Informal labor market and access to education in developing economies

Eliane El Badaoui *  Thérèse Rebière †

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Abstract

This article studies the impact of access to education on labor market flows in a search-matching model of a labor market representing a developing economy. The segmented market embodies a lower-tier informal sector, a formal sector, and an upper-tier informal sector. An increase in education raises the size of the formal sector and reduces that of the lower-tier sector but more educated workers enter into informality. When the education program is subsidized by a tax in the formal sector, overall results require data calibration that we perform with the ENOE Mexican data set. It then addresses the issue of the impact on the market efficiency of public policies aiming at increasing education.

Keywords: Informality, education, labor market, developing economies.

JEL Codes: I25, J21, J42, J64.
1 Introduction

Informality or what is also called the shadow economy represents a variable but generally large share of developing economies. Estimates from Scheider and Enste (2000) indicates that in Latin America the shadow sector represents a percentage of GDP that ranges from 25 to 65%, showing the importance of the informal sector in the labor market of developing economies. Dual economy flows has been a crucial point of interest of the well known Harris-Todaro migration model (Harris and Todaro 1970) and standard models of informal labor market generally assimilate informality to the rural sector and the formal sector to a urban/modern sector. Authors (see Field 1990) also pointed out the existence of a two-layers informal sector with an upper-tier and a lower-tier. Compared to formal workers, it is commonly admitted that on average, lower-tier informal workers work in less productive firms and receive lower wages. Informal firms tends to hire less skilled workers and are generally smaller due partly to self-employment but not only.

Access to education in developing countries as been broadly studied in the empirical literature. However to the best of our knowledge no theoretical paper linking access to education and labor market distortions in the presence of an informal sector exists. Knowing the importance of the informal sector, which concentrate the majority of uneducated workers in its lower-tier, this connection cannot be avoided. Our paper aims at studying the impact of educational changes on the dual (i.e. formal-informal) labor market composition. In order to address this issue, we build a search and matching model of the formal sector with interactions with the two-tiers informal sector. Uneducated workers’ search is directed toward the lower-tier informal sector whereas educated workers direct their search in both sectors depending on their expected asset values. We then calibrate the model using the ENOE Mexican data set from 2005-2010. The choice for Mexican data lies in the existence of the Progressa/Opportunidades subsidy program whose objective is among others to increase the education level of the poor.

Market frictions, as defined by Mortensen and Pissarides (1999), represents the time required to a worker (a firm) to obtain (to find) a job (a worker). These frictions delays the moment at which a firm and a worker meet, explaining the coexistence of unemployment and job vacancies. Matching models (see Pissarides 2000) are therefore a suitable pattern to represent the formal sector (see Zenou (2008) for a brief but clear review of the literature regarding the tradition of search model in the migration literature and for detailed explanation of matching models). Regarding search-frictions in the informal sector, their presence is still debated. Two points of view conflict: the informal sector should be simply considered as a stage toward formal employment (see Fields 1975); the two sectors are symmetric and competitive (see Heckman and Sedlacek 1985; Magnac 1991). In the former case the informal sector is generally regarded as a precarious competitive sector, or at least a sector in which frictions are not the rule, that workers wish to leave. In the latter case both sectors would allow for search frictions.

Defending the latter, Maloney (2004) presents evidences that the informal sector should be more considered as an unregulated micro-entrepreneurial sector rather than
a disadvantaged residual segment of the labor market. Relying on the case of Latin America, especially Mexico, Maloney (2004) shows that a large part of the informal sector is composed of self-employed which have chosen this sector. He relies on Balan et al (1973) which argued that one path of the labor market is that workers first enters into salaried work and accumulate knowledge before opening their own informal businesses. As Maloney (2004) explains, those workers are neither necessarily less well payed than in the formal sector nor precarious. He also specifies that being voluntarily in the informal sector does not mean workers are happier or better-off, but simply not worse-off.

Albrecht, Navarro and Vroman (2009) studies the effect of labor market policies and examine the distributional implications of those policies in an economy with an informal sector which has Maloney (2004)’s characteristics. The labor market faces search-frictions but it is not segmented. The transition rate to formal employment is endogenous whereas the transition rate toward the informal sector is exogenous. Opting for exogenous transition rate into informality seems radical as it either implicitly means transition to informality is only a matter of choice or independent on market conditions. Many authors in favor of Maloney’s perspective rather choose to endogenize this probability by assuming search-frictions in both sectors. This is the case for Boeri and Garibaldi (2007) which investigate the border between formal employment, shadow employment, and unemployment in a labor market not necessarily representative of a developing economy, as well as Charlot, Malherbet and Terra (2011).

The competitiveness of the informal sector is crucial in the model by Charlot, Malherbet and Terra (2010). Their paper deals with the issue of the size of firms in the formal and in the informal sector in a framework in which regulations in the product market affect the labor market. Charlot, Malherbet and Terra (2011) assume matching frictions in the two sectors. They claim there is no evidence that the informal sector is fully competitive but that entry costs in the formal sector tend to make the informal sector more competitive.

Fugazza and Jacques (2004) propose a model of the labor market where vacancies and workers search are directed at a specific labor market. The informal sector only arises because the government lack to enforce fiscal contribution. Considering evidences that individuals willing to operate in the informal sector need connections that takes time to be established, both sectors, formal and informal face search frictions. Taking this behavior into account derives from the standard theory in favor of a walrasian informal sector and disregard the fact that sectors are not rigid, i.e. many transitions occurs between the two.

To our opinion, the competitiveness consideration of the informal sector depends on the importance of self-employment, entrepreneurship, and family employment in the informal sector. Being short, we think there is more than one way of defining informality depending on countries. Our model could of course embedded a matching function in the informal sector but this would move us away from informality as we consider it. Zenou (2008) mentions the empirical literature on the informal market shows the informal sector generally consists of self-employment, entrepreneurship or family related works. Therefore the hiring process is much quicker. Even if not all workers meet instantaneously their
firms, search frictions are not in the same range that those in the formal sector and could therefore be avoid for the sake of simplicity. In Zenou (2008)'s dual labor market model, only the formal sector faces search-matching frictions and therefore unemployment. The informal sector is assumed competitive. In this framework, he evaluates different policies aiming at reducing unemployment. He shows that employment or wage subsidies increase the size of the informal sector whereas hiring subsidies have the reverse effect. In our model the formal sector is devoted to educated workers whereas the informal sector can welcome all type of workers. It is not a precarious sector. Our model assumes that informal wages are exogenously determined. Self-employment indeed implies that wages workers perceive are wages they can possibly afford to allocate to themselves.

Chalot, Malherbet and Terra (2011) shows several stylized facts regarding Brazilian labor market transitions between informal jobs, formal jobs and unemployment. Using the Monthly Employment Survey, conducted by the Brazilian Institute of Geography and Statistics, for several regions, they indicate the probability of transition after one year: unemployed workers have 1/3 of chances to remain unemployed, find a formal or and informal job, whereas the transition rate from informality to unemployment is 5.3% and informality to formality is 23.1%.

These figures indicate that, contrarily to Zenou (2008)'s consideration, informal workers can search while on the job to obtain a formal job. This empirical observation is taken into consideration in our framework. The transition probability is endogenous and depends on the tightness of the formal sector and therefore implicitly on wage differentials as the formal sector wages are bargained. In our model, lower-tier informality is a first step for uneducated workers whereas educated workers choose their path depending on their expected incomes. Therefore, part of educated workers evolves for some times in the informal sector. The labor market is segmented but significant mobility between the two sectors exists, and the informal sector, especially the lower-tier, cannot be considered as precarious, it only reflects an average lower productivity.

Whereas standard dual labor market model such as Harris and Todaro (1970) or Lewis (1954) assimilate the informal sector to the rural sector and the formal sector to the urban sector, Satchi and Temple (2009) using Mexican data set distinguish two types of informality seeming especially consistent for middle-income countries. As in the standard literature the rural sector is informal and fully competitive, whereas the urban sector is divided into a formal sector where search-frictions arise and an informal sector composed of self-employed workers, the latter waiting for formal jobs. Satchi and Temple (2009) perform an efficiency study and obtain efficiency of the labor market under the standard Hosios condition (see Hosios 1990). We also perform an efficiency study but in our model the optimality of job creation in the formal labor market is only one solution amongst inefficient possibilities.

Fields (1974a) has been one of the first to theoretically study the relation between individual demand for education and labor market conditions in developing countries. The empirical evidence that a large number of workers continue to demand education
whereas the labor market seems not able to absorb them leads Fields (1974a) to consider the issue of allocation of educated workers between different labor markets. Similarly to Satchi and Temple (2006), Fields (1974a) considers the agricultural sector to be restricted to uneducated workers whereas the urban sector is divided between skilled and unskilled jobs where all educated workers decide at first to enter into the skilled sector. Fields (1974a) considers that education is an individual choice which depends on private financial considerations and the expected return to education. As for us, education is not guided by personal wishes or financial ability. We assume that all workers would opt for education if this was possible for them to obtain it. The reason for this is that we deeply believe that education brings workers more than job opportunities, those provision being out of the range of economics. However staying in the fields of economics it can be argued that education provides the worker with the possibility to switch job. Education is also generally perceived as a mean to improve its personal situation disregarding a potential high average education attainment of the population. The three models presented by Fields (1974a), namely the bumping model, the stratification model and the pooling model explain possible explanations for the persistence of a high demand for education, unemployment and recruitment of educated workers at low-skill positions.

Boeri and Garibaldi (2007) present evidences for Italy that the higher the level of education, the higher the chance to obtain a formal job. Evidences from Mexico presented by Gong and Van Soest (2002) as well as Gong, Van Soest and Villagomez (2004) show a negative association between informal employment and education level within countries. However Maloney (2004) states that education should not necessarily be positively correlated to sectors. This point of view seems at first in contradiction with the commonly admitted assumption that uneducated workers are directed toward the informal sector whereas educated workers would favor the formal sector. Gong and Van Soest (2002) state that the wage is the main factor driving the sector choice and that the probability of formal sector employment strongly rises with the education level. Their results could be interpreted this way: the lower the education, the higher the chance to be in the informal sector. However, even if high education means a higher chance to be in the formal sector, it does not mean that educated workers cannot search for an informal job. This is exactly the framework we choose by assuming educated worker faces a migration condition making workers deciding in which sector to apply.

To address the issue of the impact of access to education on labor market repartition, we consider a segmented labor market with a formal sector and a two-tier informal sector. Four states coexist: unemployment, formal employment, lower-tier and upper-tier informal employment. Uneducated workers are forced to apply to the lower-tier informal sector whereas educated workers may apply in both sectors depending on their expected asset values. The formal sector is subject to market frictions and the wages are bargained, whereas wages are exogenously determined in the informal sector. Unemployment thus only exists in the formal sector and acts as a pool of entry to formal employment. Lower-tier informal employees may possibly search on-the-job for a formal job. This last feature
of the model implies that modifying access to education distorts the repartition of workers in the labor market. Two assumptions are made: first, education is increased by external intervention (international subvention to education). Second, education is self-financed by taxes paid by the formal sector (the local government faces a budget constraint). Overall results require data calibration that we perform with the ENOE Mexican data set. We also compare the decentralized equilibrium situation to the social planner equilibrium.

The paper is organized as follows: Section 2 presents the analytical framework with the interacting segmented labor market. Section 3 presents formal job creation equilibrium and workers’ flows. Section 4 studies the impact of providing a better access to education. Section 5 performs a calibration of the model using the ENEO Mexican data set. Section 6 performs an efficiency study, and finally section 7 offers a preliminary conclusion.

2 Analytical framework

The economy consists of two types of agents: workers and firms. Firms are infinity-lived whereas workers have a finite life expectancy of $1/m$. Time is continuous and parameter $m$ measures the workers’ labor market exit rate. Each worker who leaves the market is replaced with a newcomer. The measure of the total labor force is constant and normalized to one. All agents are risk-neutral and discount future payoffs at rate $r$ ($r \geq 0$).

The labor market is segmented between two interacting sectors: a formal sector, in which employment, denoted by $\ell_F$, and unemployment, denoted by $u$, coexist, and an informal sector where employment is indexed by the capita $I$. $\ell_I$ denotes lower-tier informal employment and $\hat{\ell}_I$ denotes upper-tier informal employment. When entering the labor market, firms choose the sector in which to operate. They then create a single job. Workers are of two types: educated workers amounting for an exogenous share $\gamma$ and uneducated workers amounting for a symmetric share $(1 - \gamma)$.

Figure (1) represents workers’ flows.

Uneducated workers direct their search toward the lower-tier informal sector.

Educated workers can search for a formal job (whose destruction rate $s$ is exogenous), they therefore join unemployment and find a formal job at rate $p(\theta)$. They can also decide to obtain a lower-tier informal job. The share of educated workers which decide to obtain an informal job rather than being unemployed is denoted by $\pi$. This share depends on the formal sector tightness $\theta$ so that $\pi = \pi(\theta)$. This link is captured by a migration condition. Formal employees can obtain an upper-tier informal job at rate $k$.

Lower-tier informal workers search while on the job for a formal job. For these informal workers, the probability of obtaining a formal job depends on the formal sector tightness (through the probability $p(\theta)$), but it also depends on an endogenous variable $a$ with $0 \leq a < 1$ so that obtaining a formal job coming from the lower-tier informal sector will always be harder than for educated workers which endure a spell of unemployment. This reflects the fact that working in the informal sector is badly perceived by formal firms.
Although to our knowledge no economics study has treated this issue, there seems to be a stigmatization of workers correlated with their social status (see for instance the conclusion of Serneels (2007)). A study by Soares (2004) shows that informal workers queuing for a formal job are less inclined to be selected, all the more when uneducated. According to Pradhan (1995) the high level of discourage informal workers may be due to high cost of on-the-(better)-job search due to adverse selection/stigma effect. Several reasons leading to this stigma perception can be pointed out. Among them are the followings.

- In general, uneducated workers, which represents a majority of informal workers in our Mexican study, can be seen as "not fully competent" thus being labeled and stigmatized (see Daun (2005) on the Senegalese case).

- It is commonly perceived that a large share of informal workers are poor and uneducated. These individuals, which are more likely to suffer from incurable diseases such as HIV than educated workers, suffer from discrimination and discouragement which leads them to be less work effective. The International Labor Office points out that the informal sector is particularly affected1.

- For those informal workers which are educated, employers may think there presence in the informal sector is due to hidden personal characteristics or inconsistencies which evicted them from finding, at first, a job in the formal sector, or they have been laid-off from a previous formal job. On the contrary, belonging to the formal sector send a good signal. As mentioned by Noronha (2003), for Brazil, the Labor Booklet which is only used by formal workers "is frequently used to show that the worker is a reliable citizen when he is hired for a new job or needs to get a loan, and

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1According to ILO (2001), HIV/AIDS is a major threat to the world of work as it leads to declining productivity, increasing labour costs and loss of skills and experience. It also affects fundamental rights at work through discrimination and stigmatization. The informal sector especially suffers from it notably because of lack of health facilities and social protection benefits.
that he deserves to be respected by the society" (p.112 of the original publication, p.2 from the translation).

One will argue that the previous grievances do not hold when a large share of informal workers are educated, which is the case for instance in many arabic countries. In these countries, the population suffers from over-education and the job offer faces a huge shortage of skilled jobs usually belonging to the formal sector. As a consequence the share of educated workers in informal employment is high. In such a condition, there is no proof that informal workers are being discriminated, as it becomes almost impossible for formal firms to distinguish workers with hidden characteristics or unadapted educated workers from "bad luck" educated workers.

For this reason, the variable $a$ has to be endogenized. The variable $a$ is a function of the share of educated workers, $\pi$, who opted for the informal sector. We have:

$$a = a(\pi)$$

with $a'(\pi) > 0$. When the share $\pi$ of educated workers in overall informal employees increases, we observe an increase in $a$. It is easier for informal employees to obtain a formal job. This reflects the fact that firms tend to be less discriminative toward the informal sector, knowing that many educated workers work in there (i.e. lower-tier informal workers are less discriminated).

### 2.1 The "Upper-tier" informal sector

The segmentation literature had often emphasized the fact that there was no better situation than working in the formal sector. However authors slowly underlined the existence of informal workers that were better-off than the formal sector workers. This informal segment, mostly make up of small-scale or micro-firms, was named the "upper-tier informal sector" by Fields (1990). It has also been highlighted for instance by Maloney (2004) that a significant fringe of formal workers were voluntarily leaving their formal job to become auto-entrepreneurs in the informal sector, this phenomenon being especially perceptible in the case of Mexico.

Our model takes this empirical fact into account by assuming formal workers can turn to entrepreneurship in the informal sector at an exogenous rate $k$. What we will from now on termed the upper-tier informal workers will obtain the asset value $\hat{W}_I$.

$$r\hat{W}_I = \hat{w}_I - m\hat{W}_I$$

Upper-tier informal workers earn the wage $\hat{w}_I$ and do not have any better option than to remain in this position until they permanently leave the labor market, which happens at rate $m$.

We assume that upper-tier workers receive their marginal product $\hat{y}_I$. Therefore we have:

$$\hat{w}_I = \hat{y}_I$$
2.2 The Formal sector

In the formal sector, search-frictions exist that prevent the instantaneous matching of jobs with workers. Firms thus have to pay a cost, $c$, in order to keep their vacancy open. When matched with a worker, jobs yield output $y_F$. Firms operating in the formal sector pay a wage $w_F$ which is negotiated according to a Nash bargaining game.

2.2.1 Formal matching function

A matching function must be defined in the formal sector. The tightness $\theta$ depends on the number of formal vacancies $v$ and on the number of formal job seekers. Formal job seekers are composed of unemployed workers, $u$, that search a formal job with full intensity, and informal workers searching while on-the-job, $\ell_I$, and whose search intensity is $a$. Tightness $\theta$ is therefore defined as:

$$\theta = \frac{v}{u + a\ell_I}$$

The matching function is $h = h(v, (u + a\ell_I))$. It is assumed to be increasing in both its arguments, concave and homogenous of degree 1. Job vacancies are filled by random sorting according to a Poisson process of rate $q$. Hence, the homogeneity of the matching function implies:

$$q = \frac{h(v, (u + a\ell_I))}{v} = h\left(1, \frac{1}{\theta}\right) = q(\theta)$$

where $q$ is the rate at which a formal job is filled. By the properties of the matching technology, $q'(\theta) \leq 0$ Unemployed workers find a formal job at rate $p$, determined as $p(\theta) = \theta q(\theta)$ with $p(\theta) \geq 0$.

2.2.2 Asset Values

Let $W_F$ be the asset value of a worker in a formal job, $U$ that of an unemployed worker. We have:

$$rW_F = w_F + k[\hat{W}_I - W_F] - s[W_F - \max\{W_I; U\}] - mW_F$$

$$rU = d + p(\theta)[W_F - U] - mU$$

Employees of the formal sector earn the wage $w_F$. They face an exogenous probability $k$ of leaving the formal sector for the upper-tier informal sector. Firms and workers separate at the exogenous rate $s$. When it happens workers decide whether to become to enter into lower-tier informality or to enter into unemployment by taking the maximum of the asset values associated with these two labor market states. Unemployed workers earn their domestic output, $d$, and search for a formal job that they can obtain at rate $p(\theta)$. We assume that $\hat{w}_I > w_F > d$.

Formal firms can be either in situation of vacancy or having their job occupied. Let $J_F$ be the asset value of a productive firm, and $J_F^V$ be the asset value of a firm in situation...
Bellman equations can be written as follows:

\[ rJ_F = y_F - w_F - (s + m + k)[J_F - J^V_F] \]  
\[ rJ^V_F = -c + q(\theta)[J_F - J^V_F] \]  

Firms produce \( y_F \) and pay their workers \( w_F \). They become firms in situation of vacancy when their workers exit the labor market which happened at rate \( m \), when they quit for informal entrepreneurship, or after an exogenous job destruction. Firms with a vacancy have to pay a cost \( c \) (per period) in order to maintain the vacancy open, until they find a worker at rate \( q(\theta) \).

In the formal labor market, the free-entry condition applies. Firms enter freely in the formal sector until all positive profits are exploited, driven the value of a firm is situation of vacancy to zero.

\[ J^V_F = 0 \]  

### 2.2.3 Migration condition

Uneducated incomers do not have any choice but to look for a lower-tier informal job. Educated and more generally qualified workers can of course look for a formal job but they can also obtain an informal job if this state gives them a higher utility expectation.\(^2\)

This decision of qualified workers is captured by the migration condition. Workers can revise their decision at each period of time so that at steady-state qualified workers would be indifferent between being unemployed or having an informal job when:

\[ W_I = U \]  

At steady-state all workers are indifferent between these two situations.

### 2.2.4 Bargained wages

In the formal section wages are bargained according to a Nash bargaining game where \( \beta \) is the bargaining power for workers and \( (1 - \beta) \) the bargaining power for firms operating in the formal sector.

When a worker and a firm agree to form a match, they create the surplus \( S \) which is dispatched between them according to their bargaining power. The surplus can be written as:

\[ S = [W_F - U] + [J_F - J^V_F] \]

where

\[ \beta S = [W_F - U] \]
\[ (1 - \beta)S = [J_F - J^V_F] \]

\(^2\)Qualified workers are referred to as both educated incomers and former formal job holders that separated from their jobs. With this specification of the model we assume implicitly that any experience in the informal sector that leads a worker to enter into the formal sector is skills improving. Hence any formal worker losing her job will be considered as qualified and will be concerned by the migration condition.
Combining the free-entry condition (7), the migration condition (8), the asset values (3), (4), (5), with the two previous equations leads to the determination of the formal wage:

\[
W_F = \frac{\beta y_F[(r + s + m + k)(r + m) + p(r + m + k)] + (1 - \beta)d(r + m)(r + s + m + k)}{(r + m)(r + s + m + k) + \beta p(r + m + k)}
\]

or equivalently:

\[
W_F - d = \frac{\beta (y_F - d)[(r + s + m + k)(r + m) + p(r + m + k)] - (1 - \beta)k(\hat{w}_I - d)(r + s + m + k)}{(r + m)(r + s + m + k) + \beta p(r + m + k)}
\]

### 2.2.5 Formal sector job creation

The free-entry condition (7), combined with (5) and (6) leads to:

\[
c(r + s + m + k) = q(\theta)[y_F - W_F]
\]

Replacing the wage equation (9) into (10) allows us to obtain the formal sector job creation equation:

\[
0 = -c + q(\theta)(1 - \beta)\frac{(y_F - d)(r + m) + k(\hat{w}_I - d)}{(r + m)(r + s + m + k) + \beta p(\theta)(r + m + k)}
\]

This equilibrium is different to the standard Pissarides solution as firms and workers take into account that workers may leave for the upper-tier informal sector.

### 2.3 The "lower-tier" informal sector

The term "lower-tier" informal sector is used by Fields (1990) to define a layer in which individuals were rationed out of the formal labor market. Although this statement can apply to our model in a first step (i.e., when individuals enter the labor market), one should not regard this sector as disadvantaged as workers are able to search while on the job to get a formal job in a second step. In what follows, for the sake of simplicity, the "informal sector" will refer to as the "lower-tier informal sector", whereas the "upper-tier informal sector" will be named the "upper-tier sector".

The informal sector is not subject to search-frictions as we assume that workers and firms match instantaneously. The informal wage, \( w_I \), is exogenously determined. One can see this wage as a subsistence wage. Knowing that the informal sector is composed of self-employment, entrepreneurs or family workers, this wage can also be seen as the wage workers can possibly offers to themselves. Informal firms produce \( y_I \). We assume the informal sector to be less productive that the formal sector but more productive than the output generated by unemployed workers, so we have \( d < y_I < y_F \).
2.3.1 Asset values

Let $W_I$ be the asset value of a worker in an informal job. We have:

$$rW_I = w_I + ap(\theta)[W_F - W_I] - mW_I$$  \hspace{1cm} (12)

At the current period, informal workers earn the exogenous wage $w_I$. They all search on-the-job for a formal job. They have a probability $ap(\theta)$ to obtain such a job.

There is no unemployment in the informal sector, therefore, all informal firms have their job occupied by a worker. Let $J_I$ be the asset value of an informal productive firm, and $J^V_I$ the asset value of a firm in situation of vacancy. Bellman equations can be written in the following way:

$$rJ_I = y_I - w_I - m[J_I - J^V_I]$$  \hspace{1cm} (13)

$$rJ^V_I = 0$$  \hspace{1cm} (14)

Informal firms receive $y_I$ and pay $w_I$ to their workers. If the worker retires from the labor market, firms instantaneously find a new worker.

2.3.2 On-the-job-Search condition

For the on-the-job search (OJS) process of informal workers to take place, informal workers should have an interest in obtaining a formal job. This is true as long as $W_F$ is above $W_I$, that is to say $[W_F - W_I] > 0$. Using equations (3), (12) and the migration condition (8), this on-the-job search condition is equivalent to:

$$w_F > w_I - \frac{k(\hat{w}_I - w_F)}{r + m}$$  \hspace{1cm} (15)

$w_F > w_I$ is a sufficient condition under which informal workers would search on the job. However it can also be that $w_I$ is slightly above $w_F$ as the path through formal jobs also imply formal workers has a chance to earn a higher wage as informal auto-entrepreneurs. The importance of the upper-tier sector in workers’ decision depends on the difference $\hat{w}_I - w_F$.

2.3.3 Stigmatization variable

The equation of the stigmatization variable is obtained thanks to the migration condition (8). Taking equations (12) and (4) into account, this migration condition is equivalent to:

$$w_I - d - (1 - a)p \left[ \frac{(w_F - d)(r + m) + k(\hat{w}_I - d)}{(r + s + m + p)(r + m) + k(r + m + p)} \right] = 0$$

Replacing the formal wage by (9) in the previous equation gives the equation of the stigmatization variable:

$$a(\pi) = 1 - \frac{(w_I - d)[(r + m)(r + s + m + p) + k(r + m + p)]}{\beta p[(y_F - d)(r + m) + k(\hat{w}_I - d)]}$$  \hspace{1cm} (16)
This equation (16), depending exclusively on the endogenous variable \( \theta \), determines the repartition of educated workers between unemployment and informal employment. The migration condition determines \( \pi \), through \( a \), as a function of \( \theta \).

\[
\frac{\partial \pi}{\partial \theta} = \frac{\partial \pi}{\partial a} \frac{\partial a}{\partial \theta}
\]

Knowing that \( \frac{\partial \pi}{\partial a} > 0 \) and that \( \frac{\partial p}{\partial \theta} > 0 \), the differentiation of (16) with respect to \( p \) gives the sign of the derivative:

\[
\frac{\partial \pi}{\partial \theta} = \frac{(w_I - d)(r + m)(r + s + m + k)}{\beta p^2[(y_F - d)(r + m) + k(\hat{w}_I - d)]} \times \frac{\partial \pi}{\partial a} \frac{\partial p}{\partial \theta} > 0
\]

An increase in \( \theta \) always lead to a rise in the share of qualified workers choosing the informal sector. Note that due to the model specification, qualified workers are of two kinds: educated newcomers, and workers which had a formal job in the past and exogenously separate from their job. In this sens, the "qualified workers" group combines formal education and learning-by-doing in a previous formal job thus making any work experience leading to formal employment valuable (coming from the informal sector included).

### 3 Equilibrium and Workers’ flows

#### 3.1 Decentralized equilibrium

An equilibrium of the labor market can be defined as follows:

**Definition 1.** An equilibrium of the labor market is a pair of variables \((\theta, \pi)\) which jointly satisfy equations (11), (16).

From formal sector tightness \( \theta \) and the share \( \pi \), one deduces the employment and unemployment levels by using the conditions for flow-equilibrium.

#### 3.2 Workers’ flows

Let \( u \) denotes unemployment, \( \ell_F \) formal employment, \( \ell_I \) informal employment, and \( \hat{\ell}_I \) upper-tier employment. Informal employment is divided into two subsets: uneducated informal workers, \( \ell_I^{NE} \), and qualified workers who has decided to choose the informal path to obtain a formal job, \( \ell_I^E \). So we have \( \ell_I = \ell_I^{NE} + \ell_I^E \).

In steady state, employment and unemployment levels are deduced from the flow-equilibrium conditions. Total population is normalize to one so we have:

\[
u + \ell_F + \ell_I + \hat{\ell}_I = 1
\]
Flows in and out of each employment state are such that inflows equalize outflows. For respectively unemployment, informal employment of qualified workers, informal employment of uneducated workers, formal employment, and upper-tier employment, we have:

\[
\begin{align*}
\gamma(1 - \pi)m + s(1 - \pi)\ell_F &= u(m + p(\theta)) \\
\gamma \pi m + s \pi \ell_F &= \ell_F^E (m + ap(\theta)) \\
(1 - \gamma)m &= \ell_I^{NE}(m + ap(\theta)) \\
p(\theta)u + ap(\theta)\ell_I &= (s + m + k)\ell_F \\
k\ell_F &= m\ell_I
\end{align*}
\]

These flows lead to the determination of the following levels of unemployment, \(u\), informal employment of qualified workers, \(\ell_F^E\), informal employment of uneducated workers, \(\ell_I^{NE}\), total informal employment (upper-tier excluded), \(\ell_I\), formal employment, \(\ell_F\), and upper-tier employment, \(\ell_I\).

\[
\begin{align*}
u &= \frac{(1 - \pi)m[\gamma m(s + m + ap) + \gamma k(m + ap) + aps]}{\phi} \\
\ell_F^E &= \frac{\pi m[\gamma (s + m + k + ap)(m + p) + ap(m + p)(\gamma k + s)]}{(m + ap)\phi} \\
\ell_I^{NE} &= \frac{(1 - \gamma)m}{m + ap} \\
\ell_I &= \frac{m[1 - \gamma(1 - \pi)][m(s + m + k + p) + kp] + \pi ps}{\phi} \\
\ell_F &= \frac{mp[m(a(1 - \gamma) + \gamma(1 - \pi) + a\pi\gamma) + ap]}{\phi} \\
\ell_I &= \frac{kp[m\gamma(1 - a)(1 - \pi) + a(m + p)]}{\phi}
\end{align*}
\]

where \(\phi = m(m + ap)(s + m + k + p) + kp(m + ap) + (1 - a)s\pi pm\).

Table (1) shows the direct effect of variables on employment levels.

<table>
<thead>
<tr>
<th></th>
<th>(u)</th>
<th>(\ell_F)</th>
<th>(\ell_I)</th>
<th>(\ell_F^E)</th>
<th>(\ell_I^{NE})</th>
<th>(\ell_I + \ell_I)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\gamma)</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>(p(\theta))</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>?</td>
</tr>
<tr>
<td>(\pi)</td>
<td>-</td>
<td>?</td>
<td>?</td>
<td>-</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>(k)</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>(s)</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>0</td>
<td>-</td>
<td>?</td>
</tr>
</tbody>
</table>

Increasing the formal sector tightness \(\theta\) leads to a reduction in unemployment as it becomes easier for educated workers to find a formal job (\(p(\theta)\) rises). Informal employment is reduced for educated workers as well as for uneducated workers. The reason is it also
becomes easier to obtain a formal job coming from the informal sector \((ap(\theta)) \) rises). As a consequence, formal employment increases sharply.

A rise in the share of qualified workers in informal employment leads to a reduction in unemployment. The impact on formal employment, overall informal employment and qualified informal employment remains undetermined. The reason lies in the modification in the value of \(a\): informal workers are less discriminated, they thus face a higher chance to obtain of formal job. Hence on one hand the number of qualified workers opting for unemployment is being reduced - thus reducing formal employment - but on the other hand more informal workers obtain a formal job - thus increasing formal employment.

Note that this is only the direct impact of \(\theta\) and \(\pi\). Knowing that those two variables vary in the same direction, the overall impact on employment and unemployment levels might not be that clear.

4 Providing education

Fields (1974b) postulates that public investment in education in a situation in which the labor market faces unemployment and underemployment among educated workers is a suboptimal unstable situation which has a simple political background. Knowing that educational systems in developing countries are heavily subsidized, families, facing not much private educational costs, have very high returns to education. The social pressure then encourages political support for educational subsidies. As for us, we consider subsidies for education as granted. For now, the question is not to know whether public investment in education is socially efficient but to understand how those subsidies may affect the labor market repartition of workers.

Providing education to workers can be done in two ways. From the outside: education is not provided by the government of the country but by an external intervention. In this case the budget constraint of the local government is not affected. From the inside: the local government has to pay for education which implies taxing formal firms (as informal firms escape taxation).

4.1 External financial support

The formal job creation equation (11) does not depend on \(\gamma\). This means that a change in \(\gamma\) do not modify the formal sector tightness, \(\theta\), which means no change in \(a\) and \(\pi\). Therefore the impact of \(\gamma\) is straightforward and given by table (1). Increasing education necessarily increases unemployment as part of educated workers will go for the formal sector path. More unemployed means more applicants to formal jobs each one facing the same probability of obtaining such a job. Formal employment thus increases. Less uneducated workers means less uneducated informal employees. However, even if overall lower-tier informal employment is being reduced, the reverse phenomenon appears for educated lower-tier informal employees as more educated workers face the trade-off between
choosing formal or informal employment. It is to note that upper-tier employment increases as well due to more applicants. In the end, total informal employment is reduced but more educated workers as well as more former formal employees join this sector.

**Result 1.** *An increase in education raises the size of the formal sector and reduces that of the informal sector but more educated workers enter into informality.*

The calibration presented in section 5.4 shows the importance of change in the labor market structure when education is arbitrarily increased by 10%.

### 4.2 Governmental support

The past decades proved to be a large experimental period for governmental programs aiming at reducing poverty. One of the most well known is the ongoing Progressa / Opportunidades program in Mexico. One part of the program, aiming at increasing education and reducing child work, offers a subsidy to mothers whose children keep reporting at school at primary and secondary grades. This huge program was subsidized by the cancelation of a several poverty programs. In this sense the Progressa program did not really change the government budget constraint as these expenses were taken into account for long ago. Assuming that a government would wish to encourage education not being able to use previous financing would require a new taxation strategy. The following one is an option.

Let us assume that the government allocates a fixed amount of subsidy $\sigma$ to all newcomers in the labor market in order to help their educational achievement. In order to balance its budget the government can institute a tax $\tau$ on productive formal firms. The government budget constraint is:

$$\tau \ell_F = \sigma m$$

Which gives the following $\sigma$ equation:

$$\sigma = \frac{\ell_F}{m} \tau$$

The share $\gamma$ of educated workers is not exogenous anymore but depends on the subsidy $\sigma$. The higher the subsidy the higher the share of educated workers. We have:

$$\gamma = \gamma(\sigma); \quad \gamma'(\sigma) > 0; \quad \gamma''(\sigma) < 0; \quad \lim_{\sigma \to +\infty} \gamma(\sigma) = 1; \quad \gamma(0) = \gamma_0 \quad \text{with} \quad \gamma_0 \in ]0, 1[$$

Introducing a tax on productive formal firms changes the asset value $J_F$ of a productive firm as well as the equilibrium of formal job creation.

$$r J_F = y_F - w_F - \tau - (s + m + k) [J_F - J^V_F]$$

$$0 = -c + q(\theta)(1 - \beta) \frac{(y_F - d - \tau)(r + m) + k(\hat{w}_I - d)}{(r + m)(r + s + m + k) + \beta p(\theta)(r + m + k)}$$

Increasing the tax $\tau$ reduces $\theta$, $\frac{\partial \theta}{\partial \tau} < 0$. Formal job creation is being reduced. In the same time, the share of educated workers $\gamma$ rises.
The impact of a rise in access to education on employment flows now depends on the tax (or equivalently the subsidy), on the tightness of the labor market and on the migration condition properties. Let us note $X = \{\ell_F, \ell_I, \ell^E_I, \ell^{NE}_I, u\}$, the overall impact of $\gamma$ on $X$ is given by:

$$
\frac{dX}{d\gamma} = \frac{\partial X}{\partial \gamma} + \frac{\partial X}{\partial \theta} \frac{\partial \theta}{\partial \tau} \frac{\partial \tau}{\partial \gamma} + \frac{\partial X}{\partial \pi} \frac{\partial \pi}{\partial \theta} \frac{\partial \theta}{\partial \tau} \frac{\partial \tau}{\partial \gamma}
$$

There is only one straightforward result:

**Result 2.** *As the migration condition is such that $\frac{\partial \pi}{\partial \theta} > 0$, increasing access to education raises the unemployment level.*

For all other cases, a calibration of the model is the required to sign the impact of an increase in access to education on all employment states.

## 5 Calibration

The calibration is made using a Mexican data set, the ENOE (Encuesta Nacional de Ocupación y Empleo) provided by INEGI, the National Institute of Statistics, Geography and Informatics from 2005 to 2010.

### 5.1 Data Description

The data we use comes from the Mexican National Occupation and Employment Survey (ENOE) conducted by the Instituto Nacional de Estadistica, Geographica e Informatica (INEGI). This is a quarterly household survey with a rotating panel structure in which each household is observed at most for five consecutive quarters. For our analysis, we use the data starting from the first quarter 2005 to the third quarter 2010. The survey contains a wide variety of information on demographic and education, employment status, job characteristics and income. The dataset provides the revenue of working people and the number of working hours in their main activity as well as the sector of activity.

For our study, we define nine dummies for the education level ranging from preschool level to doctorate and we define a continuous variable indicating the total number of years of education. We distinguish between salaried and self-employed workers and define the informal employment on the basis of lack of compliance with labor legislations. In Mexico employees who contribute to the social security agency (IMSS) are considered to operate in the formal sector.\(^3\) We reduce our sample to working age population and we drop

---

\(^3\)We note that in our sample only 0.72% of self-employed satisfy the IMSS registration as in Mexico there is no legal obligation to do so for self-employed. We could have used the large firm size as an indicator of formality (El Badaoui et al., 2010), however the information about firm size does not exist for self-employed in the dataset. Thus, as in Bosch and Maloney (2008) and Bargain and Kwenda (2010), we consider the IMSS registered self-employed as formal and drop them from the sample. Then the formal sector is only composed of salaried workers who satisfy the IMSS registration.
observations with missing values in education variables, hourly wages and activity sector of those who work. The sample is composed of 5,240,759 observations reported from 23 waves. The employment rate is equal to 54.3% and, among workers, only 34% have a formal activity.

For the purpose of our theoretical framework, we define upper-tier self-employed those workers who benefit from a significant wage premium that compensate the advantages obtained in formal jobs. In the lower-tier segment, both self-employed and wage earners suffer from a wage penalty compared to salaried in the formal sector. Technically, the sample of upper-tiers includes self-employed (informal) workers who have an hourly wage higher than the mean wage in the formal sector, and the sample of lower-tiers includes self-employed who have an hourly wage less than or equal to the mean wage in the formal sector as well as salaried workers in the informal sector. Moreover we define low-educated those persons who have no education, a preschool or a primary education level, and high-educated those who have at least a secondary education level. The proportion of low-educated is 19% and 37% in the formal sector and the informal sector, respectively. The proportion of high-educated workers is 71% and 62% in the upper-tier and lower-tier segments respectively.

Over the 23 waves, the share of informal workers represents 66% of total workers. In particular, the category of upper-tier workers represents 8% of the sample of workers whereas lower-tier workers constitute 58% of total working population. We compute the flows out of non-employment to employment in each sector, and vice versa, and we sum the transitions of individuals between two successive waves. Then we divide the number of individuals who moved across waves by the stock of individuals in each segment. Thus the number of people who moved from non-employment to formal employment represents 30% of total moves from non-employment. Among those who were in the formal sector, only 22.6% move to the informal sector. More surprisingly, among those who moved from the formal employment sector, we observe that only 9.7% choose the upper-tier sector while the other movers prefer the lower-tier sector. Furthermore, among those who are in the lower-tier segment, respectively the formal sector, 6.1% and 2.2% pass to the upper-tier category.

5.2 Mexican Education System

The Mexican education system is divided into four levels: preschool, compulsory basic education, upper secondary education, and higher education. Preschool provides early education for children aged three to five. According to the World Bank it currently enrolls about 56% of the relevant age group. In order to increase coverage in this level, Mexico recently made preschool a compulsory part of the country’s basic education system. Basic education includes grades 1-9. The first six grades make up primary education, and enroll 93% of the relevant age population. Grades 7-9 make up lower secondary education and enroll close to 86% of the relevant age population. Upper secondary consists of grades 10-12 and higher education is mostly delivered at large public universities. Public universities
<table>
<thead>
<tr>
<th>Variable</th>
<th>Non-employment</th>
<th>Formal Employment</th>
<th>Informal Employment</th>
<th>Lower-Tier</th>
<th>Upper-Tier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>32.82 (15.32)</td>
<td>34.30 (11.00)</td>
<td>36.56 (12.90)</td>
<td>41.66 (11.10)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>0.27 (0.44)</td>
<td>0.63 (0.48)</td>
<td>0.59 (0.49)</td>
<td>0.68 (0.47)</td>
<td></td>
</tr>
<tr>
<td>Urban dummy</td>
<td>0.83 (0.38)</td>
<td>0.93 (0.26)</td>
<td>0.82 (0.38)</td>
<td>0.91 (0.29)</td>
<td></td>
</tr>
<tr>
<td>No education</td>
<td>0.06 (0.23)</td>
<td>0.01 (0.11)</td>
<td>0.05 (0.22)</td>
<td>0.03 (0.16)</td>
<td></td>
</tr>
<tr>
<td>Preschool Level</td>
<td>0.00 (0.02)</td>
<td>0.00 (0.02)</td>
<td>0.00 (0.02)</td>
<td>0.00 (0.02)</td>
<td></td>
</tr>
<tr>
<td>Primary Level</td>
<td>0.28 (0.45)</td>
<td>0.18 (0.38)</td>
<td>0.33 (0.47)</td>
<td>0.26 (0.44)</td>
<td></td>
</tr>
<tr>
<td>Secondary</td>
<td>0.30 (0.46)</td>
<td>0.30 (0.46)</td>
<td>0.27 (0.44)</td>
<td>0.23 (0.42)</td>
<td></td>
</tr>
<tr>
<td>Baccalauréat</td>
<td>0.18 (0.39)</td>
<td>0.21 (0.41)</td>
<td>0.13 (0.34)</td>
<td>0.16 (0.36)</td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>0.01 (0.10)</td>
<td>0.01 (0.07)</td>
<td>0.02 (0.14)</td>
<td>0.01 (0.07)</td>
<td></td>
</tr>
<tr>
<td>Tech</td>
<td>0.05 (0.23)</td>
<td>0.09 (0.28)</td>
<td>0.05 (0.22)</td>
<td>0.06 (0.25)</td>
<td></td>
</tr>
<tr>
<td>Professional</td>
<td>0.12 (0.32)</td>
<td>0.20 (0.40)</td>
<td>0.13 (0.34)</td>
<td>0.24 (0.43)</td>
<td></td>
</tr>
<tr>
<td>Masters</td>
<td>0.00 (0.05)</td>
<td>0.01 (0.11)</td>
<td>0.01 (0.11)</td>
<td>0.02 (0.14)</td>
<td></td>
</tr>
<tr>
<td>Doctorate</td>
<td>0.00 (0.02)</td>
<td>0.00 (0.04)</td>
<td>0.00 (0.04)</td>
<td>0.00 (0.04)</td>
<td></td>
</tr>
<tr>
<td>Years of education</td>
<td>11.59 (4.66)</td>
<td>13.73 (4.25)</td>
<td>11.76 (5.11)</td>
<td>13.37 (5.07)</td>
<td></td>
</tr>
<tr>
<td>Work dummy</td>
<td>0.00 (0.00)</td>
<td>1.00 (0.00)</td>
<td>1.00 (0.00)</td>
<td>1.00 (0.00)</td>
<td></td>
</tr>
<tr>
<td>Hourly wage</td>
<td>28.90 (60.75)</td>
<td>23.97 (31.67)</td>
<td>68.76 (89.27)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenure</td>
<td>5.59 (6.86)</td>
<td>7.19 (9.12)</td>
<td>9.97 (9.37)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Union dummy</td>
<td>0.19 (0.39)</td>
<td>0.16 (0.37)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Written contract</td>
<td>0.86 (0.35)</td>
<td>0.29 (0.45)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long term contract</td>
<td>0.14 (0.34)</td>
<td>0.06 (0.23)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short term contract</td>
<td>0.72 (0.45)</td>
<td>0.23 (0.42)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 employees</td>
<td>0.00 (0.04)</td>
<td>0.07 (0.26)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-5 employees</td>
<td>0.09 (0.28)</td>
<td>0.45 (0.50)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-10 employees</td>
<td>0.09 (0.29)</td>
<td>0.11 (0.31)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11-15 employees</td>
<td>0.06 (0.24)</td>
<td>0.05 (0.21)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16-20 employees</td>
<td>0.07 (0.25)</td>
<td>0.04 (0.20)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-30 employees</td>
<td>0.07 (0.26)</td>
<td>0.03 (0.18)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31-50 employees</td>
<td>0.09 (0.29)</td>
<td>0.04 (0.19)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51-100 employees</td>
<td>0.13 (0.33)</td>
<td>0.04 (0.19)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>101-250 employees</td>
<td>0.12 (0.32)</td>
<td>0.03 (0.16)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>251-500 employees</td>
<td>0.08 (0.27)</td>
<td>0.01 (0.12)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 500 employees</td>
<td>0.20 (0.40)</td>
<td>0.13 (0.34)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
are autonomous and each of the 32 states of the country has its own state university or state teachers’ college. The law guarantees a free, non-religious and publicly provided basic education in Mexico.

The main issues in Mexican education have to do with poor education quality, insufficient coverage at some levels, and high dropout rates in levels beyond primary. Poor educational quality is attributed to the lack of adequate teacher preparation, short school day in primary, teacher absenteeism in rural areas, poor articulation of curriculum between primary and secondary and poor infrastructure overall.

Statistics by the European Commission indicate that in 2007 Mexico allocated 4.8% of GDP to education, compared to an estimated 4.96% for the EU-27. According to the OECD, Mexico has been consistently increasing educational expenditure. It represents 22.2% of total public expenditure, significantly above the OECD and the EU-27 average.

One of the main government educational programs is Oportunidades/PROGRESA which provides cash grants to low-income families in rural Mexico so that their children can attend school and health services. Grants are given monthly to the families of students from the third to the ninth grade. Students must commit to attending school at least 85% of school days to keep receiving this grant. Another program that has become one of the top priorities of the ministry of education is Enciclomedia. This program digitalizes the school curriculum into CD-ROMs so students can learn interactively with the aid of computers. The Programa Escuelas de Calidad (PEC), or quality schools program, is a smaller program developed in the last few years. This program targets low-performing schools which, in exchange of some grants, must consent to implement a school wide reform project mainly in infrastructure improvements.

5.3 At baseline

Employment and unemployment level are first reconstruct by taking into account the states of employment presented in the theoretical model. Table 3 gives the rate obtained with the ENOE data set (column: target value) as well as the values reached by the baseline calibration (column: reached).

<table>
<thead>
<tr>
<th>name</th>
<th>definition (in rate)</th>
<th>target value</th>
<th>reached</th>
</tr>
</thead>
<tbody>
<tr>
<td>( u )</td>
<td>unemployment</td>
<td>0.0340</td>
<td>0.0340</td>
</tr>
<tr>
<td>( \ell_F )</td>
<td>formal employment</td>
<td>0.3275</td>
<td>0.3274</td>
</tr>
<tr>
<td>( \ell_{I}^{FE} )</td>
<td>educated informal employment (lower-tier)</td>
<td>0.3493</td>
<td>0.3494</td>
</tr>
<tr>
<td>( \ell_{I}^{NE} )</td>
<td>uneducated informal employment (lower-tier)</td>
<td>0.2129</td>
<td>0.2130</td>
</tr>
<tr>
<td>( \ell_{I} )</td>
<td>lower-tier informal employment</td>
<td>0.5622</td>
<td>0.5624</td>
</tr>
<tr>
<td>( \ell_{I} )</td>
<td>upper-tier informal employment</td>
<td>0.0763</td>
<td>0.0763</td>
</tr>
</tbody>
</table>

The baseline calibration contains parameters and variables whose values have been imposed, either by the ENOE or by the literature. Table 4 lists these parameters and variables.
Table 4: Imposed values of variables and parameters

<table>
<thead>
<tr>
<th>name</th>
<th>definition</th>
<th>imposed val.</th>
<th>source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\eta$</td>
<td>vacancy duration in days</td>
<td>45</td>
<td>see text</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>elasticity</td>
<td>0.5</td>
<td>Pissarides (2000)</td>
</tr>
<tr>
<td>$y_F$</td>
<td>formal productivity</td>
<td>1</td>
<td>normalized, see text</td>
</tr>
<tr>
<td>$y_F$</td>
<td>monthly productivity</td>
<td>0.0033</td>
<td>Satchi &amp; Temple (2009)</td>
</tr>
<tr>
<td>$m$</td>
<td>monthly labor force exit rate</td>
<td>0.0018</td>
<td>Ljungqvist &amp; Sargent (1998)</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>share of educated workers</td>
<td>0.69099455</td>
<td>ENOE, see text</td>
</tr>
<tr>
<td>$p(\theta)$</td>
<td>formal job probability rate</td>
<td>0.05</td>
<td>Pissarides (2000)</td>
</tr>
</tbody>
</table>

The vacancy duration in days is set to 45 days. This estimation is that of Andolfatto (1996) and Merz (1995) whose article is based on a study of the Dutch labour market by van Ours and Ridder (1992). It is also close to 36 days that Brenèiè (2007) obtains for Slovenia. It is however longer that the 23 days used by Satchi and Temple (2009) for Mexico.

The elasticity is set to 0.5 which is a standard assumption in the literature for developed countries. As there is no estimation for developing countries we use the same estimation, as Satchi and Temple (2009) did.

The formal productivity is normalized to 1. Wages values, formal or informal, as well as value for domestic output are defined relatively to the formal productivity. As presented in the theoretical model, it is assumed that informal wages equal informal productivities.

The monthly interest rate is that of Satchi and Temple (2009) and corresponds to a standard annual rate of 4%.

The monthly labor force exist rate is that of Ljungqvist and Sargent (1998) and corresponds to 42 years on the labor market geometrically distributed.

The share of educated workers is fixed by the observations of the ENOE database.

The job finding rate is set to 0.05 as a standard in the literature. In their calibration, Satchi and Temple (2009) calculate a close job finding rate of 0.042.

Some other parameters and variables of the baseline calibration are inferred or backed out so that the inferred employment levels equals that of the ENOE (see Table 3). The rest is obtained by applying equations of the matching model. These values are given in Table 5.

The bargaining power is somehow high for a developing country. Wages obtained with the ENOE database is such that the upper-tier informal wage is more than two times higher than that of the formal sector, the exact ratio being around 2.4. The formal sector wage is only 21.38% higher than that of the lower-tier informal sector. These observations are considered in the calibration has constraints on wages. This method ensures that the wage spread observed with the ENOE remains in the calibration.

The inferred stigmatization variable is very low which means informal workers are highly discriminated when searching for a formal job. Their overall probability rate of finding a formal job is much lower than that of unemployed workers.
Table 5: Inferred values of variables and parameters

<table>
<thead>
<tr>
<th>name</th>
<th>definition</th>
<th>inferred value</th>
<th>issued from</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>bargaining power</td>
<td>0.717142767</td>
<td>inferred</td>
</tr>
<tr>
<td>$d$</td>
<td>domestic output</td>
<td>0.319766988</td>
<td>inferred</td>
</tr>
<tr>
<td>$\hat{w}_I$</td>
<td>upper-tier wage</td>
<td>2.2813</td>
<td>inferred</td>
</tr>
<tr>
<td>$w_I$</td>
<td>lower-tier wage</td>
<td>0.784097683</td>
<td>inferred</td>
</tr>
<tr>
<td>$s$</td>
<td>formal job destruction rate</td>
<td>0.004366451</td>
<td>inferred</td>
</tr>
<tr>
<td>$k$</td>
<td>prob. of becoming upper-tier</td>
<td>0.000419272</td>
<td>inferred</td>
</tr>
<tr>
<td>$\pi$</td>
<td>prob. of becoming educ. inform.</td>
<td>0.341352048</td>
<td>inferred</td>
</tr>
<tr>
<td>$a$</td>
<td>stigmatization variable</td>
<td>0.0162</td>
<td>equation (16)</td>
</tr>
<tr>
<td>$\theta$</td>
<td>formal sector tightness</td>
<td>0.1020</td>
<td>def. of $\theta$</td>
</tr>
<tr>
<td>$v$</td>
<td>formal vacancy rate</td>
<td>0.0044</td>
<td>def. of matching function</td>
</tr>
<tr>
<td>$c$</td>
<td>cost of a vacancy</td>
<td>2.4004</td>
<td>eq. (11) - see text</td>
</tr>
<tr>
<td>$w_F$</td>
<td>formal bargained wage</td>
<td>0.9517</td>
<td>equation (9)</td>
</tr>
<tr>
<td>$q$</td>
<td>prob. of filling a formal job</td>
<td>0.4904</td>
<td>inferred from vacancy days</td>
</tr>
<tr>
<td>$M$</td>
<td>Matching technology</td>
<td>0.1566</td>
<td>deduced by inferred $q$</td>
</tr>
</tbody>
</table>

Many methods have been used to calculate vacancy costs in the literature leading to wide differences in values. As for us, we choose to impute the cost of vacancy following Andolfatto (1996) for which for the United-States the ratio $\frac{c_v}{y_F}$ must be equal to 1%. As it was not possible to fix this cost in advance due to the fact that it must satisfy (11), we run the calibration so that a cost of about 2.4 is the target of the model. This way of specification implies an important vacancy cost more than two times higher than formal productivity (2.404). Satchi and Temple (2009) note that the recruitment of formal sector workers is a costlier process in developing countries because information transmission of job opportunities are less efficient. We could also have chosen, as Satchi and Temple (2009) did, 3% for the same ratio. But in that case, with our model specification, the vacancy cost would have been huge being almost seven times higher than the formal productivity (6.82)\(^4\).

The job filling rate $q$ is directly obtained thanks to the vacancy duration of 45 days. The matching function technology $M$ is then obtained assuming the matching function is a Cobb-Douglas of the following form:

$$h = h(v, (u + a\ell_I)) = M(u + a\ell_I)^\eta v^{1-\eta}$$

We thus deduce:

$$M = \frac{p}{\theta^{1-\eta}}$$

\(^4\)With such a value for the vacancy cost, inferred variables change and the bargaining power of workers is close to 0.3.
5.4 Impact of a rise in access to education, no budget constraint

First of all, we can check the theoretical results obtained in Table 1. Increasing arbitrarily $\gamma$ by 10% ($\gamma$ is thus equals to 0.76) leads to the following change in labor market states. The results are summarized in Table 6.

Table 6: Impact table

<table>
<thead>
<tr>
<th>name</th>
<th>baseline</th>
<th>$\gamma + 10%$</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$u$</td>
<td>0.0340</td>
<td>0.0365</td>
<td>+7.35%</td>
</tr>
<tr>
<td>$\ell_F$</td>
<td>0.3274</td>
<td>0.3434</td>
<td>+4.89%</td>
</tr>
<tr>
<td>$\ell_I^E$</td>
<td>0.3494</td>
<td>0.3748</td>
<td>+7.27%</td>
</tr>
<tr>
<td>$\ell_I^{NE}$</td>
<td>0.2130</td>
<td>0.1653</td>
<td>-22.39%</td>
</tr>
<tr>
<td>$\ell_I$</td>
<td>0.5624</td>
<td>0.5401</td>
<td>-3.96%</td>
</tr>
<tr>
<td>$\hat{\ell}_I$</td>
<td>0.0763</td>
<td>0.0800</td>
<td>+4.85%</td>
</tr>
</tbody>
</table>

5.5 Impact of a rise in access to education, tax and subsidy scheme

According to the International Food Policy Research Institute (Skoufias 2005), the Progresa program was equivalent to 0.2% of Mexico’s GDP in 1999, that is to say 20% of the Federal poverty alleviation budget or about US$777 million.

In the theoretical model, the GDP is the sum of production minus the recruitment costs.

$$GDP = y_F\ell_F + y_I\ell_I + \hat{y}_I\hat{\ell}_I - cv\ell_F$$

According to Schultz (2004), who uses a difference in difference method to evaluate the Mexican Progresa poverty program, the gain in cumulative enrollment of the program participant is of 0.66 years. This figure is considered as being the long term effect on child schooling attainment.

In order to estimate the impact of such an increase on labor flows, we make several assumptions. As the program target is wide and concerns the poor, and as a consequence uneducated ones, we assume that the program increase education of the uneducated ones by 0.66 years. We thus increase by 0.66 years the education level of ENOE individuals classified in the informal lower-tier. By doing so, several individuals jump from the uneducated category to the educated group. We then compute the new shares of educated and uneducated individuals and introduce the new values in the calibration.

[Work in progress: this section is under construction]

6 Labor Market Efficiency

We first define a social optimum, then compare it with the labor market decentralized equilibrium. Note that for simplification purpose this section treats the case of employ-
ment stability, $s = 0$. Hence qualified workers are only composed of educated newcomers. We assume that the discount rate is nil ($r = 0$). Moreover, the following preliminary section limits to the case of no upper-tier sector, $k = 0$.

### 6.1 Social optimum

Along the same lines as Hosios (1990) and Pissarides (2000), let us consider a social planner who is only subject to search frictions, and can redistribute income among agents at no cost. The social surplus is given by:

\[ CS = \hat{y}_I \hat{\ell}_I + y_F \ell_F + y_I \ell_I + du - \theta c(u + a \ell_I) \]  

(25)

The social optimum is given when the social planner maximizes the social surplus flow $CS$ with respect to $\theta$ and $\pi$ at steady state. Equalizing the derivative of the social surplus with respect to $\theta$ to zero give the condition under which job creation in the formal sector is socially optimal. Let us first assume, for the sake of simplicity, that there is no upper-tier sector. Thus $k = 0$.

The derivative of $CS(.)$ with respect to $\theta$ can be written as:

\[ \frac{\partial CS}{\partial \theta} = \frac{m \psi}{(m + p)^2(m + ap)^2} \times \]

\[ \left[ q(1 - \eta) \frac{a(1 - \gamma + \gamma \pi)(m + p)^2}{(m + \eta p)\psi} \left( (y_F - y_I)(m + \eta p) - (y_F - d)(m + \eta ap) \right) \right. \]

\[ \left. - c + q(1 - \eta) \frac{(y_F - d)}{(m + \eta p)} \right] \]  

(26)

where $\psi = (m + \eta p)(1 - \pi)\gamma(m + ap)^2 + a(1 - \gamma + \gamma \pi)(m + p)^2(m + \eta ap)$. Denote $FJ$ the term between brackets. The level of $\theta$, so of formal job creation, that a social planner should set is obtained when the derivative equals zero, so for $FJ = 0$.

The derivative of $CS(.)$ with respect of the share of educated informal workers, $\pi$, is:

\[ \frac{\partial CS}{\partial \pi} = \frac{m \gamma}{(m + ap)(m + p)} \left[ - (y_F - d)p(1 - a) + (y_I - d)(m + p) + \theta c(1 - a)m \right] \]  

(27)

Denoting $IJ$ the term between brackets, the level of $\pi$ that a social planner should set is obtained when the derivative equals zero, so for $IJ = 0$.

### 6.2 Efficiency of the decentralized equilibrium

In the standard Pissarides model, the social surplus condition equals the decentralized equilibrium condition when the bargaining power of workers $\beta$ is equal to the elasticity $\eta$ of $q$ with respect to $\theta$. Here, the so-called Hosios condition is clearly not sufficient to restore the efficiency of the labor market. When formal firms create jobs they do not take into consideration the path of workers and the existence of an informal sector.
Proposition 1. Under the Hosios condition, formal job creation is too weak compared to the social optimum requirement.

Proof. For \( \eta = \beta \), the decentralized equilibrium (11) is \( c = (1 - \eta)q \frac{(y_F - d)}{m + \eta p} \). Replacing this equation in \( FJ \) shows the sign of the social surplus derivative. We have:

\[
FJ \equiv q(1 - \eta) \frac{a(1 - \gamma + \gamma \pi)(m + p)^2}{(m + \eta p)} \left[ (y_F - y_I)(m + \eta p) - (y_F - d)(m + \eta p) \right]
\]

As \( y_I = w_I \), the migration condition (16) can be written as \( \eta ap(y_F - d) = \eta p(y_F - d) - (y_I - d)(m + p) \). Replacing this in the term between brackets shows that \( FJ \) has the same sign that:

\[
(y_I - d)p(1 - \eta) > 0
\]

In the decentralized equilibrium the derivative of the social surplus with respect to the labor market tightness (26) is positive. This proves the previous proposition. \( \square \)

In the decentralized equilibrium a rise in the labor market tightness leads to an increase in the social surplus. When formal firms decide on job creation, they do not take into account the applicants career path and so do not consider the recruitment of workers coming from the informal sector. As a rise in the labor market tightness increases the share of educated informal applicants, it improves the transition probability of informal workers of finding a formal job. These workers compete with unemployed workers on the same jobs. As a results formal firms do not create enough jobs compared to the social optimum.

Proposition 2. Under the Hosios condition, the share of educated workers in the informal sector is too high relative to what the social optimum requires.

Proof. For \( \eta = \beta \), the decentralized equilibrium (11) can be written \( \xi = (1 - \eta) \frac{(y_F - d)}{m + \eta p} \). Replacing this in \( IJ \) gives:

\[
IJ \equiv \frac{m + p}{m + \eta p} \left[ - (y_F - d) \eta p(1 - a) + (y_I - d)(m + \eta p) \right]
\]

Equation (16) can be written as \( \eta ap(y_F - d) = \eta p(y_F - d) - (y_I - d)(m + p) \). Replacing this last equation in the term between brackets shows that at the decentralized equilibrium \( IJ \) has the same sign that:

\[
-(y_I - d)p(1 - \eta) < 0
\]

In the decentralized equilibrium, the social surplus derivative with respect to \( \pi \) (27) is negative. This proves proposition 2. \( \square \)

In the decentralized equilibrium a rise in the educated share in the informal sector reduces the social surplus. Educated workers that enter into informality obtains a formal job at a lower rate than their unemployed counterpart but the more they are to enter informality the higher their chance is to obtain a formal job later one. Nevertheless it is not socially optimal that educated workers enter informality as these workers are to numerous in the informal sector compared to the social optimum.
6.3 $k>0$ [section under construction]

The elasticity of $q$ with respect to $\theta$, denoted by $\eta$ gives the equality $p'(\theta) = (1 - \eta)q$. We obtain:

$$
0 = -c + \frac{(1 - \eta)q}{(m + k)[(m + \eta p)\gamma(1 - \pi)(m + ap)^2 + (m + \eta ap)a[(1 - \gamma) + \gamma \pi](m + p)^2]}
\times \left[ k(\hat{y}_I - d) + m(y_F - d) \right] \left[ \gamma(1 - \pi)(m + ap)^2 + a[(1 - \gamma) + \gamma \pi](m + p)^2 \right]
- (y_I - d)(m + k)a[(1 - \gamma) + \gamma \pi](m + p)^2
$$

(28)

7 Preliminary Conclusion

In a framework in which the labor market is segmented between a formal and an informal sector, thus representing a developing economy, the impact of an increase in access to education is straightforward when the government does not face any budget constraint. It leads to an increase in formal employment but also to a rise in educated informal workers. When the government subsidizes education programs through a tax in the formal sector, distortions appear. Except for two partial results, this education policy program requires a calibration of the model. This part of the paper is currently being treated with data on Mexico. The preliminary labor market efficiency results implies that any public policy implementing a tax in the formal sector in order to improve education would moves the decentralized equilibrium away from the social optimum as this optimum would require, on the contrary, an increase in formal job creation.
References


