Reforming the Informal Sector: Assessing the Impact on Young Less-Educated Workers

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Abstract

In this paper we develop a search and matching model that allows for two important channels through which participation in the informal sector labor market may benefit low-skill workers; (i) human capital accumulation, and (ii) employer screening. While these mechanisms have been considered separately within the existing literature, our paper is the first to consider their effects simultaneously within a labor search environment. We calibrate our model using the ENOE, a Mexican household survey on income and labor dynamics. Our calibration procedure allows the model to reflect key features of the Mexican labor market, with a specific focus on the labor adjustments experienced by young less educated workers. Starting from our baseline calibration, we conduct counterfactual policy experiments to assess how labor market reforms designed to limit the informal sector impact the workers in question. Our preliminary findings suggest that policy makers must carefully consider how the informal sector is regulated as certain interventions may hurt, rather than help, disadvantaged workers.

Keywords: Informal Sector, Labor Search, Employer Screening, Human Capital Formation.

JEL Classification: J46, J64, J68, O17

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1 Introduction

In developing countries a substantial fraction of workers are employed through irregular under-the-table jobs. Jobs such as these are typically referred to as “informal jobs,” and taken together, constitute the informal sector. Traditionally, the informal sector carries negative connotations such as poor working conditions, low pay, lack of basic benefits, and lower-productivity. It has been argued that the existence of a large informal sector can negatively affect growth by congesting public services (e.g., Loayza, 1996). However, other studies have considered the possible benefits of informal sector participation, arguing that jobs in the informal sector provide young low-skilled workers with employment and worker-training opportunities outside of those offered in the formal sector or by the government (Hemmer and Mannel, 1989).

In the spirit of this last argument, our study examines the extent to which informal sector employment provides young less-educated workers with opportunities to advance their career and transition into formal-sector jobs. We focus on two possible channels through which informal-sector jobs may benefit these workers: (i) informality may provide workers with the opportunity to accumulate human capital and gain the skills required by formal-sector employers, and (ii) informality may provide firms with a cost effective way to screen employees and determine their specific skill level. While the existing literature provides empirical support for each of these mechanisms, our paper is the first to consider their combined effect within a calibrated labor market search model.\footnote{See (Cano-Urbina, 2015, 2016) for a discussion of the empirical relevance of each mechanism independently.}

Our focus on the beneficial role of informal labor participation is motivated by the labor market experience of young less-educated workers in Mexico. Figure 1 describes the distribution of less-educated workers by sector of employment and age in Mexico. Inspection of Figure 1 clearly shows that the youngest less-educated workers are predominantly employed in the informal sector. Furthermore, moving across age cohorts, we find that the proportion of workers employed in the informal (formal) sector decreases (increases) monotonically with age. This pattern of employment adjustment continues until workers reach their mid twenties, at which point sectoral employment shares remain more or less constant. This pattern is consistent with the idea that informal-sector jobs can be a “port of entry” into the labor market for young less-educated workers (Arias and Maloney, 2007) and that the informal sector offers free-entry job opportunities (Fields, 2009) whereas formal-sector jobs present some barriers to entry for this group of workers. If these are true, and if the formal
sector offers better job opportunities than the informal sector, then the distribution of less-educated workers in the formal and informal sector presented in Figure 1 is consistent with the possibility that informal-sector jobs offer less-educated workers some opportunities that facilitate their entry into the formal sector.²

Given the empirical evidence discussed above, we consider two possible channels through which the informal sector could help facilitate transitions into formal-sector employment for young less-educated workers: human capital accumulation and screening. Both of these mechanisms have been considered previously in the literature (Cano-Urbina, 2015, 2016). However, these former studies focus on each role independently and ignore their combined effect. On the one hand, Cano-Urbina (2016) finds evidence that supports the possibility that informal-sector jobs provide opportunities for less-educated workers to accumulate general human capital. On the other hand, Cano-Urbina (2015) finds evidence that supports the possibility that informal-sector jobs serve as a screening device that helps in solving an information problem about the worker’s skills. This last study is the closest to our current paper since it considers both roles of informal-sector jobs mentioned above, however, each role is considered separately in two parallel models and the analysis is not suitable to learn which role dominates. Furthermore, these previous works lack a detailed calibration strategy, and as such, must remain silent regarding the qualitative and quantitative impact of various policy changes related to the informal sector.

Our paper contributes to the literature in the following three ways. First, we develop a multi-sector search and matching model that simultaneously allows for human capital accumulation and worker screening. We assume that all workers enter the labor market with an unknown/unobserved skill level that is revealed randomly while working in either sector. Furthermore, a worker’s true skill level is either high or low, and all low-skill workers can become high-skilled over time by working in either sector. Second, we use both aggregate and survey level data to calibrate our baseline model to key features of the Mexican economy. Specifically, the parameters governing human capital accumulation and employer screening are calibrated based on findings in the existing literature related to the rate of human capital accumulation and to ensure that the model generates a plausible distribution of workers across skill types (low, high, and unknown) in equilibrium.³ And lastly, we use our

²Note that Figure 1 makes clear that we are treating informal-sector workers separately from self-employed workers. That is, when we refer to the informal sector, we refer to those salaried workers. Some studies pool informal salaried and self-employed in the same category. Our reason to separate informal salaried from self-employed corresponds to our interest in human capital accumulation and screening of workers skills, which might not be very relevant, specially screening, for a self-employed worker.

³A more detailed description of the calibration process is presented below.
Figure 1: Distribution of Less-Educated Workers by Sector of Employment in Mexico

Notes: Figure taken from Cano-Urbina (2015). The lines correspond to the proportion of workers employed in each sector by age. Data obtained from the Mexican survey ENOE (Encuesta Nacional de Empleo Urbano).
calibrate model to determine the labor market implications of two contrasting policies that both attempt to restrict the size of the informal sector.

Policies that attempt to restrict informal-sector participation typically focus on firm behavior and either work by (i) increasing the likelihood of punishment for non-compliance, or (ii) reducing the regulatory burden associated with formal-sector participation. We consider the impact of both types of polices within our model environment. For the first type of policy, we consider an exogenous increase in the rate at which informal firms are monitored, thereby increasing the expected cost of creating jobs in the informal sector. As for the second type of policy, we consider exogenous reductions in the firing costs faced by formal sector firms, thereby reducing the expected cost of creating jobs in the formal sector. Our preliminary findings suggest that governments must carefully chose the policies that are used to encourage formal labor participation, as informal labor participation allows for the accumulation of skills and facilitates transitions into formal sector employment.

The rest of the paper is organized as follows. Section 2 presents the model, while Section 3 reviews our data sources and outlines our calibration procedure. Section 4 present our results, and Section 5 concludes.

2 The Model

We consider a labor market with two sectors, a formal and an informal sector. Firms in the formal sector are on average more productive than firms in the informal sector. This difference in average productivity between sectors could be a result of formal-sector firms having access to better outside financing and more investment in physical capital than informal-sector firms (as modeled in Amaral and Quintin, 2006). We follow Bosch and Esteban-Pretel (2012) in assuming that: (i) formal-sector firms are subject to a firing cost incurred when matches are exogenously destroyed whereas informal-sector firms do not incur this cost, and (ii) informal-sector firms are subject to a penalty if they are caught by the authorities in which case the job is destroyed whereas formal-sector firms do not incur this penalty.\(^4\)

Workers possess one of two skill levels, low or high. However when workers first enter the labor market their skill level is unknown. We assume that neither the worker nor the firm know the worker skill level, so that information about the new worker’s skill level is symmetric, and all that is known is that a fraction \(\nu\) of these new workers are low skilled. We

\(^4\)It should be mentioned that the regulatory costs of formality extend well beyond that of firing costs and include additional costs ranging from paid sick leave and vacation days, to employer-paid tax bills. To simplify our model environment we summarize these costs into an aggregate term that we call “firing costs.”
refer to new workers with unknown skill level as “newcomers.” All newcomers enter the labor market through unemployment where they search for jobs in both the formal and informal sectors. When workers find a job in the formal or informal sector their skill level can be revealed. Skills cannot be revealed while the newcomer is unemployed. Workers’ skills are revealed according to a stochastic process such that at every moment a worker’s skill level can be revealed with probability $\sigma_F$ if the worker is employed in the formal sector and $\sigma_I$ if employed in the informal sector. High-skilled workers are on average more productive than low-skilled workers.

Once a worker’s skill level is revealed, those workers who are found to be low skilled can accumulate human capital and become high skilled while employed in the formal or the informal sector, but not while unemployed. Similar to the skill-revelation process, the process of human capital accumulation is also a stochastic process such that at every moment a low-skilled worker accumulates human capital and becomes high skilled with probability $\kappa_F$ if employed in the formal sector and with probability $\kappa_I$ if employed in the informal sector.

All unemployed workers search for jobs in both the formal and informal sectors, irrespective of whether their type is known. When workers find a job in the informal sector, these workers keep searching for jobs in the formal sector and move to a formal-sector job whenever it is optimal for them to do so. Workers who find a job in the formal sector do not search for jobs in the informal sector. We abstract from on-the-job search within sector. Given this job-search behavior, unemployed workers contact firms in the informal sector according to the function:

\begin{equation}
\text{(1)} \quad m_I(u, v_I) = \gamma_1^I u^{\gamma_2^I} v_I^{1-\gamma_2^I}
\end{equation}

where $u$ is the unemployment rate, and $v_I$ is the number of vacant informal-sector jobs as a fraction of the labor force. The function $m_I(\cdot, \cdot)$ is increasing in both its arguments, concave, and homogenous of degree one. As a result, informal-sector firms contact unemployed workers at rate $q_I = m_I(u, v_I)/v_I = \gamma_1^I \theta_I^{-\gamma_2^I}$, where $\theta_I = v_I/u$ is the labor-market tightness in the informal sector. Similarly, unemployed workers contact informal-sector firms at rate $f_I = m_I(u, v_I)/u = \gamma_1^I \theta_I^{1-\gamma_2^I}$.

Unemployed and informal-sector workers contact formal-sector firms according to the function:

\begin{equation}
\text{(2)} \quad m_F(u + n_I, v_F) = \gamma_1^F (u + n_I)^{\gamma_2^F} v_F^{1-\gamma_2^F}
\end{equation}
where \( n_I \) is the number of workers employed in the informal-sector as a fraction of the labor force and \( v_F \) is the number of vacant formal-sector jobs as a fraction of the labor force. The function \( m_F(\cdot, \cdot) \) is increasing in both its arguments, concave, and homogenous of degree one. Following Bosch and Esteban-Pretel (2012) we allow for the possibility that unemployed and informal-sector workers are not equally efficient in their job search efforts. Then, formal-sector firms contact unemployed individuals at rate 

\[
q_F = m_F(u + n_I, v_F)/v_F = \gamma_1^F \theta_F^{1/2}
\]

where \( \theta_F = v_F/(u + n_I) \) is the labor-market tightness in the formal sector, and contact informal-sector workers at rate \( \eta q_F \), where \( \eta \) is the parameter that summarizes the relative efficiency in job search behavior between unemployed and informal-sector workers. Similarly, unemployed individuals contact formal-sector firms with unfilled vacancies at rate 

\[
f_F = m_F(u + n_I, v_F)/(u + n_I) = \gamma_1^F \theta_F^{1-\gamma_F^2},
\]

and informal-sector workers at rate \( \eta f_F \).\(^5\)

Not all contacts between job seekers and firms in both sectors end up in a match being created. We assume that matches in the formal and informal sectors are created according to a stochastic job matching process as in chapter 6 of Pissarides (2000). That is, we assume that when a firm and a job seeker make contact they draw a match quality \( x \) from a distribution \( G(x) \) with support on \([0, 1]\). Then, only those contacts with a match quality higher than a hiring standard end up in a match being created. Once the match quality is drawn it stays constant, if the match is created, until the match is destroyed.

As we show below, hiring standards depend on the sector of employment (formal or informal), on the worker’s skill level, and whether the skill level has been revealed yet. We denote the hiring standards in sector \( j \in \{F, I\} \) as \( C_{jH} \) and \( C_{jL} \) for high- and low-skilled workers, respectively, and \( C_j \) for newcomers, where \( j = F \) corresponds to the formal sector and \( j = I \) to the informal sector. We do not impose any ordering on these cut-offs but instead their ordering is an equilibrium outcome. As a result, it is possible that a match between a newcomer and a firm is destroyed once the newcomer’s skill level is revealed if the current match quality is lower than the hiring standard for the revealed skill level of the worker.\(^6\)

We assume that formal-sector matches are exogenously destroyed at a Poisson rate \( \lambda_F \) and

\(^5\)Bosch and Esteban-Pretel assume that \( \eta < 1 \) (see first paragraph of page 277 of Bosch and Esteban-Pretel, 2012). While this is a reasonable assumption for a labor market with a formal and an informal sector, recent work by Faberman et al. (2017) suggests that on-the-job search is more efficient than search while unemployed, however this result is true for the US labor market where there is no informal and formal sector duality, and so we cannot directly map this result to the case of informal-formal sector on-the-job search.

\(^6\)That is, suppose that the current match quality between a newcomer and a formal-sector firm is \( \tilde{x} \), then, if the worker is revealed low skilled and \( \tilde{x} < C_{FH} \) the match is destroyed, or if the worker is revealed high skilled and \( \tilde{x} < C_{FL} \) the match is destroyed.
that informal-sector matches are exogenously destroyed at Poisson rate $\lambda_I$. Additionally, jobs in the informal sector can be exogenously destroyed when informal-sector firms are caught by the authorities, which happens with probability $\pi$. Finally, we assume that workers exit the labor market permanently at an exogenous rate $\tau$ regardless of their current state and regardless of their skill level. We assume that every worker that exits the labor market permanently is replaced by a newcomer that enters the labor market through unemployment and that is low-skilled with probability $\nu$.

### 2.1 Steady-State Worker Flows

Given the assumptions stated above and the job search and matching behavior we have the following equilibrium worker flows in the steady state:

\begin{align}
(3) \quad & [\tau + f_f \bar{G}(C_F) + f_I \bar{G}(C_I)]u = \lambda_F n_F + \lambda_I n_I + \pi n_I + \tau \\
(4) \quad & [\tau + \lambda_F + \sigma_F] n_F = f_F \bar{G}(C_F) u + \eta f_F \bar{G}(C_F) n_I \\
(5) \quad & [\tau + \lambda_I + \eta f_F \bar{G}(C_F) + \pi + \sigma_I] n_I = f_I \bar{G}(C_I) u \\
(6) \quad & [\tau + \lambda_F] n_{FH} = f_F \bar{G}(C_{FH}) u_H + \eta f_F \bar{G}(C_{FH}) n_{IH} + \kappa_F n_{FL} + \sigma_F (1 - \nu) \bar{G}(C_{FH} | x \geq C_F) n_F \\
(7) \quad & [\tau + \lambda_F + \kappa_F] n_{FL} = f_F \bar{G}(C_{FL}) u_L + \eta f_F \bar{G}(C_{FL}) n_{IL} + \sigma_F \nu \bar{G}(C_{FL} | x \geq C_F) n_F \\
(8) \quad & [\tau + \lambda_I + \pi + \eta f_F \bar{G}(C_{FH})] n_{IH} = f_I \bar{G}(C_{IH}) u_H + \kappa_I n_{IL} + \sigma_I (1 - \nu) \bar{G}(C_{IH} | x \geq C_I) n_I \\
(9) \quad & [\tau + \lambda_I + \pi + \kappa_I + \eta f_F \bar{G}(C_{FL})] n_{IL} = f_I \bar{G}(C_{IL}) u_L + \sigma_I \nu \bar{G}(C_{IL} | x \geq C_I) n_I \\
(10) \quad & [\tau + f_I \bar{G}(C_{IH}) + f_F \bar{G}(C_{FH})] u_H = \\
& \quad = (\lambda_I + \pi) n_{IH} + \lambda_F n_{FH} + \sigma_F (1 - \nu) \bar{G}(C_{FH} | x \geq C_F) n_F + \sigma_I (1 - \nu) \bar{G}(C_{IH} | x \geq C_I) n_I \\
(11) \quad & [\tau + f_I \bar{G}(C_{IL}) + f_F \bar{G}(C_{FL})] u_L = \\
& \quad = (\lambda_I + \pi) n_{IL} + \lambda_F n_{FL} + \sigma_F \nu \bar{G}(C_{FL} | x \geq C_F) n_F + \sigma_I \nu \bar{G}(C_{IL} | x \geq C_I) n_I 
\end{align}

where $\bar{G}(x) = 1 - G(x)$. In these equilibrium flows, $u$, $n_F$, and $n_I$ represent the number of newcomers who are unemployed, employed in the formal sector, and employed in the informal sector, respectively, as a fraction of the labor force. Similarly $u_k$, $n_{Fk}$, and $n_{Ik}$ is the number of workers of skill level $k \in \{H, L\}$ who are unemployed, employed in the formal sector, and employed in the informal sector, respectively, as a fraction of the labor force.
Since all worker shares are represented as a fraction of the labor force we have that:

\[ u + n_I + n_F + u_L + n_{IL} + n_{FL} + u_H + n_{IH} + n_{FH} = 1 \]

The left-hand side of the flows in equations (3)-(11) represent all the worker flows out of a given state and the right-hand side represent all the worker flows into that particular state. For example, equation (3) is the equilibrium flow of newcomers into and out of unemployment. On the left-hand side we have the three channels out of the unemployment state for newcomers: they could exit the labor market permanently with probability \( \tau \), they could contact a formal-sector firm with probability \( f_F \) and with probability \( G(C_F) \) they create a match, or they could find a job in the informal sector with probability \( f_I \). Similarly, on the right-hand side we have the four channels into unemployment for newcomers: their match could be exogenously destroyed while they are employed in the formal sector with probability \( \lambda_F \), or their informal-sector match could be destroyed with probability \( \lambda_I \), or their informal-sector match could be destroyed with probability \( \pi \) due to being caught by authorities, or they could enter the labor market for the first time to replace workers that exogenously exit the labor market with probability \( \tau \).

Equations (4) and (5) show that workers can leave the state of employment in the formal or informal sector, respectively, as newcomers and be revealed as either low- or high-skilled with probabilities \( \sigma_F \) and \( \sigma_I \), respectively. Now notice that equations (6) - (9) describe that when workers' skills are revealed workers can loose their jobs when their skill level is revealed. For example, in the formal sector, for a worker of skill level \( k \in \{ H, L \} \) to be hired in the formal sector, it must be the case that the match quality drawn when the formal-sector firm and the worker get in contact is higher than the hiring standard \( C_{Fk} \) for \( k \in \{ H, L \} \). Similarly, for a newcomer it must be the case that the match quality drawn is higher than the cut-off \( C_F \). However, we do not make any assumption about the relative size of the cut-offs, this makes it possible for a newcomer to be hired with a match quality \( \tilde{x} \) larger than \( C_F \), but that once the worker's skill level is revealed that same match quality \( \tilde{x} \) is not larger than the cut-off for the skill level of the worker. This is what equations (6) and (7) indicate, that only those workers with a match quality larger than the cut-off \( C_{Fk} \) would keep their job once it is renegotiated with the firm given their now revealed skill level. Those whose current match quality is lower than the cut-off would become unemployed and join the group of unemployed of skill level \( k \in \{ H, L \} \) as it is described in equations (10) and (11). Something similar occurs in the informal sector as indicated by equations (8) and (9) for workers that keep their informal-sector job and by equations (10) and (11) for workers
that loose their informal-sector job.

2.2 Value Functions

The value functions for newcomers that just entered the labor market and are searching for jobs is given by:

\( rU = z + f_I \int_{C_j}^1 [W_I(x) - U]dG(x) + f_F \int_{C_F}^1 [W_F(x) - U]dG(x) - \tau U \)  

where \( z \) is the flow utility in unemployment, \( r \) is the discount rate, \( U \) is the present-discounted value of the expected income stream from unemployment, that is the value of unemployment, for a newcomer, \( W_k(x) \) is the value of employment in sector \( j \in \{F, I\} \) for a newcomer with a match quality equal to \( x \). Only those contacts with firms in sector \( j \in \{F, I\} \) that result in a match quality larger than \( C_j \) result in a match being created between a newcomer and a firm in sector \( j \in \{F, I\} \) and result on an expected gain equal to \( E[W_j(x) - U | x > C_j] \), where \( E[\cdot] \) is the expectation operator. Finally, with probability \( \tau \) a newcomer who is currently unemployed exits the labor market permanently which results in a loss of \( U \).

Once newcomers find a job in the formal or informal sector the value of holding those jobs is given by:

\( rW_I(x) = w_I(x) + (\lambda_I + \pi)[U - W_I(x)] + \eta f_F \int_{C_F}^1 [W_F(x') - W_I(x)]dG(x') \)

\[ + \sigma_I \nu \left( \Gamma_{IL}(x)[W_{IL}(x) - W_I(x)] + (1 - \Gamma_{IL}(x))[U_L - W_I(x)] \right) \]

\[ + \sigma_I(1 - \nu) \left( \Gamma_{IH}(x)[W_{IH}(x) - W_I(x)] + (1 - \Gamma_{IH}(x))[U_H - W_I(x)] \right) - \tau W_I(x) \]

\( rW_F(x) = w_F(x) + \lambda_F[U - W_F(x)] \)

\[ + \sigma_F \nu \left( \Gamma_{FL}(x)[W_{FL}(x) - W_F(x)] + (1 - \Gamma_{FL}(x))[U_L - W_F(x)] \right) \]

\[ + \sigma_F(1 - \nu) \left( \Gamma_{FH}(x)[W_{FH}(x) - W_F(x)] + (1 - \Gamma_{FH}(x))[U_H - W_F(x)] \right) - \tau W_F(x) \]

Newcomers receive wage \( w_I(x) \) or \( w_F(x) \) when they get an informal or a formal job, respectively, and the wage depends on the match quality \( x \) drawn when the worker and the firm make contact for the first time. With probability \( \lambda_j, j \in \{F, I\} \), the job is exogenously destroyed in which case newcomers become unemployed. Additionally, an informal-sector
job can be exogenously destroyed if the firm is caught by the authorities which happens with probability $\pi$. Informal-sector workers keep searching for jobs in the formal sector and with probability $\eta f_F$ they contact a formal-sector firm with a vacancy; at this point the firm and the informal-sector worker draw a new match quality $x'$ from distribution $G(x')$ and if the match quality $x'$ is larger than the cut-off for newcomers in the formal sector, $C_F$, the newcomer quits the informal-sector job and moves into the formal-sector job.\(^7\) When workers move to the formal sector they have an expected gain of $E[W_F(x') - W_I(x)|x' > C_F]$.

The skill level of a newcomer can be revealed in the formal or informal sectors with probability $\sigma_j$, for $j \in \{F, I\}$, and depending on the current match quality the worker and the firm renegotiate their contract or separate.\(^8\) This is reflected in the value function with the indicator function $\Gamma_{jk}(x) = \mathbf{1}\{x \geq C_{jk}\}$ for $j \in \{F, I\}$ and $k \in \{H, L\}$. If the current match quality is higher than the corresponding cut-off given the worker’s skill level then the contract is renegotiated and the worker has a gain of $[W_{jk}(x) - W_j(x)]$. If the current match quality is lower than the corresponding cut-off the match is destroyed and the worker has gain of $[U_k - W_j(x)]$. Similarly, the match can be exogenously destroyed if the worker permanently exits the labor market before the skill level is revealed.

Once a worker skill level is revealed workers who are found to be low skilled can accumulate human capital while employed in the formal or the informal sector. The value of employment in the formal and informal sectors for a worker of skill level $k \in \{H, L\}$ are given by:

\begin{align}
(16) \quad rW_{Fk}(x) &= w_{Fk}(x) + \lambda_F[U_k - W_{Fk}(x)] + \kappa_F[W_{FH}(x) - W_{Fk}(x)] - \tau W_{Fk}(x) \\
(17) \quad rW_{Ik}(x) &= w_{Ik}(x) + (\lambda_I + \pi)[U_k - W_{Ik}(x)] + \eta f_F \int_{C_{Fk}}^{1} [W_{Fk}(x') - W_{Ik}(x)]dG(x') \\
&\quad + \kappa_I[W_{IH}(x) - W_{Ik}(x)] - \tau W_{Ik}(x)
\end{align}

where the description of the value function is very similar to that of newcomers. Low-skilled

\(^7\)Notice that both unemployed and informal newcomers have the same hiring standard, $C_F$, regardless of their employment status. We follow Pissarides (1994) by assuming that once a match between a worker and a firm occurs the threat point of the worker is unemployment. This is based on the assumption that wage contracts are negotiated continuously. Dolado et al. (2009) and Bosch and Esteban-Pretel (2012) adopt this assumption in their matching models. See page 206 of Dolado et al. (2009) and footnote of Bosch and Esteban-Pretel (2012).

\(^8\)Intuitively this stochastic process can be understood considering that it takes on average $1/\sigma_j$ periods to learn the skill level of a newcomer employed in sector $j \in \{F, I\}$.
workers accumulate human capital with probability $\kappa_F$ and $\kappa_I$ when employed in the formal and informal sectors, respectively. Workers who accumulate human capital have a gain of $[W_{jH}(x) - W_{jL}(x)]$ for $j \in \{F, I\}$. Notice that the gain associated with human capital accumulation only enters the value function of low-skilled workers.

The value of unemployment for a worker of skill level $k \in \{H, L\}$ is given by:

$$(18) \quad rU_k = z + f_I \int_{C_{Ik}}^1 [W_{Ik}(x) - U_k]dG(x) + f_F \int_{C_{Fk}}^1 [W_{Fk}(x) - U_k]dG(x) - \tau U_k$$

where only those contacts between an unemployed worker of skill level $k \in \{H, L\}$ and a firm in sector $j \in \{F, I\}$ that draw a match quality $x$ larger than the cut-off $C_{jk}$ result in a match. Notice that human capital accumulation can only happen when low-skilled workers are employed in the formal or informal sector but not while unemployed.

The values of having a vacancy for informal- and formal-sector firms are given by:

$$(19) \quad rV_j = -h_j + q_j \varphi_{jL} \int_{C_{jL}}^1 [J_{jL}(x) - V_j]dG(x) + q_j \varphi_{jH} \int_{C_{jH}}^1 [J_{jH}(x) - V_j]dG(x)$$

$$+ q_j (1 - \varphi_{jL} - \varphi_{jH}) \int_{C_j}^1 [J_j(x) - V_j]dG(x)$$

for $j \in \{F, I\}$ and where $h_j$ is the recruitment cost in sector $j \in \{F, I\}$. $V_j$ is the present-discounted value of the expected income stream from having a vacancy in sector $j \in \{F, I\}$, that is the value of a vacancy. Similarly, $J_{jL}(x)$, $J_{jH}(x)$, and $J_j(x)$ are the value of a match with a low-skilled, a high-skilled, and a newcomer, respectively, with match quality $x$ for firm in sector $j \in \{F, I\}$. The $\varphi_{jk}$ represents the fraction of job seekers of skill level $k \in \{H, L\}$ that contact firms in sector $j \in \{F, I\}$. For example, $\varphi_{IL} = u_L/(u + u_L + u_H)$ since only unemployed workers search for informal-sector jobs, but $\varphi_{FL} = (u_L + n_{IL})/(u + u_L + u_H + n_I + n_{IL} + n_{IH})$ since both unemployed and informal-sector workers search for formal-sector jobs.

The value of a match for an informal-sector firm with a newcomer or a worker with skill
level $k \in \{H, L\}$ are given by:

\begin{align*}
(20) \quad rJ_I(x) &= p_I x - w_I(x) + (\lambda_I + \eta f_F \bar{G}(C_F) + \tau)[V_I - J_I(x)] + \pi[V_I - T - J_I(x)] \\
&\quad + \sigma_I \nu \left( \Gamma_{IL}(x)[J_{IL}(x) - J_I(x)] + (1 - \Gamma_{IL}(x))[V_I - J_I(x)] \right) \\
&\quad + \sigma_I (1 - \nu) \left( \Gamma_{IH}(x)[J_{IH}(x) - J_I(x)] + (1 - \Gamma_{IH}(x))[V_I - J_I(x)] \right)
\end{align*}

\begin{align*}
(21) \quad rJ_{Ik}(x) &= p_{Ik} x - w_{Ik}(x) + (\lambda_I + \eta f_F \bar{G}(C_{Fk}) + \tau)[V_I - J_{Ik}(x)] \\
&\quad + \kappa_I [J_{IH}(x) - J_{Ik}(x)] + \pi[V_I - T - J_{Ik}(x)]
\end{align*}

where $p_I$ and $p_{Ik}$ are the worker productivity for newcomers and for workers of skill level $k \in \{H, L\}$ when employed in the informal sector, respectively, and $x$ is the current match productivity. Notice that these value functions indicate four reasons for termination of informal-sector jobs. The first three are: (i) exogenous job destruction, (ii) the worker finds a formal-sector job and quits, and (iii) the worker permanently exits the labor market. In these three cases, the firm has a gain of $[V_I(x) - J_I(x)]$ and $[V_I(x) - J_{Ik}(x)]$ if the worker was a newcomer and if the worker had skill level $k \in \{H, L\}$, respectively. The fourth reason is if the job is terminated because the authorities caught the informal-sector firm in which case the firm incurs a penalty of $T$.

Notice that the value function for a match with a low-skilled worker ($k = L$) in the informal sector reflects the probability that the worker accumulates human capital and so the firm has a gain of $[J_{IH} - J_{IL}]$ and this happens with probability $\kappa_I$.

The value function for a match with a newcomer in the informal sector reflects the probability that the worker’s skill level is revealed, which happens with probability $\sigma_I$. If the worker’s skill level is revealed, the firm has a gain of $[J_{IL}(x) - J_I(x)]$ with probability $\nu$ and a gain of $[J_{IH}(x) - J_I(x)]$ with probability $(1 - \nu)$ given that the current match quality $x$ is higher than the cut-off for low- and high-skilled workers in the informal sector, respectively, which is denoted by the indicator functions $\Gamma_{Ik}(x) = 1\{x > C_{Ik}\}$. If the current match quality $x$ is smaller than the cut-off corresponding to the worker’s skill level then the firm has a gain of $[V_I - J_I(x)]$.

The value of a match for a formal-sector firm with a newcomer or a worker with skill
level \( k \in \{H, L\} \) are given by:

\[
\begin{align*}
(22) \quad r_{JF}(x) &= p_F x - w_F(x) + \lambda_F [V_F - D - J_F(x)] \\
&\quad + \sigma_F \nu \left( \Gamma_{FL}(x)[J_{FL}(x) - J_F(x)] + (1 - \Gamma_{FL}(x))[V_F - D - J_F(x)] \right) \\
&\quad + \sigma_F (1 - \nu) \left( \Gamma_{FH}(x)[J_{FH}(x) - J_F(x)] + (1 - \Gamma_{FH}(x))[V_F - D - J_F(x)] \right) \\
&\quad + \tau [V_F - J_F(x)]
\end{align*}
\]

\[
\begin{align*}
(23) \quad r_{JFk}(x) &= p_{Fk} x - w_{Fk}(x) + \lambda_F [V_F - D - J_{Fk}(x)] + \kappa_F [J_{FH}(x) - J_{Fk}(x)] + \tau [V_F - J_{Fk}(x)]
\end{align*}
\]

where \( p_F \) and \( p_{Fk} \) are the worker productivity for newcomers and for workers of skill level \( k \in \{H, L\} \) when employed in the formal sector, respectively, and \( x \) is the current match quality. Notice that, in the formal sector, when jobs are exogenously destroyed the firm incurs a firing cost \( D \) and this happens with probability \( \lambda_F \). However, if the worker permanently exits the labor market the firm does not incur the firing costs \( D \) and this happens with probability \( \tau \).

The value of a match with a newcomer in the formal sector reflects the possibility that the contract with the worker could be renegotiated if the current match quality is higher than the cut-off for the corresponding worker skill level or that the job is destroyed if the match quality is lower than that cut-off. If the match is destroyed after the worker’s skill level is revealed the firm incurs firing cost \( D \). If contracts get renegotiated the firm has a gain of \( [J_{Fk}(x) - J_F(x)] \) for \( k \in \{H, L\} \). If the job is destroyed, the firm has a gain of \( [V_F - D - J_F(x)] \).

Finally, notice that the value of a match with a low-skilled worker reflects the possibility of the worker accumulating human capital. If a worker accumulates human capital the firm and the worker renegotiate their contract and the firm has a gain of \( [J_{FH}(x) - J_{FL}(x)] \) and this happens with probability \( \kappa_F \).

### 2.3 Wages

Wages for all workers in the labor market are determined according to a surplus-sharing rule that entitles workers to a fraction \( \beta \) of the match surplus. In equilibrium, free entry implies that the profit from one more vacancy in the formal and the informal sectors is zero, and so in equilibrium it is the case that \( V_F = 0 \) and \( V_I = 0 \). Matches of a firm in sector \( j \in \{F, I\} \) and a worker with known skill level are given by

\[
S_{jk}(x) = W_{jk}(x) - U_k + J_{jk}(x) - V_j
\]


\( k \in \{H, L\} \), and so the surplus-sharing rule dictates that \( [W_{jk}(x) - U_k] = \beta S_{jk}(x) \). In equilibrium, free entry and the surplus sharing rule result in formal- and informal-sector wages for workers with known skill level given by:

(24) \( w_{FH}(x) = \beta p_{FH}x + (1 - \beta)(r + \tau)U_H - \beta \lambda_F D \)

(25) \( w_{FL}(x) = \beta p_{FL}x + (1 - \beta)(r + \tau)U_L - \beta \lambda_F D - (1 - \beta)\kappa_F[U_H - U_L] \)

(26) \( w_{IH}(x) = \beta p_{IH}x + (1 - \beta)(r + \tau)U_H - \beta \pi T - (1 - \beta)\eta F \int_{C_{FH}}^{1} [W_{FH}(x) - U_H]dG(x) \)

(27) \( w_{IL}(x) = \beta p_{IL}x + (1 - \beta)(r + \tau)U_L - \beta \pi T - (1 - \beta)\eta F \int_{C_{FL}}^{1} [W_{FL}(x') - U_L]dG(x') \)

\[- (1 - \beta)\kappa_I[U_H - U_L] \]

where all wage contracts are functions of the match quality. If the job is destroyed in the formal sector the firm incurs a firing cost \( D \) and since the firm and worker are sharing the match surplus the worker’s wage in this sector is reduced by a fraction \( \beta \) of the expected firing cost. Similarly, if authorities catch an informal-sector job the firm incurs a penalty of \( T \) and given the surplus sharing rule the worker’s wage is reduced by a fraction \( \beta \) of the expected penalty. A low-skilled worker that accumulates skills and becomes high skilled experiences a gain in lifetime utility of \( [U_H - U_L] \); given the surplus sharing rule the worker shares this gain with the firm and so the wage for low-skilled workers is additionally reduced by a fraction \( 1 - \beta \) of the gain. Finally, an informal-sector worker that moves to the formal sector experiences a gain of \( E[W_{FL}(x') - U_k|x' > C_{Fk}] \) and this gain is shared with the firm, and so wages in the informal sector are reduced by the expected gain from such movement.

Match surplus for matches between firms in sector \( j \in \{F, I\} \) and newcomers is given by \( S_j(x) = W_j(x) - U + J_j(x) - V_j \). In equilibrium, free entry and the corresponding surplus-sharing rules result in wages for newcomers given by:

(28) \( w_{F}(x) = \beta p_f x + (1 - \beta)(r + \tau)U - \beta \lambda_F D - (1 - \beta)\sigma_F[uU_L + (1 - \nu)U_H - U] \)

\[- \beta \sigma_F \nu(1 - \Gamma_{FL}(x))D - \beta \sigma_F(1 - \nu)(1 - \Gamma_{FH}(x))D \]

(29) \( w_{I}(x) = \beta p_I x + (1 - \beta)(r + \tau)U - \beta \pi T - (1 - \beta)\eta_f \int_{C_{F}}^{1} [W_F(x) - U]dG(x) \)

\[- (1 - \beta)\sigma_I[uU_L + (1 - \nu)U_H - U] \]

where now wage contracts for newcomers account for the possible gain associated with having
their skill level revealed given by \([\nu U_L + (1 - \nu)U_H - U]\). In the formal sector, wage contracts also account for the possibility that once the worker’s skill level is revealed, the match might have to be destroyed and the firm incur firing cost, \(D\). Wages in the formal sector for newcomers account for the possibility that the match may be exogenously destroyed before the worker’s type is revealed. This possibility is also accounted for in the expression for the informal sector wage, but this wage must also account for the possibility the worker might quit and move to the formal sector before having their skill level revealed.

### 2.4 Hiring Standards in the Formal Sector

Contacts between job seekers and firms in both sectors result in a match if and only if the match quality drawn when they make contact is higher than a reservation match quality. The reservation match quality depends on the sector of employment, and whether the worker is a newcomer, high-skilled, or low-skilled. The reservation match quality \(C_{jk}\) is such that

\[
J_{jk}(C_{jk}) = V_j, \quad \text{for } j \in \{F, I\} \text{ and } k \in \{H, L\}.
\]

In equilibrium, free entry implies that \(V_j = 0\) and so the cut-offs for high-skilled workers \(C_{FH}\) and \(C_{IH}\) solve:

\[
\begin{align*}
(p_{FH} C_{FH} &= (r + \tau)U_H + \lambda_F D, \\
p_{IH} C_{IH} &= (r + \tau)U_H + \pi_T - \beta \frac{\eta f_F}{r + \tau + \lambda_F} p_{FH} \left[ \hat{x}_{FH} - \bar{G}(C_{FH})C_{FH} \right]
\end{align*}
\]

where \(\hat{x}_{FH} = \int_{C_{FH}}^{1} x dG(x)\) is the average match quality in the formal sector for high-skilled workers.

For low-skilled workers \(C_{FL}\) and \(C_{IL}\) solve:

\[
\begin{align*}
(p_{FL} C_{FL} &= (r + \tau)U_L + \lambda_F D - \kappa_F [U_H - U_L] - \left( \frac{\kappa_F}{\lambda_F} \right) p_{FH} (C_{FL} - C_{FH}), \\
p_{IL} C_{IL} &= (r + \tau)U_L + \pi_T - \kappa_I [U_H - U_L] - \left( \frac{\kappa_I}{\lambda_I + \pi + \mu_{FH}} \right) p_{FH} (C_{IL} - C_{IH}) \\
&- \beta \frac{\eta f_F}{r + \tau + \lambda_F + \kappa_F} \left( p_{FL} + \frac{\kappa_F}{\lambda_F} p_{FH} \right) \left[ \hat{x}_{FL} - \bar{G}(C_{FL})C_{FL} \right]
\end{align*}
\]

where \(\hat{x}_{FL} = \int_{C_{FL}}^{1} x dG(x)\) is the average match quality in the formal sector for low-skilled workers.

The value of unemployment increases all measures of reservation match quality since unemployment is the outside option when considering taking a job. Note that firing costs
and penalty costs increase the reservation match quality in the formal and informal sectors, respectively, for both high- and low-skilled workers. For low-skilled workers, the third and fourth terms in (32) and (33) indicate that the reservation match quality for these workers is reduced by the possibility of accumulating skills. Finally, for informal-sector workers, the last terms in (31) and (33) indicate that the reservation match quality of these workers is reduced by the possibility of making a transition to the formal sector.

For newcomers, the reservation match quality $C_j$ is such that $J_j(C_j) = 0$ and so $C_F$ and $C_I$ solve:

$$ (34) \quad p_F C_F = (r + \tau)U + \lambda_F D - \sigma_F [\nu U_L + (1 - \nu)U_H - U] $$

$$ - \Gamma_{FL}(C_F) \frac{\sigma_F \nu}{r + \tau + \lambda_F + \kappa_F} \left[ p_{FL} + \frac{\kappa_F}{r + \tau + \lambda_F} p_{FH} \right] (C_F - C_{FL}) $$

$$ - \Gamma_{FH}(C_F) \frac{\sigma_F (1 - \nu)}{r + \tau + \lambda_F} p_{FH} (C_F - C_{FH}) $$

$$ - (1 - \Gamma_{FL}(C_F)) \nu \sigma_F D + (1 - \Gamma_{FH}(C_F))(1 - \nu) \sigma_F D $$

$$ + (1 - \Gamma_{FL}(C_F)) \nu \sigma_F D + (1 - \Gamma_{FH}(C_F))(1 - \nu) \sigma_F D $$

$$ - \eta_f F \int_{C_F}^{1} [W(x') - U] dG(x'). $$

As in the case of workers with known skill level, the reservation match quality for newcomers depends on the value of unemployment, the firing costs, and the penalty costs. However, for these workers the reservation match quality also depends on the gains associated with the process of the revelation of skills. Gains associated with the revelation of skills reduce the reservation match quality and these are the gains for both the worker and the firm and are represented by the third, fourth, and fifth terms in equations (34) and (35). In the case of the formal sector, there are also costs associated with the revelation of skills. These are the costs incurred if the match has to be destroyed once the worker skill level is revealed and it is indicated in the last two terms in the equation (34). In all cases, the gains and costs associated with the revelation of skills depend on the value of $C_j$ with respect to $C_{jH}$ and
$C_{jL}$ as indicated by the indicator functions $\Gamma_{jk}(x)$ for $j \in \{F,I\}$ $k \in \{H,L\}$.

Finally, the reservation match quality in the informal sector also depends on the gains associated with the possibility that the newcomer moves from the informal to the formal sector before the skill level is revealed. This gain is represented by the last term in equation (35). The solution to the integral of this term is very cumbersome and it is presented in the Appendix.

### 2.5 Job Creation Conditions

The last two equilibrium conditions are determined by the job creation condition. In equilibrium, free entry in both the formal and informal sectors imply that all gains from an additional vacancy are exploited and so that $V_F = 0$ and that $V_I = 0$, respectively. Then from equation (19) the job creation conditions for $j \in \{F,I\}$ is given by:

$$
\frac{h_j}{q_j} = \varphi_jL \int_{C_{jL}}^1 J_{jL}(x)dG(x) + \varphi_jH \int_{C_{jH}}^1 J_{jH}(x)dG(x) + (1 - \varphi_jL - \varphi_jH) \int_{C_j}^1 J_j(x)dG(x)
$$

which indicates that the expected recruitment cost in both the formal and informal sectors should equal the expected profit of a match given the distribution of workers in the labor market and this is represented in the following equation. The closed-form for each of these value functions are presented in the Appendix.

### 3 Data and Calibration

The core steady state system for our model consists of equations (30)-(36), where (36) summarizes two conditions, and depends on the following endogenous variables: $C_{FH}$, $C_{FL}$, $C_F$, $C_{IH}$, $C_{IL}$, $C_I$, $\theta_F$, and $\theta_I$. The other endogenous variables in our system (including flow values, value functions, matching probabilities, etc) can be determined recursively given values for the formal sector cutoffs and sector-specific labor market tightness. Given this core system, we calibrate our model to replicate key features of the Mexican labor market during the sample period 2005-2010, with a focus on young less educated workers. In the next two subsections we provide a detailed overview of the survey data used to determine our empirical targets, as well as the calibration strategy that we employ in order to take our model to the data.
3.1 Data: The ENOE

We use a household survey from Mexico called the Occupation and Employment Survey, ENOE (Encuesta Nacional de Ocupación y Empleo). The ENOE is a rotating panel where households are visited five times over the course of a year, one visit every three months. As a result, the ENOE provides information quarterly. As the ENOE is a rotating panel, every three months 20% of the sample is replaced. Although information from each family member is recorded, this information is provided by only one member; the respondent is not necessarily the same individual on each visit.

The ENOE records the demographics of each family member (e.g. education, age, marital status), and information on the main and secondary jobs of family members older than 12 years of age. Job information includes working hours, earnings, fringe benefits, job position, firm size, industry, occupation and job tenure. For further details about the ENOE see INEGI (2005, 2007).

To focus on the less-educated workers our sample only includes individuals not currently attending school and with less than 12 years of education. To focus on young workers, our sample only includes workers between the ages of 16 and 30. Age 16 is the minimum age at which a worker can be hired according to Mexican Labor Law (see Congress, 1970), and age 30 seems to be the age at which transitions from the informal to the formal sector have reached a plateau (see Figure 1). Our sample only includes male workers because women may have different reasons for joining the informal sector, e.g. job flexibility to balance work and child rearing (Arias and Maloney, 2007).

In Mexico when a worker is hired, it is the employer’s responsibility to register the worker in the IMSS or the ISSSTE. These institutions provide a bundle of benefits to their affiliates. For example, the bundle of services offered by IMSS include: health insurance, day-care services for children, life insurance, disability pensions, work-risk pensions, sports and cultural facilities, retirement pensions, and housing loans (Levy, 2007). Both the worker and the employer must pay fees to fund these institutions, but the portion paid by the employer is much higher than that paid by the worker. If the firm is caught not complying

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9 For example, a household visited for the first time in January 2005 will be visited a second time in April of 2005, a third time in July of 2005, a fourth time in October 2005, and a fifth time in January of 2006. Not all households are visited for the first time in January, they could be visited for the first time in any other month of the year.

10 The ENOE has two formats: a long form and a short form. The job tenure information is only recorded in the long form of the ENOE, which is answered at least once during the five visits to the household.

11 IMSS is the acronym in Spanish for the Mexican Institute of Social Security and ISSSTE is the acronym in Spanish for the Institute of Security and Social Services for the State’s Workers.
with these regulations, it incurs a penalty.

The questionnaire of the ENOE does not ask the individual whether he is a formal or an informal worker. Instead, the survey asks the individual if he has access to medical services provided by the IMSS or the ISSSTSE. We consider a worker to belong to the formal sector if he is salaried and has access to the IMSS or the ISSSTSE, and to belong to the informal sector if he is salaried and does not have access to these services. Notice that the self-employed are not included in our definition of informal sector.

Finally, the sample is restricted to the urban areas. In principle, we include all the cities that are statistically self-represented in the sample of the ENOE. This includes 32 cities. All of the cities, except for one, have a population larger than 100,000 people. We use data from the ENOE from the first quarter of 2005 to the fourth quarter of 2010.

Table 1 presents the summary statistics for the sample. As the table indicates formal sector workers are on average older, more educated, more likely to be married, and have higher hourly earnings than informal sector workers. Also formal sector workers tend to be concentrated in larger firms whereas informal sector workers tend to be concentrated in small firms. In term of the industry of occupation, formal sector workers are mainly concentrated in manufacturing and services whereas informal sector workers tend to be concentrated in services and construction.

### 3.2 Calibration Strategy

Our model contains the following 29 parameters, $r$, $\tau$, $\eta$, $\nu$, $\beta$, $\gamma_F$, $\gamma_I$, $\lambda_F$, $\lambda_I$, $D$, $z$, $z_L$, $h_F$, $h_I$, $p_{FH}$, $p_{FL}$, $p_F$, $p_{IH}$, $p_{IL}$, $p_I$, $\kappa_F$, $\kappa_I$, $\sigma_F$, $\sigma_I$, $\pi$, $T$, and as such we must apply 29 additional restrictions on our model. Of these 29 restrictions, 9 follow simply from the existing literature or by assumptions regarding model timing. Given that data from the ENOE is quarterly, we adopt a quarterly frequency within our model and set the interest rate, $r$, to 0.01. This restriction implies an annualized rate of return of approximately 4%, consistent with existing estimates for Mexico. We also set the exit rate, $\tau$, to 0.0179 in order to target an average duration of approximately 14 years. This ensures that the time horizon for agents in our model is consistent with that of subjects in our sample (e.g., individuals

---

12 The one self-represented city that is not larger than 100,000 people is the city of Tlaxcala. It is classified as a city with a population between 15,000 and 99,999 people. According to the INEGI, the Statistics Bureau in Mexico in charge of the Census (and the ENOE), in 2010 the population of the city of Tlaxcala was 89,795 people (see http://www3.inegi.org.mx/sistemas/mexicocifras/default.aspx).
<table>
<thead>
<tr>
<th></th>
<th>Formal Sector</th>
<th>Informal Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>24.34</td>
<td>23.02</td>
</tr>
<tr>
<td>Education</td>
<td>8.57</td>
<td>7.76</td>
</tr>
<tr>
<td>Married</td>
<td>0.36</td>
<td>0.23</td>
</tr>
<tr>
<td>Hourly earnings</td>
<td>20.19</td>
<td>17.81</td>
</tr>
<tr>
<td>Firm Size (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-5</td>
<td>8.27</td>
<td>66.31</td>
</tr>
<tr>
<td>6-50</td>
<td>39.74</td>
<td>28.84</td>
</tr>
<tr>
<td>51+</td>
<td>51.99</td>
<td>4.85</td>
</tr>
<tr>
<td>Industry (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>9.15</td>
<td>29.08</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>35.34</td>
<td>20.1</td>
</tr>
<tr>
<td>Commerce</td>
<td>22.84</td>
<td>15.57</td>
</tr>
<tr>
<td>Services</td>
<td>32.67</td>
<td>35.25</td>
</tr>
<tr>
<td>Sample size</td>
<td>62,520</td>
<td>52,009</td>
</tr>
</tbody>
</table>

NOTES: Male with less than 12 years of education and not attending school, ages 16 to 30. Individual and job characteristics at the time of the first interview. Hourly earnings are in Mexican pesos as in the second half of December of 2010. The sample size for formal sector workers is 62,520 and for informal sector workers is 52,009, but the statistics for hourly earnings, firm size, and industry are based in slightly smaller samples due to missing observations.
Table 2: Transition Probabilities ENOE Q1:2005 - Q4:2010

<table>
<thead>
<tr>
<th></th>
<th>Informal Sector</th>
<th>Formal Sector</th>
<th>Unemployed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informal Sector</td>
<td>0.769</td>
<td>0.174</td>
<td>0.057</td>
</tr>
<tr>
<td>Formal Sector</td>
<td>0.129</td>
<td>0.833</td>
<td>0.037</td>
</tr>
<tr>
<td>Unemployed</td>
<td>0.385</td>
<td>0.282</td>
<td>0.333</td>
</tr>
</tbody>
</table>

Following Bosch and Esteban-Pretel (2012), we assume that on-the-job search in the informal sector is only half as efficient as traditional search from unemployment ($\eta = 0.5$). We also take an agnostic approach regarding the fraction of newcomers who are high- or low-type, setting $\nu$ to 0.5. For our surplus sharing rule, we follow the literature and assume symmetric bargaining power between firms and workers, $\beta = 0.5$. We also follow Hosios (1990) and set the elasticity of matches with respect to vacancies in both markets equal to firm’s bargaining power. Lastly, we set the vacancy posting costs in each sector, $h_F$ and $h_I$, to target the following values of market tightness: $\theta_I = 1$ and $\theta_F = 0.5$. Recall, that the concept of market tightness is from the perspective of the firm. As such, a higher $\theta$-value implies more vacancies relative to potential searchers. Therefore, from the perspective of a job searcher, the last two restrictions simply imply that job search is “easier” in the informal sector, with is consistent with the data and previous literature.

After imposing the 9 restrictions described above, we still need 20 additional restrictions to pin down our remaining parameter values. To this end, we turn our attention back to our sample from the ENOE. Table 2, presents the transition probabilities between informal employment, formal employment, and unemployment. The last elements in the first and second rows of Table 2 represent the flow of workers transitioning into unemployment from informal and formal employment respectively. We set the exogenous separation rates in our model, $\lambda_I$ and $\lambda_F$, equal to the observed transition rates into unemployment for their respective sector. The coefficients on both sectors’ matching functions ($\gamma^I_1$ and $\gamma^F_1$) are equalized, and their value is set to target an unemployment rate of 6.9%, consistent with our sample from ENOE. Next, we assume that agents’ flow utility from unemployment is constant across worker skill levels ($z = z_H = z_L$), and we set its value to 40% of the expected wage.

---

13While $\tau$ is often interpreted as probability of death, we are interpreting $\tau$ as the probability an agent transitions out of this segment of the labor market.

14In future drafts we will perform sensitivity analysis on $\nu$, considering 0.25 and 0.75 along with the baseline case of 0.5.

15Our models results are robust to moderate variation in these tightness targets.
in the formal sector. Given that Mexico does not have a formal unemployment insurance program, our value of $z$ should be interpreted as the total value or income received while unemployed, which includes things like severance pay and the value of home production.\footnote{We feel that equalizing the flow utility of unemployment across worker skill levels is a reasonable assumption. However, one could worry that high-skill workers actually possess a higher $z$. As such, we will conduct sensitivity analysis on variation in this parameter across worker skill-types.} Firing costs in the formal sector, $D$, is set to 12 times the average quarterly wage in the formal sector. While this value may seem high, it is important to remember that $D$ is standing in for all regulatory costs associated with formality. Also, formal sector firms only pay $D$ when an employee separates exogenously, which occurs at rate $\lambda_F = 0.037$. Therefore, our chosen value of $D$ is of a reasonable size. As of the parameters government detection and punishment of firms operating in the informal sector, $\pi$ and $T$ respectively, we set their values equal to zero in our baseline steady state. This is motivated by the fact that only modest actions are currently in place to monitor and punish firms who hire workers informally, and furthermore, this provides a nice starting place to determine how increasing punishment may impact equilibrium outcomes.

Next, we set the skill and sector-specific productivity values to target the value of wages across the formal and informal sectors in our sample. We use wage information from all employed individuals in our sample to construct sector-specific wage distributions. With these wage distributions in hand, we compute the average wage in the top and bottom quintile of each distribution, normalizing by the average formal sector wage. The idea is that wages observed in the upper (lower) portion of the wage distribution are likely to be associated with individuals who possess high (low) skills. As such, $p_{FH}$, $p_{FL}$, $p_{IH}$, and $p_{IL}$ are set so the model produces consistent values for these wages. The productivity of newcomers in each sector, $p_F$ and $p_I$ are adjusted so that the average wage in each sector generated by our model is close to that observed in the data.

Given the above restrictions, the only parameters left are those that govern the rate of employer screening and worker human capital accumulation. To simplify the process we assume that that both rates are symmetric across sectors. Following Burdett et al. (2011), we set the rate of human capital accumulation to 0.25% per quarter, implying an annual rate of approximately 1%. Lastly, we set the rate at which newcomers types are revealed in order to target a steady state share of newcomers of approximately 50%.
Table 3: Aggregate Effects

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Baseline</th>
<th>Reduce $D$ by 25%</th>
<th>Increase $\pi$ to 2%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of Informal Sector</td>
<td>0.445</td>
<td>0.327</td>
<td>0.122</td>
<td>0.272</td>
</tr>
<tr>
<td>Unemployment Rate</td>
<td>0.069</td>
<td>0.069</td>
<td>0.053</td>
<td>0.069</td>
</tr>
<tr>
<td>Fraction of Newcomers</td>
<td>-</td>
<td>0.495</td>
<td>0.488</td>
<td>0.495</td>
</tr>
<tr>
<td>Fraction of High-Skill</td>
<td>-</td>
<td>0.281</td>
<td>0.286</td>
<td>0.282</td>
</tr>
<tr>
<td>Fraction of Low-Skill</td>
<td>-</td>
<td>0.223</td>
<td>0.226</td>
<td>0.224</td>
</tr>
</tbody>
</table>

4 Results

Given our calibration strategy, we compute the steady state solution of our model economy to recover a set of baseline results that are consistent with data. Next, we fix all model parameters and consider the following two counterfactual policy experiments: (i) Reduce firing costs, $D$, by 25% and (ii) Increase the probability of informal detection, $\pi$, from 0 to 2%. The next subsection details the impact of these policy changes on various equilibrium outcomes of our model.

4.1 Policy Change

The two policy changes that we consider both attempt to reduce informal-sector labor participation, but they approach this goal in two very different ways. The first policy lowers firing costs in an attempt to “deregulate” the formal sector, while the second policy increases the cost of informal labor market participation by increasing the screening/detection probability. As such, we can compare the effectiveness of both types of policies and determine if one policy dominates the other in terms of other equilibrium outcomes within the labor market (e.g., the effect on aggregate unemployment, hiring cutoff rules, etc).

Table 3 presents the effects of the policy changes on aggregate outcomes such as the size of the informal sector, the unemployment rate, and fraction of workers of each skill type present in equilibrium. Inspection of the first row of Table 3 shows that even though our calibration strategy did not target the size of the informal sector, our baseline model does a reasonable job at replicating this moment (44.5% vs 32.7%). Moving across columns, we see that cutting firing costs by 25% reduces informal sector participation from 37.9% to 12.2%, while increasing the probability of informal detection from 0 to 2% only reduces informal participation to 27.2%. Therefore, while both policies succeed in reducing informal sector participation, deregulating the formal sector by cutting firing costs is found to be much more
Table 4: Skill-Specific Unemployment Effects

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Baseline</th>
<th>Reduce $D$ by 25%</th>
<th>Increase $\pi$ to 2%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment Rate Newcomers</td>
<td>-</td>
<td>0.088</td>
<td>0.061</td>
<td>0.086</td>
</tr>
<tr>
<td>Unemployment Rate High-Skill</td>
<td>-</td>
<td>0.037</td>
<td>0.035</td>
<td>0.039</td>
</tr>
<tr>
<td>Unemployment Rate Low-Skill</td>
<td>-</td>
<td>0.068</td>
<td>0.059</td>
<td>0.070</td>
</tr>
</tbody>
</table>

Table 5: Hiring Cutoffs

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Baseline</th>
<th>Reduce $D$ by 25%</th>
<th>Increase $\pi$ to 2%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Formal Sector Cutoffs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-Skill Cutoff</td>
<td>-</td>
<td>0.765</td>
<td>0.788</td>
<td>0.768</td>
</tr>
<tr>
<td>Newcomer Cutoff</td>
<td>-</td>
<td>0.928</td>
<td>0.849</td>
<td>0.911</td>
</tr>
<tr>
<td>Low-Skill</td>
<td>-</td>
<td>0.858</td>
<td>0.845</td>
<td>0.860</td>
</tr>
<tr>
<td><strong>Informal Sector Cutoffs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-Skill Cutoff</td>
<td>-</td>
<td>0.678</td>
<td>0.683</td>
<td>0.670</td>
</tr>
<tr>
<td>Newcomer Cutoff</td>
<td>-</td>
<td>0.632</td>
<td>0.518</td>
<td>0.593</td>
</tr>
<tr>
<td>Low-Skill</td>
<td>-</td>
<td>0.808</td>
<td>0.854</td>
<td>0.803</td>
</tr>
</tbody>
</table>

Now that we see how both policies impact informal participation, we can also consider how these policies impact other equilibrium variables of interest. Recall that we calibrated our baseline steady state to replicate the unemployment rate in our sample, 6.9%. However, the unemployment rate is free to vary during our policy experiments. From Table 3 we see that reducing firing costs by 25% results in the unemployment rate falling from its baseline value of 6.9% to 5.3%. In contrast, when the informal sector detection rate is increased to 2%, the unemployment rate remains mostly unchanged. Therefore, reducing firing costs is seen to lead to a strong reduction in both informal sector participation and aggregate unemployment in equilibrium. Figure 3 also shows how the skill composition of the economy changes across the policy scenarios. While these adjustments are modest, it is important to note that reducing firing costs also results in a near 1 percentage point reduction in the fraction of newcomers in equilibrium. Therefore, this policy also helps facilitate employer learning and worker type revelation vis-a-vis the baseline specification.

While the previous results showed how the two policies impact unemployment on average, it is also interesting to consider how these policies may effect agents of different skill levels.

\[17\] In fact, increasing the informal detection rate to 2% actually increased the unemployment rate from 6.9% to 6.911%, though this change is very small.
Table 4 presents unemployment by skill for the baseline steady state as well as that under the two policy scenarios. Inspection of Table 4 shows that reducing firing costs results in a reduction in the unemployment rate for all types of agents, but the largest effect is found for newcomers (unknown skill). The baseline unemployment rate for this group is 8.8%, which falls to 6.1% after firing costs are cut by 25%. In contrast, there are only modest changes to skill-specific unemployment rates following the increase in the informal detection rate. And interestingly, this policy actually increase the unemployment rates of high and low-skilled agents (3.7 vs 3.9 and 6.8 vs 7.0, respectively).

Both of the policies that we consider should result in relatively fewer informal vacancies being created in equilibrium. Reducing firing costs incentivizes vacancy creation in the formal sector relative to the informal sector, while increasing informal detection reduces the direct incentive to create informal vacancies. So, why do our results indicate that reducing firing costs will have a substantially better effect on the economy? The answer is quite intuitive and requires inspection of the model’s endogenous hiring cutoffs. Figure 5 presents the endogenous hiring cutoffs for both sectors of the economy in baseline and across the two policy experiments. As mentioned before, we do not impose any ordering for these cutoffs, so all values are equilibrium outcomes based on model calibration/parameterization. Inspection of Table 5 makes two points very clear. First, increasing informal detection has a negligible impact on the endogenous cutoffs across both sectors. This follows from the fact that increasing the cost of informal sector jobs does not, in any meaningful way, reduce the ability threshold for employment. Second, reducing firing costs significantly lowers the cutoff for newcomers across both sectors. Specifically, the formal-newcomer cutoff falls from 0.928 to 0.849 while the informal-newcomer cutoff falls from 0.632 to 0.518. Lowering firing costs reduces the implicit cost of hiring a worker, especially a newcomer who comes with the added risk of being revealed as low-skill. Therefore, once firing costs are reduced, the formal sector hiring standards for newcomers will fall. As there is competition among firms across sectors, this reduction in formal sector hiring standards will also drive down the newcomer cutoffs in the informal sector. In summary, while both policies result in relatively fewer informal vacancies being posted in equilibrium, lowering firing costs has the added benefit of reducing the hiring cutoffs for newcomers across both employment sectors, and as a consequence will lead to lower unemployment in equilibrium.
Table 6: Skill and Sector-Specific Wage Effects

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Baseline</th>
<th>Reduce $D$ by 25%</th>
<th>Increase $\pi$ to 2%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected High-Skill Wage, Formal</td>
<td>1.850</td>
<td>1.850</td>
<td>1.958</td>
<td>1.807</td>
</tr>
<tr>
<td>Expected Low-Skill Wage, Formal</td>
<td>0.525</td>
<td>0.525</td>
<td>0.623</td>
<td>0.526</td>
</tr>
<tr>
<td>Average Wage, Formal</td>
<td>1.000</td>
<td>1.000</td>
<td>1.005</td>
<td>0.969</td>
</tr>
<tr>
<td>Expected High-Skill Wage, Informal</td>
<td>1.350</td>
<td>1.350</td>
<td>1.356</td>
<td>1.339</td>
</tr>
<tr>
<td>Expected Low-Skill Wage, Informal</td>
<td>0.450</td>
<td>0.450</td>
<td>0.468</td>
<td>0.448</td>
</tr>
<tr>
<td>Average Wage, Informal</td>
<td>0.700</td>
<td>0.700</td>
<td>0.671</td>
<td>0.681</td>
</tr>
</tbody>
</table>

5 Conclusion

Work in progress...
References


