informal jobs. Such a reform causes a shift of jobs in the informal sector, which are very flexible by definition given that they are not controlled by any institutional regulations, to formal work. Our model's simulations show however that by increasing the job surplus in the formal sector, the search value of the unemployed workers increases: this diffuses the wage increase in all sectors, leading to employment losses in the informal sector that over-compensate the employment gains in the formal sector. Hence the convergence between the two setors reduces the overall employment. If at the same time, the wages offered by the public sector are increased (which is what happened in the Egyptian labor market), a crowding out effect is created: the new surpluses created in the formal private sector by the liberalization reform are more than compensated by the increase in the workers' reservation wage, in other words the new costs of worker mobility induced by the increase in the attractiveness of the public sector due to the increase of the the public sector's

compensation. The proposed model offers a way to identify these two policy changes that both induce an increase in unemployment rates. The reduction of the firing taxes lead to opposite job finding rate movements between the formal and informal sector. On the contrary, the rise in the public sector's compensation reduces simultaneously these two job finding rates. This paper therefore supports the view that since reducing firing taxes in Egypt has been accompanied simultaneously by an increase in the real wages of public sector workers[8], 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, which is also observed empirically via a structural break in time series data from Egypt, 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. Our theoretical model also allows the identification of the two main components of the job-to-job mobility flows towards the public sector: the proportion of workers on-the job search (represented by the distance between the reservation productivity of a job and the on-the-job search productivity threshold) and the public sector structural hiring component. While the introduction of reduced firing taxes only affects the former by increasing the reservation productivity significantly (i.e. decreasing the on-the-job search), the increase in the public sector's wages affects both the proportion of on-the-job search, by increasing substantially the on-the-job search productivity threshold, and decreases the public sector's structural hiring component.

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

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[8]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.

to obtain the most efficient labor market outcomes.

The rest of the paper is divided as follows. Section 2 motivates the set-up of our theoretical model by exposing some stylized facts about workers' turnover, wages and stocks in Egypt. In section 3, 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 4 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 5 confirms the theoretical interactions in the model by showing supporting evidence from the 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 6.

2. Some Stylized Facts about the Labor Market in Egypt

2.1. Sample Description

Data on wages, workers' flows and stocks all throughout this paper is obtained from three waves of the Egypt Labor Market Panel Surveys (ELMPS) fielded in the years 1998, 2006 and 2012. These 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 unemployment sectors, over the period 1997-2010[9]. 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). Only Cross-sectional wages for each employment sector are available i.e. wages are only available for 1998, 2006 and 2012.

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[9]To avoid distortions by the 2011 Uprising in Egypt, the year 2011 has been excluded from our panel even though the point in .

2.2. Policy Interventions in Egypt

Egypt is a Middle East and North Africa (MENA) country with a substantial unregulated informal private sector and a sizable public sector employer. Egypt has long been ranked as a country with very rigid labor laws[10]. 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, 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 the contract 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 provided that he provides a certain notice period(see WorldBank (2014) for more details). This liberalization reform was concomitant to a significant increase in the compensation of the public sector. Said (2015) shows that over the period 1998-2006, there has been a 40% and a 26% increase in the median real monthly wages of government employees and public firms' employees respectively, as opposed to only a 9% increase in the median real wage of the private sector. With such an increase in the wage bill and due to the government budget constraint, public sector hiring has slowed down significantly (where the share of the public sector of total employment has fallen from about 39% in 1998 to about 30% in 2006 (Krafft and Assaad, 2015)).

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[10]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 private sector in the Egyptian total industrial value added reached 70 percent and its share of total employment increased substantially to 60 percent.
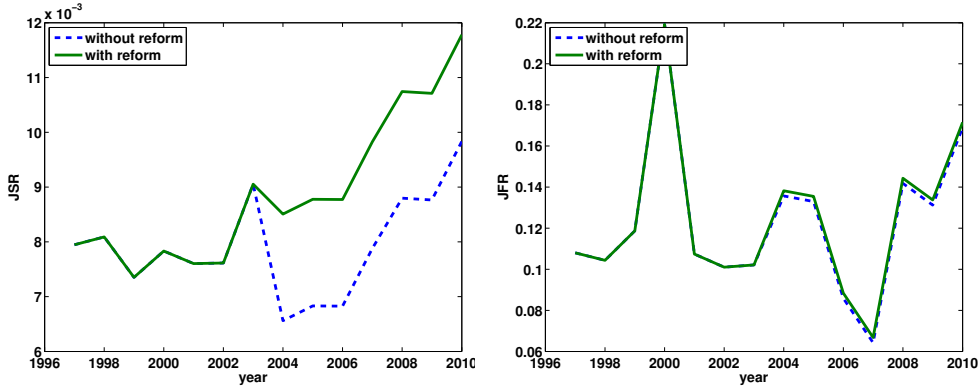
2.3. An Empirical Paradox

Langot and Yassin (2015) attempt to detect a structural break in the time series of the economy's job finding and job separation rates, over the period 1998-2011, by using an econometric methodology that extracts the cyclical component from the trends of the labor market flows. The analysis is limited, which is also the case through out this paper, to individuals being either employed or unemployed. Figure 1 replicates this econometric exercise over the period 1997-2010. By detecting the reform as a structural break in the series, the 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 a specific type of flow, it would be necessary to use the regression $x_t - x_t^{\star} = \alpha(y_t - y_t^{\star}) + \beta + \epsilon_t$, for $x = JSR, JFR$ and where x_t and $x_t^{\star}$ represent the current values and the natural rates of the labor market flows. 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 Δy_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:

$$x_t = \alpha \Delta y_t + b + \mathbb{I}_a \gamma + \epsilon_t \quad \text{for } x = JSR, JFR \tag{1}$$

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

Langot and Yassin (2015) obtained a significant increase in separation rates (at the 1% level) after the implementation of the liberalization reform in 2004, while no significant change in the job finding rates takes place. With a very significant rise in the separations and a no significant change in the job findings, it becomes intuitive that the normal net effect of the reform is higher levels of steady-state unemployment (panel(c) in Figure 1). These results are robust and coherent when the econometric exercise is redone using a three-state model. Theoretically, these results present an important paradox, where one would expect to observe an increase in the job finding rates following the increase in the net job surplus induced by the liberalization reform. The theoretical mechanisms proposed in the model in Section 3 seeks to provide an explanation to this empirical paradox.

(a) Separation rate

(b) Job finding rate

	JFR		JSR	
α	0.4724	0.4307	0.0148	-0.0173
β	0.1222***	0.1230***	0.0073***	0.0079***
γ		0.0025		0.0019***

*p<0.1, **p<0.05 and ***p<0.01

(c) Unemployment rate

Figure 1: Job finding, separation and steady-state unemployment rates with and without the new labor market reform in 2004, courtesy of Langot and Yassin (2015)

Source: Authors' calculations based on workers' flows data obtained from the ELMPS 1998, 2006 and 2012.

Note: JFR refers to job finding rate and JSR refers to job separation rate.

2.4. Workers' Turnover and Wages

To set the mood for the theoretical contribution of this paper, Table 1 presents a summary of descriptive statistics of the average transition probabilities in the Egyptian labor market over the periods 1997-2003 and 2004-2010 (i.e. before and after the new Labor Law). It's important to note that one might think that the substantial size of the public sector is only sustained by very low separation rates. Table 1 shows however that the flow of workers into the public sector in Egypt is substantial when compared to the flow of workers into the formal private sector (our sector of interest). An annual average of 4.66% of the unemployed find a job in the public sector before 2004 (i.e. before the liberalization reform) and 4.43% after 2004, as opposed to an average annual job finding rate in the formal private sector of 3.37% before the reform and 3.79% after the reform. Flows from the formal and informal sectors towards the public sector reach 1.45% and 1.29% in each sector respectively, a non-ignorable rate in such a rigid labor market. Table 2 presents the averages of labor market shares before and after 2004, showing that while the Egyptian economy has experienced following its reforms a rise in its unemployment rate, informal and formal sectors' shares, the share of public employment has declined substantially by almost 4 percentage points. In Table 3, we present the median real monthly wages in 2012 Egyptian Pounds in 1998 and 2006. The main aim of this table is to present the average differences between the wages in the three different sectors before the reform in 1998. The median real wage in the public (informal) sector represents 80% (70%) of the formal sector's median wage. The second important key message of table 3 summarizes the rate at which the median real wages in each sector increases between 1998 and 2006. As in Said (2015), wages of our sample of male workers in the public sector increases at a faster rate (32%) than in the private formal (24%) and private informal (13%) sectors. It's important to note here that the public sector considered in this paper comprises both the government and public enterprises which are considered separately in Said (2015). Moreover, while we consider the formal and informal private sectors separately, Said (2015) discusses wages in the private sector as a whole.

3. A Model with Formal, Informal and Public Sectors

3.1. 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

	FG	FU	IG	IU	UG	UF	UI
Average before 2004	1.45%	0.59%	1.29%	1.19%	4.66%	3.37%	12.06%
Average after 2004	0.98%	1.32%	1.04%	1.56%	4.43%	3.79%	11.69%

(i) G refers to the public sector, F refers to the formal private sector, I refers to the informal private sector and U refers to unemployment.
(ii) Transitions are denoted by ij for $i, j = G, F, I, U$ where i refers to the state of origin and j refers to the state of destination.
Source: Authors' calculations based on workers' flows data obtained from the ELMPS 1998, 2006 and 2012.

Table 1: Transition Probabilities of Male Wage Workers in Egypt before and and after the liberalization reform in 2004

	U	I	F	G
Average before 2004	8.22%	39.93%	13.58%	38.27%
Average after 2004	9.18%	41.21%	15.12%	34.50%

(i) G refers to the public sector, F refers to the formal private sector, I refers to the informal private sector and U refers to unemployment.
Source: Authors' calculations based on workers' flows data obtained from the ELMPS 1998, 2006 and 2012.

Table 2: Stocks of Male Wage Workers in Egypt before and and after the liberalization reform in 2004

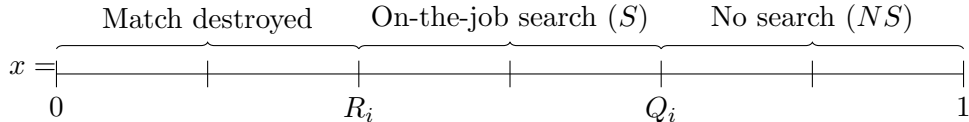| Wages	G	F	I
1998	702	887.6774	608.9608
2006	930	1100.087	688.1689
1998/2006 increase	32%	24%	13%
Ratio in 1998	0.8	1	0.7

(i) G refers to the public sector, F refers to the formal private sector and I refers to the informal private sector.
Source: Authors' calculations based on the ELMPS 1998 and 2006.

Table 3: Median Real Wages of Male Wage Workers in Egypt in 1998 (before the liberalization reform) and 2006 (after the reform), in 2012 Egyptian Pounds

sector $i = F, I$ associated with every possible vacancy in that sector (formal or informal sector respectively) and unemployment pair. Based on evidence from Petrongolo and Pissarides (2001), constant returns is considered a convenient assumption, such that for $i = F, I$, 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. 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 θ_i, while $\theta_i q_i(\theta_i)$ increases in θ_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 sector i, and x, the idiosyncratic component taking values on the unit interval and arriving from time to time at the Poisson rate λ_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 until 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 λ_{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 until 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 $R_i \leq x \leq Q_i$.

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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 δ.

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.

3.2. Private Firms' Behavior
3.2.1. Formal Firms

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

$$(r + \delta)J_F^0(1) = p_F + \rho - w_F^0 + \lambda_F \int_{R_F}^1 \left[\max\{J_F^{NS}(z), J_F^S(z)\} - J_F^0(1) \right] dF(z)$$
$$+ \quad \lambda_F F_F(R_F)[V_F - p_F T - J_F^0(1)] \tag{2}$$

r and ρ represent respectively the risk free interest rate and an additional productivity linked to the choice of having a formal job (for instance choosing to operate formally, the productivity of a job can be increased by benefiting from public infrastructure, rent controls...etc.). Unlike the common productivity of jobs in the formal sector p_F, the returns to the public infrastructure are not be affected by the match-specific productivity x. V_F is the value of a vacancy in the formal private sector.

If the continuing match is 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,

$$(r + \delta)J_F^{NS}(x) = p_F x + \rho - w_F^{NS}(x) + \lambda_F \int_{R_F}^1 \left[\max\{J_F^{NS}(z), J_F^S(z)\} - J_F^{NS}(x) \right] dF(z)$$
$$+ \quad \lambda_F F_F(R_F)[V_F - p_F T - J_F^{NS}(x)] \tag{3}$$

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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:

$$
\begin{aligned}
(r+\delta)J_F^S(x) &= p_F x + \rho - w_F^S(x) + \lambda_F \int_{R_F}^1 \left[\max\{J_F^{NS}(z), J_F^S(z)\} - J_F^S(x)\right] dF_F(z) \\
&+ \lambda_F F_F(R_F)[V_F - p_F T - J_F^S(x)] + \lambda_{FG}(V_F - J_F^S)
\end{aligned}
\tag{4}
$$

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:

$$
rV_F = -p_F c_F + q_F(\theta_F)(J_F^0(1) - p_F C - V_F)
\tag{5}
$$

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:

$$
\frac{p_F c}{q_F(\theta_F)} + p_F C = J_F^0(1)
\tag{6}
$$

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

3.2.2. Informal Firms

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:

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

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:

$$
\begin{aligned}
(r + \delta)J_I^S(x) &= p_I x - w_I^S(x) + \int_{R_I}^1 max\{J_I^{NS}(z), J_I^S(z)\} - J_I^S(x)dF_I(z) \\
&+ \lambda_I F_I(R_I)(V_I - J_I^S(x)) + \lambda_{IG}(V_I - J_I^S(x))
\end{aligned}
\tag{8}
$$

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

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

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

$$
\frac{p_I c}{q_I(\theta_I)} = J_I^{NS}(1)
\tag{10}
$$

3.3. 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:

$$
\begin{aligned}
(r + \delta)W_i^0(1) &= w_i^0(1) + \lambda_i \int_{R_i}^1 \left[max\{W_i^{NS}(z), W_i^S(z)\} - W_i^0\right] dF_i(z) \\
&+ \lambda_i F(R_i)(U - W_i^0(1))
\end{aligned}
\tag{11}
$$

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 λ_{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:

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

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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:

$$
\begin{aligned}
(r + \delta)W_i^{NS}(x) & = w_i^{NS}(x) + \lambda_i \int_{R_i}^{1} \left[\max\{W_i^{NS}(z), W_i^S(z)\} - W_i^{NS} \right] dF_i(z) \\
& + \lambda_i F_i(R_i)(U - W_i^{NS}(x))
\end{aligned}
\tag{13}
$$

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:

$$
(r + \delta)U = b + \theta_F q_F(W_F^0(1) - U) + \theta_I q_I(W_I^0(1) - U) + \lambda_{UG}(W_G - U) \tag{14}
$$

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[11]. 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

$$
(r + \delta)W_G = w_g \tag{15}
$$

3.4. 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 $J(R_I) + W(R_I) = V_I + U$.

3.5. 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

$$\lambda_{FG} S_F^S(Q_F) = \lambda_{FG}[p_F T + (W_G - U)] \tag{16}$$

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 16 and A.3, the expression for Q_F, the on-the-job threshold in the formal sector, when $\lambda_{FG} > 0$ is :

$$Q_F = R_F + (r + \delta + \lambda_F + \lambda_{FG}) \left(T + \frac{W_G - U}{p_F} \right) \tag{17}$$

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

$$\lambda_{IG} S_I^S(Q_I) = \lambda_{IG}(W_G - U) \tag{18}$$

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

$$Q_I = R_I + (r + \delta + \lambda_I + \lambda_{IG}) \frac{W_G - U}{p_I} \tag{19}$$

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3.6. Nash Bargaining and Wage Determination

The wages are bargained, with β being the worker's bargaining power, 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 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

$$\beta(J_F^0(1) - V_F - p_F C) = 1 - \beta(W_F^0(1) - U) \tag{20}$$

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

$$\beta(J_F^S(x) - V_F - p_F T) = 1 - \beta(W_F^S(x) - U) \quad \text{for } x \le Q_F \tag{21}$$
$$\beta(J_F^{NS}(x) - V_F - p_F T) = 1 - \beta(W_F^{NS}(x) - U) \quad \text{for } x > Q_F \tag{22}$$

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

$$\beta(J_I^{NS}(x) - V_I) = 1 - \beta(W_I^{NS}(x) - U) \quad \text{for } x > Q_I \tag{23}$$
$$\beta(J_I^S(x) - V_I) = 1 - \beta(W_I^S(x) - U) \quad \text{for } x \le Q_I \tag{24}$$

Using the free entry conditions for the formal and informal sectors $\frac{p_F c}{q_F(\theta_F)} + p_F C = J_F^0(1)$ 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[12]:

$$(r+\delta)U = \frac{r+\delta}{r+\delta+\lambda_{UG}}\left(b + \frac{\beta c}{1-\beta}(\theta_F p_F + \theta_I p_I)\right) + \frac{\lambda_{UG}}{r+\delta+\lambda_{UG}}w_G \tag{25}$$

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 is[13]:

$$w_F^0(1) = \beta\left[p_F + \rho - (r+\delta+\lambda_F)p_F C - \lambda_F p_F T + \frac{r+\delta}{r+\delta+\lambda_{UG}}c(\theta_F p_F + \theta_I p_I)\right]$$
$$+ (1-\beta)\left[\frac{r+\delta}{r+\delta+\lambda_{UG}}b + \frac{\lambda_{UG}}{r+\delta+\lambda_{UG}}w_G\right] \tag{26}$$

---

[12] 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 $W_G - U = \frac{w_G - b - \frac{\beta c}{1-\beta}(\theta_F p_F + \theta_I p_I)}{r+\delta+\lambda_{UG}}$.

[13] See appendix Appendix A for the details of the derivation of the wages equations.

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

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

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

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

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 θ_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 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, θ_I and θ_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:

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

$$+ \quad (1-\beta) \left[\frac{r+\delta}{r+\delta+\lambda_{UG}} b + \frac{\lambda_{UG}}{r+\delta+\lambda_{UG}} w_G \right] \qquad (29)$$

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

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

$$+ \quad (1-\beta) \left[\frac{r+\delta+\lambda_{IG}}{r+\delta+\lambda_{UG}} b + \frac{\lambda_{UG}-\lambda_{IG}}{r+\delta+\lambda_{UG}} w_G \right] \qquad (30)$$

3.7. Equilibrium

Definition 1. *The labor market equilibrium is defined by the labor market tightness in each segment of the private sector, θ_F and θ_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:*

$$\frac{p_F c_F}{q_F(\theta_F)} \quad = \quad (1-\beta)[\frac{p_F(1-R_F) - \lambda_{FG} p_F T - \lambda_{FG}(W_G - U)}{r+\delta+\lambda_F} - p_F(C+T)] \qquad (31)$$

$$\frac{p_I c_I}{q_I(\theta_I)} \quad = \quad (1-\beta)[\frac{p_I(1-R_I) - \lambda_{IG}(W_G - U)}{r+\delta+\lambda_I}] \qquad (32)$$

$$p_F R_F \quad = \quad (r+\delta)U - \rho - \lambda_F \int_{R_F}^1 S_F(z) dF_F(z) - (r+\delta+\lambda_{FG})p_F T - \lambda_{FG}(W_G - U) \qquad (33)$$

$$p_I R_I \quad = \quad (r+\delta)U - \lambda_I \int_{R_I}^1 S_I(z) dF_I(z) - \lambda_{IG}(W_G - U) \qquad (34)$$

$$p_F Q_F \quad = \quad p_F R_F + (r+\delta+\lambda_F+\lambda_{FG})(p_F T + W_G - U) \qquad (35)$$

$$p_I Q_I \quad = \quad p_I R_I + (r+\delta+\lambda_I+\lambda_{IG})(W_G - U) \qquad (36)$$

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 Appendix A for the derivation of the expected surpluses.*

Using the wage equations (26)-(27), 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 (33) and (34)) 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

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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 (35 and (36) 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:

$$1 = n_F + n_I + n_G + u \qquad (Pop) \qquad (37)$$

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[14]

$$\delta n_G = \lambda_{UG} u + \lambda_{FG} F_F (Q_F - R_F) n_F + \lambda_{IG} F_I (Q_I - R_I) n_I \quad (Pop_G)$$
$$(38)$$

$$f_F u = \lambda_F F_F (R_F) n_F + \lambda_{FG} F_F (Q_F - R_F) n_F \qquad (Pop_F) \qquad (39)$$

$$f_I u = \lambda_I F_I (R_I) n_I + \lambda_{IG} F_I (Q_I - R_I) n_I \qquad (Pop_I) \qquad (40)$$

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

$$n_G = \frac{\lambda_{UG}}{\delta + \lambda_{UG}} + \frac{\lambda_{FG} F_F (Q_F - R_F) - \lambda_{UG}}{\delta + \lambda_{UG}} \frac{f_F}{\lambda_F F_F (R_F) + \lambda_{FG} F_F (Q_F - R_F)} u$$
$$+ \frac{\lambda_{IG} F_I (Q_I - R_I) - \lambda_{UG}}{\delta + \lambda_{UG}} \frac{f_I}{\lambda_I F_I (R_I) + \lambda_{IG} F_I (Q_I - R_I)} u \qquad (41)$$

Finally the steady-state unemployment rate is obtained:

$$u = \frac{\delta(\lambda_I F_I (R_I) + \lambda_{IG} (F_I (Q_I - R_I)))(\lambda_F F_F (R_F) + \lambda_{FG} F_F (Q_F - R_F))}{\begin{bmatrix} (\lambda_I F_I (R_I) + \lambda_{IG} F_I (Q_I - R_I))(\lambda_{FG} F_F (Q_F - R_F) + \delta) f_F \\ + (\lambda_F F_F (R_F) + \lambda_{FG} F_F (Q_F - R_F))(\lambda_{IG} F_I (Q_I - R_I) + \delta) f_I \\ + (\lambda_I F_I (R_I) + \lambda_{IG} F_I (Q_I - R_I))(\lambda_F F_F (R_F) + \lambda_{FG} F_F (Q_F - R_F))(\lambda_{UG} + \delta) \end{bmatrix}} \qquad (42)$$

---

[14] 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 $f_I = \theta_I q_I(\theta_I)$.

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

$$D = n_G(\lambda_{UG}, \lambda_{FG}, \lambda_{IG}) \times w_G \tag{43}$$

4. 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 annul 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[15] 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[16]. 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), where as has been shown in section 2 as the firing taxes are reduced, only separations increase significantly, while job creations remain 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 4. Other baseline parameters are structurally estimated, using transitions data moments (table 5) obtained from the ELMPS datasets, and by applying a simulated method of moments to match unemployment spell durations, the oversized share of the public sector and

---

[15]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.

[16]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	Benchmark	Reason for setting this value
Returns to public infrastructure ρ	0.95	To fit the average salary differences between G and F
Worker Bargaining power β	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	0.3062	Average share of public sector $\times$ public sector wage
Duration Elasticity (Formal Sector) η_F	0.5	Petrongolo and Pissarides (2001)
Duration Elasticity (Informal Sector) η_I	0.5	Petrongolo and Pissarides (2001)
Firing Tax T	1.6	2 years of the average wage
Exit rate from participation δ	0.0286	35 years as average duration of a worker in the job market

Table 4: Exogenous Baseline parameters

incidences typically experienced by the Egyptian workers in the different sectors. Section 2 provides descriptive statistics and stylized facts of the labor market transition probabilities, wages, sectors' shares and unemployment rates in the Egyptian labor market over the period 1999-2010 (i.e before and after the reform). These descriptive statistics provide the main guidelines in our numerical analysis to choose the baseline parameters.

4.1. 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 χ_i denote the scale parameter of the matching function and η_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 $[0, 1]$. We therefore have $F_i(x) = x$. The baseline parameter used for the policy cases under study are presented in Table 4. This table also justifies the choice of the value of the exogenous baseline parameters. These parameters are 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 $\beta = \eta$. We use the available information on average wage differences between the three sectors in 1998, presented in Section 2, to calibrate $\{p_I, w_g\} = \{0.95, 0.8\}$ by normalizing p_F and w_F to the unit. With no available information on b, which represents the value of unemployment benefit and domestic production, we arbitrarily set $b = 0.4$, as in Shimer (2005) for the USA where unemployment allocations are among the lowest in the OECD. This calibration therefore satisfies the intuitive ranking $p_F > p_I > w_g > b$.

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We then use the labor market transitions data moments before the reform (table 5) as well as the the budget constraint which the government faces (as per the model described in section 3) 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 ψ 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 $x^{SS} = \{\theta_F^{SS}, \theta_I^{SS}, R_F^{SS}, R_I^{SS}, Q_F^{SS}, Q_I^{SS}\}$, we obtain $\hat{\Theta} = \mathrm{argmin}_\Theta ||g(x^{SS}, \widetilde{\Theta})||$, where

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

(44)

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 31, 32, 33, 34, 35 and 36 respectively[17]. The results are reported in table 5.

Figure 2 exposes how the flows and the steady state outcomes of our model fits the average levels of the corresponding empirical variables obtained from the Egyptian data as per section 2. We show that our reference economy is a good representation of the Egyptian labor market before 2004.

4.2. The quantitative impacts of the reforms
4.2.1. 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 3, we show the impact of decreasing the firing taxes on the steady-state labor market outcomes, and consequently the impact on the corresponding labor market flows in panel (b). The blue solid lines represent the reference economy obtained with $T = 1.6$.

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[17]JFR_i refers to the job finding rate, JSR_i refers to the job separation rate, where $i = F, I, G$, and JTJ_i refers to the rate of transition from sector i to the public sector (G).

Type of Transition (ψ)	Average rate over 1997-2003	Parameters (Θ)	Estimated values
JFR_F	0.0337	Reallocation Shock (Formal) $\widehat{\lambda}_F$	0.0180
JFR_I	0.1206	Reallocation Shock (Informal) $\widehat{\lambda}_I$	0.0204
JSR_F	0.0059	Transition from Formal to Public $\widehat{\lambda}_{FG}$	0.0289
JSR_I	0.0119	Transition from Informal to Public $\widehat{\lambda}_{IG}$	0.0461
JTJ_F	0.0145	Transition from unemployment to Public $\widehat{\lambda}_{UG}$	0.0466
JTJ_I	0.0129	Matching Efficiency (Formal) $\widehat{\chi}_F$	0.0921
JFR_G	0.0466	Matching Efficiency (Informal) $\widehat{\chi}_I$	0.1703

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. For consistency with the empirical section of the paper, we consider transitions between the unemployment state, formal, informal and public wage employment to obtain these data moments. Results are robust when considering the non-employment state (i.e. unemployed and inactive combined).

Table 5: Data Moments obtained from ELMPS datasets
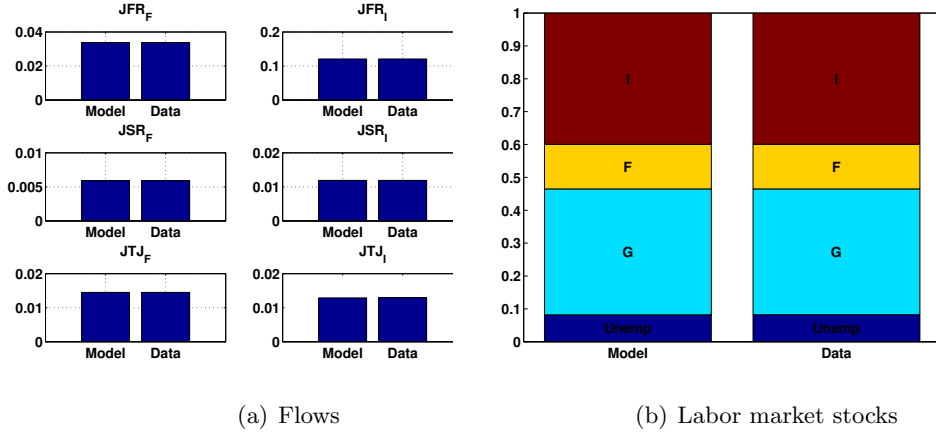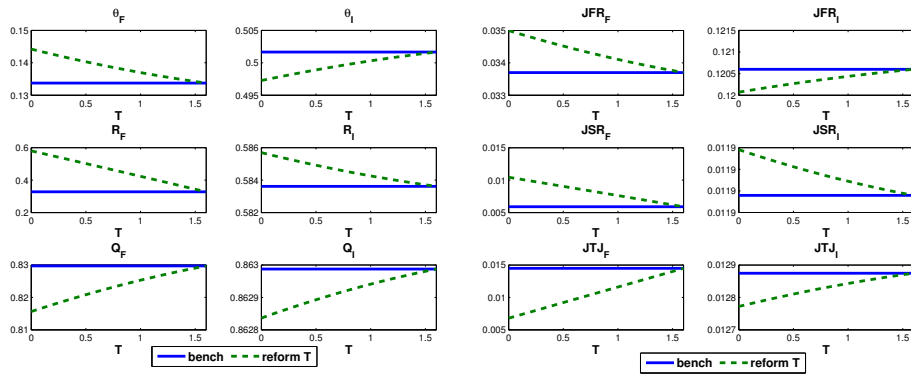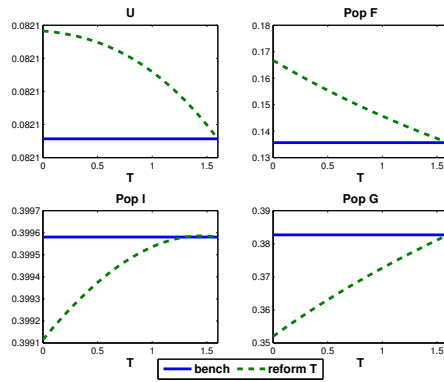

(a) Flows (b) Labor market stocks

Figure 2: Model's Fit, with estimates from the ELMPS datasets, at the baseline parameters

(a) Steady State Outcomes

(b) Labor Market Flows

(c) Labor market stocks

Figure 3: Impact of reducing firing Taxes, keeping all other baseline parameters constant

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, by increasing the profitability of formal jobs, therefore scales down the difference in terms of flexibility between the formal and informal sector shifting job creation and consequently employment from the informal to the formal sector. Moreover, our simulations show that decreasing firing taxes reduces substantially the job-to-job transitions of the private formal workers towards the public sector jobs (panel(b) of Figure 3). 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, job-to-job transitions towards the public sector almost remain unchanged or slightly decrease, following a relatively small increase in the reservation productivity R_I and almost no change in the on-the-job search threshold Q_I. Panel(c) of Figure 3 shows that unemployment rate increases as well as the total employment in the formal sector, whereas total employment in the informal and public sectors decline. The first result underlines that the impact of the reform on job separations is larger than on job creations. Nevertheless, its impact remains positive on the targeted sector. The share of the informal sector is reduced due to the rise in the relative labor costs. The size of the public sector also shrinks because the new composition of the labor market reduces the average rate to match a public job offer.

4.2.2. The crowding-out impact of the wage policy in the public 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 constant proportions such that $\lambda'_{iG} = \kappa_i \lambda_{iG}$, for $i = F, I, U$. To match the trends of decline in the public sector's hiring strategy in our data and given the identification restrictions of the system, we set $\kappa_F = \kappa_I$, while κ_U is set exogenously to meet a very slow linear decline (approximately 5% between before and after 2004) in the unemployment to public sector job finiding rate (see Table 2). Thus, we deduce that:

$$
n'_G = \frac{\kappa_U \lambda_{UG}}{\delta + \kappa_U \lambda_{UG}} + \left(\begin{array}{c} \frac{\kappa_F \lambda_{FG} F_F(Q_F - R_F) - \kappa_U \lambda_{UG}}{\delta + \kappa_U \lambda_{UG}} \frac{JFR_F}{JSR_F + \kappa_F \lambda_{FG} F_F(Q_F - R_F)} \\ + \frac{\kappa_I \lambda_{IG} F_I(Q_I - R_I) - \kappa_U \lambda_{UG}}{\delta + \kappa_U \lambda_{UG}} \frac{JFR_I}{JSR_I + \kappa_I \lambda_{IG} F_I(Q_I - R_I)} \end{array} \right) \kappa u'
$$

with

$$
u' = \frac{\delta(\lambda_I F_I(R_I) + \kappa_I \lambda_{IG}(F_I(Q_I - R_I)))(\lambda_F F_F(R_F) + \kappa_F \lambda_{FG} F_F(Q_F - R_F))}{\left[\begin{array}{c} (\lambda_I F_I(R_I) + \kappa_I \lambda_{IG} F_I(Q_I - R_I))(\kappa_F \lambda_{FG} F_F(Q_F - R_F) + \delta)f_F \\ + (\lambda_F F_F(R_F) + \kappa_F \lambda_{FG} F_F(Q_F - R_F))(\kappa_I \lambda_{IG} F_I(Q_I - R_I) + \delta)f_I \\ + (\lambda_I F_I(R_I) + \kappa_I \lambda_{IG} F_I(Q_I - R_I))(\lambda_F F_F(R_F) + \kappa_F \lambda_{FG} F_F(Q_F - R_F))(\kappa_U \lambda_{UG} + \delta) \end{array} \right]}
$$

Given these constraints and the ex-ante information of $\{JFR_F, JFR_I, JSR_F, JSR_I, JFR_G, JFR'_G\}$[18], the parameter $\kappa = \kappa_F = \kappa_I$ is estimated using $D = n'(\kappa)w'_G$. Hence, this estimated value for κ 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 λ_{iG}, for $i = F, I, U$, as the public sector wage increases, are reported graphically in figure 4.

Implications for the labor market. In Figure 5, 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. Interestingly, the increase in public

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[18]We assume that for each 1% increase in w_g, JFR_G decreases by 0.5%
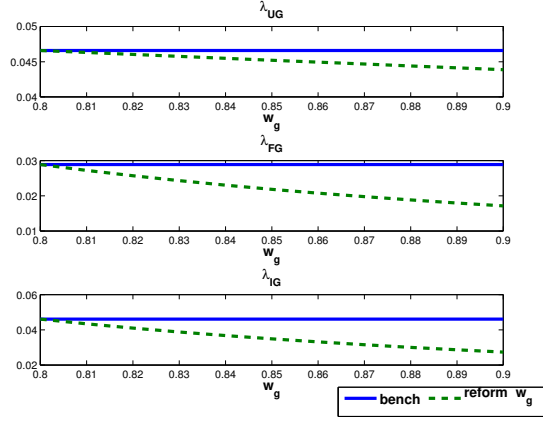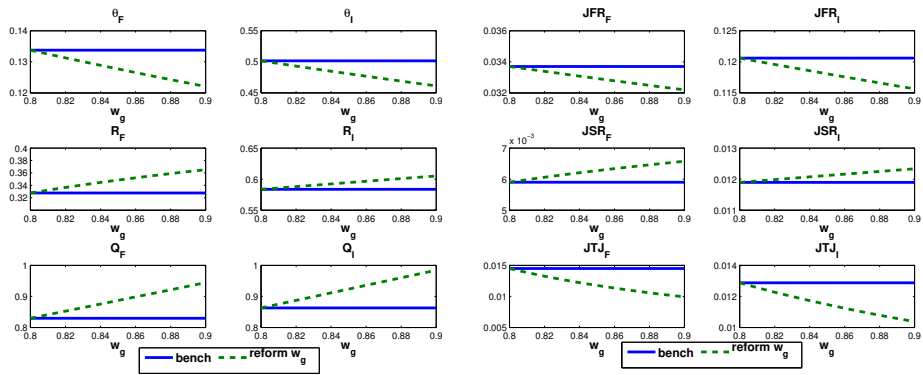
Figure 4: Evolution of λ_{iG}, $i = F, I, U$ as w_G increases

sector wages shows similar effects to the decrease in firing costs on the reservation productivity levels of both sectors R_F and R_I: they both increase.
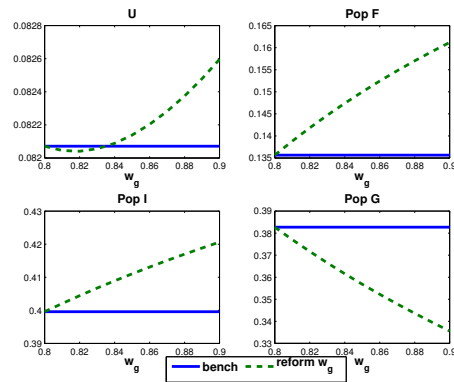
When the public sector jobs become more attractive, the reservation productivities R_F and R_I are typically pushed downwards. Workers in that case might choose to stay temporarily in these private sector jobs knowing that eventually there are potentials to move to the public sector. Taking the budget constraint into account it might be possible however, that even if the public sector wages increase, if the hiring rate encounters a substantial relative decrease, in other words λ_{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. Figure 5 shows via the calibration based on our reference economy this phenomenon, where following the new wage and hiring policies adopted by the public employer, separations in both public sectors are increased.

Figure 5 also shows that job creations are discouraged in both formal and informal sectors. This comes from the evolution of the value of an unemployed worker, for whom, following the rise in w_G, the attractiveness of the public sector pushes up the unemployment value and hence reduces the job surplus captured by the firm. This implies that θ_F and θ_I decrease, leading to a decrease in the job finding rates of both sectors (Panel (b) Figure 5). Job-to-job transitions to the public sector decrease following the downsizing hiring strategy adopted by the Public Employer being constrained by the budget D. The decrease in the job-to-job rates of both the formal and in-

(a) Steady State Outcomes

(b) Labor Market Flows

(c) Labor market stocks

Figure 5: Impact of an increase in public sector wages at $(T = 1.6)$, keeping all other baseline parameters constant

formal sectors is represented in Panel (b) Figure 5. Finally, it is interesting to note in panel (c) of Figure 5 how the increase in the public sector's wage results indirectly in a larger informal sector and higher unemployment rates.

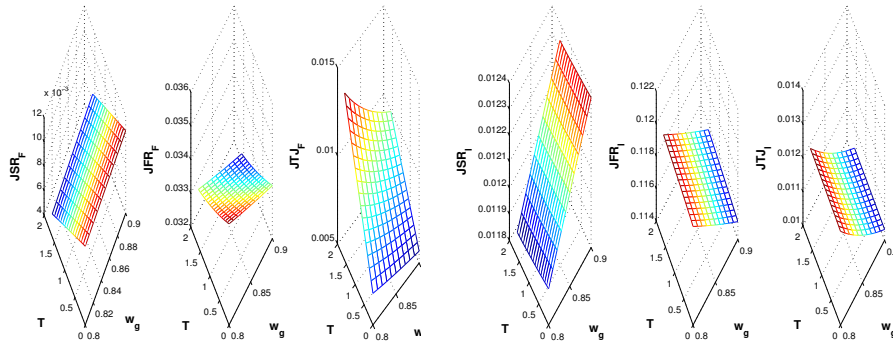*4.2.3. The impact of a simultaneous change in T and w_g*

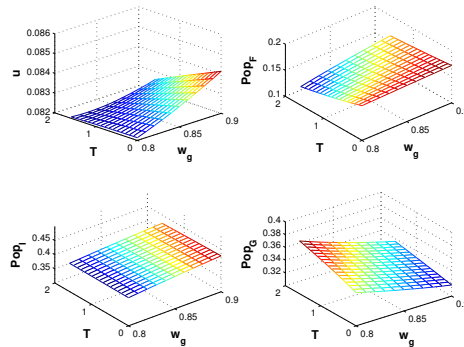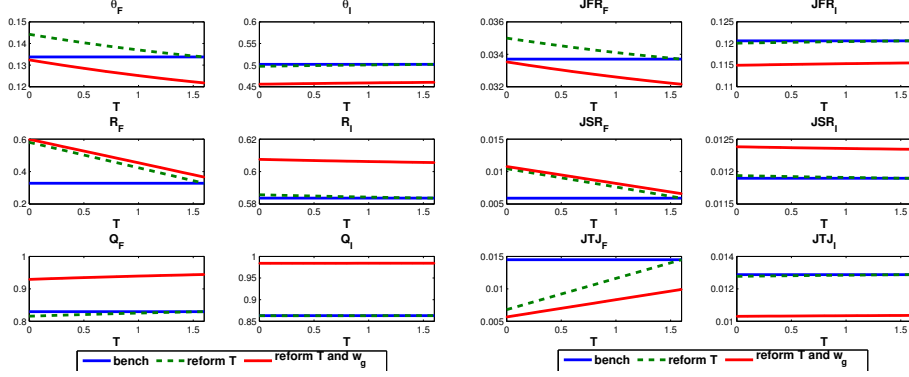Figure 6: Impact of changing T and w_G on labor market flows

Figure 7: Impact of changing T and w_G on labor market stocks

Figures 6 and 7 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,

(a) Steady State Outcomes (Before and Af-
ter both Reform)

(b) Labor market Flows (Before and After
both Reforms)

Figure 8: Impact of changing T over the range $[0, 1.6]$ and increasing w_G from 0.8 to 0.9
on the steady state outcomes and labor market flows

nothing is improved in the formal sector of the labor market. Given the
budgetary constriant of the governement, the hiring process is blocked in
the public sector, and thus all the residual workforce goes to unemployment
or the informal sector, even if the hiring conditions in this labor market
segment are not improved.

In the formal sector, for the match surplus the net effect of these op-
posite 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 6 shows that the positive effects
on job creations resulting from the liberalization of the labor market, are
dampened and can be totally cancelled out by an increase in the public sec-
tor wage. This is evident in Figure 8 where the magnitude of the decrease
in θ_F, and consequently JFR_F, following a rise in the compensation of the
public sector by only 12.5% is large enough to totally cancel out the increase
in the job findings induced by a 100% decrease in the firing tax T. 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. In the informal sector, the
surplus unambigously declines, driven by the shorter horizon of these jobs.
This is obvious in Figure 6, showing the large increases in Q_F and Q_I. Yet,
following the decrease in the hiring of the public sector, the corresponding
JTJ flows from both sectors decline substantially (Panel (b) of Figure 6).

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Overall for the formal sector's separations, i.e. R_F (Figure 6), 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 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 therefore provide an explanation to the empirical results dicussed in Section 2 showing that although the Egypt labor law came into action in 2004, overall job findings remain unchanged afterwards (Figure 1). In all cases, steady-state unemployment increases after the change in both parameters.

5. Empirical Evidence from Egypt

To show evidence of these theoretical interactions in the Egyptian labor market, we use the relevant detailed flows from the ELMPS datasets presented in Section 2 to re-run the regression 1 for $x = JSR_i, JFR_i, JTJ_i$, where $i = F, I$ for the for formal and informal sectors respectively and where x_t and $x_t^\star$ represent the current values and the natural rates of the labor market flows. JFR_i refers to the empirical job finding rate, JSR_i refers to the empirical job separation rate, where $i = F, I$, and JTJ_i refers to the rate of transition from sector i, where $j = F, I$, to the public sector (G)). The estimations reported in table 6 show the results of running the regressions of equation (1), allowing us to test for the impact of the policy change in 2004 on the natural rate of these detailed worker flows. Figures 9, 10 and 11 display the time series of the labor market flows and their counterfactual counterparts.

The results of these regressions show that only the separations in both formal and informal sectors increase significantly after the reform. The impact on all other flows are insignificant[19]. The results are however in ac-

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[19]This can be due to the fact that we're over exploiting the data by detailing the

	JSR_F	JSR_F	JSR_I	JSR_I	JFR_F	JFR_F	JFR_I	JFR_I	JTJ_F	JTJ_F	JTJ_I	JTJ_I
α	0.0717	-0.0387	0.0361	-0.0311	-0.0554	-0.1602	0.2054	0.3417	−0.1721	-0.1226	-0.0071	0.0420
b	0.0054	0.0076	0.0120***	0.0133***	0.0386*	0.0406*	0.1085***	0.1059***	0.0217**	0.0198**	0.120***	0.0111***
γ		0.0067**		0.0041*		0.0064		-0.0083		-0.0030		-0.0030

*p<0.1, **p<0.05 and ***p<0.01

Source: Authors' calculations based on workers' flows data obtained from the ELMPS 1998, 2006 and 2012.

Table 6: OLS regression results showing the impact of Egypt 2004 New Labor Law on Labor market flows

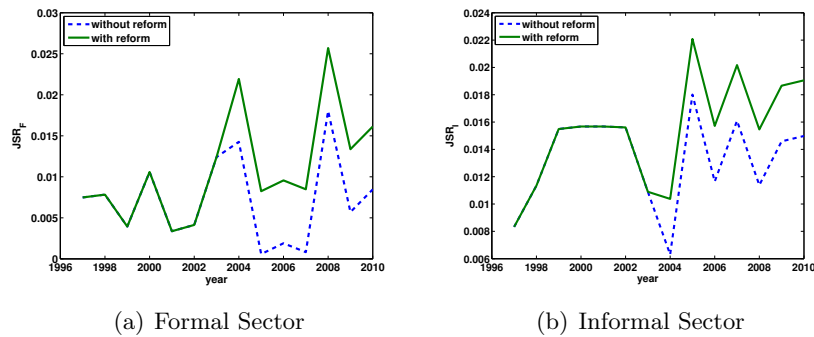
(a) Formal Sector

(b) Informal Sector

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

Source: Authors' calculations based on workers' flows data obtained from the ELMPS 1998, 2006 and 2012.
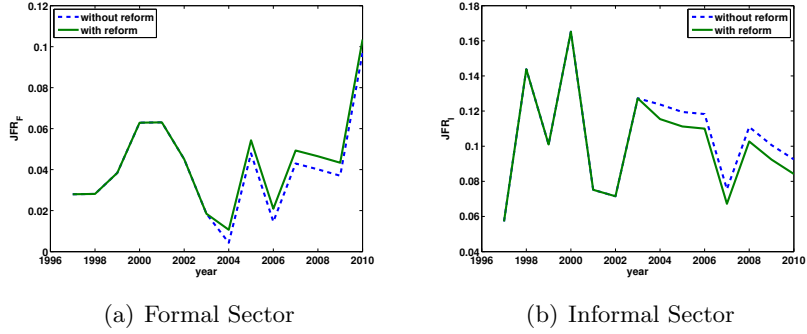
(a) Formal Sector   (b) Informal Sector

Figure 10: Impact of Egypt 2004 New Labor Law on Job Findings of the Formal and Informal Sector

Source: Authors' calculations based on workers' flows data obtained from the ELMPS 1998, 2006 and 2012.

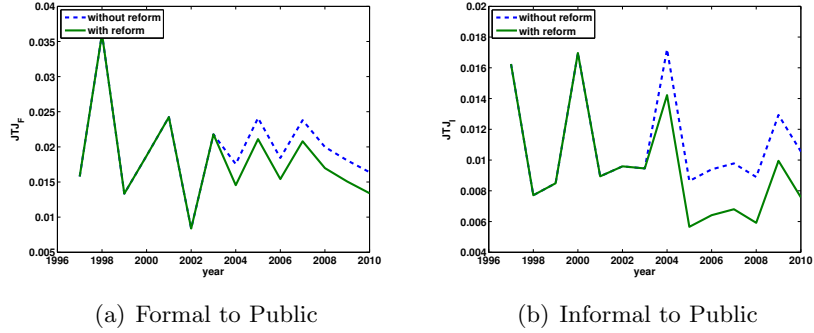(a) Formal to Public   (b) Informal to Public

Figure 11: Impact of Egypt 2004 New Labor Law on job-to-job transitions towards the Public Sector

Source: Authors' calculations based on workers' flows data obtained from the ELMPS 1998, 2006 and 2012.

cordance 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. While job findings in the formal sector increased after the reform in 2004 by about

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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).
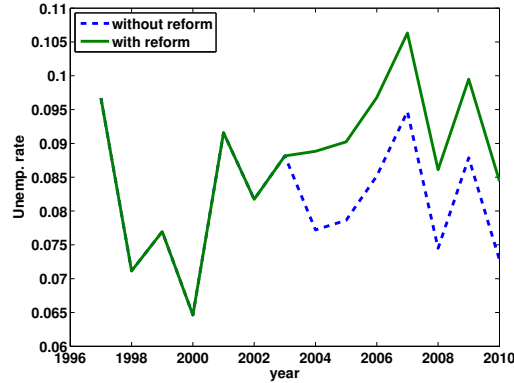
Figure 12: Structural unemployment rate calculated using detailed labor market flows as per Table1 before and after 2004

 Source: Authors' calculations based on workers' flows data obtained from the ELMPS 1998, 2006 and 2012.

0.6% , the informal sector experienced an insignificant deterioration in its job finding rates by 0.8%. For the informal sector, this deterioration, as has been evoked by the theoretical model, originates from 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 amelioration in job creations seems to have been cancelled out by the increase in the public sector wage even though the hiring has slightly increased. This increase however, when compared to the magnitude of the job finding rate on average, is relatively small and insignificant. With the increase in the public sector's attractiveness via the rise in its wages, the proportion of workers considering on-the-job search is intuitively higher than before. Interestingly however, this is not translated empirically by more people really moving to the public sector. On the contrary, actual job-to-job transitions occurring to the public sector from both the formal and informal sectors declined. This comes in accordance with the JTJ flows decreasing substantially in our theoretical model following the slowdown in the hiring of the public sector from all employment sectors. In real life this downsizing strategy has been adopted by the Egyptian government via rationing its hiring processes (Assaad, 2014). Indeed, in accordance with the theoretical simulations and the empirical results of the overall flows of the economy in Section 2, Figure 12 sums up all these results and identifies a significant increase (at the 1% level) after 2004 in the steady-state unemployment rate calculated using these relevant detailed

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flows (between unemployment, formal, informal and public sectors).

6. 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,

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and particularly the increase in job creations, have been 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. Moreover, the results show that with an increase in the public sector's wage and a substantial decline in its hiring process, the government is contributing indirectly to larger shares of an informal sector and adds pressure to a rising unemployment rate.

These results arise at a very interesting point in time for a developing country such as Egypt, where moves by the post-2011 revolution governments still boost salaries in the public sector by about 15% and act to convert temporary positions into permanent appointments (Morsy et al., 2015), adding additional attractiveness to the public sector and consequently more pressure on the dynamics of the labor market.

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Appendix A. Deriving the Market's Surplus

Appendix A.1. Formal Sector

The initial surplus in the formal sector is defined as $S_F^0 = J_F^0 - V_F - p_F C + W_F^0(1) - U$, 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 :

$$
\begin{aligned}
(r + \delta + \lambda_F)S_F^0(1) & = & p_F + \rho + \lambda_F \int_{R_F}^1 S_F(z)dF_F(z) - (r + \delta)(U + V_F) \\
& - & (r + \delta + \lambda_F)p_F C - \lambda_F p_F T \qquad\qquad\text{(A.1)}
\end{aligned}
$$

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

$$
\begin{aligned}
(r + \delta + \lambda_F + \lambda_{FG})S_F^S(x) & = & p_F x + \rho + \lambda_F \int_{R_F}^1 S_F(z)dF_F(z) + (r + \delta + \lambda_{FG})p_F T \\
& - & (r + \delta)(V_F + U) + \lambda_{FG}(W_G - U) \qquad\quad\text{(A.2)}
\end{aligned}
$$

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:

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

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

$$S_F^S(x) = \frac{p_F(x - R_F)}{r + \delta + \lambda_F + \lambda_{FG}} \tag{A.3}$$

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

$$S_F^{NS}(x) = \frac{p_F(x - R_F) - \lambda_{FG}p_F T - \lambda_{FG}(W_G - U)}{r + \delta + \lambda_F} \tag{A.4}$$

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

$$\int_{R_F}^{1} S_F(z)dF_F(z) \;\; = \;\; \int_{R_F}^{Q_F} S_F^S(z)dF_F(z) + \int_{Q_F}^{1} S_F^{NS}(z)dF_F(z)$$

$$= \;\; \frac{p_F}{r + \delta + \lambda_F + \lambda_{FG}} \left\{ -(Q_F - R_F)(1 - F_F(Q_F)) + \int_{R_F}^{Q_F} [1 - F_F(x)]dx \right\}$$

$$+ \;\; \frac{p_F}{r + \delta + \lambda_F} \left\{ (Q_F - R_F)(1 - F_F(Q_F)) + \int_{Q_F}^{1} [1 - F_F(x)]dx \right\}$$

$$- \;\; \frac{\lambda_{FG}p_F T - \lambda_{FG}(W_G - U)}{r + \delta + \lambda_F}(1 - F_F(Q_F)) \tag{A.5}$$

Appendix 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:

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

$$\tag{A.6}$$

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

$$
\begin{aligned}
(r + \delta + \lambda_I + \lambda_I G) S_I^S(x) &= p_I x + \lambda_I \int_{R_I}^1 S_I(z) dF_I(z) - (r + \delta)(V_I + U) \\
&+ \lambda_{IG}(W_G - U) \tag{A.7}
\end{aligned}
$$

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

$$
S_I^S(x) = \frac{p_I(x - R_I)}{r + \delta + \lambda_I + \lambda_{IG}} \tag{A.8}
$$

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

$$
S_I^{NS}(x) = \frac{p_I(x - R_I) - \lambda_{IG}(W_G - U)}{r + \delta + \lambda_I} \tag{A.9}
$$

Using all the above we can therefore conclude that the total surplus in the informal sector is derived as follows:

$$
\begin{aligned}
\int_{R_I}^1 S_I(z) dF_I(z) &= \int_{R_I}^{Q_I} S_I^S(z) dF_I(z) + \int_{Q_I}^1 S_I^{NS}(z) dF_I(z) \\
&= \frac{p_I}{r + \delta + \lambda_I + \lambda_{IG}} \left\{ -(Q_I - R_I)(1 - F_I(Q_I)) + \int_{R_I}^{Q_I} [1 - F_I(x)] dx \right\} \\
&+ \frac{p_I}{r + \delta + \lambda_I} \left\{ (Q_I - R_I)(1 - F_I(Q_I)) + \int_{Q_I}^1 [1 - F_I(x)] dx \right\} \\
&- \frac{\lambda_{IG}(1 - F_I(Q_1))}{r + \delta + \lambda_I} (W_G - U) \tag{A.10}
\end{aligned}
$$