2018-79

Papiers de Recherche | Research Papers

Labor Market Search, Informality and Schooling Investments

Matteo Bobba[1]

Luca Flabbi[2]

Santiago Levy[3]

This version: November 2017

Please cite this paper as: BOBBA, M., L. FLABBI and S. LEVY (2018), "Labor Market Search, Informality and Schooling Investments", *AFD Research Papers Series*, No. 2018-79, September.

Contact at AFD: Rohen d'Aiglepierre (daiglepierrer@afd.fr)

[1] Toulouse School of Economics, E-mail: matteo.bobba@tse-fr.eu.
[2] *Department of Economics, University of North Carolina, E-mail: luca.abbi@unc.edu.*
[3] *Inter-American Development Bank, E-mail: slevy@iadb.org.*

Papiers de Recherche de l'AFD

Les *Papiers de Recherche de l'AFD* ont pour but de diffuser rapidement les résultats de travaux en cours. Ils s'adressent principalement aux chercheurs, aux étudiants et au monde académique. Ils couvrent l'ensemble des sujets de travail de l'AFD : analyse économique, théorie économique, analyse des politiques publiques, sciences de l'ingénieur, sociologie, géographie et anthropologie. Une publication dans les Papiers de Recherche de l'AFD n'en exclut aucune autre.

L'Agence Française de Développement (AFD), institution financière publique qui met en œuvre la politique définie par le gouvernement français, agit pour combattre la pauvreté et favoriser le développement durable. Présente sur quatre continents à travers un réseau de 72 bureaux, l'AFD finance et accompagne des projets qui améliorent les conditions de vie des populations, soutiennent la croissance économique et protègent la planète. En 2014, l'AFD a consacré 8,1 milliards d'euros au financement de projets dans les pays en développement et en faveur des Outre-mer.

Les opinions exprimées dans ce papier sont celles de son (ses) auteur(s) et ne reflètent pas nécessairement celles de l'AFD. Ce document est publié sous l'entière responsabilité de son (ses) auteur(s).

Les *Papiers de Recherche* sont téléchargeables sur : http://editions.afd.fr/

AFD Research Papers

AFD Research Papers are intended to rapidly disseminate findings of ongoing work and mainly target researchers, students and the wider academic community. They cover the full range of AFD work, including: economic analysis, economic theory, policy analysis, engineering sciences, sociology, geography and anthropology. *AFD Research Papers* and other publications are not mutually exclusive.

Agence Française de Développement (AFD), a public financial institution that implements the policy defined by the French Government, works to combat poverty and promote sustainable development. AFD operates on four continents via a network of 72 offices and finances and supports projects that improve living conditions for populations, boost economic growth and protect the planet. In 2014, AFD earmarked EUR 8.1bn to finance projects in developing countries and for overseas France.

The opinions expressed in this paper are those of the author(s) and do not necessarily reflect the position of AFD. It is therefore published under the sole responsibility of its author(s).

AFD Research Papers can be downloaded from: http://editions.afd.fr/en/

AFD, 5 rue Roland Barthes

75598 Paris Cedex 12, France

✉ ResearchPapers@afd.fr

ISSN 2492-2846

Labor Market Search, Informality and Schooling Investments

Matteo Bobba, Toulouse School of Economics, University of Toulouse Capitole, Manufacture des Tabacs, 21 Allée de Brienne 31015 Toulouse France. E-mail: matteo.bobba@tse-fr.eu.

Luca Flabbi, Department of Economics, University of North Carolina - Chapel Hill, 107 Gardner Hall, CB 3305 Chapel Hill, NC 27599-3305 USA. E-mail: luca.abbi@unc.edu.

Santiago Levy, Vice-Presidency for Sectors and Knowledge, Inter-American Development Bank, 1300 New York Avenue 20577 Washington DC USA. E-mail: slevy@iadb.org.

Abstract

We develop a search and matching model where firms and workers are allowed to form matches (jobs) that can be formal or informal. Workers optimally choose the level of schooling acquired before entering the labor market and whether searching for a job as unemployed or as self-employed. Firms optimally decide the formality status of the job and bargain with workers over wages. The resulting equilibrium size of the informal sector is an endogenous function of labor market parameters and institutions. We focus on an increasingly important institution: a "dual" social protection system whereby contributory benefits in the formal sector coexist with non-contributory benefits in the informal sector. We estimate preferences for the system - together with all the other structural parameters of the labor market -using labor force survey data from Mexico and the time-staggered entry across municipalities of a non-contributory social program. Policy experiments show that informality may be reduced by either increasing or decreasing the payroll tax rate in the formal sector. They also show that a universal social security benefit system would decrease informality, incentivize schooling, and increase productivity at a relative fiscal cost that is similar to the one generated by the current system.

Keywords: Labor market frictions, Search and matching, Nash bargaining, Informality, Returns to schooling.

JEL Codes: J24, J3, J64, O17

Disclaimer: This work was supported by Agence Française de Développement. However, the analyses and conclusions presented in this document are the responsibility of the authors only. They do not necessarily reflect the position of AFD or its partner institutions.

Original version: English

Accepted: May 2017

Labor Market Search, Informality and Schooling Investments*

Matteo Bobba† Luca Flabbi‡ Santiago Levy§

November 24, 2017

Abstract

We develop a search and matching model where firms and workers are allowed to form matches (jobs) that can be formal or informal. Workers optimally choose the level of schooling acquired before entering the labor market and whether searching for a job as unemployed or as self-employed. Firms optimally decide the formality status of the job and bargain with workers over wages. The resulting equilibrium size of the informal sector is an endogenous function of labor market parameters and institutions. We focus on an increasingly important institution: a "dual" social protection system whereby contributory benefits in the formal sector coexist with non-contributory benefits in the informal sector. We estimate preferences for the system – together with all the other structural parameters of the labor market – using labor force survey data from Mexico and the time-staggered entry across municipalities of a non-contributory social program. Policy experiments show that informality may be reduced by either increasing or decreasing the payroll tax rate in the formal sector. They also show that a universal social security benefit system would decrease informality, incentivize schooling, and increase productivity at a relative fiscal cost that is similar to the one generated by the current system.

Keywords: Labor market frictions, Search and matching, Nash bargaining, Informality, Returns to schooling. *JEL Codes:* J24, J3, J64, O17

*We thank participants at conferences, workshops and seminars at Barcelona GSE, Bordeaux, CEPR-IGC, EUDN, Geneva, IZA, Laval, NYU, SOLE, Toulouse, Turin, UCL-CeMMAP, and Wisconsin-Madison for very useful comments. Marco Pariguana, Jose Mauricio Salazar, and especially Matias Morales provided excellent research assistance. Financial support from the *Agence Française de Développement* (AFD) and the Inter-American Development Bank (IDB) is gratefully acknowledged.

†Toulouse School of Economics, University of Toulouse Capitole, Manufacture des Tabacs, 21 Allée de Brienne 31015 Toulouse France. E-mail: matteo.bobba@tse-fr.eu.

‡Department of Economics, University of North Carolina – Chapel Hill, 107 Gardner Hall, CB 3305 Chapel Hill, NC 27599-3305 USA. E-mail: luca.flabbi@unc.edu.

§Vice-Presidency for Sectors and Knowledge, Inter-American Development Bank, 1300 New York Avenue 20577 Washington DC USA. E-mail: slevy@iadb.org.

1 Introduction

High levels of informality characterize many labor markets, typically in medium- and low-income countries.[1] Informality can be broadly defined as any deviation from labor contracts, such as avoiding payroll contributions and not conforming to labor law statutes. If regulations are rigid and imperfectly enforced, non-compliance allows both firms and workers greater labor market flexibility that may improve labor allocations across sectors and occupations. The firms' direct cost of the increased flexibility is the possibility of being discovered and punished. The main workers' cost – on top of the loss of some protections on the job – is the lack of social security coverage, such as the provision of health and pension benefits.[2]

Studying costs and benefits of informality – including consequences for productivity and welfare – requires an equilibrium model of the labor market taking into account how workers and firms jointly sort between formal and informal jobs. It does also require to explain empirical evidence that does not conform to neither a segmented or a competitive view of the labor market. The evidence on labor market dynamics shows mobility of workers not only from formal to informal jobs but also from informal to formal jobs. The evidence on wage distributions shows that on average wages are higher in formal jobs but also that many informal jobs pay more than formal ones, creating a large overlap between the formal and informal wage distributions. The frequent and significant flow of workers from formal to informal is in contrast with a segmented view where barriers restrict access to the formal sector. But it is also in contrast with a competitive view whereby the presence of the two types of jobs in equilibrium is justified by compensating differentials mapping into preferences and skills that are supposed to be stable over time. The overlap in the wage distributions does not seem consistent with either view. Both segmentation and compensating differentials should generate a much starker wage ranking between the formal and the informal sector.[3]

In this paper, we develop and estimate a search, matching, and bargaining framework that takes into account sorting and endogenous decisions over formality regimes and that replicates the main empirical features of labor markets with high informality. Search and matching frictions

[1] This issue is particularly acute in Latin America where even large middle-income economies with well-developed labor market institutions feature more than half of the labor force in the informal sector [Perry et al., 2007; Levy and Schady, 2013]. But the phenomenon is also common in other parts of the world [La Porta and Shleifer, 2014].

[2] There are other less direct but potentially more persistent costs related to informality. Informality may reduce firms' access to capital markets, affecting their investment decisions in physical capital and technology. But it may also change workers' labor market returns, affecting their investment decisions in human capital. Moreover, informality reduces governments revenues, generating fiscal imbalances and hampering the government ability to provide public goods.

[3] Magnac [1991] presents these two competing views of the labor market. Meghir et al. [2015] provide an instructive discussion based on empirical evidence collected on Brazil. Maloney [1999] is a seminal contribution showing that transitions between the formal and the informal sector in Mexico are equally probable in both directions. Maloney [2004] is an update adding sociological and anthropological evidence to the economic evidence in supporting a non-segmented view. Recent evidence on Mexico is in Anton et al. [2012]. Perry et al. [2007] provide and review evidence on a large number of Latin American countries, confirming the empirical evidence summarized in the text. In Section 2 we confirm the same data patterns on our sample extracted from the Mexican labor force survey.

support the presence of different types of contracts in equilibrium. Optimal decisions rules based on reservation values and the presence of termination shocks generate transitions between labor market states in any direction. Finally, match-specific productivity and bargaining generate the overlapping wage distributions. We also develop an identification and estimation strategy that is able to recover all the structural parameters of the model using standard labor market data from Mexico. We next perform policy experiments where we can evaluate the impact of changes in the institutional parameters responsible for the emergence of informality in the first place.

We further incorporate in our modeling and estimation strategy three features that take into account three relevant but overlooked issues. First, we introduce an endogenous schooling decision. Labor market distortions generate informality by affecting labor market behavior. But in a dynamic environment they may also affect crucial decisions taken before entering the market. Among them, the schooling decision is arguably one of the most relevant and with the most persistent effects on workers' outcomes. If the distortions leading to informality are found to be strong enough to significantly impact returns to schooling, then their consequences go beyond the misallocation of workers across jobs but also include the long term composition of workers in terms of human capital.[4]

Second, we model in detail the structure of the social security system. In response to the lack of social security coverage for informal workers, several countries are increasingly providing social security benefits that are not based on payroll contributions. This has created a "dual" social security system where formal jobs come with benefits financed by payroll contributions and informal jobs come with benefits financed by resources collected outside the labor market.[5] This duality creates subsidies and incentives that cannot be ignored if one wants to explain the observed levels of informality. On top of modeling the institutional details of the system, we go a step further by tackling an issue common to any system providing social security benefits: The benefits may not be valued by the consumer at full value. The consumer willingness to pay for the service may be very different from the contribution they are forced to pay to receive it or from the actual cost incurred to provide it. Recovering these preferences for the social security system is crucial to evaluate its impact on labor market outcomes. The problem is only exacerbated if the system is composed by two separate systems coexisting in the same labor market, as in Mexico and other countries with a dual system.

Third, we propose a more nuanced definition of informality by allowing workers to perform an informal job as either an employee or a self-employed. "Necessity" self-employment – i.e. a form of self-employment requiring very limited skills and capital and imposing almost no barriers to entry – is so common and pervasive in labor markets with high informality that is frequently used as a proxy for informality itself. However, if it is true that almost all these self-employed workers

[4]So far, the literature on the long-term investment impact of informality has focused on the firms' side. See for example, La Porta and Shleifer [2008]; de Paula and Scheinkman [2010, 2011]; Ulyssea [2015].

[5]Non-contributory programs are generally financed with public resources that are independent of the revenues from the social security system within the formal sector. See Levy [2008] for a detailed description of Mexico and Melguizo et al. [2017] for a recent review for Latin American countries.

are informal, it is not true that almost all the informal jobs are performed by self-employed. A prominent portion of informal jobs is organized as a genuine subordinate working relationship with a well-defined employer. Since self-employed and employees have markedly different labor market dynamics, these differences must be explicitly taken into account in order to provide a complete characterization of the informal sector.[6]

We propose a model where individuals decide whether acquiring productivity-enhancing schooling prior to labor market entry. Conditional on schooling, they choose whether to search full-time for a job or to search only part of the time while working as self-employed. Agents are then randomly matched with firms that could offer formal or informal wage contracts. The number of meetings between workers and firms is governed by a matching function that depends on the endogenous proportions of searchers and vacancies in each schooling sub-market. Upon observing match-specific productivity, firms optimally post the formality status of the job and engage in bargaining with workers to negotiate wages. Searchers and informal workers receive a non-contributory social benefit while formal workers receive a contributory social benefit, which partly depends on their wages. Workers are allowed to have preferences over these benefits. Firms face no costs in entering the market but they pay a flow cost to keep a vacancy open. Workers are heterogenous in their cost for acquiring additional schooling and in their ability to generate self-employment income. Jobs are heterogenous in their match-specific productivity. Accepted wages, the distribution of workers over labor market states, the level of benefits in the formal sector, the overall size of the informal sector, and the schooling levels are all endogenously determined in the search equilibrium.

The model is estimated on individual-level data from the Mexican labor force survey (ENOE).[7] The empirical implications of the model together with some distributional assumptions are enough to identify most of the structural parameters from the micro data. The exception is the preference parameter for non-contributory benefits. In order to identify this parameter, we rely on an additional source of variation in the data: the time-staggered introduction of the *Seguro Popular* program across municipalities. The program increases access to health care benefits for individuals not covered by the contributory system.[8] Estimation results show reasonable values of the model parameters, including those harder to identify like the firms' costs of being discovered and punished for hiring informally, the workers' preferences for the social security system, and the parameters of the matching functions for each schooling sub-market.

[6]Fields [1975] is a seminal contribution pointing out the specific role played by self-employment in labor markets with high informality. Margolis [2014] and World Bank [2012] provide an overview of the evidence on many developing countries. Bianchi and Bobba [2013] confirms that financial barriers are not an important obstacle to enter self-employment in Mexico. Both Meghir et al. [2015] and Bosch and Esteban-Pretel [2012] acknowledge that informal workers may be both self-employed or employee but they aggregate them in one unique labor market state. Narita [2011] is a rare contribution making the distinction between self-employed and employees in characterizing workers' informality.

[7]ENOE (*Encuesta Nacional de Ocupación y Empleo*) is Mexico's official labor force survey, which is similar to the US Current Population Survey.

[8]The same source of exogenous variation is used by Conti et al. [2017] in an equilibrium search model to identify the marginal willingness to pay for the benefit provided by the *Seguro Popular* program.

The estimated model is used to understand how the characteristics of the labor market and of the institutional setting lead to informality in the presence of optimal dynamic behavior. It is also used to perform policy experiments evaluating the impact of the dual social security system on informality levels, labor market outcomes, schooling acquisition, productivity and welfare. Results show that equilibrium wages and informality rates are very sensitive to the payroll tax rate in formal jobs and to the level of non-contributory social security benefits. Contrary to the usual belief found in previous literature and in the policy debate, the contribution rate is shown to have a non-monotone impact on the informality rate. Informality may be reduced by either increasing or decreasing the payroll tax rate from current levels. Consistently with previous literature, the non-contributory social security benefits has a monotone impact on informality but the elasticity is not constant and it is high around current levels. The policy approximates recent reforms proposed in Latin America, which are aimed at increasing the generosity of the non-contributory benefits. Setting the non-contributory benefits to zero would be enough to completely eliminate informality among the employees but would have a limited impact on informality among the self-employed.

We finally propose a policy scheme that may represent a feasible and concrete alternative to the recent reforms proposed in Latin America. The scheme consists in harmonizing benefits between formal and informal workers, restoring the link between contributions and wages in the formal sector, and reducing the payroll tax rate of formal jobs. Results show that this policy would completely eliminate informality among the employees with a High School degree and would provide incentives to acquire more schooling. In the post-policy equilibrium, the proportion of High School graduates increases to 70% from a baseline value of 40%. As a result of these composition effects, the value of production increases by 17 percentage points, overall workers' welfare increases by 35 percentage points while the relative cost of the policy remains very similar to benchmark levels. The results of these policy experiments on both schooling and aggregate productivity are very sensitive to equilibrium effects. For example, increasing the payroll tax rate from zero to more than 60 percent decreases schooling only by a few percentage points in partial equilibrium but cuts High School completion rates from 70 percent to 35 percent in general equilibrium. Endogenous meeting rates between firms and workers are the main channel behind this difference, which are influenced by the schooling-specific vacancy creations implemented by firms.

The informality literature using equilibrium models of the labor market characterized by frictions is growing but it is still thin. Meghir et al. [2015] is the contribution closest to ours. In it, the authors develop an equilibrium search model with wage posting in which firms endogenously locate in the formal or informal sector. They estimate the model parameters on Brazilian labor force data, showing that stricter enforcement reduces informal employment and increases welfare by improving the allocation of workers to higher-productivity firms. The other published contributions in this literature do not attempt model estimation. Bosch and Esteban-Pretel [2012] calibrate a two-sector model of the Brazilian labor market where firms have a choice of hiring workers formally or informally. Albrecht et al. [2009] is a theoretical contribution developing an

equilibrium search model in order to study the distributional implications of labor market policies in a labor market with a significant informal sector.

We contribute to this literature along several dimensions. First, we develop and estimate a search, matching, and bargaining model that takes into account optimal decisions over formality regimes and that replicates the main empirical features of labor markets with high informality. Second, we include an endogenous schooling decisions and therefore the policy experiments that we perform are allowed to alter the returns to schooling and to incorporate the equilibrium impacts of the resulting schooling choices. Indeed, our results show that the productivity costs of informality go beyond the misallocation of workers across jobs since the lower investments in human capital generates long term productivity losses. Third, we incorporate in the model one of the main institutional innovation introduced by governments faced with high informality rates: the dual system of social protection. We also estimate the preferences for the system showing that it provides a positive net subsidy to the average informal job and generates a net loss for the average formal job. Fourth, we critically distinguish between two margins of informality: informal employment in firms and informal self-employment. Our estimated model show that these two groups of workers respond to incentives very differently, therefore the policy instruments suitable at targeting one group or the other should take this into account.

By allowing individuals to make schooling decisions prior to enter a non-competitive labor market, our paper is also related to the literature studying holdup problems in human capital investments. Holdup problems arise since the investment leading to higher productivity (schooling) is made before the rewards are realized (labor market match with a firm). Acemoglu and Shimer [1999] examine the issue in frictional markets, showing that higher frictions exacerbate the inefficiencies and studying the role that contracts play in reducing them. More closely related to our paper, Flinn and Mullins [2015] develop and estimate a model extending the standard search and matching framework to allow for *ex-ante* schooling decisions. In the context of the US labor market, they find that the extent of the hold up inefficiency is very sensitive to the workers' bargaining power parameter. To account for this, our paper estimates the workers' bargaining power parameter for Mexico using information on schooling-specific vacancy rates. We complement this literature by proposing an application to a developing country with a large informal sector. We also extend the identification and estimation strategy of this class of model to include parameters describing school-specific workers' bargaining power and school-specific preferences for non-wage benefits of the job.

Finally, our paper is related to a recent and growing empirical literature that seeks to explore how exogenous institutional changes or labor demand shocks altering the returns to schooling affect schooling investments.[9] We complement this literature by proposing an equilibrium framework while still exploiting some exogenous institutional changes. Our framework allows for policy experiments that take into account equilibrium effects and for a more detailed interaction between

[9]See for example Munshi and Rosenzweig [2006]; Jensen [2012]; Abramitzky and Lavy [2014]; Heath and Mobarak [2015]; Atkin [2016].

returns to schooling, occupational choices and schooling decisions.

The paper is organized as follows. In the next section, we describe the institutional context and the data we use in the empirical analysis. Section 3 presents the model and its empirical implications. Section 4 discusses the identification of the parameters of the model using the data at our disposal. Section 5 defines the estimation method and presents the estimation results. Section 6 is devoted to the policy experiments and Section 7 concludes.

2 Context and Data

2.1 Institutional Setting

We define informality with reference to compliance with regulations on salaried labor.[10] In Mexico, as in most countries, firms are obligated to enroll salaried workers in the social security registry (IMSS, for its Spanish acronym) and pay a contribution proportional to workers' wages whose revenue is used to fund social security benefits. Unlike in the United States, those benefits are bundled in the sense that firms and workers must pay for a fixed-proportions package that includes health benefits, housing benefits, some day care services, and death, disability, and retirement pensions. Some benefits are directly proportional to the worker's individual wage and contribution (pensions) while others are not (health benefits), implying redistribution within salaried workers. There is no unemployment insurance and thus no flow payments out of wages into an unemployment fund or individual accounts. In Mexico, the rate of the social security contribution is approximately 33 percent of the wage of salaried workers. Since these regulations are imperfectly enforced, non-compliance occurs as a device for firms to save on labor costs. When caught hiring illegally, firms have to pay monetary fines that range between 20-350 daily minimum wages for each non-registered worker.[11] Many firms operate in both the formal and informal sector because they hire workers both legally and illegally.[12]

To the extent that there is no firm-worker relationship, these rights and obligations do not apply to self-employed workers. For most of the individuals engaged in those activities, the notion of self-employment differs quite fundamentally from its counterpart in high-income countries. It can be mostly ascribed as a "necessity" labor market state whereby individuals who are not matched with firms start their own micro-enterprises while also searching for a job [Fields, 1975].

[10] See Kanbur [2009] and Levy [2008]. This definition abstracts from other dimensions of the formal-informal divide that are possibly relevant for worker behavior, such as the compliance with income taxes. While conceptually relevant, in our context this is of second-order importance as labor income tax is small over the wage support that we consider in our sample.

[11] The exact parameters that IMSS uses to determine which establishments to inspect are confidential. However, according to IMSS officers in charge of inspections, when deciding which firms to inspect they take into account firm size, industry, history of previous violations and notifications made to IMSS by the Ministry of Labor.

[12] For instance, Perry et al. [2007] show that in Mexico 50% to 70% of small-medium firms have used both formal and informal contracts simultaneously in a given point in time. Ulyssea [2015] documents that in small formal firms in Brazil 40% percent of workers are informal. At the same time, 52% of all informal workers are employed in large firms that are unlikely to be fully informal.

Financial barriers to enter into self-employment do not appear as an important obstacle [Bianchi and Bobba, 2013], which is consistent with the fact that unemployment is in general very limited in those labor markets.

In the early 2000s Mexico's Federal Government designed a new safety net program, named *Seguro Popular*, aimed at expanding the scope of medical benefits for those not covered by the employer-provided system. The program started as a pilot during 2002 in five states and by the end of 2007 virtually all municipalities in the country had enrolled, with more than 21 million beneficiaries. During the same period, similar non-contributory programs were launched to expand the coverage of housing subsidies, retirement pensions and day care facilities. Spending in those programs doubled between 2002 and 2013, from 0.8 to 1.65 percent of GDP – a pattern that is in common across many countries with a dual social security system [Frolich et al., 2014].[13] The voluntary, unbundled, and practically free nature of non-contributory programs implies that valuation issues are substantially less complex than in the case of contributory programs. There are no significant regional or quality differences between contributory and non-contributory pension, housing and day care programs; with regards to health, differences have narrowed considerably as a result of a large expansion in the health infrastructure of state governments, which provide services to those not covered by IMSS [Levy, 2008].

2.2 Data

The data is extracted from Mexico's official labor force survey (ENOE, by its Spanish acronym) for the year 2005. Similar to the US Current Population Survey, the dataset has a panel component – households stay in the sample for five consecutive quarters. We restrict the sample to nonagricultural, full-time, male, private-sector workers between the ages of 35 and 55 who reside in urban areas (defined as localities with a population greater than 15,000 inhabitants).[14] We focus our analysis on workers at the mid-range of the skill distribution for whom the relevant education decision is to complete or not a secondary education career. We thus drop from the sample those who did not complete junior secondary schooling (i.e. below 9th grade) and those who completed college or a higher educational degree. We then split the resulting sample in two groups according to whether the worker has completed high school (i.e. 12th grade) or not.

We define a worker to be an *employee* if he declares (i) being in a subordinate working relationship in their main occupation; and (ii) receiving a wage as a result of that working relationship.[15] We identify the formal or informal status of the job depending on whether the employee reports

[13] The corresponding figures for other Latin American countries document even steeper growth rates than Mexico over the same period. For instance, in Chile spending in non-contributory social programs increased from 0.5 percent of GDP in 2002 to 1.5 percent of GDP in 2013. In Argentina, spending increased from 1 percent of GDP to 4 percent of GDP.

[14] By discarding public sector workers, we don't consider the possible interactions between public, formal private and informal private sectors. However, these workers constitute only 6% of the sample and have their own labor statute and social security system.

[15] 4% of individuals in our sample report having a secondary occupation. Results are robust once we exclude them.

having access to health benefits through their employers, which is equivalent to the most common practice in the literature of defining informality with reference to firms' compliance with the social security regulation.[16] We define the *self-employed* workers as those who declare (i) not being in a subordinate relationship in their main occupation and (ii) having a business by their own. In order to obtain a more homogenous population of self-employed individuals, we drop those who report having paid employees (roughly 30% of the self-employed sample) and those who report having access to contributory health benefits (1% of the remaining sample). The entire sub-population of self-employed workers that we consider is thus informal, as opposed to employee workers who can be formal or informal depending on employers' decision to enroll some, none or all of their employees in the social security registries. We define the *unemployed* as those who declare (i) not to be working during the last week; and (ii) being actively searching for a job. Earning distributions are trimmed at the top and bottom 1% in each schooling group, separating formal employees, informal employees and self-employed.

The final sample that we use in our empirical analysis is comprised of 15,212 individual observations stacked across the four quarters of the year 2005, with 9,199 observations in the low schooling group and 6,013 observations (39.5%) in the high schooling group. Table 1 and Figure 1 report descriptive statistics on the sample by schooling group.[17] The emerging patterns describe the main stylized facts of labor markets characterized by high informality. First, there is a significant mass of workers in each employment labor market state: about half of the workers are in the formal sector, the other half is almost equally split between informal employment and self-employment. Unemployment rates are less than 5%. Second, mean durations in unemployment are short (between two and four months) while durations in self-employment are long on average (between 11 and 12 years), suggesting different dynamics in the two labor market states. Roughly 77% of the unemployed find a job over a period of three months compared with 23% of the self-employed.[18] Third, there is a large overlap between the formal and the informal wage distributions

[16] We have cross-checked this definition of informality with two auxiliary data sources. First, we use the nationally representative household survey (ENIGH) collected in the same period. This information allows us to construct the exact definition of informality that we have employed in the ENOE survey as well as an alternative definition based on more detailed information on respondents' occupations and access to benefits though their job. The resulting discrepancies at the individual-level in the categories of formal and informal employees are minimal. Second, using our definition we use the survey weights in the ENOE in order to generate aggregate shares of formal workers at the national level. Those are by and large comparable with the share of formal workers resulting from aggregating the total number of individuals that are registered in the social security administration (IMSS) as a share of the total national workforce contained in the Mexican population census.

[17] For identification purposes (see Section 4.2), we further split this sample according to whether the individuals reside in a municipality that receive the *Seguro Popular* program or not. The time-staggered expansion of the program across municipalities implies that in 2005, the year from which our estimation sample is extracted, roughly 68% of the individuals who are not formal employees belong to municipalities where the program was operating while the remaining 32% belong to municipalities where the program was not yet operating. The descriptive statistics reported and discussed here do not differ systematically across these two sub-samples.

[18] There are some transitions between these two states, with less than 2% of the self-employed becoming unemployed over a period of three months. Since the amount of these transitions is relatively small, we will not explicitly model them in our theoretical model.

(see Figure 1), with the former first-order stochastically dominating the latter.[19] Self-employed earnings distributions are approximately in between those of formal and informal employees, with a larger standard deviation specially in the high schooling group. Finally, there is a fair amount of transitions of employees between the formal and informal status. Over a three month period, 7% of the formal employees transit to informal employment and 19% of the informal employees transit to formal employment, possibly with a period of unemployment in between.

We complement this sample with two aggregate data sources. We obtain labor shares for Mexico in 2005 as measured by the total compensations per employee as percentage of GDP at market prices per person employed using data collected by AMECO (the *Annual Macro-ECOnomic* database of the European Commission's Directorate General for Economic and Financial Affairs). In addition, we use a data set that comes from a government-run, free employment service under the supervision of the Ministry of Labor (*Bolsa de Trabajo*), which records monthly observations for job vacancies in the urban areas for each of Mexico's 31 states and its Federal District. This information allows us to analyze the job matching process in the segment of the Mexican labor market that is the focus of our analysis.[20] We compute schooling-specific vacancy rates for the year 2005 by aggregating over all the available job vacancies featuring the educational requirements that correspond to the two schooling categories identified above (i.e. workers with lower secondary or upper secondary education degrees, respectively) and dividing the resulting statistics by the labor force in each category after applying the appropriate survey weights to the ENOE sample.

3 Model

3.1 Environment

The model assumes stationarity, continuous time and infinitely lived agents. All agents are subject to a common discount rate ρ. There are four labor market states: unemployment, self-employment, informal employment and formal employment. The informal sector is composed by the self-employed and by the informal employees.

Before entering the labor market, agents make an irrevocable one-shot decision about which schooling level they want to acquire. For consistency with the empirical analysis, we assume only two schooling levels denoted by $h \in \{0, 1\}$, with 1 indicating the higher level and 0 the lower one. Each agent incurs an individual-specific cost $\kappa \sim T(\kappa)$ when acquiring schooling level $h = 1$ instead of staying at schooling level $h = 0$. Therefore, κ summarizes any monetary and utility costs associated with acquiring additional schooling.

[19] The Komolgorov-Smirnov (KS) test statistic for the directional hypothesis that wages of formal employees FOSD wages of informal employees is equal to 0.28 for incomplete secondary and 0.33 for complete secondary.

[20] See Arroyo Miranda et al. [2014] for more details on this dataset. One concern with the job posting data is that they might be skewed towards the formal sector. It is unclear though how the employment service can guarantee that firms' postings comply with all labor regulations. Hence, we rather interpret the resulting vacancies as plausibly representative of both formal and informal jobs in urban Mexico.

Unemployed individuals search for a job as employees receiving job offers at the Poisson rate λ_h. The subscript $_h$ denotes that the arrival rate – as most of the other structural parameters – is allowed to vary by schooling level. While searching, unemployed agents receive an instantaneous utility (or disutility) flow ξ_h which summarizes all costs and benefits of being an unemployed searcher. Additionally, they receive a non-contributory benefit denoted by B_0, i.e. the agents receiving the benefits do not provide any contributions to finance it. The benefit is fixed and distributed equally among all the individuals receiving it. This institution reflects the current social security system in Mexico and has become widespread in a large number of low-income and middle-income countries (see Section 2 for details).

Self-employed individuals receive the benefit B_0 and their self-employment income, which is denoted by y and distributed in the population accordingly to the exogenous cdf $R(y|h)$. Heterogeneity in y reflects differences in self-employment opportunities, costs and abilities and it is allowed to vary with the schooling level h. While working, self-employed agents can still search for a job as employee. We introduce this feature to match the numerous transitions between self-employment and employment as employee that we observe in the data. They receive employee offers at the Poisson rate γ_h.

A meeting between a potential employee and a firm produces a match-specific monetary value x, modeled as a draw from the exogenous distribution $G(x|h)$. Again, the level of schooling previously acquired, h, is allowed to impact the whole distribution. In this representation, firm-side and work-side heterogeneity are summarized by the unique value produced by the meeting of a specific worker with a specific firm.[21] The match value is observed by both parties upon meeting. If the match is formed, it can be terminated by an exogenous Poisson process with rate η_h. The labor relation when the match is formed may be formal or informal. We denote the formality status of the job with $f \in \{0, 1\}$, where $f = 1$ denotes a formal job. The formality status of the job offer is posted by the firm optimally, based on the observed schooling level h and the match-specific productivity x. Assuming that the authority to post the formality status is in the hand of the firm is consistent with the institutional setting in Mexico as well as in other countries. Conditioning on x and f, workers and firms engage in bargaining to determine wage and to finally decide if accepting the match or not.

Workers' flow utility when working as employees is:

$$w_f(x; y, h) + \beta_{f,h}[fB_1(w_1(x; y, h)) + (1 - f)B_0], \tag{1}$$

where w_f is the net wage; B_f is the amount spent to provide social security benefits such as pensions and health services; and $\beta_{f,h}$ is the valuation that workers give to each pesos spent to provide the benefit. It represents the preferences for the non-monetary components of the labor market state and – since we assume linear preferences – has a direct interpretation as the

[21] It is the representation commonly used in search-matching-bargaining models of the labor market, including Eckstein and Wolpin [1995], Cahuc et al. [2006] and Flinn [2006]. It is motivated by the theoretical work of Wolinsky [1987] and Jovanovic [1979]. For a recent review, see Chapter 4.2 in Keane et al. [2011].

marginal willingness to pay for the benefit.[22] In presence of partial enforcement, the trade-off between benefits and contributions determines the equilibrium level of informality. At the same level of contribution rate and benefit, the incentives to work formally may change considerably if the benefits are valued more or less than the contribution paid to receive them.

As discussed before, B_0 is received by all the individuals except formal employees and is paid in a fixed amount equal for everybody. Instead, B_1 is a function of wages and is only received by the formal employees. It is defined as:

$$B_1(w_1(x;y,h)) \equiv \tau t\left[w_1(x;y,h)\right] + b_1, \tag{2}$$

where τ denotes the share of the total contribution $t\left[w_1(x;y,h)\right]$ that is proportional to the worker's wage and represents benefits such as a defined contribution retirement plan. The $(1-\tau)$ share of the total contribution is instead redistributed equally among all formal employees. The equal amount received by each agent is denoted by b_1. which is endogenous because it depends on the total amount contributed by the Formal employees which is itself a function of how many agents work as formal employees in equilibrium and at what wages.[23] The b_1 benefit is meant to capture another institutional feature that is present in the system: contributory benefits that are the same for all formal employees, the most notable example being health benefits. The system has important distributional implications. Since the collection of contributions is proportional to wages and b_1 is equal for all formal employees, the system implies redistribution from high-wage earners to low-wage earners within the formal sector. Moreover, since b_1 is not schooling-specific and since workers with higher levels of schooling earn higher wages, it does also imply redistribution from high schooling workers to low schooling workers. This feature introduces a crucial equilibrium link between the high schooling group and the low schooling group, which would be otherwise separated in two segmented labor markets.

Firms search to fill vacancies and they meet workers at a Poisson rate ζ_h. To keep a vacancy open, firms incur a flow cost ν_h. Once they meet a worker, the same behavior and sequence of events described above take place: a match-specific value x is observed, the formality status f is posted, a wage $w_f(x;y,h)$ is determined by bargaining, a decision about accepting or rejecting the match is taken. In making their decisions, firms take into account their flow payoffs, i.e. the instantaneous profits from a filled job. For given productivity, the profits are different if hiring formally or informally and are respectively defined as:

$$x - w_0(x;y,h) - c_h x \tag{3}$$

$$x - (1+t)w_1(x;y,h), \tag{4}$$

where x is the match-specific value generating revenues for the firm; w_0 and w_1 are the wages

[22] A similar setting and interpretation is used by Dey and Flinn [2005] to evaluate health insurance and by Flabbi and Moro [2012] to evaluate job flexibility.

[23] See Appendix A.3 for the formal derivation of b_1 in equilibrium.

paid to the workers in the informal and formal sector, respectively, and t – described in equation (2) – is the payroll tax rate. Equation (4) clarifies that it is withdrawn at the source by the firm. The parameter c_h is the way we model the cost to firms of hiring informally. As discussed in Section 2, there is a positive probability of being discovered hiring workers informally and having to pay a penalty. However, not all firms have the same probability of being caught: larger and more productive the firm face a higher probability of being audited and fined. Given this institutional context and since our model does not allow to pin down firm size, we assume that the cost simply increases with productivity (in our notation, the match value x). Since we do not have direct observation of the monitoring process in in our data, we impose a particularly parsimonious specification: the linear, one-parameter function $c_h x$.[24]

The last element that needs to be added to complete the description of the two-sided search environment is the specification of the matching process. We have anticipated that both firms and workers search at random in each schooling sub-market and meet each other at Poisson rates λ_h, γ_h, and ζ_h. Since the equilibrium proportions of workers searching for jobs and of firms searching to fill vacancies is endogenous, the meeting rates must also be endogenous. We capture this process by assuming a standard matching function.[25] The number of jobs per worker by schooling level m_h is assumed to depend on the measures of individuals actively searching for a job and on the vacancies, v_h, according to the following parametrization:

$$m_h = (u_h + \psi_h s_h)^{\iota_h} (v_h)^{1-\iota_h}, \tag{5}$$

where $\psi_h \in (0, 1]$ is a parameter denoting the lower search efficiency of the self-employed with respect to the unemployed. It may be interpreted as the time spent searching by each self-employed or as the proportion of self-employed searching at each moment in time. We can now write all the contact rates as functions of the degree of tightness in the labor market, $\omega_h \equiv \frac{v_h}{u_h + \psi_h s_h}$:

$$\begin{array}{rcccc} \lambda_h & = & \frac{m_h}{u_h} \frac{u_h}{u_h + \psi_h s_h} & = & \omega_h^{1-\iota_h} \\ \gamma_h & = & \frac{m_h}{s_h} \frac{\psi_h s_h}{u_h + \psi_h s_h} & = & \psi_h \omega_h^{1-\iota_h} \\ \zeta_h & = & \frac{m_h}{v_h} & = & \omega_h^{-\iota_h}. \end{array}$$

3.2 Value Functions

3.2.1 Workers

Before entering the labor market, workers face an individual-specific cost $\kappa \sim T(\kappa)$ of acquiring schooling level $h = 1$. Since the cost is assumed to be uncorrelated with future labor market performance, the only relevant state variable affecting the present discounted value of participating

[24] To the extent that size and productivity are positively correlated, this specification flexibly captures the notion that imperfect enforcement creates a size-dependent distortion in the economy [de Paula and Scheinkman, 2011; Ulyssea, 2015].

[25] See Petrongolo and Pissarides [2001] for a survey. See Meghir et al. [2015] and Bosch and Esteban-Pretel [2012] for applications to Latin American countries.

in the labor market is the schooling level h acquired prior to labor market entry. To characterize this choice we just need to present the value function of completing a given schooling level *before* any labor market shock occurs and *before* any value of self-employment is revealed. We capture this choice with the function $Z(h)$:

$$Z(h) = \int_0 Q(y,h)dR(y) \tag{6}$$

$$Q(y,h) \equiv \max\{S(y,h), U(h)\}, \tag{7}$$

where we introduce the functional $Q(y,h)$ to simplify the conditioning on y in the rest of the paper. The present discounted value of participating in the labor market with a given schooling level h is the value of searching in that market. However, individual can choose if they want to search as unemployed $U(h)$ or as self-employed $S(y,h)$. If they choose the second, they enjoy income from the self-employment activity but they meet employers at a lower rate.

The trade-off is clarified by looking at the value functions of these two searching states:

$$(\rho+\lambda_h)U(h) = \xi_h + \beta_{0,h}B_0 + \lambda_h \sum_{f\in\{0,1\}} \int_x \max\{E_f[w_f(x),y,h], U(h)\}dG(x|h) \tag{8}$$

$$(\rho+\gamma_h)S(y,h) = y + \beta_{0,h}B_0 + \gamma_h \sum_{f\in\{0,1\}} \int_x \max\{E_f[w_f(x),y,h], S(y,h)\}dG(x|h). \tag{9}$$

The arrival rates of offers are λ_h and γ_h. The meeting can be with an employer offering a formal or an informal job. The formality status choice is a function of the match-specific productivity x but it is posted by the firm: that is why, from the point of view of the worker, it appears in the option value as a simple sum. Conditioning on the formality status and the specific productivity draw, agents bargain over wages and decide if accepting the job or not. The optimal decision is represented by the maximization between the current state (either $U(h)$ or $S(y,h)$) and the new employee state (either $E_0[w_f(x),y,h]$ or $E_1[w_f(x),y,h]$).[26] While the option values of the two searching states have a very similar structure, there is an important difference between their flow values. Both states receive a constant flow value of non-contributory benefits $\beta_{0,h}B_0$, but the self-employed also receive income y that is allowed to vary between the different self-employed searchers. Instead, all the unemployed searchers have the same utility or disutility from searching ξ_h.[27]

The values of working as an employee with a formal or informal job contract are, respectively:

$$(\rho+\eta_h)E_0[w_0(x;y,h),y,h] = w_0(x;y,h) + \beta_{0,h}B_0 + \eta_h Q(y,h) \tag{10}$$

$$(\rho+\eta_h)E_1[w_1(x;y,h),y,h] = w_1(x;y,h) + \beta_{1,h}B_1[w_1(x;y,h)] + \eta_h Q(y,h). \tag{11}$$

[26]Notice that we force notation a bit by not differentiating between employees coming from unemployment and employees coming from self-employment. To be precise, we should eliminate the dependence of y from the value of employment of agents searching as unemployed just as the value of unemployment $U(h)$ does not depend on y.

[27]This ex-ante homogeneity is the usual assumption in search-matching-bargaining models, while the heterogeneity in the outside options for self-employed searchers is a feature akin to search models with on-the-job search.

The flow values received by employees is the sum of the wage and the value attached to social security benefits. The wage is a function of productivity, schooling level, formality status and, possibly, self-employment income. As it will be shown in section 3.3.3, wages depend on schooling and self-employment income because they both potentially affect the worker's outside option when bargaining with the employer. The social security benefit is fixed for the informally employed but it is increasing in wages and productivity for the formally employed. The only shock received by employees is a termination shock, received at the Poisson rate η_h. If employees receive the shock, they go back to their respective searching state: either $U(h)$ or $S(y,h)$.

3.2.2 Firms

Firms post vacancies and search for workers to fill them. The value of a posted vacancy is:

$$\begin{aligned}(\rho+\zeta_h)V[h] &= \nu_h+\zeta_h[\frac{u_h}{u_h+\psi_h s_h}\int_x \max\{F_1[x,y,h],F_0[x,y,h],V[h]\}dG(x|h), \\ &+ \frac{\psi_h s_h}{u_h+\psi_h s_h}\int_y\int_x \max\{F_1[x,y,h],F_0[x,y,h],V[h]\}dG(x|h)dR(y|h)].\end{aligned} \tag{12}$$

The flow cost of keeping a vacancy open is denoted by ν_h. Employers meet potential employees at a rate ζ_h. Since potential employees may be unemployed or self-employed, the probability of meeting one or the other is a function of their proportion in the equilibrium measure of searchers. This is taken into account by the two fractions multiplying the integrals. If the employer meets an unemployed searcher, a match-specific productivity is extracted. Based on its value and the knowledge of the outside option of the potential employee (unemployment), the employer optimally decides if posting the job offer as formal or informal. This is captured by the max operator over three possible options: $F_0[x,y,h], F_1[x,y,h]$ and the status quo option $V[h]$. If the employer meets a self-employed searcher, the same process takes place except that in this case the employer must also take into account that the potential employee's outside option changes with self-employment income y. This is incorporated in expression (12) by integrating over the distribution of y values, $R(y|h)$.

Once the job is filled, either formally or informally, the corresponding value functions are:

$$(\rho+\eta_h)F_0[x,y,h] = x-w_0(x;y,h)-c_h x+\eta_h V[h], \tag{13}$$

$$(\rho+\eta_h)F_1[x,y,h] = x-(1+t)w_1(x;y,h)+\eta_h V[h]. \tag{14}$$

The expressions are analogous to the workers side expressions (10) and (11): flow values plus the option value given by the probability of the termination shock η_h times the value of the searching state. The flow values are simply the flow profits but they parsimoniously incorporate all the complexity of the institutional system. This is why the mapping between productivity and wage paid by the firm depends on the formality status of the job. We represent this feature by indexing the wages with the status indicator f, leading to w_0 in equation (13) and to w_1 in equation (14).[28]

[28]Table B.1 in the Appendix summarizes the environment of the model and introduces the notation for the value

3.3 Equilibrium

3.3.1 Schooling

Before entering the labor market, workers have to decide whether acquiring the high schooling level $h = 1$ or remaining at the default schooling level $h = 0$. Since acquiring additional schooling requires an investment $\kappa \sim T(\kappa)$, agents decide based on the following maximization:

$$\max_h \{Z(0), Z(1) - \kappa\},$$

where $Z(h)$ – defined in equation (6) – is the value of participating in the labor market given schooling level h. The cost κ is assigned by nature and does not vary over time. Since $Z(1) - \kappa$ is decreasing in κ and $Z(0)$ does not vary in κ, there exists a unique:

$$\kappa^* : Z(0) = Z(1) - \kappa^*.$$

The optimal decision rule is therefore a reservation value rule where only agents with $\kappa < \kappa^*$ acquire the schooling level $h = 1$, whereas agents with $\kappa \geq \kappa^*$ remain in the default schooling level $h = 0$.

3.3.2 Searching Status

Once schooling is completed, agents take a draw from the self-employment income distribution $R(y|h)$. Upon observing the draw, they decide if searching for an employee job while also working as self-employed or not. Given the notation just introduced, the decision is equivalent to the following maximization:

$$\max\{S(y, h), U(h)\}.$$

Since $S(y, h)$ is monotone increasing in y and $U(h)$ is constant in y, there exists a unique:

$$y^*(h) : S(y^*(h), h) = U(h).$$

The optimal decision rule is again a reservation value rule where only agents with $y \geq y^*(h)$ search for an employee job while also working as self-employed.

3.3.3 Labor Market Dynamics

Upon meeting a worker and observing the match-specific productivity x, the schooling level h, and the worker's outside option $Q(y, h)$, the firm chooses the formality status based on the following maximization:

$$\max_f \{F_0[x, y, h], F_1[x, y, h]\}.$$

functions.

Upon meeting a firm, the worker also observes the match-specific productivity x and the formality status proposal f. Worker and firm then engage in bargaining to determine the wage and to decide if accepting the match or not. We assume the axiomatic Nash bargaining solution, which is equivalent to solving:

$$\max_{w|f}\{E_f[w,y,h]-Q(y,h)\}^{\alpha_h}\{F_f[x,y,h]-V[h]\}^{(1-\alpha_h)}.$$

To define equilibrium conditions and optimal decision rules, it is useful to start from the firms' entry decision. Since the arrival rate of offers to a given firm is decreasing in the number of firms entering the market, the value of posting a vacancy $V[h]$ is monotone decreasing in v_h. We assume free-entry of firms in both markets. As a result, firms enter until the value of posting a vacancy reaches zero:

$$V[h]=0. \tag{15}$$

Imposing condition (15), the Nash bargaining framework leads to the following wage schedules:

$$w_1(x;y,h) = \frac{\alpha_h}{1+t}x+\frac{(1-\alpha_h)}{(1+\beta_{1,h}\tau t)}[\rho Q(y,h)-\beta_{1,h}b_1] \tag{16}$$

$$w_0(x;y,h) = \alpha_h(1-c)x+(1-\alpha_h)[\rho Q(y,h)-\beta_{0,h}B_0]. \tag{17}$$

The wage schedules have the usual structure generated by Nash bargaining in this context: they are a convex combination of the match-specific productivity values x and the values of the worker's outside option $\rho Q(y,h)$ (recall that by (15) the firm's outside option is zero). The higher the working bargaining coefficient α the higher the weight on x. On top of this usual structure, the two wage schedules show the impact of the institutional parameters. Both the contribution rate t and the cost of hiring informally c are partially transferred to the worker implying a negative relationships with wages at any x. The non-wage benefits of the employment relationship ($\beta_{1,h}b_1$ and $\beta_{0,h}B_0$) also decrease wages at any x since the benefits are valued by the worker.

Solving backward, we find the match-specific productivity value that makes the firm indifferent between posting a formal or an informal job:

$$\tilde{x}(y,h): F_0[\tilde{x}(y,h),y,h]=F_1[\tilde{x}(y,h),y,h].$$

Both F_0 and F_1 are linearly increasing in x, but F_1 is increasing faster.[29] As a result, for any $\{y,h\}$ there exists a unique $\tilde{x}(y,h)$.[30] By equations (16)-(17) and the definitions of the value functions,

[29]The proof is in the Appendix, section A.1. The intuition for this result is straightforward since the cost of signing an informal job contract is linearly increasing in c while the cost of signing a formal job contract increases in x only through the wage schedule (16).

[30]Notice that $\tilde{x}(y,h)$ only guarantees indifference on the firms' side but not necessarily on the workers' side. This is a direct implication of the "formality posting"assumption.

we can compute its value and obtain:

$$\begin{aligned} \tilde{x}(y,h) &= \frac{1}{c_h}[\beta_{0,h}B_0 - \phi_h\beta_{1,h}b_1 + (\phi_h - 1)\rho Q(y,h)] \qquad (18) \\ &\text{where:} \\ \phi_h &\equiv \frac{1+t}{1+\beta_{1,h}\tau t}; \phi_h \in [1, 1+t]. \end{aligned}$$

Since the value of accepting the match is increasing in x for both workers and firms, for any $\{y, h\}$ there exist two unique productivity reservation values at which workers are indifferent between accepting the firm's offer or keep searching for a better match, and analogously firms are indifferent between filling the vacancy or not:

$$\begin{aligned} x_0^*(y,h) : F_0[x_0^*, y, h] = 0 \quad &\Longleftrightarrow \quad E_0[w_0[x_0^*(y,h)], y, h] = Q(y,h), \\ x_1^*(y,h) : F_1[x_1^*, y, h] = 0 \quad &\Longleftrightarrow \quad E_1[w_1[x_1^*(y,h)], y, h] = Q(y,h). \end{aligned}$$

The agreement result is assured by the Axiomatic Nash bargaining solution. By the definition of the value functions and wage schedules (16) and (17), we obtain:

$$x_0^*(y,h) = \frac{1}{1-c_h}[\rho Q(y,h) - \beta_{0,h}B_0], \qquad (19)$$

$$x_1^*(y,h) = \phi_h[\rho Q(y,h) - \beta_{1,h}b_1]. \qquad (20)$$

Equations (19)-(20) state that job formality status $f \in \{0, 1\}$ has two opposite effects on the reservation productivity values at which the match is formed. It decreases the reservation value because employees receive additional benefits associated to the match (b_1 or B_0), but it also increases the reservation value because the firm faces some costs (t or c) in order to activate one or the other job contract. As a result of these two effects, the equilibrium is characterized by different optimal decision rules depending on parameters and on $\{y, h\}$. Still, all the decision rules retain the reservation value property. We summarizes this property in the following:

Proposition 1 ***Equilibrium Characterization: optimal decision rules.***

There are only two possible decision rules, for any y, h:

If $\tilde{x}(y,h) > x_1^*(y,h)$:

$$\begin{array}{rcccl} & x & < & x_0^*(y,h) & \Longleftrightarrow \quad \{Q(y,h); 0\} \\ x_0^*(y,h) & \leq & x & < \quad \tilde{x}(y,h) & \Longleftrightarrow \quad \{E_0[w_0(x), y, h]; F_0[x, y, h]\} \\ \tilde{x}(y,h) & \leq & x & & \Longleftrightarrow \quad \{E_1[w_1(x), y, h]; F_1[x, y, h]\} \end{array}$$

If $\tilde{x}(y,h) \leq x_1^*(y,h)$:

$$\begin{array}{rcccl} & x & < & x_1^*(y,h) & \Longleftrightarrow \quad \{Q(y,h); 0\} \\ x_1^*(y,h) & \leq & x & & \Longleftrightarrow \quad \{E_1[w_1(x), y, h]; F_1[x, y, h]\} \end{array}$$

The proof of this result and the formal definition of the equilibrium are reported in the Appendix, sections A.1 and A.2. The intuition is clarified in Figure 2, where we depict the equilibrium case where $\tilde{x}(y,h) > x_1^*(y,h)$. For low values of the match-specific productivity, firms prefer to keep the vacancy open. For intermediate values ($x_0^*(y,h) \leq x < \tilde{x}(y,h)$), firms post informal job offers that are accepted by workers receiving a wage governed by (17). For larger values ($\tilde{x}(y,h) \leq x$), firms post formal job offers that are accepted by workers receiving a wage governed by (16).[31]

3.4 Empirical Implications

The equilibrium of the model is able to replicate and explain the main empirical evidence that characterizes labor markets with high informality, including those for Mexico as described in Section 2.

The first set of stylized facts is the significant mass of workers in each labor market state and the significant amount of transitions between the formal and informal status. In the model, individuals can accept jobs with different formality status as a result of different values of match-specific productivity. Since they receive different draws of match-specific productivity in their labor market careers, some draws may lead to formal jobs and other to informal jobs generating the transitions that we observe in the data. That all labor market states are relevant and filled in equilibrium depends on parameters values. In Section 5, we show that an estimated version of the model on Mexican data delivers proportions that closely match the data.

The second set of stylized facts refers to the wages distributions. Formal employees have on average higher wages than informal employees but the two wage distributions overlap over a large portion of their support. Both results are delivered by the reservation match productivity value being higher for formal employment (Proposition 1) and by the two wage schedules being both monotonically increasing in the match productivity value but at different rates (equations (16) and (17)). Conditioning on the value of the outside option, the average productivity of the accepted matches between workers and firms is higher in formal jobs than in informal ones. This is a direct result of the optimal decision rule: informal jobs are formed when $x_0^*(y,h) \leq x < \tilde{x}(y,h)$, formal jobs when $\tilde{x}(y,h) \leq x$. Since wages are monotonically increasing in x, the productivity differential is typically enough to generate the observed ranking in accepted wages. The economic reason for the overlap between the two wage distributions is more elaborate but equally intuitive. Formal employees earn a lower net wage than informal employees with same productivity because they receive higher non-wage benefits – i.e. $\beta_{1,h}B_1[w_1(x;y,h)]$ is larger than $\beta_{0,h}B_0$.[32] Figure 3 shows, for a given outside option (y,h), the wage schedules for formal and informal employees as

[31] It is also possible that the reservation value $\tilde{x}(y,h)$ is negative or, equivalently, that $\tilde{x}(y,h) \leq x_1^*(y,h)$. This case is easy to see in Figure 2 by shifting up the $F_f = 0$ axis. When this is the case, there are no values of x that induce the firm to post an informal job and only formal jobs will be realized in equilibrium.

[32] Almeida and Carneiro [2012] emphasize the same argument in an application focusing on enforcement of labor regulations in Brazil. Their empirical results based on regional variations in inspections is consistent with our empirical implications: the jobs more susceptible to switch from formal to informal are those relatively lower paid.

a function of the match value x.[33] Define the reservation match values $x'(y,h)$ and $x''(y,h)$ as:

$$x'(y,h) : w_0(x'(y,h);y,h) = w_1(\tilde{x}(y,h);y,h) \tag{21}$$

$$x''(y,h) : w_1(x''(y,h);y,h) = w_0(\tilde{x}(y,h);y,h). \tag{22}$$

then all the $x \in [x'(y,h), \tilde{x}(y,h)]$ generate an informal employment relationship with accepted wages in the interval $[w_1(\tilde{x}(y,h);y,h), w_0(\tilde{x}(y,h);y,h)]$. At the same time, all the $x \in [\tilde{x}(y,h), x''(y,h)]$ generate a formal employment relationship with accepted wages exactly in the same interval. As a result, accepted wages in formal and informal employment will overlap over the support $[w_1(\tilde{x}(y,h);y,h), w_0(\tilde{x}(y,h);y,h)]$. However, this support may be too tight to generate the large overlap we observe in the data. The larger overlap, potentially able to cover the entire support, is delivered by the heterogeneity in the value of the searchers' outside options. All the agents searching as unemployed – i.e. such that $y < y^*(h)$ – generate one unique overlap because their value in the searching state is identical. But all the agents searching as self-employed – i.e. such that $y > y^*(h)$ – generate different overlaps because their value in the searching state is a function of y. The larger the y, the larger the reservation value $\tilde{x}(y,h)$, the more to the right the location of the overlap. Figure 4 shows these features on simulations based on estimated parameters. The left panel shows the overlap considering only workers transiting from unemployment to formal and informal employment. The overlap is present but it is limited to a relative narrow portion of the support. The bottom panel considers only workers transiting from self-employment to formal and informal employment. As expected the overlap is much larger, covering the entire support of the accepted wage distributions. Mixing over the two generates the wage ranking and the overlap observed in the data.

The last set of stylized facts refers to the differences between the unemployed and the self-employed. The differences involve both transition rates out of the state and accepted employee wages once the transition has taken place. As observed above, the reservation productivity value and value while searching are the same among the unemployed but depend on y among the self-employed. This difference is enough to deliver different hazard rates and different accepted wages as shown by Proposition 1 and equations (16) and (17).

[33] In the figure, the informal wage schedule is more sensitive to x and has higher intercept: this is not always the case but it is the case for the combination of parameters that better matches the data. The slope of $w_0(x;y,h)$ is steeper when the cost c with respect to the contribution rate t is small enough (formally, when $c < t/(1+t)$). This condition is always satisfied at our parameter estimates and its violation leads to a proportion of informal workers which is in general too low to fit the data. The intercept of $w_0(x;y,h)$ is higher when the valuation of the non-contributory benefit is small enough with respect to formal contributory benefits (formally, when $\frac{1}{(1+\beta_{1,h}\tau t)}[\rho Q(y,h) - \beta_{1,h} b_1] < [\rho Q(y,h) - \beta_{0,h} B_0]$). Again, this is what we find at our parameter estimates for most of the (y,h) combinations. It may be violated without major changes in the argument.

4 Identification

The data available for identification were presented in Section 2.2 and include both individual-level data and aggregate-level data. The individual-level data can be described by the following set:

$$\{w_0(i;h); w_1(i;h); y(i;h); t_U(i;h); t_S(i;h)\}_{i=1}^{n},$$

where i denotes individual observations; w_0, w_1 and y are, respectively hourly wages for informal employees, formal employees and self-employed workers; and t_U and t_S are monthly durations in unemployment and self-employment, respectively. We observe the same set of variables on both schooling groups $h \in \{0, 1\}$. The aggregate-level data we use in the identification and estimation of the model are the schooling-specific vacancy rates v_h and the economy-wide labor shares. Finally, we exploit the municipality-level roll out of the *Seguro Popular* program.

In an institutional context that allows for the observation of $\{B_0, \tau, t\}$ we need to identify the following set of parameters:

$$\{\lambda_h, \gamma_h, \eta_h, \alpha_h, \rho, \xi_h, \beta_{0,h}, \beta_{1,h}, c_h, \psi_h, \iota_h, \zeta_h, \nu_h\}$$

and the following probability distribution functions:

$$\{G(x|h), R(y|h), T(\kappa)\}. \tag{23}$$

Notice that the mobility parameters λ_h, γ_h and ζ_h are not really primitive parameters of the model since they can be obtained from the tightness and the matching function parameters ψ_h and ι_h – see equation (5). However, it is convenient to keep them as separate parameters to ease the exposition of both the identification and the estimation strategy as well as to facilitate comparisons with previous work.

We split the identification discussion in four parts. We first discuss the usual search, matching and bargaining parameters. We then focus on the preferences for social security benefits and the cost to firms of hiring informally. In the third part we consider the identification of the matching function and the other demand side parameters. We conclude by discussing the cost of schooling parameters.

4.1 Search, Matching and Bargaining Parameters

The identification of the mobility parameters $\{\lambda_h, \eta_h\}$ and of the match-specific productivity distribution $G(x|h)$ is standard and follows from results in Flinn and Heckman [1982]. Duration information and steady state conditions identify hazard rates out of unemployment and termination rates out of employment. No additional progress in the identification of the model can be made without a parametric assumption on the exogenous match-specific productivity distribution. If we assume a recoverable distribution – i.e. a distribution that can be identified by

observing its truncation – then the identification can proceed as follows. Observed wages in the data correspond to accepted wages in the model. Accepted wages in the model can be mapped to accepted match-specific productivity by inverting the wage schedules (17) and (16). Finally, the truncated accepted productivity distribution identifies the primitive $G(x|h)$ thanks to the recoverability property of the distribution. Following previous literature on empirical job search models (see, e.g., Eckstein and van den Berg [2007]), we assume that the productivity distribution belongs to a two-parameter lognormal distribution and denote the schooling-specific location and scale parameters as $(\mu_{x,h}, \sigma_{x,h})$. The lognormal distribution possesses the recoverability condition necessary for identification and guarantees a good fit of the accepted wage data.

With the identification of $G(x|h)$ secured, durations information is enough to separate the probability of accepting job offer in the exogenous arrival rate component λ_h and in the acceptance probability component. Termination rates η_h are identified by exploiting the equilibrium rate of unemployment implied by the model which imposes a cross-constraint between unemployment rates, hazard rates out of unemployment and termination rates.

In the identification discussion so far we have exploited the one-to-one mapping of the wage schedules (17) and (16). However, the mapping involves a set of model parameters that need to be identified. We discuss most of them in Section 4.2 while here we focus only on the Nash bargaining coefficient, α_h. Previous literature has shown that the parameter is very hard to identify without demand-side information. As a result, numerous contributions simply calibrate the parameter to a fixed value.[34] Instead, we have chosen to use a limited amount of demand side information in order to identify α_h.[35] The information we use are the aggregate labor shares (see Section 2.2 for more details). Suppose all the parameters of the wage schedules (17) and (16) are identified with the exception of α_h. By rewriting the wage schedules as:

$$w_1(x;y,h) = \alpha_h \left\{ \frac{x}{1+t} - \frac{[\rho Q(y,h) - \beta_{1,h} b_1]}{(1+\beta_{1,h}\tau t)} \right\} + \frac{[\rho Q(y,h) - \beta_{1,h} b_1]}{(1+\beta_{1,h}\tau t)} \tag{24}$$

$$w_0(x;y,h) = \alpha_h \left\{ (1-c)x - [\rho Q(y,h) - \beta_{0,h} B_0] \right\} + [\rho Q(y,h) - \beta_{0,h} B_0] \tag{25}$$

it is immediate to see that the α_h parameter is governing the portion of the surplus (net production minus the value of the outside option) appropriated by the worker through the wage. Since labor shares are the ratio between the aggregate value of worker's wages $w_f(x;y,h)$ and the aggregate value of production x, their observation provides sufficient information to identify α_h. As shown in Flinn [2006], asymptotic consistency is attained either by observing a firm with a sufficiently large number of workers or by observing a sufficiently large number of firms. Since our labor shares come from aggregate data, we follow Flinn and Mullins [2015] by appealing to the second result.

[34] See Cahuc et al. [2006] and Flinn [2006] for a formal discussion and Eckstein and Wolpin [1995] for a seminal contribution. A typical value at which α_h is calibrated is 0.5, corresponding to the symmetric bargaining case [Flabbi and Moro, 2012]. Other contributions set the value lower than 0.5 if they perceive the workers have a weaker bargaining position [Borowczyk-Martins et al., 2018].

[35] See Flinn [2006] for a detailed and formal discussion. See Dey and Flinn [2005] and Flinn and Mullins [2015] for applications using the same type of information we use in our application.

In our setting, it would be desirable to allow for schooling-specific α_h. However, since we cannot observe schooling-specific labor shares, we have to impose:

$$\alpha_1 = \alpha_0 \equiv \alpha \tag{26}$$

Another set of parameters that need to be identified relates to the self-employment state. The argument we used to identify $\{\lambda_h, \eta_h\}$ and $G(x|h)$ can be applied to identify the exogenous arrival rates of employee offers while self-employed γ_h and the primitive distribution of self-employed labor income $R(y|h)$. In this case too, we observe a truncation of the primitive distribution (labor incomes of individuals working as self-employed) and the durations in the self-employed state. We can then use the same identification strategy if we assume that $R(y|h)$ belongs to a recoverable parametric distribution but without any appeal to a mapping between wages and productivity since the truncation applies directly to the distribution of interest $R(y|h)$. We make the same parametric assumption as we did before by assuming log-normality, and we denote location and scale parameters with $(\mu_{y,h}, \sigma_{y,h})$. In this case too, log-normality assures recoverability and a good fit of the data.

Finally, the parameters ξ_h and ρ can only be jointly identified. Following Flinn and Heckman [1982] and more recent literature, we fix the yearly discount rate, ρ, to 5% and use the equilibrium expression for the workers' value function (see Appendix A.2) to recover ξ_h.

4.2 Preferences and Informality Parameters

The second set of parameters to be identified is specific to our labor market model with a dual social security system and imperfect enforcement. They are the preference parameters $\beta_{0,h}$ and $\beta_{1,h}$ – representing the valuation that workers give to each pesos spent to provide the social benefits – and the cost parameter c_h – representing the amount firms set aside to cover for the expected costs of being caught hiring workers informally.

We first discuss the identification of $\beta_{1,h}$ and c_h assuming $\beta_{0,h}$ is known. We identify $\beta_{1,h}$ and c_h by exploiting the location and extent of the overlap between the distribution of accepted wages for formal employees and the distribution of accepted wages for informal employees. This is a crucial feature observed in the data that our model is able to replicate. Recall from section 3.4 that in the relevant range of the parameters space we have:

$$w_0(\tilde{x}(y,h); y, h) - w_1(\tilde{x}(y,h); y, h) > 0, \tag{27}$$

i.e. at the reservation productivity value $\tilde{x}(y,h)$, the wage received working informally is higher than the one received working formally. This implies an overlap in the support of the formal and informal accepted wage distributions. The difference between the two wages represents the extent of the overlap while the reservation value $\tilde{x}(y,h)$ governs the location of the overlap.

The parameters of interest $\beta_{1,h}$ and c_h shape the extent and the location of the overlap very

intuitively. At any given value of the match productivity, formal employees receive lower net wages than informal employees because they are receive higher non-wage benefits. The higher $\beta_{1,h}$, the more sensitive the worker to the added benefit, the larger the overlap. At the same time, informal employees receive higher net wages than formal employees with the same productivity because firms do not pay social security contributions. However, firms pay the cost of hiring informally c_h: the higher c_h, the less convenient to hire informally, the smaller the overlap. Finally, the location of the overlap is determined by $\tilde{x}(y,h)$ which, in general, depends negatively on both $\beta_{1,h}$ and c_h.[36] Both a larger valuation of formal benefits and a higher cost of hiring informally make formal employment more attractive.

If the previous discussion is informative on how both $\beta_{1,h}$ and c_h have an impact on the location and on the extent of the overlap, it still does indicate how the two parameters impact these data features differently. The intuition for the differential impact is illustrated in Figure 5. The figure reports the benchmark wage schedules of Figure 3 – denoted by $w_0(x;y,h)$ and $w_1(x;y,h)$ – and the wage schedules resulting by changing $\beta_{1,h}$ and c_h – denoted by $w_0'(x;y,h)$ and $w_1'(x;y,h)$. To simplify the discussion, we focus only on the direct effects of the parameters, ignoring for the moment the equilibrium effects acting through the reservation value $\tilde{x}(y,h)$, the outside option $Q(y,h)$ and the redistributive component b_1.[37]

A decrease in c_h increases the sensitivity of informal wages to productivity x because it implies a lower cost of hiring informally. Graphically, it is equivalent to rotating the w_0 wage schedule up. Ignoring equilibrium effects, a change in c_h has no direct impact on formal wages leaving the w_1 wage schedule unaffected. As a result, the overlap increases because the upper bound moves up reaching $w_0'(\tilde{x}(y,h);y,h)$. The direct impact of an increase in $\beta_{1,h}$ also leads to a larger overlap but by affecting a different margin. If $\beta_{1,h}$ increases, formal wages decrease at each productivity value x because the non-monetary benefits are now valued more. Graphically, it is equivalent to a parallel downward shift of the w_1 wage schedule. Ignoring equilibrium effects, a change in $\beta_{1,h}$ has no direct impact on informal wages leaving the w_0 wage schedule unaffected. As a result, the overlap increases because the *lower* bound moves down reaching $w_1'(\tilde{x}(y,h);y,h)$.

In conclusion, if movement in $\beta_{1,h}$ and c_h can achieve the same extent of the overlap, they do so by moving its location in different directions generating a different shape in the accepted wage distribution of formal and informal employees. The heterogeneity in the outside options (unemployment or the different states of self-employment for the different values of y) generates many such overlaps, as we pointed out in Section 3.4. The presence of many overlaps magnifies the differential impact of $\beta_{1,h}$ and c_h and helps with the empirical identification. This is the case since

[36] This holds for most of the parameter space. Equilibrium effects work here through the outside option $Q(y,h)$ and the endogenous redistributive component b_1. It is still possible that for a particular combination of the parameters and for specific values of y, the equilibrium effects are so large to change the sign. Even when this is the case, the impact on the overall mixture distribution is limited because it involves only specific values of y.

[37] When equilibrium effects are considered – i.e. when the outside options $Q(y,h)$ and the redistributive component b_1 are allowed to change – the differential impact may be stronger or weaker depending on the specific region of the parameters space and on the specific value of the outside option. However, the main identification argument for the differential impact of $\beta_{1,h}$ and c_h does not change.

the observed wage distributions are mixtures over different accepted wages distributions, each of which belongs to agents with potentially different outside options and therefore potentially different overlaps. It is indeed the presence of many overlaps *and* the joint action of $\beta_{1,h}$ and c_h that is able to extend the overlap over the entire support of the accepted wage distributions, as we observe in our and many similar datasets.

The above discussion concerns the separate identification of $\beta_{1,h}$ and c_h, assuming $\beta_{0,h}$ known. It is not possible to make progress on the identification of $\beta_{0,h}$ without additional sources of variation in the data since this preference parameter involves trade-offs in the model that are similar to the ones used to identify $\beta_{1,h}$ and c_h. However, $\beta_{0,h}$ has the property of being the valuation of a fixed exogenous benefit (B_0). If we were able to observe exogenous changes in the benefit, then we could exploit the additional information to identify B_0. The time-staggered entry across municipalities of the *Seguro Popular* program provides this additional source of information. As mentioned in Section 2.1, *Seguro Popular* is a non-contributory social security program providing health services to everyone but formal workers. In terms of our model, it can be interpreted as an increase in the non-contributory benefit B_0. The magnitude of the increase corresponds to a change of B_0 from 1.92 to 2.42 pesos per hour, or about a 25% increase in the per-capita hourly extra-wage benefits for informal, self-employed and unemployed workers.[38] The identification assumption that we use is that the structural parameters of the model do not differ between the set of municipalities that are exposed to the program during the year 2005 and the set of municipalities that are not yet exposed to the program as of 2005.[39] Under this assumption, the differences in labor market behavior that we observe between agents belonging to the two groups are solely due to the change in B_0. The elasticities of labor market variables to the change in health benefits induced by the policy is a direct results of the valuation of these benefit, $\beta_{0,h}$, which is the parameter that we need to identify.

4.3 Matching Function and Demand Side Parameters

The next set of parameters that needs to be identified are those governing the matching function. By equation (5), they are the Cobb-Douglas coefficient ι_h and the parameter denoting the lower search efficiency of the self-employed ψ_h. By observing the schooling specific vacancy rate v_h

[38] See Appendix C for a detailed description of the computation of the two values of B_0 with and without the *Seguro Popular* benefits.

[39] We support the assumption that the structural parameters of the model do not systematically differ between the two groups of municipalities by looking at labor market outcomes before the *Seguro Popular* program was introduced. We can do this thanks to a previous round of the labor market survey conducted in 2001 (ENE). Since in 2001 no municipality received *Seguro Popular* benefits, we can use the 2001 data to check if the two groups are balanced in the pre-treatment environment. We implement this by running OLS regression of the relevant labor market moments on an indicator variable for whether workers reside in municipalities that received the program in 2005. Estimation results are reported in Appendix B, Table B.2. The estimated coefficients are very small in magnitude and not statistically different from zero, suggesting balance between the two groups in the same labor market variables that we use in estimation. These findings are consistent with evidence reported in Bosch and Campos-Vazquez [2014] and Azuara and Marinescu [2013], which document that the roll-out of the *Seguro Popular* program was not correlated with labor market characteristics.

together with the unemployment and self-employment rates u_h and s_h, we can use the definition of the matching function and the equations defining the endogenous arrival rates to obtain:

$$\psi_h = \frac{\gamma_h}{\lambda_h} \tag{28}$$

$$\iota_h = \frac{\ln \omega_h - \ln \lambda_h}{\ln \omega_h}. \tag{29}$$

Since γ_h and λ_h are identified by information on durations and wages (see Section 4.1) and since ω_h is defined as $\frac{v_h}{u_h+\psi_h s_h}$, equations (28) and (29) are sufficient for the identification of the parameters and directly deliver consistent estimators.

The identification of the matching functions parameters allow for the computation of the arrival rate of workers to firms $\zeta_h = \omega_h^{-\iota_h}$. This information is enough to identify the other demand side parameter: the flow value of keeping the vacancy open ν_h. To see this, consider the equilibrium equations for the firms' value functions (see Appendix A.2) and notice that they can be solved for ν_h since all the other parameters in the equations are already identified at this stage.

4.4 Schooling Parameters

The last element of the parameter vector (23) and (23) that needs to be identified is the $T(\kappa)$ distribution of the cost of acquiring the high schooling level. We do not have any direct information on schooling costs or on behavior at the time of the schooling decision. The only available information about this process is the proportion of individuals that have completed either the high or the low schooling level. We can exploit this information using the threshold-crossing impact generated by the model's equilibrium.

Recall from Section 3.3 that agents with a cost of schooling higher than κ^* do not acquire additional education, while those with a cost lower than κ^* do. If we assume a one-parameter, invertible distribution for $T(\kappa)$, we can write:

$$p_h = T(\kappa^*; \delta), \tag{30}$$

where p_h denotes the proportion of high schooling individuals in the sample and δ denotes the parameter of the T distribution. Since the other (already identified) parameters of the model determine κ^*, we can solve for δ and conclude the identification. Based on previous literature and computational convenience, we choose the negative exponential distribution as the one-parameter distribution for $T(\kappa)$.[40]

[40] A similar strategy is used in search models of the labor market to account for the extensive margin of the labor supply decision. The analogy is that even if no information about the value of non-participation is available, a threshold-crossing condition can be used to identify a one-parameter distribution from the proportion of labor market participants. For a recent example, see Flabbi and Mabli [2018].

5 Estimation

5.1 Method

We estimate the parameters of the model in two steps. In the first step we jointly estimate the search, matching and bargaining parameters discussed in Section 4.1 and the preferences and informality parameters discussed in Section 4.2. In the second step we estimate the matching function and demand side parameters discussed in Section 4.3 and the schooling parameter discussed in Section 4.4. Throughout the estimation procedure, the institutional parameters $\{B_0, \tau, t\}$ are set to the values determined by the Mexican legislation (see Appendix C for details) and the discount rate ρ is set to 5% a year.

The first step of the estimation procedure concerns the parameters:

$$\Theta_h \equiv \{\lambda_h, \gamma_h, \eta_h, \alpha, \mu_{x,h}, \sigma_{x,h}, \mu_{y,h}, \sigma_{y,h}, \beta_{0,h}, \beta_{1,h}, c_h, \xi_h\}$$

and uses the Method of Simulated Moments (MSM).[41] Given the vector of parameters for each schooling group Θ_h, the method defines a joint estimator $\hat{\Theta} \equiv [\hat{\Theta}_0|\hat{\Theta}_1]$ as:

$$\hat{\Theta} = \underset{\Theta}{\operatorname{argmin}} \left[M_R(\Theta) - m_N\right]' W^{-1} \left[M_R(\Theta) - m_N\right], \tag{31}$$

where m_N is an appropriately chosen set of sample moments derived from our sample of size N and $M_R(\Theta)$ is the set of the same moments derived from a simulated sample of size R, based on a steady state equilibrium obtained at the parameter vector Θ. We set R at 20,000, corresponding to simulated samples of size 10,000 for each schooling group. W is a weighting matrix that we introduce to harmonize the different scales of the moments and to weight them according to their sample variability. In practice, we build W by replacing the diagonal of an identity matrix with the bootstrapped sample variances of the sample moments.

The second step of the estimation procedure concerns the parameters:

$$\{\psi_h, \iota_h, \zeta_h, \nu_h, \delta\}$$

As mentioned in the identification strategy, given a consistent estimator $\hat{\theta}$, the parameters can be consistently estimated by solving equations (28), (29) and (30) and by applying the definition of ζ_h. This is the procedure we follow in this second estimation step.

We now focus on the choice of moments to be used in the quadratic form (31). We choose the moments in order to capture the stylized facts described in Section 2.2 and to describe in detail the data features we need from the identification strategy. We start by dividing the sample observations in four groups where each group is defined by the schooling level and by the exposure

[41] The method has become increasingly popular to estimate highly nonlinear models with value functions solved numerically such as ours. For the asymptotic properties of the MSM estimator defined in (31), see Pakes and Pollard [1989] and Newey and McFadden [1994].

to the *Seguro Popular* program (see Sections 2 and 4.2). For each of these four groups, we build moments derived from the proportions in each labor market state, from the durations in the searching states, from the wages at formal and informal jobs, and from the self-employment income. For durations, we compute means; for wages and incomes we compute means and standard deviations. To capture the overlap between the distributions of formal and informal wages, we follow the procedure proposed by Flabbi and Moro [2012] to address a similar problem. We compute quintiles over the distribution of accepted wage for formal workers. For each interval, we compute: (i) the mean wage of informal employees; (ii) the mean wage of informal employees; and (iii) the proportion of employees in informal jobs earning a wage in that interval. Finally, we compute the aggregate labor share necessary to identify and estimate α.[42]

5.2 Results

The estimated parameter values are reported in Table 2. The values of parameters governing the rates of job arrival and termination $\{\lambda_h, \gamma_h, \eta_h\}$ are comparable to previous estimates for similar models on high-income countries.[43] There are differences between the two schooling groups, with lower arrival and termination rates for individuals who did not complete a high-school degree.[44] The differences in arrival rates between the unemployed and the self-employed are very large, explaining in part the observed persistency in the self-employment state and the high-turnover in the unemployment state. For example, an unemployed worker belonging to the Low Schooling group meets a firm on average every 3.5 months while a self-employed worker on average every more than 2 years. Taking into account the endogenous acceptance probability, these rates translate in unemployed workers belonging to the Low Schooling group accepting a job after on average 5.1 months. Unemployed workers belonging to the High Schooling group receive more offers but they are pickier, leading to a slightly higher average duration in unemployment (5.7 months). These durations result from transitions to either an informal job or to a formal job. The composition of these transitions is where the main difference between the two schooling groups rests. Both groups have a higher probability to accept a formal employee job than an informal one but the extent of the difference is much larger in the High Schooling group. The probability of accepting a formal job compared to an informal one is eight times higher in the High Schooling group but only two times higher in the Low Schooling group.[45]

[42]The complete set of 108 sample moments (27 micro-moments defined in each of the four groups plus one aggregate moment) – along with the simulated moments at the estimated parameters and the corresponding weight used in the quadratic form – is reported in Appendix B, Tables B.3 and B.4.

[43]See for example the review in Eckstein and van den Berg [2007] and specifically models of individual search without on-the-job search such as Flinn and Heckman [1982], Flinn [2006] and Flabbi and Moro [2012].

[44]A similar ranking by schooling levels is found in Flinn and Mullins [2015] (under the No renegotiation specification) and in Flabbi and Leonardi [2010], even if both papers use US data and define schooling levels differently.

[45]These results are different from the estimates obtained by Meghir et al. [2015] on Brazil where they estimate on the basis of an equilibrium search model that it takes on average three years to transit to a formal job from unemployment but only a few months to transit to an informal one. The main reason for the difference – on top of some country-specific factors – is the definition of informality. Meghir et al. [2015] do not differentiate between

Important differences between the two schooling groups are also observed in the estimated values of the parameters of the match-specific productivity distribution $\{\mu_{x,h}, \sigma_{x,h}\}$ and the self-employed earning distribution $\{\mu_{y,h}, \sigma_{y,h}\}$. As reported in the bottom panel, average productivity in the High Schooling group is about 6.3% higher than in the Low Schooling group when working as employee and about 18.2% higher when working as self-employed. These differences in productivity – along with the differences in the mobility parameters and in the valuation of the benefits – generates differences in labor market performance that affect the returns to investing in additional schooling. We focus on this feature in Section 5.3.

The Nash bargaining coefficient α is estimated at 0.48, giving a slightly weaker bargaining position to the worker, but quite close to the value of 0.5 that characterizes symmetric bargaining. This value is higher but comparable to those estimated on US data using a similar identification strategy.[46]

The estimated values of the preference parameters $\{\beta_{1,h}, \beta_{0,h}\}$ show that both formal and informal benefits are valued less than the monetary value used to provide them. However, the valuation of the non-contributory benefit is close to full monetary value (about 91 cents to the Peso for both schooling groups) while the valuation of the contributory benefit is much less than full value (about 67 cents to the Peso for the High Schooling group, and about 56 for the Low Schooling group). Since this implies that formal employees have a willingness to pay for the benefit significantly lower than the contribution paid to receive it, the payroll contribution rate introduces a net loss that reduces the incentive to work formally. Based on parameters estimates and equilibrium matches, the worker at the average accepted formal wage in the Low Schooling group pays about 7 pesos in payroll contributions while receiving a monetary benefit of about 8. But that amount of benefit is valued less than 5 pesos by the worker, leading to a loss of about 12% of the average wage. In the High School group, the average loss is similar – about 11% – because the higher loss due to redistribution is compensated by the higher valuation of the benefit.

We speculate about two possible explanations of why the valuation of the benefits is close to full value for informal workers and much lower for formal workers. The first relates to the contributory nature of the benefit. Formal employees contribute a proportion of their wages to obtain the benefit while informal employees, self-employed workers, and unemployed workers do not. As a result, the attitude toward the service provided and its valuation may be different, even if the quality is comparable. The second possible interpretation relates to the composition of the benefit. The extra-wage benefits in the formal sector, $B_1(w_1(x; y, h))$, bundle together two types of benefits: a retirement benefit and a health benefit – see equation (2). Only the second benefit (b_1) is comparable to the non-contributory benefit received by informal and unemployed workers, B_0, but the valuation parameter is estimated over the bundle of both types of benefits.

self-employed and informal employees in their definition of the informal sector as well as in their modeling and estimation strategy.

[46] Flinn [2006] estimates α in the range of 0.39-0.43 on a sample of young low skilled US workers. Flinn and Mullins [2015] estimate it at 0.25 on a sample of very young US workers (25 to 34 years of age) but with a broader range of skills.

If retirement benefits are valued less than health benefits then $\beta_{1,h}$ should be lower than $\beta_{0,h}$.

The estimates of the cost of hiring informally parameter c_h are 10.9% of job productivity in the Low Schooling group and 8.5% of job productivity in the High Schooling group. The parameter captures all the costs associated with hiring informally, including the probability and penalty of getting caught. While the estimated cost is economically important, at relatively low productivity level – for given self-employed income, y – it is still lower than the cost of hiring formally, justifying the significant but not dominant presence of informal employees observed in our labor market. For example, the cost of hiring informally as measured by $c_h x$ at the mean productivity of the realized informal matches is between 2.4 and 2.2 pesos per hour; the cost of formality as measured by $tw_1(x; y.h)$ at the mean productivity of the realized formal matches is between 7 and 9.1 pesos per hour.[47]

The flow value of being an unemployed searcher ξ_h is estimated to be negative in both schooling groups. A negative value was expected in order to generate enough wage dispersion in accepted wages.[48] However, the value is not as unrealistically low as in previous work due to the presence of a searching state that generates labor income – the self-employed state – and due to the provision of the non-contributory social security benefits.

The last set of parameters in Table 2 refers to the matching function, the demand side and the schooling decision. The first matching function parameter ψ_h represents the lower search efficiency of the self-employed workers with respect to the unemployed workers. If we interpret it as the time spent searching by each self-employed and we assume that an unemployed searches full-time, the estimated values imply between four and five hours a week devoted to job search by the average self-employed. The second matching function parameter ι_h represents the elasticity of the number of jobs with respect to the measure of searchers – see equation (5). Our estimated values are lower than those estimated using macro data on high-income countries [Petrongolo and Pissarides, 2001] and on Mexico [Arroyo Miranda et al., 2014] but not far from the 0.5 frequently used in calibration. Our estimated matching function also implies an arrival rate of workers to firm ζ_h of about 1.8 in the Low Schooling group and of about 2.1 in the High schooling group. The other demand side parameter is the flow value of keeping the vacancy open ν_h. We estimate that keeping a vacancy open and unfilled is 23% more costly when the job must be filled by a more educated worker, a ranking we find reasonable.

Finally, δ is the parameter of the cost of schooling distribution. As reported at the bottom of Table 2, it implies that the average cost of completing High School with respect to stopping at Junior High is about 137.6. This value should be compared with the overall values of participating in the market $Z(h)$. These values are reported at the bottom of Table 3 and they are between 300 and 400. As a result, the average cost of acquiring additional schooling is about one third of the value of participating in the labor market as an High Schooling type. This relatively high cost is

[47] Notice that these are only direct costs, i.e. they do not take into account that through bargaining firms are able to partially transfer them to the workers, as seen in the equilibrium wage schedules (16) and (17).

[48] See Hornstein et al. [2011] for an extensive treatment of the issue.

consistent with less than 40% of the population completing additional schooling.

5.3 Returns to Schooling

Table 3 reports various outcomes useful to interpret the returns to schooling in our context. The first panel reports accepted wages and it is similar to common measures obtained by comparing conditional means or by estimating wage equations. Completing High School with respect to completing at most Junior High School, increases average accepted wages by 22.2% when working as informal employee, by 28.9% when working as formal employee, and by 29.4% when working as self-employed.

However – as already pointed out by Eckstein and Wolpin [1995] and following literature – accepted earnings are not an appropriate measure of returns since they are selected by the decision of accepting or rejecting a given job match. A more appropriate measure can be obtained by looking at offered wages.[49] We report mean offered wages in the second panel of Table 3. Here, the ranking of the returns is different, with the return in formal employee jobs (11.8%) being lower than the one in informal employee jobs (15.3%) or in self-employment (18.2%). The result shows that the extent of the higher selectivity of accepting a formal job is different between the two schooling groups.

Finally, we can provide a measure of returns that summarizes not only wages and self-employment incomes but also labor market frictions, the probability of job termination, the selection over labor market states, and the valuation of the non-wage benefits. As seen in Section 3.3, this is the relevant measure when deciding if completing additional schooling or not. It is the measure that summarizes the value of participating in the labor market as a High Schooling worker or as a Low Schooling worker and we have denoted it in the paper with $Z(h)$. The overall estimated return to completing High School with respect to Junior High is therefore 20.7%, as reported in the bottom panel of Table 3.

5.4 Model Fit

Tables B.3 and B.4 in the Appendix report the complete set of moments targeted by the MSM estimator. They are computed separately for individuals belonging to municipalities exposed to the *Seguro Popular* program and for those that are not. They are also unconditional to the labor market state to guarantee a smoother and well-defined quadratic form during the optimization procedure. There are no major mismatches in the moments targeted by the procedure but some data features are captured better than others.

[49] Notice that offered wages by formality status may be defined in different ways in our context. We have decided to exclude any endogenous truncation in computing these measures: they are simply the mean offered wage obtained by integrating the wage schedules (16) and (17) over the primitive productivity distribution $G(x|h)$. That is the reason why the average wage offer in informal jobs may be higher than the average accepted wage in informal jobs: the first measure uses the entire support of x while the second measure has support with upper bound at $\tilde{x}(y,h)$.

To ease the discussion and the interpretation, Table 4 reports moments aggregated over the differential exposure to the *Seguro Popular* program but conditional on the labor market state. The distribution over the four labor market states is well matched by the simulated data on both schooling groups with the exception of the unemployment state. The unemployment rate we generate at estimated values is lower than the one observed in the data, in particular for the Low Schooling group. While this is a concern, unemployment is the least relevant of all labor market states since both the rates and the durations are relatively low.

The second set of moments in Table 4 reports means and standard deviations of the accepted wages and of the self-employment incomes. The match is quite good on all the means, with differences in the 10% range. Standard deviations on informal employees, instead, are lower than in the sample in both schooling groups. This is a direct consequences of the constraints imposed by the theoretical model: informal wages have a bounded support, with lower bound at $w_0(x_0^\star(y,h);y,h)$ and upper bound at $w_0(\tilde{x}(y,h);y,h)$. While this constraint does not necessarily prevents us from reaching a good fit, it is not too surprising that this particular data feature is the one we have the most difficulty to replicate.

A peculiar and relevant feature of Mexico's and other labor markets with high informality is the overlapping of the formal and informal accepted wages distributions. We are able to replicate the overlap quite well, both in terms of the proportions of informal employees in each quantile and in the mean accepted wages by quantiles. This result is obtained through two channels. First, the endogenous mapping between match-specific productivity and wages implied by bargaining. Second, the flexibility introduced by allowing the self-employment state to be a searching state, with heterogenous productivity levels that are pinned down by the (observed) income generated while in self-employment.

6 Policy Experiments

Our model incorporates the structure of the social security system implemented by several countries in response to the lack of coverage for informal workers. The resulting dual system is characterized by contributory benefits – governed by a payroll tax rate, a benefit level increasing in wages and a redistributive component – and non-contributory benefits. The estimates of the preferences over these benefits indicate that contributory benefits generate a net loss, reducing the incentives to work formally, while non-contributory benefits amount to a net subsidy, increasing the incentives to work informally. The impact is mediated by the redistributive component of the contributory system which favors formality on the range of productivities most likely to be at the margin between formality and informality.

To evaluate the impact of this complex system of incentives and disincentives, we use the estimated model to generate counterfactual experiments that varies the policy parameters of the social security system. Thanks to the structure of the model, we can evaluate the impacts in an equilibrium context, looking at labor market outcomes, informality levels, schooling rates and

overall productivity and welfare.

We report results on two crucial policy parameters: the payroll tax rate in formal jobs t and the per-capita level of the non-contributory social benefits B_0. First, we focus on each of the two policy parameters, changing their values over a large neighborhood of the benchmark values. We present the impact on informality rates in Section 6.1 and the impact on schooling and productivity in Section 6.2. Then, we focus on a policy combining both parameters and setting them at levels that are both realistic in terms of policy implementation and able to generate better incentives in terms of labor market outcomes. We call this policy *universal social security benefit* and we discuss it in Section 6.3.

The policy experiments procedure works as follows. For each value of the policy parameter, we find and compute the new equilibrium holding fix the other institutional parameters and the estimated parameters. Then, we simulate the labor market careers for 20,000 individuals (10,000 individuals in each schooling group) in these counterfactual labor markets. Finally, we compute the relevant statistics on the simulated data.

6.1 Labor Market Informality

Figure 6 reports simulation results on the equilibrium rate of informality. In the top panels, we compute the rate only as proportion of informal employees, while in the bottom panels we also include the self-employed workers.

Panels (a) and (c) of Figure 6 report the impact of changes in the payroll tax rate t for formal employees. The informality rate increases quickly as the rate moves from zero to positive, the effect predicted by most of the existing literature. However, above a threshold quite close to the rate charged in the Mexican system (the vertical line), an additional increase in t leads to a decrease in the informality rate. The effect is particularly pronounced when focusing only on informal employees (top panel). The reason for the non-monotone impact of the payroll tax rate on informality is the redistributive feature of the social security system. As described in Section 3, a proportion τ of the contributory benefit is increasing in the contribution (the retirement benefit) but the rest is redistributed equally among all the formal employees (the health benefit b_1). As a result, an increase in t impacts informality through two main channels. The first channel makes formal jobs less attractive across the board because the firm has to pay a higher contribution for each level of productivity. The second channel makes formal jobs more attractive at relatively low productivity levels because the workers filling these jobs receive a relatively larger portion their benefit through b_1. Since these workers and jobs are exactly those at the margin between formality and informality, the second effect may dominate when a high contribution rate makes the transfer through b_1 generous enough.

Panels (b) and (d) of Figure 6 report the impact of changes in the non-contributory social security benefit B_0. As expected, the effect is monotone in this case but the elasticities indicate interesting dynamics. Setting the non-contributory benefit to zero would be enough – in this

labor market – to completely eliminate informal employees. This is a policy-relevant result since many countries in the region are attempting to eliminate informality by increasing enforcement while at the same time adding resources to non-contributory benefits.[50] The sensitivity of the informality rate to changes in the benefit increases non-linearly with the benefit's level and it becomes large exactly in the area where the benchmark Mexican values are.[51] The impact on the overall informality rate as measured by the sum of illegal employees and the self-employed is still monotone but less sensitive to the policy. In particular, a benefit set at zero will not eliminate self-employment. The reason is the relative productivity of different workers in the employee sector and in the self-employment sector. Since individuals are heterogenous in their ability to generate self-employment income, particularly productive individuals in the sector will always choose to spend at least some time in self-employment. This result is informative about the distinction that we introduce in the paper between informal workers working as employee or as self-employed. Since these two groups of workers respond to different incentives, the policy instruments suitable at targeting one group or the other should take this into account.

6.2 Schooling and Productivity

Figure 7 reports simulation results of the impact of the same policy changes on schooling levels and the overall value of production. Schooling levels are measured as the proportion of individuals acquiring the high schooling level (High School completed). The value of production include the productivity of all the realized matches in equilibrium (the x's above $x^\star(0,h)$) and of all the self-employed active in equilibrium (the y's above $y^\star(h)$). We normalize the value of production in the benchmark case to 1 and we aggregate over the two schooling levels. Each panel present two lines. The dashed line reports the general equilibrium case, i.e. the full model where the demand side is taken into account by allowing firms to post more or less jobs in each of the two schooling markets as a result of the policy changes. In this case, the contact rates are endogenous and governed by the matching function (5). The solid line reports the partial equilibrium case which is frequently studied in search models estimated on individual-level data, i.e. a model in which the contact rates are policy-invariant and set at the benchmark values $\hat{\lambda}_h$ and $\hat{\gamma}_h$ reported in Table 2. This comparison is informative about the quantitive importance of a general equilibrium approach in evaluating policies.[52]

As expected, an increase in the payroll tax rate of formal employees decreases overall schooling monotonically (Panel A). Since higher schooling levels means higher wages and productivity and since the payroll tax rate is proportional to wages but the contributory benefit less so (again, due

[50]Improving enforcement of the labor regulations is the policy studied by Meghir et al. [2015]. Since their model does not incorporate the details of the dual social security system, their setting cannot generate a policy experiments such as the one conducted in this Section.

[51]The two vertical lines correspond to the benefit level of individuals in municipalities with and without *Seguro Popular*.

[52]Examples of this partial equilibrium approach are: Flinn and Heckman [1982]; Eckstein and Wolpin [1995]; Dey and Flinn [2005]; Flabbi and Leonardi [2010].

to the b_1 component), an increase in the payroll tax rate affects proportionally more the High Schooling group. As a result, equilibrium returns to schooling decrease and individuals acquire less education. This is a potentially very important but frequently neglected dimension of social security systems in context of high informality. Indeed, the effect in general equilibrium is very large: increasing the payroll tax rate from zero to about 60% leads to cutting high schooling rates in half, from about 70% to about 35%. In partial equilibrium, instead, the impact is relatively small: the same change leads to cutting high schooling rates only by a few percentage points. The source of this stark difference lies in the reaction of the demand side. A rate increase affects the firms' decision to post formal or informal jobs, magnifying the impact of the policy on the equilibrium returns to schooling. The positive externality of this effect is also reflected in the overall value of production. Lowering t can potentially increase production by reducing distortion but also by inducing more individuals to acquire additional schooling and therefore becoming more productive. In fact, lowering the payroll tax rate to zero would increase the value of production by about 17% in general equilibrium but only by about 6% in partial equilibrium. However, the sensitivity to a further increase of the payroll tax rate from the benchmark level (the vertical line in Panels A and C) would be quite low both in general and partial equilibrium since the curves are relatively flat in that region of the t support.[53]

Changes in non-contributory benefits B_0 generate a similar results (Panels B and D). Schooling levels and productivity are monotone decreasing in the benefit's amount and the general equilibrium impacts are much larger than the partial equilibrium ones. The reasons are also similar: since the benefits are the same for all, they favor relatively more the low schooling individuals. Since firms decide posting by schooling, the difference is magnified in general equilibrium. It is worth emphasizing the large impact on schooling levels in equilibrium: the fraction of workers completing secondary schooling almost doubles with respect to its benchmark value – from 39.5% to roughly 70% – when the benefit is completely eliminated. The impact of non-contributory benefits on long-run investment is frequently ignored in the policy debate and it is shown here – conditionally on our model and estimates – to have potentially large effects. The result highlights the trade-offs faced when expanding social security benefits to informal workers through B_0. On one hand, workers have better coverage; on the other, formal employment and output fall, and so does the fraction of workers acquiring the High Schooling level.

6.3 Universal Social Security Benefits

As shown, each of the policy parameters have significant effects on labor market outcomes, schooling investment decisions, and aggregate productivity. A combination of both policy instruments

[53]This channel is clarified by looking at Figure B.1 in the Appendix. The figure reports the arrival rates of employee job offers to the unemployed (top panel) and to the self-employed (bottom panel). In partial equilibrium, they are fixed to the benchmark values while in general equilibrium they change as a result of the searchers/vacancies ratio. The arrival rates of offers to the High Schooling group is much higher for smaller values of t and B_0. This significantly improves the labor market opportunities of the more educated.

is promising in improving outcomes from current levels and in balancing incentives and equity objectives. Instead of attempting an optimal policy design, we simulate policies that may solve one of the main distortions of the system: the "dual" nature of the social security benefits where contributory benefits in the formal sector coexist with non-contributory benefits in the informal sector and redistribution occurs only within the formal sector. The objective is to mimic a *universal* social security system where benefits are not linked to the formality status of the job. The first policy consists in simply increasing the level of per-capita non-contributory benefits to the equilibrium value of the lump-sum component of the social security benefits in the formal sector ($B_0 = b_1 = 4.04$ Pesos per hour). Again, this is a policy that is currently implemented in Mexico and many other countries (see Section 2). The second policy achieves the same objective but introduces changes in the contributions paid in the formal sector in order to reduce the distortions in the choice of the formality regime. To achieve this, we eliminate the redistributive component of the contributory social security system and we provide some non-contributory benefit to formal employees. Specifically: (i) all the contributions in the formal sector are retirement benefits ($\tau = 1$); (ii) all the health benefits are non-contributory for all workers in any formality regime and are set to the benchmark formal employee level ($B_0 = b_1 = 4.04$ Pesos per hour); (iii) the payroll tax rate for formal jobs is reduced accordingly ($t = 0.33 \times 0.45 = 0.15$).

Table 5 reports the results of the policy experiments on labor market outcomes for the low-schooling group (Panel A), for the high-schooling group (Panel B) and for aggregate benefits, schooling, productivity and costs (Panel C). The first column reports statistics on the benchmark economy, the second column on the experiment that simply equates the benefit, the third column on the policy that restores the full proportionality between the benefits and the contributions for formal employees.

The first policy creates an incentive to work informally: the relative fractions of informal employees with respect to formal employees increases substantially in both schooling groups. The difference between the match-specific productivity cutoff value for accepting an informal job and the cutoff value for accepting a formal job widens, creating significant gaps in the average accepted wages in equilibrium between formal and informal employees. The value of participating in each schooling-specific labor market goes up since the system is receiving an increase in non-contributory benefits. Since the benefits are not paid by the agents, the fiscal cost is high. Since favoring informality reduces the returns to schooling, overall schooling completed is reduced and overall production decreases.

The second policy provides advantages for both formal and informal workers. In equilibrium, the advantage is higher for the formals since their benefits' levels do not change while their payroll tax rate is lowered. The incentives are enough to completely eliminate informal employment in the High Schooling level sector but have almost no impact on the informality level in the Low Schooling sector. However, the overall informality rate in the economy decreases substantially because the share of agent with High School completed increase by 30 percentage points, reaching almost 70%. The asymmetry of the effects by schooling is due to the complete removal of the

redistributive component ($\tau = 1$) and to the firms' reaction (higher vacancy posting in the High Schooling sector). What is notable is that the positive externality on schooling levels induces an increase in the value of production large enough to keep the relative fiscal cost of the benefit system almost constant. The relative fiscal cost only increases from 2.8% of overall value of production in the benchmark to 3.1% post-policy. As a result of the joint increase in benefits, in schooling, and in the value of production, overall worker's welfare (Z) increases substantially, reaching a value 35% higher than in the benchmark model.[54]

7 Conclusion

Informality is a defining feature of many labor markets. In Latin America, over 50% of the labor force work is employed informally. Studying costs and benefits of informality requires an equilibrium model of the labor market that takes into account how workers and firms endogenously sort between the formal and the informal sector. If the model wants to generate credible estimates and relevant counterfactual policy scenarios, it also needs to replicate the empirical regularities and the salient institutional features observed in these markets.

This paper developed and estimated a search and matching model where firms and workers endogenously decide to form matches (jobs) that can be formal or informal. The model replicates the main features of labor market dynamics in Mexico by allowing endogenous formality posting and endogenous wage determination through bargaining. The sources of heterogeneity determining wages and formality status are the match-specific productivity and the income of self-employed workers. Meeting rates are also endogenous, as they are governed by the equilibrium proportions of (unemployed and self-employed) searchers and vacancies. In this environment, we introduce three relevant but neglected features. First, recognizing that the labor market distortions that generate informality may affect not only short-run labor market outcomes but also long-run investment decisions, we allowed for endogenous schooling decisions. Second, we modeled a crucial and increasingly important institutional feature: the presence of a dual social security system where non-contributory benefits targeting informal workers coexists with a standard contributory system reserved for the formals. Finally, we introduced the crucial distinction between informal employees and informal self- employed.

We identified and estimated the model parameters using a combination of individual-level data, policy-induced institutional changes, and aggregate data from Mexico. The Mexican labor force survey (ENOE) is used to extract accepted wages and labor market transitions to identify the main labor market parameters. Variations in non-contributory benefit introduced by a large-scale public health program (*Seguro Popular*) are used to identify the preference for benefits provision. Finally, aggregate information on labor shares and on vacancy posting by schooling levels are used

[54] $Z(h)$ defines the value of participating in the labor market with a given schooling level h (see equation (6)). In Table 5, we report the average value over the two schooling group, where the average is weighted by the equilibrium proportion of agents that have completed the High or Low level of schooling.

to identify the workers' bargaining coefficients relative to firms and the parameters of the matching function. Estimation results delivered reasonable and precise point estimates. They also generated a good fit of the data. The overall return to complete a secondary schooling education is found to be about 20 percent.[55] This a metric that summarizes not only wages and self- employment incomes but also labor market frictions, the probability of job termination, the selection over labor market states (including between formal and informal jobs), and the valuation of the non-wage benefits.

We focused our policy experiments on the two main policy levers of the social security system: the payroll tax rate in formal jobs and the monetary value of the non-contributory benefits. Unlike previous literature, we found that informality may decrease even if the payroll tax rate were to be increased from current levels. The result is driven by the redistributive features of the system. Increasing non-contributory benefits has the unambiguous effect of increasing informality and decreasing schooling. We proposed a policy that combines both policy levers by providing universal health benefits to both formal and informal workers while at the same time reducing the payroll tax rate of formal employees. By reducing distortions and incentivizing schooling, this policy increases aggregate productivity and welfare without significantly increasing the relative fiscal cost of the system.

We see two main limitations in our work. The first concerns the demand side. If we allow workers to decide (at least in part) on long-term investments in schooling, we do not let firm make investment decisions. Firms can enter the market and post vacancies for different schooling levels but they cannot change their capital/labor mix and they are restricted to constant returns to scale technologies. A unified model able to merge the demand and supply side's investment decisions in labor markets with high informality is still missing in the empirical literature.[56] The second concerns the workers. They are allowed to decide on human capital investments before entering the labor market but not after. Just as our results show that a labor market with high informality strongly affects the first decision, so it is likely to matter for the second. Evidence on the higher instability of informal jobs and on the reluctance of firms to invest in specific human capital when hiring informally, indicates that the associated distortions in human capital decisions and earning dynamics over the life-cycle can be large.[57] Given our results, allowing for both firms' investment decisions and human capital accumulation on the job should enrich our understanding of the benefits and costs of informality in labor markets where agents have shown to respond to the incentives and limitations created by the institutional system.

On top of the specific implications for Mexico, two important general lessons can be derived from our results. The first is that equilibrium effects are sizable and should be taken into account

[55]Specifically, it is the return to complete High School with respect to Junior High.

[56]An interesting and growing literature has focused on firms' investment decisions in the presence of informality[de Paula and Scheinkman, 2011; Ulyssea, 2015]. While this literature allows for a richer description of the demand side of the economy, the labor market is assumed perfectly competitive. Meghir et al. [2015] develop and estimate a model able to explain labor market dynamics and firms size but they still do not allow for capital investments and productivity shocks.

[57]See, e.g.,Lagakos et al. [forthcoming] for recent cross-country evidence.

when evaluating policies related to informality. To assess the issue, we also performed all our policy experiments while shutting down the reaction of the demand side (vacancy creation). Results show that if this equilibrium channel is ignored, the impact of the policies on schooling and productivity is limited. Instead, when this channel is activated, the impact is large and significant. For example, implementing our proposed universal social security benefit policy is shown to increase the proportion of High School graduates from the current 40 percent to 70 percent and to decrease the overall informality rate from the current 45 percent to 23 percent. Without equilibrium effects, the same policies imply a change of just a few percentage points. The second general lesson is that focusing on the social security benefit system is at least as important as focusing on enforcement when considering policy alternatives in labor markets with high informality rates. If Meghir et al. [2015] show that, for a given social security system, tightening enforcement increases output and welfare by generating better allocations of workers to jobs; our paper shows that, for given enforcement level, changing the crucial parameters of the dual social security system has the potential to substantially increase output, welfare and long-term productivity by affecting allocations and schooling decisions.

References

Abramitzky, R. and Lavy, V. [2014], 'How responsive is investment in schooling to changes in redistributive policies and in returns?', *Econometrica* **82**(4), 1241–1272.

Acemoglu, D. and Shimer, R. [1999], 'Holdups and efficiency with search frictions', *International Economic Review* **40**(4), 827–49.

Albrecht, J., Navarro, L. and Vroman, S. [2009], 'The Effects of Labour Market Policies in an Economy with an Informal Sector', *Economic Journal* **119**(539), 1105–1129.

Almeida, R. and Carneiro, P. [2012], 'Enforcement of labor regulation and informality', *American Economic Journal: Applied Economics* **4**(3), 64–89.

Anton, A., Hernandez, F. and Levy, S. [2012], *The End of Informality in Mexico?*, The Inter-American Development Bank.

Arroyo Miranda, J., Gómez Cram, R. and Lever Guzmán, C. [2014], Can matching frictions explain the increase in mexican unemployment after 2008?, Technical report, Working Papers, Banco de México.

Atkin, D. [2016], 'Endogenous Skill Acquisition and Export Manufacturing in Mexico', *American Economic Review* **106**(8), 2046–2085.

Azuara, O. and Marinescu, I. [2013], 'Informality and the expansion of social protection programs: Evidence from Mexico', *Journal of Health Economics* **32**(5), 938–950.

Bianchi, M. and Bobba, M. [2013], 'Liquidity, Risk, and Occupational Choices', *Review of Economic Studies* **80**(2), 491–511.

Borowczyk-Martins, D., Bradley, J. and Tarasonis, L. [2018], 'Racial discrimination in the us labor market: Employment and wage differentials by skill', *Labour Economics* .

Bosch, M. and Campos-Vazquez, R. M. [2014], 'The trade-offs of welfare policies in labor markets with informal jobs: The case of the "seguro popular" program in mexico', *American Economic Journal: Economic Policy* **6**(4), 71–99.

Bosch, M. and Esteban-Pretel, J. [2012], 'Job creation and job destruction in the presence of informal markets', *Journal of Development Economics* **98**(2), 270–286.

Cahuc, P., Postel-Vinay, F. and Robin, J.-M. [2006], 'Wage Bargaining with On-the-Job Search: Theory and Evidence', *Econometrica* **74**(2), 323–364.

Conti, G., Ginja, R. and Narita, R. [2017], Non-contributory health insurance and household labor supply: Evidence from mexico, Technical report, Mimeo.

de Paula, Á. and Scheinkman, J. A. [2010], 'Value-added taxes, chain effects, and informality', *American Economic Journal: Macroeconomics* **2**(4), 195–221.

de Paula, Á. and Scheinkman, J. A. [2011], 'The informal sector: An equilibrium model and some empirical evidence from brazil', *Review of Income and Wealth* **57**, S8–S26.

Dey, M. S. and Flinn, C. J. [2005], 'An equilibrium model of health insurance provision and wage determination', *Econometrica* **73**(2), 571–627.

Eckstein, Z. and van den Berg, G. J. [2007], 'Empirical labor search: A survey', *Journal of*

Econometrics **136**(2), 531–564.

Eckstein, Z. and Wolpin, K. I. [1995], 'Duration to first job and the return to schooling: Estimates from a search-matching model', *Review of Economic Studies* **62**(2), 263–86.

Fields, G. S. [1975], 'Rural-urban migration, urban unemployment and underemployment, and job-search activity in LDCs', *Journal of Development Economics* **2**(2), 165–187.

Flabbi, L. and Leonardi, M. [2010], 'Sources of earnings inequality: Estimates from an on-the-job search model of the us labor market', *European Economic Review* **54**(6), 832–854.

Flabbi, L. and Mabli, J. [2018], 'Household search or individual search: Does it matter?', *Journal of Labor Economics* **35**(1).

Flabbi, L. and Moro, A. [2012], 'The effect of job flexibility on female labor market outcomes: Estimates from a search and bargaining model', *Journal of Econometrics* **168**(1), 81–95.

Flinn, C. [2006], 'Minimum wage effects on labor market outcomes under search, bargaining and endogenous contact rates', *Econometrica* **73**, 1013–1062.

Flinn, C. and Heckman, J. [1982], 'New methods for analyzing structural models of labor force dynamics', *Journal of Econometrics* **18**(1), 115 – 168.

Flinn, C. and Mullins, J. [2015], 'Labor Market Search and Schooling Investment', *International Economic Review* **56**, 359–398.

Frolich, M., Kaplan, D., Pages, C., Rigolini, J. and Robalino, D., eds [2014], *Social Insurance, Informality, and Labor Markets: How to Protect Workers While Creating Good Jobs*, number 9780199685233 *in* 'OUP Catalogue', Oxford University Press.

Heath, R. and Mobarak, M. A. [2015], 'Manufacturing growth and the lives of Bangladeshi women', *Journal of Development Economics* **115**(C), 1–15.

Hornstein, A., Krusell, P. and Violante, G. L. [2011], 'Frictional wage dispersion in search models: A quantitative assessment', *The American Economic Review* **101**(7), 2873–2898.

Jensen, R. [2012], 'Do labor market opportunities affect young women's work and family decisions? experimental evidence from india', *The Quarterly Journal of Economics* **127**(2), 753–792.

Jovanovic, B. [1979], 'Job matching and the theory of turnover', *Journal of political economy* **87**(5, Part 1), 972–990.

Kanbur, R. [2009], 'Conceptualizing informality: Regulation and enforcement.', *Indian Journal of Labour Economics* **52**(1), 33–42.

Keane, M. P., Todd, P. E. and Wolpin, K. I. [2011], 'The structural estimation of behavioral models: Discrete choice dynamic programming methods and applications', *Handbook of Labor Economics* **4**, 331–461.

La Porta, R. and Shleifer, A. [2008], 'The unofficial economy and economic development', *Brookings Papers on Economic Activity* **2008**, 275–352.

La Porta, R. and Shleifer, A. [2014], 'Informality and development', *Journal of Economic Perspectives* **28**(3), 109–26.

Lagakos, D., Moll, B., Porzio, T., Qian, N. and Schoellman, T. [forthcoming], 'Life-cycle wage growth across countries', *Journal of Political Economy* .

Levy, S. [2008], *Good Intentions, Bad Outcomes: Social Policy, Informality, and Economic Growth in Mexico*, Washington DC, The Brooking Institution Press.

Levy, S. and Schady, N. [2013], 'Latin America's Social Policy Challenge: Education, Social Insurance, Redistribution', *Journal of Economic Perspectives* **27**(2), 193–218.

Magnac, T. [1991], 'Segmented or competitive labor markets', *Econometrica* **59**(1), 165–187.

Maloney, W. F. [1999], 'Does Informality Imply Segmentation in Urban Labor Markets? Evidence from Sectoral Transitions in Mexico', *World Bank Economic Review* **13**(2), 275–302.

Maloney, W. F. [2004], 'Informality revisited', *World development* **32**(7), 1159–1178.

Margolis, D. N. [2014], 'By choice and by necessity: entrepreneurship and self-employment in the developing world', *The European Journal of Development Research* **26**(4), 419–436.

Meghir, C., Narita, R. and Robin, J.-M. [2015], 'Wages and informality in developing countries', *The American Economic Review* **105**(4), 1509–1546.

Melguizo, A., Bosch, M. and Pages, C. [2017], 'Better pensions, better jobs: status and alternatives toward universal pension coverage in Latin America and the Caribbean', *Journal of Pension Economics and Finance* **16**(02), 121–143.

Munshi, K. and Rosenzweig, M. [2006], 'Traditional institutions meet the modern world: Caste, gender, and schooling choice in a globalizing economy', *American Economic Review* **96**(4), 1225–1252.

Narita, R. [2011], Self employment in developing countries: a search-equilibrium approach, PhD thesis, PhD Dissertation, University College London.

Newey, W. K. and McFadden, D. [1994], Large sample estimation and hypothesis testing, Vol. 4 of *Handbook of Econometrics*, Elsevier, pp. 2111 – 2245.

Pakes, A. and Pollard, D. [1989], 'Simulation and the Asymptotics of Optimization Estimators', *Econometrica* **57**(5), 1027–1057.

Perry, G. E., Maloney, W. F., Arias, O. S., Fajnzylber, P., Mason, A. D. and Saavedra-Chanduvi, J. [2007], *Informality : Exit and Exclusion*, number 6730 *in* 'World Bank Publications', The World Bank.

Petrongolo, B. and Pissarides, C. A. [2001], 'Looking into the black box: A survey of the matching function', *Journal of Economic literature* **39**(2), 390–431.

Ulyssea, G. [2015], Firms, informality and development: Theory and evidence from brazil, Technical report, Mimeo.

Wolinsky, A. [1987], 'Matching, search, and bargaining', *Journal of Economic Theory* **42**(2), 311–333.

World Bank [2012], *World Development Report 2013: Jobs*, Washington, DC: The World Bank.

Tables and Figures

Table 1: Descriptive Statistics

	Low Schooling	High Schooling
Proportions:		
Formal Employees	0.500	0.523
Informal Employees	0.223	0.193
Self-employed	0.235	0.238
Unemployed	0.042	0.045
Wages and Income: (Hourly)		
Formal Employees: Mean	24.001	30.355
Formal Employees: Standard Deviation	11.926	18.309
Informal Employees: Mean	18.138	21.792
Informal Employees: Standard Deviation	9.908	15.291
Self-employed: Mean	21.591	24.054
Self-employed: Standard Deviation	12.683	15.448
Durations: (Monthly)		
Unemployed: Mean	2.387	3.708
Self-employed: Mean	133.7	122.9
Number of observations:	9,199	6,013

NOTE: Data extracted from the four quarters of 2005 of the Mexican labor force survey (ENOE). Wages and Incomes figures are reported in Mexican pesos (exchange rate: 10 Mex. pesos $\approx$ 1 US dollars in 2005). The Formal status of the job is defined according to whether or not workers report having access to health care through their employers. *Low Schooling* is defined as having completed at most junior secondary (9th grade); *High Schooling* is defined as having completed at most high school (12th grade).

Table 2: Estimates of the Model Parameters

	Low Schooling: $h = 0$		High Schooling: $h = 1$	
	Coeff.	Std. Error	Coeff.	Std. Error
Parameters:				
λ_h	0.2890	0.0162	0.3597	0.0083
γ_h	0.0279	0.0005	0.0354	0.0009
η_h	0.0071	0.0004	0.0102	0.0008
$\mu_{x,h}$	2.8114	0.0095	2.6116	0.0087
$\sigma_{x,h}$	0.8359	0.0172	1.1051	0.0120
$\mu_{y,h}$	2.2615	0.0145	2.4129	0.0125
$\sigma_{y,h}$	0.7120	0.0072	0.7338	0.0107
α	0.4813	0.0135	0.4813	0.0135
$\beta_{1,h}$	0.5615	0.0034	0.6705	0.0101
$\beta_{0,h}$	0.9166	0.0055	0.9082	0.0081
c_h	0.1089	0.0026	0.0856	0.0014
ξ_h	-17.509	0.6445	-20.141	0.7263
ψ_h	0.0965	0.0061	0.0983	0.0038
ι_h	0.3157	0.0494	0.4218	0.0365
ζ_h	1.7730	0.1721	2.1080	0.1857
ν_h	-79.649	4.8504	-100.75	9.4442
δ	0.0073	0.0011	0.0073	0.0011
Predicted Values:				
$E_h(x)$	23.59	0.4607	25.08	0.3271
$SD_h(x)$	23.72	1.1345	38.79	1.1453
$E_h(y)$	12.37	0.1879	14.62	0.1845
$SD_h(y)$	10.05	0.2254	12.35	0.3151
$E(k)$	137.62	17.062	137.62	17.062

NOTE: Bootstrap standard errors based on 120 replications reported. For the definition of the parameters, see Section 3.1 and Section 4. All the parameters are schooling-specific with the exception of α and δ, which we report under both schooling columns at the jointly estimated value. *Low Schooling* is defined as having completed at most junior secondary (9th grade); *High Schooling* is defined as having completed at most high school (12th grade).

Table 3: Estimates of the Returns to Schooling

	Low Schooling $h = 0$	High Schooling $h = 1$	Relative Difference
Accepted Wages and Income:			
Formal: $E_h[w_1 \mid \tilde{x}(y,h) \leq x]$	21.442	27.636	0.289
Informal: $E_h[w_0 \mid x_0^*(y,h) \leq x < \tilde{x}(y,h)]$	17.396	21.253	0.222
Self-Employed: $E_h[y \mid y^*(h) \leq y]$	19.652	25.438	0.294
Offered Wages and Income:			
Formal: $E_h[w_1]$	15.226	17.021	0.118
Informal: $E_h[w_0]$	17.592	20.292	0.153
Self-Employed: $E_h[y]$	12.366	14.617	0.182
Labor Market Value:			
$Z(h)$	329.60	397.73	0.207

NOTE: Simulated samples of 10,000 worker-level observations for each schooling group based on the estimates reported in Table 2. For the definition of Z see equation (6). *Low Schooling* is defined as having completed at most junior secondary (9th grade); *High Schooling* is defined as having completed at most high school (12th grade).

Table 4: Model Fit: Conditional Moments

Moments	Low Schooling Model	Low Schooling Data	High Schooling Model	High Schooling Data
Proportions:				
Formal Employees	0.512	0.500	0.546	0.523
Informal Employees	0.220	0.223	0.182	0.193
Self-employed	0.254	0.235	0.241	0.238
Unemployed	0.014	0.042	0.030	0.045
Wages and Income:				
Formal Employees: Mean	21.442	24.001	27.636	30.355
Formal Employees: Standard Deviation	12.742	11.926	19.555	18.309
Informal Employees: Mean	17.396	18.138	21.253	21.792
Informal Employees: Standard Deviation	8.810	9.908	10.746	15.291
Self-employed: Mean	19.652	21.591	25.438	24.054
Self-employed: Standard Deviation	13.077	12.683	14.659	15.448
Durations:				
Unemployed: Mean	5.063	2.387	5.695	3.708
Self-employed: Mean	113.1	133.7	112.5	122.9
Quintiles:				
Proportions:				
Informal Employee - Q1	0.421	0.412	0.356	0.448
Informal Employee - Q2	0.151	0.243	0.277	0.233
Informal Employee - Q3	0.158	0.141	0.130	0.123
Informal Employee - Q4	0.155	0.123	0.137	0.096
Informal Employee - Q5	0.116	0.080	0.100	0.101
Mean Wages:				
Formal Employees - Q1	11.250	11.207	14.008	12.528
Formal Employees - Q2	14.196	16.901	17.212	19.070
Formal Employees - Q3	17.735	21.432	21.441	25.696
Formal Employees - Q4	23.162	27.506	28.637	33.767
Formal Employees - Q5	40.858	42.930	56.843	58.317
Informal Employees - Q1	11.132	10.463	14.537	11.359
Informal Employees - Q2	14.159	16.509	16.700	19.070
Informal Employees - Q3	17.728	21.104	21.648	25.696
Informal Employees - Q4	22.916	27.529	28.598	33.767
Informal Employees - Q5	36.599	42.773	47.266	58.317
Aggregate Moment:	Model		Data	
Labor Share	0.415		0.419	

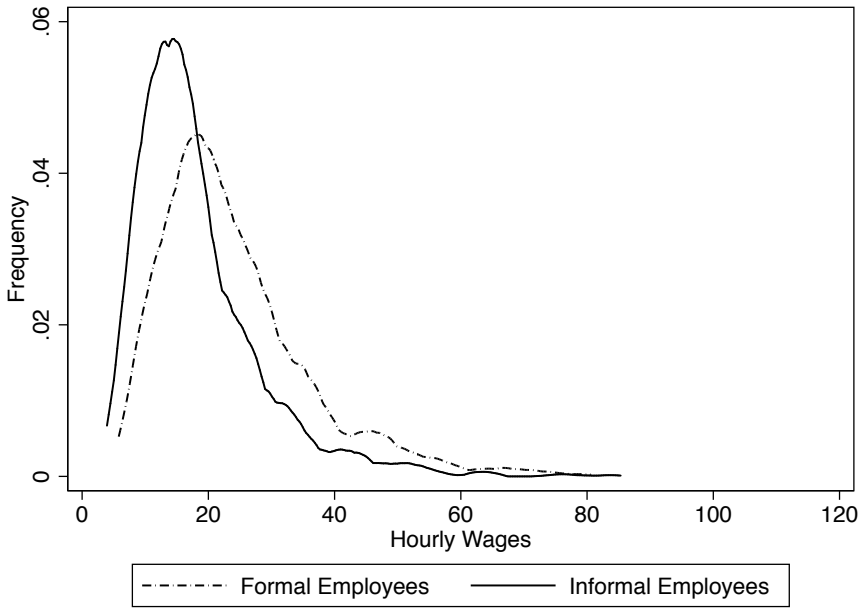
NOTE: *Model* columns report moments computed on the simulated sample of 10,000 worker-level observations for each schooling group based on the estimates reported in Table 2. *Sample* columns report moments computed on the estimation sample extracted from the four quarters of 2005 of the Mexican labor force survey (ENOE) and on 2005 AMECO data for the labor share. *Low Schooling* is defined as having completed at most junior secondary (9th grade); *High Schooling* is defined as having completed at most high school (12th grade).

Table 5: Universal Social Security Benefits

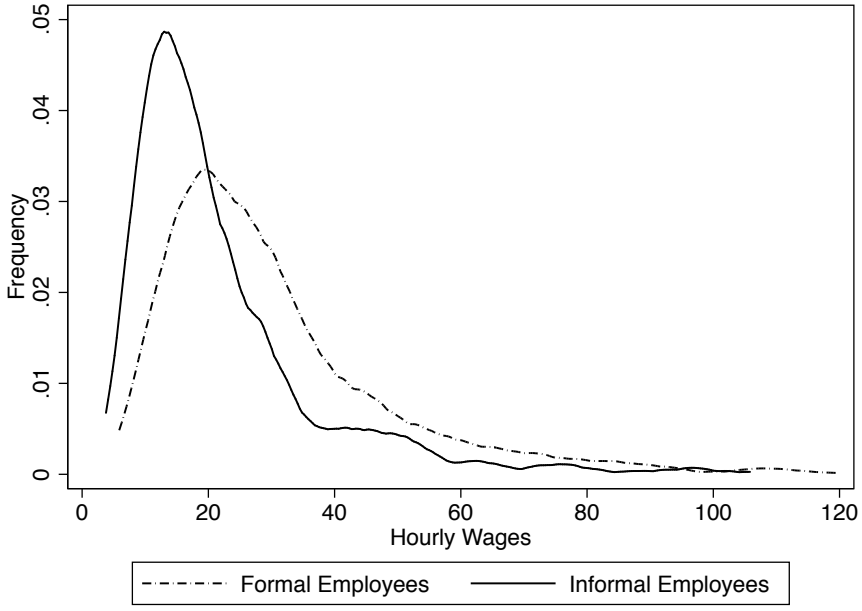
	Benchmark	Policy 1: $B_0 = b_1 = 4.04$	Policy 2: $B_0 = b_1 = 4.04$ $\tau = 1$; $t = 0.15$
	Panel A: Low Schooling $h = 0$		
Proportions:			
Self-employed	0.254	0.253	0.250
Informal Employee	0.220	0.478	0.217
Formal Employee	0.512	0.257	0.518
Unemployed	0.014	0.012	0.015
Mean Wages and Income:			
Self-Employed Income	19.652	19.810	20.314
Informal Employee	17.396	17.127	13.181
Formal Employee	21.442	27.801	26.217
	Panel B: High Schooling $h = 1$		
Proportions:			
Self-employed	0.241	0.256	0.122
Informal Employee	0.182	0.418	0.000
Formal Employee	0.546	0.297	0.827
Unemployed	0.030	0.029	0.051
Mean Wages and Income:			
Self-Employed Income	25.438	24.792	34.617
Informal Wages	21.253	20.206	0.000
Formal Wages	27.636	36.403	36.404
	Panel C: Aggregate Statistics		
Social Security Benefits:			
Formal Lump-sum $= b_1$	4.039	4.946	4.039
Formal Proportional (at mean w) $= \tau * t * \bar{w_1}$	4.472	5.883	4.823
Informal and Unemployed $= B_0$	2.257	4.039	4.039
Outcomes:			
Share with High Schooling	0.395	0.364	0.697
Labor Market Value $= Z$	356.5	380.0	480.9
Value of Production (normalized)	1.000	0.985	1.167
Cost:			
Fiscal Cost $= [B_0/(\text{Value of Production})]$	0.028	0.080	0.031

NOTE: Simulation results computed on the simulated sample of 10,000 worker-level observations for each schooling group based on the estimates reported in Table 2. The benchmark case sets the institutional parameters at the values for the Mexican labor market in 2005 – see Appendix C for details. Policy 1 increases the monetary value of per-capita non-contributory social security benefits (B_0) to the benchmark level of of the lump-sum portion of contributory benefits (b_1). Policy 2 eliminates the lump-sum redistributive component ($\tau = 1$), accordingly decrease social security taxes ($t(1 - \tau)$), and provides non-contributory social security benefits ($B_0 = b_1$) to all workers.

Figure 1: Observed Wages Density Functions



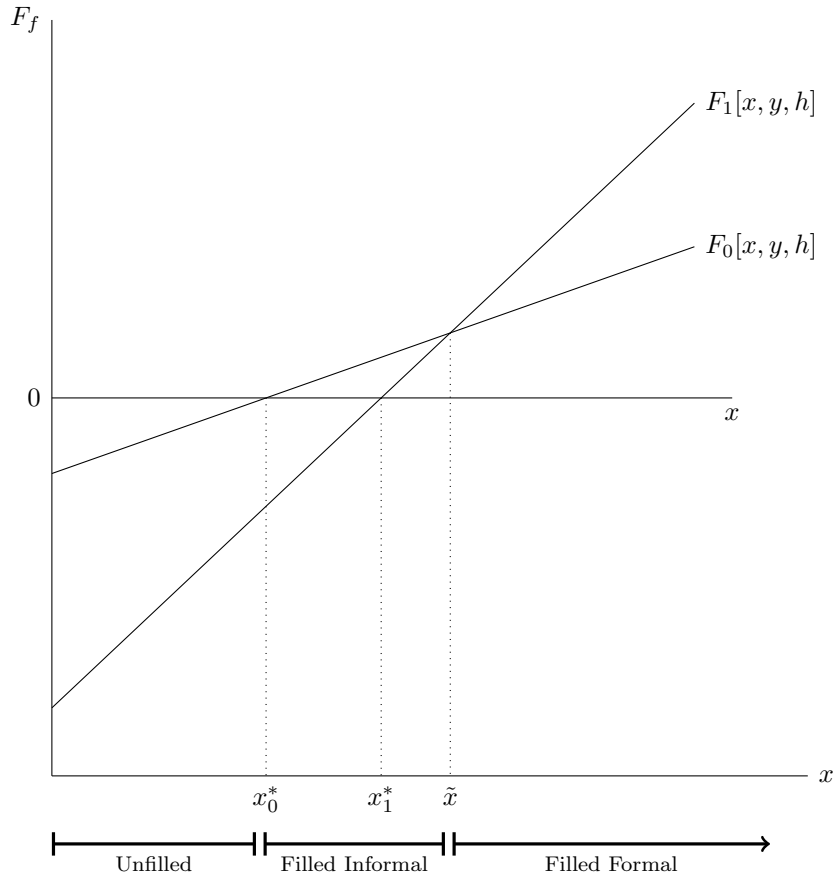
(a) Low Schooling



(b) High Schooling

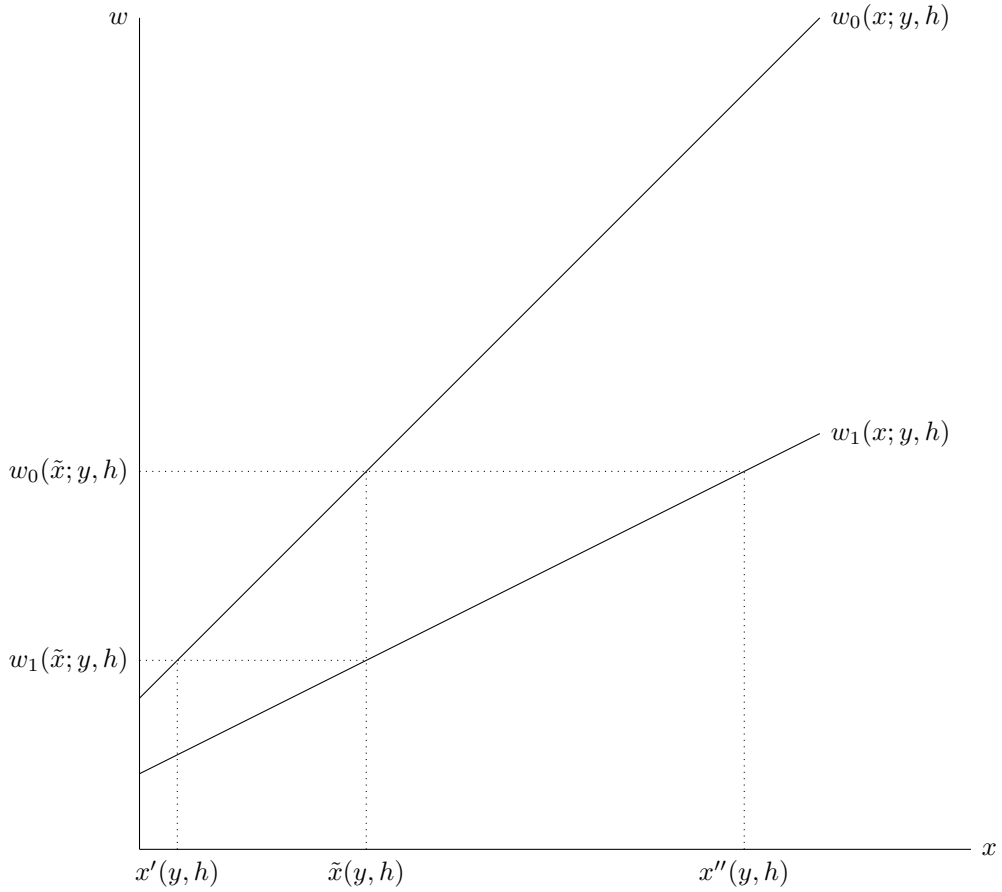
NOTE: Data extracted from the four quarters of 2005 of the Mexican labor force survey (ENOE). The Figure shows the empirical densities of the hourly wages (in Mexican Pesos). *Low Schooling* is defined as having completed at most junior secondary (9th grade); *High Schooling* is defined as having completed at most high school (12th grade). The Formal status of the job is defined according to whether or not workers report having access to health care through their employers.

Figure 2: Equilibrium Representation



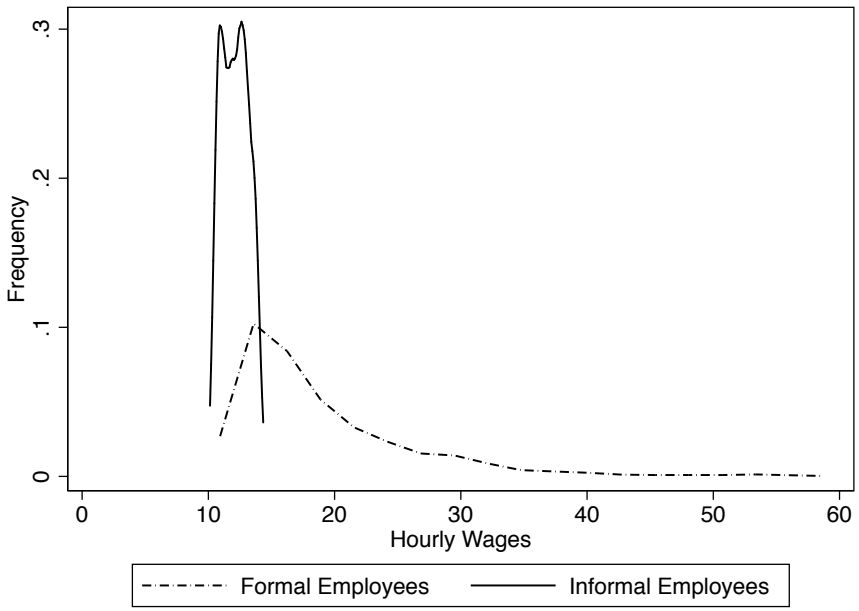
NOTE: Illustrative figure, not based on actual data. For the definitions of F_0, F_1, x_0^*, x_1^*, and $\tilde{x}$, see equations (13), (14), (19), (20), and (18).

Figure 3: Wage Schedules and Overlap



NOTE: Illustrative figure, not based on actual data. For the definitions of $w_0(x;y,h)$, $w_1(x;y,h)$, $x'(y,h)$, $x''(y,h)$ and $\tilde{x}(y,h)$, see equations (17), (16), (21), (22), and (18).

Figure 4: Simulated Accepted Wage Distributions and Overlap

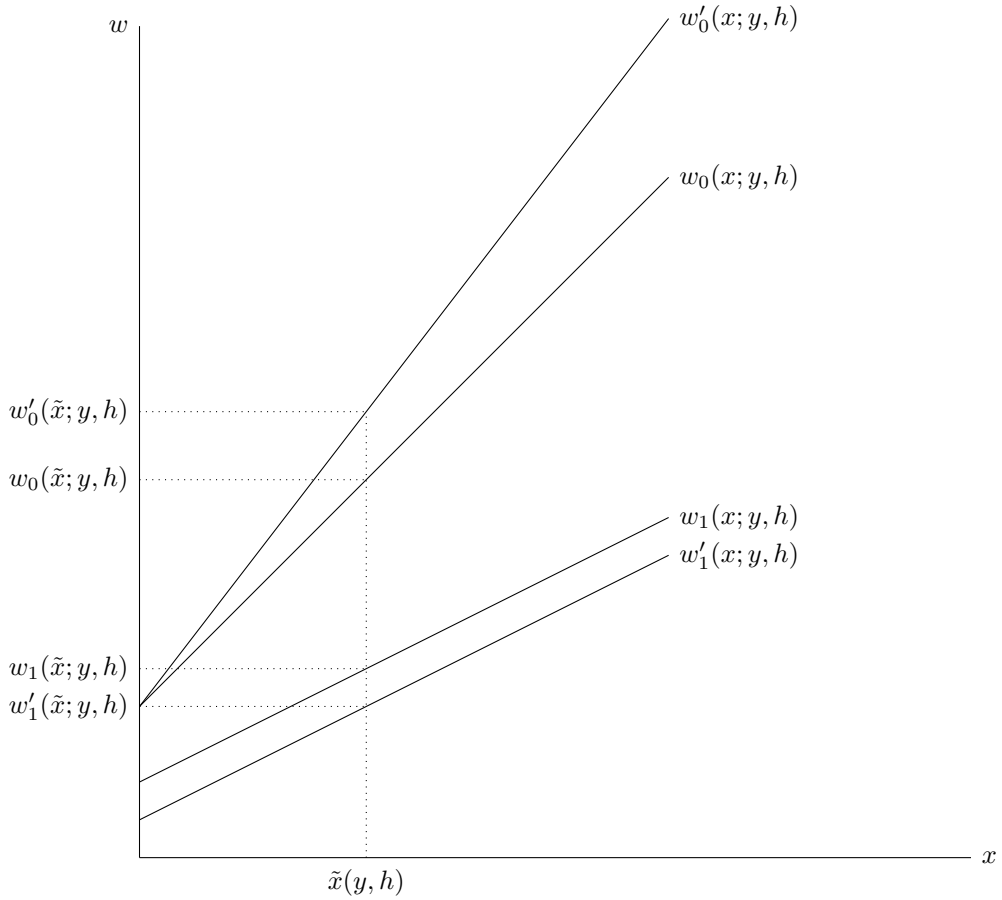


(a) Outside Option is Unemployment

(b) Outside Option is Self-employment

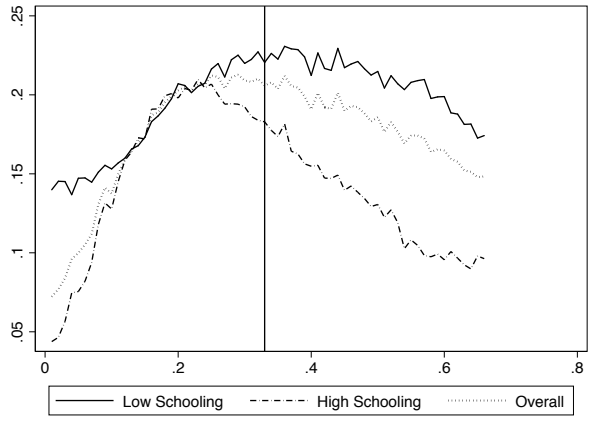
NOTE: Simulated sample of 10,000 worker-level observations for the high schooling group based on the estimates reported in Table 2. The Figure shows the empirical densities of the accepted hourly wages (in Mexican Pesos), separately for formal employees and informal employees.

Figure 5: Overlap and Identification of $\beta_{1,h}$ and c_h

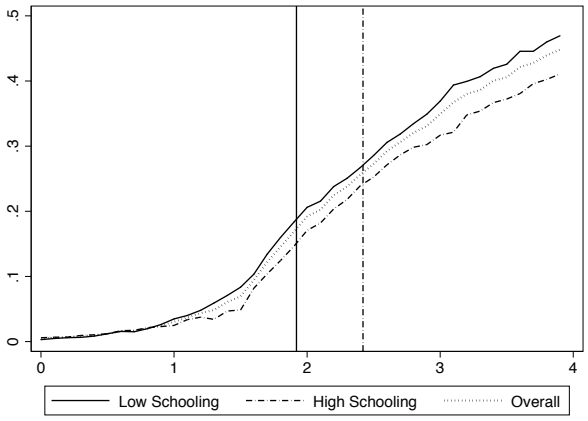


NOTE: Illustrative figure, not based on actual data. For the definitions of $w_0(x;y,h)$, $w_1(x;y,h)$, $\tilde{x}(y,h)$, see equations (17), (16), (18). The wage schedules resulting by changing $\beta_{1,h}$ and c_h are denoted by $w_0'(x;y,h)$ and $w_1'(x;y,h)$.

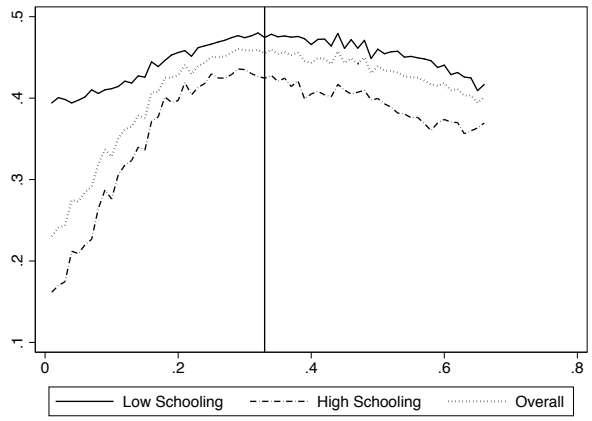
Figure 6: Policy Impacts on Informality Rate



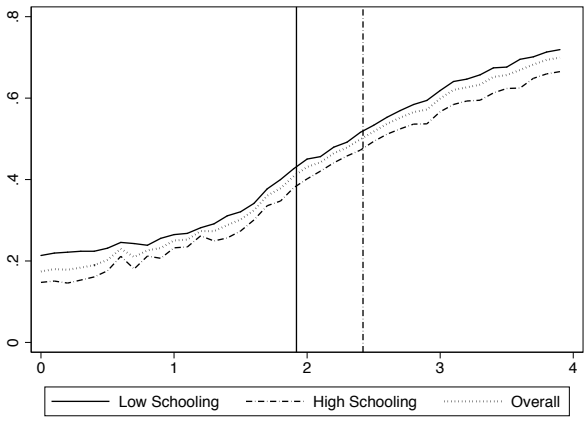
(a) Changes in t – Share of Informal Employees



(b) Changes in B_0 – Share of Informal Employees



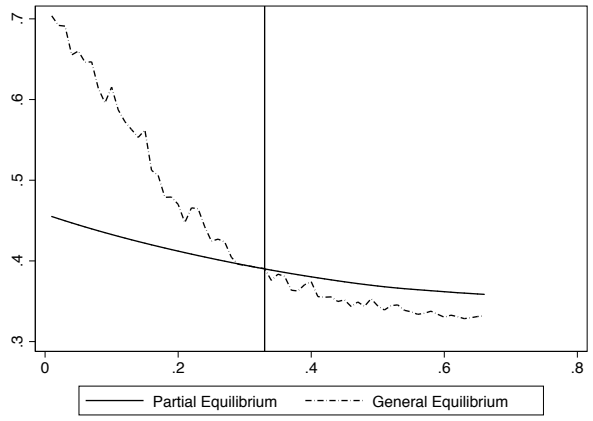
(c) Changes in t – Share of Informal Employment



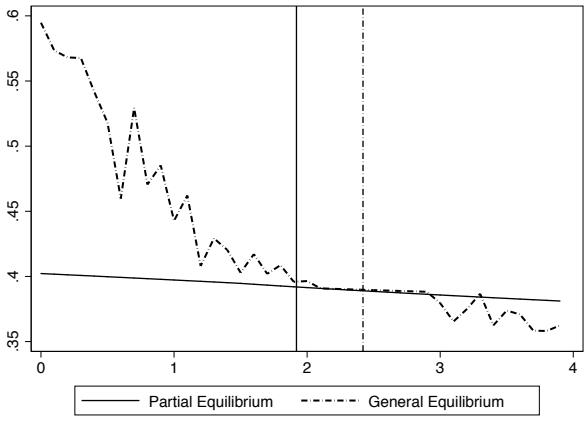
(d) Changes in B_0 – Share of Informal Employment

NOTE: Top panel reports the proportion of informal employees, the bottom panel the proportion of informal employees and the self-employed. Simulated samples of 10,000 worker-level observations for each schooling group based on the estimates reported in Table 2. The *Overall* dotted line is computed as a weighted average between the the high schooling group and the low schooling group, where the weights are defined by the equilibrium frequencies. The vertical lines are set at the institutional values for the Mexican labor market in 2005. See Appendix C for details.

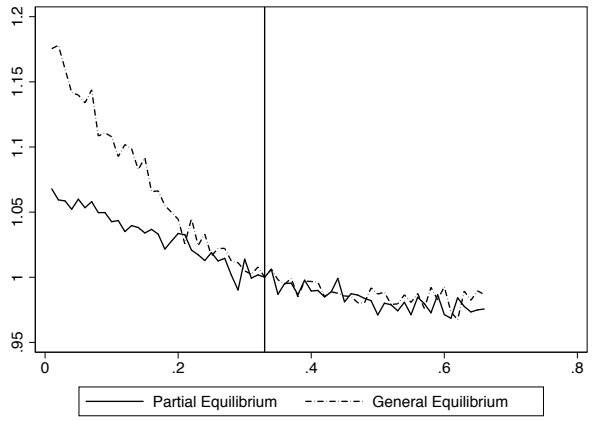
Figure 7: Policy Impacts on Schooling and Productivity



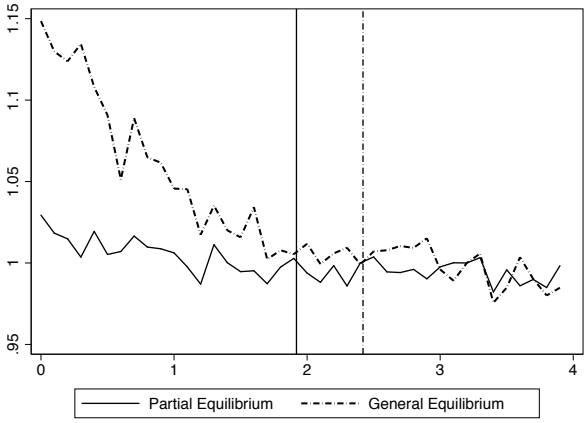
(a) Changes in t – Proportion High School



(b) Changes in B_0 – Proportion High School



(c) Changes in t – Value of Production



(d) Changes in B_0 – Value of Production

NOTE: Simulated samples of 10,000 worker-level observations for each schooling group based on the estimates reported in Table 2. The *Partial Equilibrium* solid lines are computed with exogenous contact rates. The *General Equilibrium* dashed lines are computed using the endogenous contact rates implied by equilibrium measures of vacancies and searchers. See equation (5) for details. The vertical lines represent the institutional values for the Mexican labor market in 2005. See Appendix C for details.

Appendix

A Additional Material on the Model and the Computational Algorithm

A.1 Proof of Proposition 1

Proof. The result is proved by observing that:

$$\frac{\partial F_1[x,y,h]}{\partial x} = \frac{1-\alpha_h}{\rho+\eta_h} \geq \frac{1-\alpha_h}{\rho+\eta_h}(1-c_h) = \frac{\partial F_0[x,y,h]}{\partial x} > 0$$

■

A.2 Definition of the Equilibrium

By substituting the optimal decision rules in Proposition 1 in the expressions (7)-(14) and (15), we obtain the following equilibrium expressions for the workers' side value functions:

$$\begin{aligned}
\text{If } \tilde{x}(y,h) &> x_1^*(y,h): \\
\rho Q(y,h) &= \xi_h \mathbb{1}_{y<y^*(h)} + y\mathbb{1}_{y\geq y^*(h)} + \beta_{0,h}B_0 \qquad \text{(A.1)} \\
&+ \frac{\lambda_h^{\mathbb{1}_{y<y^*(h)}}\gamma_h^{\mathbb{1}_{y\geq y^*(h)}}\alpha_h}{\rho+\eta_h} \left\{ \begin{array}{c} \int_{x_0^*(y,h)}^{\tilde{x}(y,h)}[(1-c_h)x + \beta_{0,h}B_0 - \rho Q(y,h)]dG(x|h) \\ + \int_{\tilde{x}(y,h)}[\frac{1}{\phi_h}x + \beta_{1,h}b_1 - \rho Q(y,h)]dG(x|h) \end{array} \right\} \\
\text{If } \tilde{x}(y,h) &\leq x_1^*(y,h): \\
\rho Q(y,h) &= \xi_h \mathbb{1}_{y<y^*(h)} + y\mathbb{1}_{y\geq y^*(h)} + \beta_{0,h}B_0 \qquad \text{(A.2)} \\
&+ \frac{\lambda_h^{\mathbb{1}_{y<y^*(h)}}\gamma_h^{\mathbb{1}_{y\geq y^*(h)}}\alpha_h}{\rho+\eta_h} \left\{ \int_{x_1^*(y,h)} [\frac{1}{\phi_h}x + \beta_{1,h}b_1 - \rho Q(y,h)]dG(x|h) \right\}
\end{aligned}$$

and the following equilibrium expressions for the firms' side value functions:

$$
\begin{aligned}
\text{If } \tilde{x}(y,h) &> x_1^*(y,h): \\
0 &= \nu_h + \frac{\zeta_h(1-\alpha_h)}{(\rho+\eta_h)} \\
&\times \Big[\frac{u_h R(y^*(h)|h)}{u_h+\psi_h s_h}\left\{\begin{array}{c}\int_{x_0^*(0,h)}^{\tilde{x}(0,h)}[(1-c_h)x+\beta_{0,h}B_0-\rho U(h)]dG(x|h)\\ +\int_{\tilde{x}(0,h)}^{\infty}[x+\phi_h\beta_{1,h}b_1-\phi_h\rho U(h)]dG(x|h)\end{array}\right\} \\
&+ \frac{\psi_h s_h}{u_h+\psi_h s_h}\int_{y^*(h)}^{\infty}\left\{\begin{array}{c}\int_{x_0^*(y,h)}^{\tilde{x}(y,h)}[(1-c_h)x+\beta_{0,h}B_0-\rho S(y,h)]dG(x|h)\\ +\int_{\tilde{x}(y,h)}^{\infty}[x+\phi_h\beta_{1,h}b_1-\phi_h\rho S(y,h)]dG(x|h)dR(y|h)\end{array}\right\}dR(y|h)\Big]
\end{aligned}
\tag{A.3}
$$

$$
\begin{aligned}
\text{If } \tilde{x}(y,h) &> x_1^*(y,h): \\
0 &= \nu_h + \frac{\zeta_h(1-\alpha_h)}{(\rho+\eta_h)} \\
&\times \Big[\frac{u_h R(y^*(h)|h)}{u_h+\psi_h s_h}\left\{\int_{x_1^*(0,h)}^{\infty}[x+\phi_h\beta_{1,h}b_1-\phi_h\rho U(h)]dG(x|h)\right\} \\
&+ \frac{\psi_h s_h}{u_h+\psi_h s_h}\int_{y^*(h)}^{\infty}\left\{\int_{x_1^*(y,h)}^{\infty}[x+\phi_h\beta_{1,h}b_1-\phi_h\rho S(y,h)]dG(x|h)dR(y|h)\right\}dR(y|h)\Big]
\end{aligned}
\tag{A.4}
$$

We can now propose the following:

Definition 2 ***Equilibrium Definition.***

Given the vector of parameters $\{\rho, \xi_h, \lambda_h, \gamma_h, \eta_h, \psi_h, \iota_h, \beta_{0,h}, \beta_{1,h}, \alpha_h, c_h, \nu_h\}$ *and the probability distribution functions* $\{R(y|h), G(x|h), T(\kappa)\}$ *a* ***search model equilibrium*** *in an economy with institutional parameters* $\{B_0, \tau, t\}$ *is a set of values* $Q(y,h) \equiv \max\{S(y,h), U(h)\}$ *that:*

1. *solves the equilibrium equations (A.1)-(A.4);*
2. *satisfies firms' free-entry condition (15);*
3. *satisfies steady state conditions over the measures* $\{p_h, u_h, s_h, e_h, l_h, v_h\}$.

The proportions of individuals with high schooling level (p_h) is determined by the workers' optimal decision rule, given equilibrium values of participating in the labor market. The vacancy rate by schooling (v_h) is determined by the firms' optimal decision rule and the free-entry condition. The steady steady state conditions for the four labor market states in our model are the usual conditions equating workers flows in and out of each state. Flows in and out can be derived by the optimal decision rules described in Proposition 1 together with the structure of the shocks

described in Section 3.1. For all individuals with $y < y^{\star}(h)$:

$$u(h) = R(y_h^*|h)\frac{\eta_h}{\lambda_h[1-G(x_0^*(0,h))]+\eta_h} \quad (A.5)$$

$$l(h|y<y_h^*) = R(y_h^*|h)\frac{\lambda_h[1-G(\tilde{x}(0,h))]}{\lambda_h[1-G(x_0^*(0,h))]+\eta_h} \quad (A.6)$$

$$e(h|y<y_h^*) = R(y_h^*|h)\frac{\lambda_h[G(\tilde{x}(0,h))-G(x_0^*(0,h))]}{\lambda_h[1-G(x_0^*(0,h))]+\eta_h}. \quad (A.7)$$

For all individuals with $y \geq y^{\star}(h)$, we solve by approximation imposing a discretization on y. Define $y_j \in \{y_1, y_2, ..., y_J\}$ over all the $y \geq y_h^*$. Assume that all the $y \in [y_j, y_{j+1}]$ share the same reservation values that we denote with y_j. Then,

$$s(h|y\in[y_j,y_{j+1}]) = [R(y_{j+1})-R(y_j)]\frac{\eta_h}{\gamma_h[1-G(x_0^*(y_j,h))]+\eta_h} \quad (A.8)$$

$$l(h|y\in[y_j,y_{j+1}]) = [R(y_{j+1})-R(y_j)]\frac{\gamma_h[1-G(\tilde{x}(y_j,h))]}{\gamma_h[1-G(x_0^*(y_j,h))]+\eta_h} \quad (A.9)$$

$$e(h|y\in[y_j,y_{j+1}]) = [R(y_{j+1})-R(y_j)]\frac{\gamma_h[G(\tilde{x}(y_j,h))-G(x_0^*(y_j,h))]}{\gamma_h[1-G(x_0^*(y_j,h))]+\eta_h}. \quad (A.10)$$

A.3 Derivation of Per-Capita Social Security Benefits

Tax revenues from social security contributions in each schooling market h after taking out the proportional extra-wage benefits are:

$$ss_h = l_h p_h (1-\tau) t \int_y \int_{\bar{x}(y,h)} w_1(x;y,h)\frac{g_h(x)dx}{1-G_h(\bar{x}(y,h))}dR(y|h), \quad (A.11)$$

where l_h is the steady-state proportion of formal employees in each schooling group h, which value depends on the equilibrium case discussed in Proposition 1:

$$l_h = \left\{ \begin{array}{ll} \left[\frac{\gamma_h\eta_h(1-R_h(y_h^\star))}{\eta_h+\gamma_h(1-G_h(x_0^\star(0,h)))}+\frac{\lambda_h\eta_h R_h(y_h^\star)}{\eta_h+\lambda_h(1-G_h(x_0^\star(0,h)))}\right]\left[\frac{1-G_h(\tilde{x}(0,h))}{\eta_h}\right] & \text{if } \tilde{x}(0,h) > x_1^\star(0,h) \\ \left[\frac{\gamma_h\eta_h(1-R_h(y_h^\star))}{\eta+\gamma_h(1-G_h(x_1^\star(0,h)))}+\frac{\lambda_h\eta_h R_h(y_h^\star)}{\eta_h+\lambda_h(1-G_h(x_1^\star(0,h)))}\right]\left[\frac{1-G_h(x_1^\star(0,h)))}{\eta_h}\right] & \text{if } \tilde{x}(0,h) < x_1^\star(0,h)) \end{array} \right\},$$

where $\bar{x}(y,h) = \max\{\tilde{x}(y,h), x_1^\star(y,h)\}$. We can thus obtain the per-capita transfer that each formal employee receives in equilibrium (b_1 in expression 2) by summing up the quantities in expression (A.11) in the two schooling groups and dividing by the corresponding equilibrium shares:

$$b_1 = \frac{ss_0 + ss_1}{l_0 p_0 + l_1 p_1} \quad (A.12)$$

The fact that $\bar{x}(0,h) = \bar{x}(y_h^\star, h) < \bar{x}(y,h)$, $\forall y > y_h^\star \, \forall h \in \{0,1\}$ (see equations 15, 18 and 20) implies that we can separate the two integrals in expression A.11 for those individuals with $y < y_h^\star$. Using the equilibrium wage schedule (expression 16), we obtain the total wage bills for

those formal employees coming from unemployment:

$$W_h^u = R_h(y_h^\star)\left\{\frac{\alpha_h}{(1+t)(1-G_h(\bar{x}(0,h)))}\int_{\bar{x}(0,h)} x dG(x|h) + \frac{(1-\alpha_h)}{(1+\beta_{1,h}\tau t)}\left[\rho U(h) - \beta_{1,h} b_1\right]\right\}, \quad \text{(A.13)}$$

For those coming from self-employment ($y > y_h^\star$), we discretize the support of $\rho S(y,h)$ into sufficiently small intervals, and approximate the total wage bills as follows:

$$W_h^{se} = \left\{ \begin{array}{c} \sum_{y\in[y_h^\star,\tilde{y}_h]}\left[R_h(y+y/2) - R_h(y-y/2)\right]\frac{\alpha_h}{1+t}\left[\int_{\tilde{x}(y,h)} x\frac{dg_h(x)dx}{1-G_h(\tilde{x}(y,h))} + \frac{(1-\alpha_h)}{(1+\beta_{1,h}\tau t)}(\rho S(y) - \beta_{1,h}b_1)\right] + \\ \sum_{y>\tilde{y}_h}\left[R_h(y+y/2) - R_h(y-y/2)\right]\frac{\alpha_h}{1+t}\left[\int_{x_1^\star(y,h)} x\frac{dg_h(x)dx}{1-G_h(x_1^\star(y,h))} + \frac{(1-\alpha_h)}{(1+\beta_{1,h}\tau t)}(\rho S(y) - \beta_{1,h}b_1)\right] \text{ if } \tilde{x}(0,h) > x_1^\star(0,h) \\ \sum_{y>y_h^\star}\left[R_h(y+y/2) - R_h(y-y/2)\right]\frac{\alpha_h}{1+t}\left[\int_{x_1^\star(y,h)} x\frac{dg_h(x)dx}{1-G_h(x_1^\star(y,h))} + \frac{(1-\alpha_h)}{(1+\beta_{1,h}\tau t)}(\rho S(y) - \beta_{1,h}b_1)\right] \text{ if } \tilde{x}(0,h) < x_1^\star(0,h) \end{array} \right\}. \quad \text{(A.14)}$$

where $\tilde{y}_h$ is the value of self-employed earnings such that $\tilde{x}(\tilde{y}_h, h) = x_1^\star(\tilde{y}_h, h)$. Hence, we can approximate the quantity in expression A.11 as follows:

$$ss_h \simeq l_h p_h (1-\tau) t (W_h^u + W_h^{se}). \quad \text{(A.15)}$$

A.4 Derivation of Per-Capita Social Security Benefits with two different values for B_0

Let $B_{0,d}$, where $d \in \{0,1\}$, denote whether or not non-formally employed individuals receive higher non-contributory benefits (e.g. due to the receipt of the *seguro popular* in their municipality of residence).

$$l_{h,d} = \left\{ \begin{array}{l} \left[\frac{\gamma_h\eta_h(1-R_h(y_{h,d}^\star))}{\eta_h+\gamma_h(1-G_h(x_0^\star(0,h,d)))} + \frac{\lambda_h\eta_h R_h(y_{h,d}^\star)}{\eta_h+\lambda_h(1-G_h(x_0^\star(0,h,d)))}\right]\left[\frac{1-G_h(\tilde{x}(0,h,d))}{\eta_h}\right] \text{ if } \tilde{x}(0,h,d) > x_1^\star(0,h,d) \\ \left[\frac{\gamma_h\eta_h(1-R_h(y_{h,d}^\star))}{\eta_h+\gamma_h(1-G_h(x_1^\star(0,h,d)))} + \frac{\lambda_h\eta_h R_h(y_{h,d}^\star)}{\eta_h+\lambda_h(1-G_h(x_1^\star(0,h,d)))}\right]\left[\frac{1-G_h(x_1^\star(0,h,d)))}{\eta_h}\right] \text{ if } \tilde{x}(0,h,d) < x_1^\star(0,h,d) \end{array} \right\}, \quad \text{(A.16)}$$

Also, for each couple $\{h,d\}$ we can derive expressions for the total wage bills for Formal employees depending on their search status. In particular, for those Formal employees coming from unemployment:

$$W_{h,d}^u = R_h(y_{h,d}^\star)\left\{\frac{\alpha_h}{(1+t)(1-G_h(\bar{x}(0,h,d)))}\int_{\bar{x}(0,h,d)} x dG(x|h) + \frac{(1-\alpha_h)}{(1+\beta_{1,h}\tau t)}\left[\rho U(h,d) - \beta_{1,h} b_1\right]\right\}, \quad \text{(A.17)}$$

where $\bar{x}(y,h,d) = \max\{\tilde{x}(y,h,d), x_1^\star(y,h,d)\}$. For those coming from self-employment ($y > y_{h,d}^\star$), we discretize the support of $\rho S(y,h,d)$ into sufficiently small intervals, and approximate the wage

bills as follows:

$$W^{se}_{h,d} = \left\{ \begin{array}{c} \sum_{y\in[y^\star_{h,d},\tilde{y}_{h,d}]} \left[R_h(y+y/2) - R_h(y-y/2)\right] \frac{\alpha_h}{1+t} \left[\int_{\tilde{x}(y,h,d)} x \frac{dg_h(x)dx}{1-G_h(\tilde{x}(y,h,d))} + \frac{(1-\alpha_h)}{(1+\beta_{1,h}\tau t)}(\rho S(y,h,d) - \beta_{1,h} b_1)\right] + \\ \sum_{y>\tilde{y}_{h,d}} \left[R_h(y+y/2) - R_h(y-y/2)\right] \frac{\alpha_h}{1+t} \left[\int_{x^\star_1(y,h,d)} x \frac{dg_h(x)dx}{1-G_h(x^\star_1(y,h,d))} + \frac{(1-\alpha_h)}{(1+\beta_{1,h}\tau t)}(\rho S(y,h,d) - \beta_{1,h} b_1)\right] \text{ if } \tilde{x}(0,h,d) > x^\star_1(0,h,d) \\ \sum_{y>y^\star_{h,d}} \left[R_h(y+y/2) - R_h(y-y/2)\right] \frac{\alpha_h}{1+t} \left[\int_{x^\star_1(y,h,d)} x \frac{dg_h(x)dx}{1-G_h(x^\star_1(y,h,d))} + \frac{(1-\alpha_h)}{(1+\beta_{1,h}\tau t)}(\rho S(y,h,d) - \beta_{1,h} b_1)\right] \text{ if } \tilde{x}(0,h,d) < x^\star_1(0,h,d) \end{array} \right\}, \tag{A.18}$$

where $\tilde{y}_{h,d}$ is the value of self-employed earnings such that $\tilde{x}(\tilde{y}_{h,d}, h, d) = x^\star_1(\tilde{y}_{h,d}, h, d)$.

Then, tax revenues from social security contributions in schooling group h after taking out the proportional extra-wage benefits can be written as:

$$ss_h \simeq (1-\tau)t \sum_{d\in\{0,1\}} p_{h,d} l_{h,d} (W^u_{h,d} + W^{se}_{h,d}). \tag{A.19}$$

B Additional Tables and Figures

Table B.1: Notation for the Model Environment

State	Value Function	Measure	Shock	Flow Utility
Workers:				
Pre Labor Market	$Z(h)$	p_h	-	-
Unemployed	$U(h)$	$u_h p_h$	λ_h	$\xi_h + \beta_{0,h} B_0$
Self-Employed	$S(y,h)$	$s_h p_h$	γ_h	$y + \beta_{0,h} B_0$
Informal Employee	$E_0[w,y,h]$	$e_h p_h$	η_h	$w_0(x;y,h) + \beta_{0,h} B_0$
Formal Employee	$E_1[w,y,h]$	$l_h p_h$	η_h	$w_1(x;y,h) + \beta_{1,h} B_1[w_1(x;y,h)]$
Firms:				
Filled Informal Job	$F_0[x,y,h]$	$e_h p_h$	η_h	$x - w_0(x;y,h) - cx$
Filled Formal Job	$F_1[x,y,h]$	$l_h p_h$	η_h	$x - (1+t) w_1(x;y,h)$
Vacancy	$V[h]$	$v_h p_h$	ζ_h	ν_h

Table B.2: Roll-out of the *Seguro Popular* Program and Pre-determined Labor Market Characteristics

	(1) $\ln(w_f)$	(2) $\ln(w_i)$	(3) $\ln(w_{se})$	(4) Formal	(5) Informal	(6) Self-Empl	(7) Unempl
Seguro Popular in 2005 (1=yes)	0.014	0.083	0.043	-0.038	0.024	0.013	0.001
	(0.042)	(0.068)	(0.060)	(0.023)	(0.017)	(0.016)	(0.003)
Complete Secondary (1=yes)	0.187	0.182	0.189	-0.034	-0.015	0.048	0.001
	(0.016)	(0.034)	(0.020)	(0.007)	(0.006)	(0.008)	(0.003)
Mean Dep. Var.				0.494	0.154	0.327	0.024
Number of Obs	10077	3061	6534	20803	20803	20803	20803
Number of Clusters	217	190	217	238	238	238	238

NOTE: OLS estimates. Standard errors clustered at the municipality level are reported in parenthesis. Data is drawn from the Mexican labor market survey (ENE, 2001) and matched at the municipality-level with the roll-out of the *Seguro Popular* program.

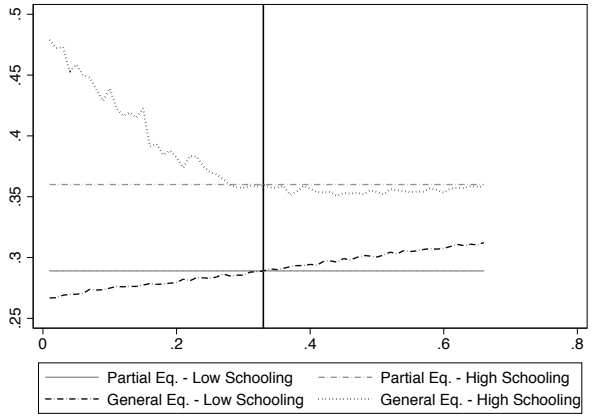
Table B.3: Unconditional Moments: Municipalities With *Seguro Popular* in 2005

	Low Schooling			High Schooling		
Moment	Model	Data	Weight	Model	Data	Weight
Share Self-employed	0.259	0.241	0.005	0.241	0.238	0.007
Share Formally Employed	0.429	0.486	0.006	0.485	0.514	0.007
Share Informally Employed	0.297	0.236	0.006	0.245	0.206	0.006
Share Unemployed	0.016	0.037	0.003	0.028	0.042	0.003
Mean Informal Wages	5.043	4.252	0.114	5.074	4.480	0.179
SD Informal Wages	8.873	9.009	0.182	10.141	11.119	0.380
Mean Formal Wages	9.860	11.651	0.183	14.681	15.690	0.309
SD Formal Wages	14.195	14.615	0.168	21.229	20.294	0.348
Mean Self-empl Income	5.332	5.408	0.143	6.276	5.983	0.203
SD Self-empl Income	11.272	11.531	0.216	13.871	13.218	0.334
U Duration (months)	0.076	0.095	0.014	0.162	0.159	0.023
SE Duration (months)	30.965	33.017	0.996	27.432	29.786	1.116
Share Informally Employed - Q1	0.162	0.094	0.005	0.143	0.092	0.005
Share Informally Employed - Q2	0.037	0.061	0.005	0.033	0.046	0.004
Share Informally Employed - Q3	0.038	0.033	0.004	0.029	0.026	0.003
Share Informally Employed - Q4	0.034	0.029	0.003	0.025	0.020	0.003
Share Informally Employed - Q5	0.025	0.018	0.002	0.015	0.021	0.003
Mean Informal Wages - Q1	1.950	0.973	0.054	2.204	1.049	0.071
Mean Informal Wages - Q2	0.584	1.005	0.080	0.603	0.883	0.078
Mean Informal Wages - Q3	0.739	0.695	0.074	0.700	0.669	0.075
Mean Informal Wages - Q4	0.848	0.797	0.072	0.794	0.675	0.096
Mean Informal Wages - Q5	0.921	0.781	0.081	0.773	1.204	0.143
Mean Formal Wages - Q1	1.116	1.063	0.023	1.525	1.220	0.043
Mean Formal Wages - Q2	1.358	1.626	0.046	1.823	1.969	0.095
Mean Formal Wages - Q3	1.645	2.046	0.044	2.277	2.707	0.075
Mean Formal Wages - Q4	2.140	2.715	0.070	3.049	3.534	0.085
Mean Formal Wages - Q5	3.601	4.201	0.089	6.007	6.260	0.166
Aggregate Moment:		Model			Data	
Labor Share		0.415			0.419	

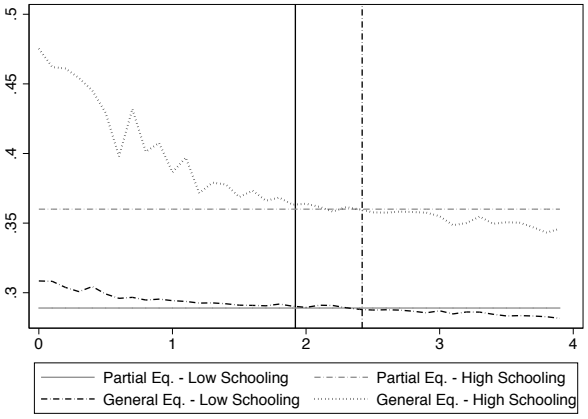
Table B.4: Unconditional Moments: Municipalities Without *Seguro Popular* in 2005

	Low Schooling			High Schooling		
Moment	Model	Data	Weight	Model	Data	Weight
Share Self-employed	0.267	0.224	0.007	0.244	0.239	0.010
Share Formally Employed	0.551	0.527	0.009	0.626	0.545	0.011
Share Informally Employed	0.171	0.198	0.007	0.100	0.165	0.009
Share Unemployed	0.011	0.051	0.004	0.030	0.052	0.005
Mean Informal Wages	3.281	3.632	0.152	2.422	3.607	0.243
SD Informal Wages	8.245	8.609	0.274	8.317	10.425	0.635
Mean Formal Wages	11.555	12.675	0.259	16.187	16.320	0.455
SD Formal Wages	13.757	14.746	0.224	19.670	19.770	0.502
Mean Self-empl Income	5.452	4.440	0.177	5.886	5.193	0.266
SD Self-empl Income	11.699	9.951	0.293	12.486	11.556	0.468
U Duration (months)	0.066	0.109	0.012	0.182	0.186	0.033
SE Duration (months)	29.523	28.462	1.252	27.747	28.245	1.546
Share Informally Employed - Q1	0.052	0.085	0.006	0.011	0.078	0.007
Share Informally Employed - Q2	0.024	0.043	0.005	0.028	0.036	0.006
Share Informally Employed - Q3	0.034	0.027	0.004	0.018	0.020	0.004
Share Informally Employed - Q4	0.032	0.025	0.003	0.025	0.015	0.003
Share Informally Employed - Q5	0.029	0.017	0.003	0.018	0.015	0.003
Mean Informal Wages - Q1	0.570	0.902	0.079	0.162	0.896	0.099
Mean Informal Wages - Q2	0.338	0.727	0.082	0.413	0.690	0.105
Mean Informal Wages - Q3	0.585	0.571	0.074	0.365	0.531	0.096
Mean Informal Wages - Q4	0.744	0.693	0.094	0.665	0.531	0.114
Mean Informal Wages - Q5	1.045	0.740	0.125	0.819	0.960	0.200
Mean Formal Wages - Q1	1.211	1.153	0.041	1.635	1.363	0.049
Mean Formal Wages - Q2	1.521	1.880	0.068	1.960	2.130	0.090
Mean Formal Wages - Q3	1.920	2.234	0.118	2.442	2.793	0.115
Mean Formal Wages - Q4	2.532	2.837	0.091	3.364	3.695	0.134
Mean Formal Wages - Q5	4.371	4.571	0.112	6.787	6.340	0.234
Aggregate Moment:		Model			Data	
Labor Share		0.415			0.419	

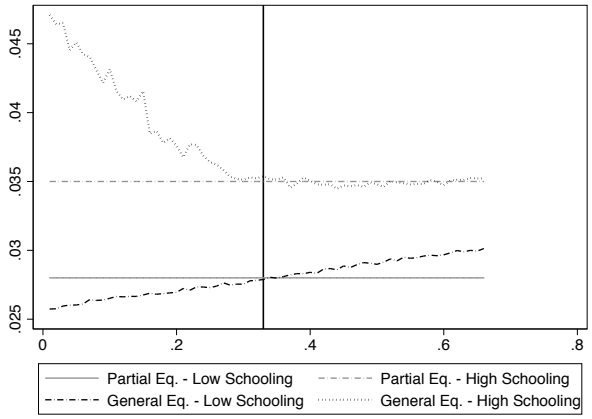
Figure B.1: Policy Impacts on Job Arrival Rates



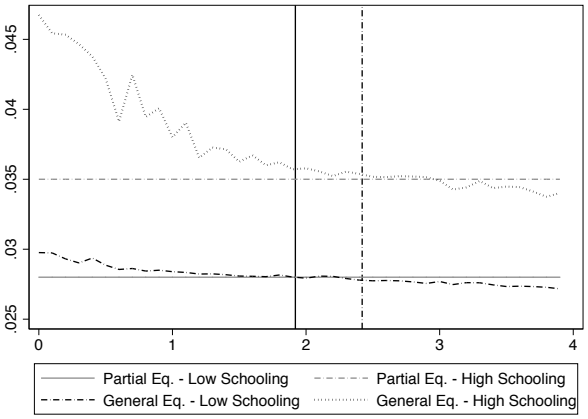
(a) Changes in t – Unemployed arrival rate



(b) Changes in B_0 – Unemployed arrival rate



(c) Changes in t – Self-Employed arrival rate



(d) Changes in B_0 – Self-Employed arrival rate

NOTE: Simulated samples of 10,000 worker-level observations for each schooling group based on the estimates reported in Table 2. The *Partial Equilibrium* solid lines are computed with exogenous contact rates. The *General Equilibrium* dashed lines are computed using the endogenous contact rates implied by equilibrium measures of vacancies and searchers. See equation (5) for details. The vertical lines represent the institutional values for the Mexican labor market in 2005. See Appendix C for details.

C Institutional Parameters

The parameters $\{B_0, \tau, t\}$ are set to the values determined by the institutional setting of the Mexican labor market. In particular:

$\boldsymbol{\tau = 0.55}$ In order to derive the share of the bundle of additional benefits for Formal employees (τ), we follow calculations reported in Levy [2008], which are based on the current legislation in Mexico. Accordingly, for a worker who earns twice the minimum wage in 2007 (2,931 Pesos), social security contributions amount to 864.30 Pesos (almost 30% of the wage), of which 55% are attributable to spending categories that are proportional to the wage - notably, work-risk insurance (76.2 Pesos), disability and life insurance (69.6 Pesos), retirement pensions (184 Pesos) and housing fund (146.6 Pesos).

$\boldsymbol{t = 0.33}$ We rely on calculations reported in Anton et al. [2012], which are based on official statistics reported by the Mexican Social Security Institute (IMSS). The authors decompose the average tax rate on formal labor (38%) into government subsidies (5%) and firms and workers contributions (33%).

$\boldsymbol{B_{0,1} = 2.42}$ **and** $\boldsymbol{B_{0,0} = 1.92}$ Total spending in non-contributory social security programs for the year 2005 amounted to 133,090,002,747 Pesos, of which 11,916,448,117 Pesos were devoted to the *Seguro Popular* program. For the same year, we compute the total number of informal workers (25,035,508) and unemployed (1,353,561) by applying sampling weights to the nationally-representative labor market survey used in our empirical analysis (ENOE). Assuming full time working hours over a period of one year (2,080 hours), we can compute the per-capita hourly monetary benefits extended to the part of the labor force that is non-Formally employed, separately for those who reside in municipalities with ($B_{0,1}$) and without ($B_{0,0}$) the *Seguro Popular* program.

List of recent AFD Research Papers

AFD Research Papers are available through AFD's website at https://www.afd.fr/en/ressources

2018-69 MILUSHEVA, S., E. zu ERBACH-SCHOENBERG, L. BENGTSSON, E. WETTER and A. TATEM (2017), "Understanding the Relationship between Short and Long Term Mobility", *AFD Research Papers Series*, No. 2018-69, June.

2018-70 DE NADAI, M., E. LETOUZÉ, M.C. GONZÁLEZ and B. LEPRI (2017), "Characterizing and analyzing urban dynamics in Bogota", *AFD Research Paper Series*, No. 2018-70, June.

2018-71 BERROU, J.-P., D. DARBON, C. BOUQUET, A. BEKELYNCK, M. CLEMENT, F. COMBARNOUS et E. ROUGIER (2017), "Le réveil des classes moyennes ivoiriennes ? Identification, caractérisation et implications pour les politiques publiques ", *Papiers de recherche AFD*, n° 2018-71, Juillet.

2018-72 BURNS, J., G. HULL, K. LEFKO-EVERETT and L. NJOZELA (2018), "Defining Social Cohesion", *AFD Research Papers Series*, No. 2018-72, June.

2018-73 BURNS, J., K. LEFKO-EVERETT and L. NJOZELA, (2018), "From definition to measurement: constructing a social cohesion index for South Africa", *AFD Research Papers Series*, No. 2018-73, June.

2018-74 MEIRING, T., C. KANNEMEYER and E. POTGIETER (2018), "The Gap Between Rich and Poor: South African Society's Biggest Divide Depends on Where You Think You Fit In", *AFD Research Papers Series*, No. 2018-74, June.

2018-75 TORNAROLLI, L., M. CIASCHI and L. GALEANO (2018), "Income Distribution in Latin America. The Evolution in the Last 20 Years: A Global Approach", *AFD Research Papers Series*, No. 2018-75, April.

2018-76 TROTTIER, J. (2018), "Harnessing the commons to govern water as a flow", *AFD Research Papers Series*, No. 2018-76, July.

2018-77 BAZILLIER, R. and V. GIRARD (2018), "The Gold Digger and the Machine: Evidence on the Distributive Effect of the Artisanal and Industrial Gold Rushes in Burkina Faso", *AFD Research Papers Series*, No. 2018-77, July.

2018-79 CRAMER, C., J. DI JOHN and J. SENDER (2018), "Poinsettia Assembly and Selling Emotion: High Value Agricultural Exports in Ethiopia", *AFD Research Papers Series*, No. 2018-78, August.