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Trade, Informal Employment and Labor Adjustment Costs

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Abstract

Informal employment is ubiquitous in developing countries, but few studies have estimated workers' switching costs between informal and formal employment. This paper builds on the empirical literature grounded in discrete choice models to estimate these costs. The results suggest that inter-industry labor mobility costs are large, but entry costs into informal employment are significantly lower than the costs of entry in formal employment. Simulations of labor-market adjustments caused by a trade-related fall in manufacturing goods prices indicate that the share of informally employed workers rises after liberalization, but this is due to entry into the labor market by previously idle labor.

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Trade, Informal Employment and Labor Adjustment Costs*

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1 Introduction

Informal employment is commonplace in developing countries. Although since the term "informal employment" was coined in the early 1970s the literature has proposed various definitions, from the viewpoint of workers (as opposed to firms) the consensus seems to be that workers who are not covered by social protection, such as social security, or who work without a wage contract are considered to be informal (World Bank 2013, p. 64). In taking this definition to data from labor force or employment surveys, workers who are self-employed or salaried without social security benefits are considered to be informal. According to the World Bank (2013), existing global studies of the incidence of informal employment in developing countries suggest that informality rates range between 40 and 80 percent of the employed labor force. Similarly, in the data from Labor Force Surveys from Brazil and Mexico used in this paper, the informal-employment share exceeds 40 percent of the labor force in Brazil, and it is almost 60 percent in Mexico.

More importantly, the large informal employment shares in developing countries has inspired decades of research aiming to understand the causes of informality and more broadly the functioning of developing-country labor markets. One strand of the literature emerged in the late 1990s out of concerns about the role of international integration as a determinant of informality in developing economies.

Goldberg and Pavcnik (2003) examined the impact of trade liberalization implemented in the 1980s and 1990s in Brazil and Colombia. They found that trade reforms had no relationship with changes in informal employment in Brazil, and found weak evidence that trade reforms caused an increase in informal employment in Colombia. Bosch and Maloney (2010) studied labor market dynamics in three large Latin America countries, namely Argentina, Brazil and Mexico. They explored labor dynamics using statistical markov processes of individual workers' trajectories across sectors from labor force surveys. The authors found evidence that

self-employed workers are typically characterized by "voluntary entry to informality," while informal salaried workers are more likely to be excluded from the formal sector.

More recently, several authors have developed and estimated dynamic discrete choice models to study the impact of trade liberalization on labor reallocations, wages and welfare [1]. Artuc *et al.* (2010) study the impact of trade liberalization on the US labor market. The authors find low labor mobility in response to trade liberalization. They simulated a 30% reduction of tariffs in the manufacturing sector, and found that 95% of the labor reallocation in the entire economy would take place in eight years after the reform. This growing literature, however, has focused on worker flows across industries ignoring one of the main characteristics of labor markets in developing countries, the existence of a large informal sector. This paper seeks to contribute to the literature by explicitly modeling workers' decision to move both across sectors and employment status.

The model proposed herein is empirically tractable, requiring only worker employment transitions across industries and employment status from labor-force surveys with panel data. With these estimates of labor mobility costs, we use simulations of changes in labor demand across sectors to study labor-market adjustments caused by a reduction in the relative price of manufactures that could be brought about by trade liberalization or other trade-related persistent shocks, such as the growth of Chinese exports in global markets. The results suggest that inter-industry labor mobility costs are large but entry costs into informal employment tends to be significantly lower than the costs of entry into formal employment. Consequently, declines in prices raise real wages and thus increase labor flows into the labor market but with disproportionate entry into informal employment. The share of informal employment rises after trade liberalization (or other price-reducing shocks) but this is due predominantly to entry into the labor market rather than displacement out of the affected industry.

[1] See Artuc *et al* (2010); Dix-Carneiro (2010); and Menezes-Filho and Muendler (2011).

The rest of the paper is organized as follows. The following section 2 briefly places the modeling approach in the context of the existing literature about the causes of informality. The structural model is presented in Section 3. The data from Labor Force Surveys used for the estimation of the structural parameters of the model is discussed in Section 4, which also includes a discussion of the data used in the simulations. Section 5 presents the results from the estimations as well as from the simulations. Section 6 concludes.

2 Informality and Mobility Costs

There are two leading views about fundamental drivers of informal employment in developing countries. The first view argues that workers in the informal sector have been excluded from the formal sector by some sort of barrier to entry, such as labor market rigidities and excessive regulation. This view is associated with the early work of De Soto (1989), and was labelled the "romantic" view by Laporta and Shleifer (2008) as it emphasizes that informal employment "is potentially extremely productive, and is held back by government taxes and regulation, as well as by lack of secure property rights and access to finance" (La Porta and Shleifer, 2008).

The second view has its origins in the work of Lucas (1978) and Rauch (1991) on managerial skills and entrepreneurial ability. This approach views informality as the result of a self-selection decision that maximizes individuals' comparative advantage in each sector. Under this rational-choice view, workers and firms optimally choose the sector based on expected pecuniary and non-pecuniary benefits associate with each sector.

The model presented in this paper captures the two views of informality. We incorporate workers' decision to enter the informal sector in a dynamic discrete choice model with rational expectations. The model is an extension of Artuc *et al.* (2010). In each period, workers

choose the industry in which they prefer to work and under which employment status. The key parameter of the model is the perceived mobility cost of a particular sector and formality status. This structural parameter is identified from actual data on workers mobility; thus the higher the entry cost, the less likely it is that workers would choose to enter into a given sector and employment status. That is, workers might not afford to move into a particular industry and status (the "romantic" view), but after taking into account sector-specific utility shocks, forward looking workers are always better off in the chosen sector and status than in any other alternative state (the "rational view"). The following section presents the structure of the model.

3 Model

The model builds on the general equilibrium labor mobility framework introduced by Artuc, Chaudhuri and McLaren (2010). Consider an M-goods economy consisting of perfectly competitive N sectors. The number of sectors, N, is larger than the number of goods, M, because goods can be produced by informal and formal sectors. For example, manufacturing goods can be produced either in the formal manufacturing sector or in the informal manufacturing sector. Workers are distributed across these N sectors: A type s worker in sector i receives wage $w_t^{i,s}$ at time t. A worker's type, s, can be her gender, education or other characteristics. We assume that workers within a type category s are identical. In addition to the wage, workers receive a sector specific common utility $\eta^{i,s}$ while working in sector i. The fixed utility $\eta^{i,s}$ accounts for compensating differentials, such as working conditions, hours, benefits, on-the-job hazards, etc. That is, the sector with the highest wage is not necessarily the most attractive one. For simplicity, we assume that both the wage $w_t^{i,s}$ and the fixed utility $\eta^{i,s}$ are common for all type s workers in sector i.

In every time period, workers have an option to change their industry of employment.

However, switching industries is costly. Workers pay a moving cost if they decide to move. The moving cost has two components: a fixed moving cost common to all type s workers, and a random idiosyncratic component that is worker-specific in every time period. When a worker moves from sector i to j, she pays the fixed moving cost $C^{ij,s}$ and the random idiosyncratic cost $\epsilon_t^i - \epsilon_t^j$, where the random variable ϵ_t^i follows an "extreme value" distribution with scale parameter ν, which is proportional to the standard error. Stayers do not pay the entry cost, i.e. $C^{ij,s} = 0$ if $i = j$.

Workers choose the optimal sector dynamically considering wages, fixed utility, fixed moving costs, random moving costs and future values of all these variables. Workers are rational, risk neutral, live infinitely and discount the future with the parameter β. The optimal sector for a worker may not be the one with the highest wage and fixed utility because of the moving costs and workers' expectations about the future. Under the rational expectations assumption, workers have an expectation about future wages but their expected wages do not necessarily equal the revealed wage in the data. That is, workers can make errors in their guesses about the future, but the errors cannot be systematic, i.e workers cannot persistently underestimate or overestimate the future wages. Our econometric strategy does not require parameterization of workers' expectations, however.

Workers' optimization problem can be characterized with the following Bellman equation:

$$V_t^{i,s} = w_t^{i,s} + \eta^{i,s} + \beta E_t \max_j \left\{ V_{t+1}^{j,s} - C^{ij,s} - \epsilon_{t+1}^j \right\}, \tag{1}$$

where $V_t^{i,s}$ is the present discounted value of the type s workers in sector i, who are taking their wages, fixed utilities and future values into account. The choice-specific Bellman equation can be rearranged as

$$(2) \quad V_t^{i,s} = w_t^{i,s} + \eta^{i,s} + \beta E_t V_{t+1}^{i,s} + \beta \Omega_{t+1}^{i,s},$$

where $\Omega_{t+1}^{i,s}$ is the "option value of moving", which is equal to the expected benefit of moving conditional on the net benefit of moving being positive. The "option value of moving" can be solved analytically when the random variable ϵ_t^i is distributed iid"extreme value"(see Artuc, Chaudhuri, and McLaren (2010) for further details). Following McFadden (1973), labor flows can be expressed as

$$(3) \quad y_t^{ij,s} = \frac{\exp\left(\left(EV_{t+1}^{j,s} - EV_{t+1}^{i,s} - C^{ij,s}\right)\frac{1}{\nu}\right)}{\sum_{k=1}^{N} \exp\left(\left(EV_{t+1}^{k,s} - EV_{t+1}^{i,s} - C^{ik,s}\right)\frac{1}{\nu}\right)} L_t^{i,s},$$

where $y_t^{ij,s}$ is the number of type s workers moving to sector j from sector i and $L_t^{i,s}$ is the total number of type s workers in sector i.

3.1 Production

Formal and informal sector products are assumed to be identical, but informal and formal workers are substitutes. However, consistent with existing literature, informal workers are less productive than formal workers. This assumption is also consistent with the lower informal wages observed in the data. The effective total human capital in an industry i can be expressed as

$$(4) \quad L_t^i = \sum_s a^{j,s} L_t^{j,s} + \sum_s a^{k,s} L_t^{k,s},$$

where j and k are the formal and informal sub-sectors of industry i. $a^{j,s}$ is the productivity parameter of type s workers in the formal sector j. $a^{k,s}$ is the productivity of the same type of worker in the informal sector k. Assuming Cobb-Douglas production, output q_t^i in main-

industry i at time t is equal to

$$(5) \quad q_t^i = A^i (K^i)^{1-\gamma_i} (L_t^i)^{\gamma_i},$$

where the labor share is γ_i and the sectoral capital is K^i.

From the production function (5), we can derive the real wage equations

$$(6) \quad w_t^{i,s} = \frac{p_t^i}{P_t} a^{i,s} \tilde{A}^i (L_t^i)^{\gamma_i - 1},$$

where P_t is the aggregate price index and p_t^i is the unit price of sector i output. The wage equation multiplier is defined as $\tilde{A}^i = A^i (K^i)^{1-\gamma_i}$.

We close the model with the following consumer price index equation

$$(7) \quad P_t = \prod_i (p_t^i)^{\theta_i}.$$

with consumption shares θ_i.

3.2 Estimation and Calibration

The estimation strategy entails imputing expected values from the data. In their seminal paper, Hotz and Miller (1993) impute expected values from conditional choice probabilities. Their method relies on an inversion equation and estimation of conditional choice probabilities with a non-parametric method. In a departure from the literature, we use a Poisson Pseudo Maximum Likelihood (PPML) regression to estimate expected values instead of the Hotz and

Miller (1993) inversion equation. PPML is used in the international trade literature to estimate the gravity model as in Santos Silva and Tenreyro (2006) and Anderson (2011). The use of PPML is intuitive and simplifies the estimation procedure significantly. Most recently, Artuc and McLaren (2012) used a very similar strategy to estimate occupational mobility. See Artuc (2013) for the technical details of our estimation strategy.

Wages, $w_t^{i,s}$, the sectoral distribution of workers, $L_t^{i,s}$, and labor flows, $y_t^{ij,s}$, are directly taken from the data. The discount factor β is fixed to 0.95 and the variance parameter ν is set at 1.0. The moving cost parameter, $C^{ij,s}$, the values $EV_t^{i,s}$ and the option values $\Omega_t^{i,s}$ are estimated. The remaining fixed utility parameters, $\eta^{i,s}$, and production function parameters are calibrated with the data.

Stage 1: Estimating the Flow Equation

The labor flow equation (3) can be interpreted as a PPML regression similar to the gravity equation, where the entry costs create a resistance term similar to distance and the origin-destination parameters are essentially the destination and origin fixed effects. The labor flow equation can be expressed as a PPML regression such that

$$(8) \quad y_t^{ij,s} = \exp\left(\Gamma_t^{i,s} + \Lambda_t^{j,s} + \mathbf{1}_{i\neq j}\delta^{ij,s}\right) + e_t^{ij,s}.$$

$\Gamma_t^{i,s}$ is the coefficient of the origin-industry fixed effect; $\Lambda_t^{j,s}$ is the coefficient of destination-industry fixed effect[2]; and $\delta^{ij,s}$ is the normalized fixed entry cost to sector j from sector i. $\mathbf{1}_{i\neq j}$ is an indicator function equal to one if i is not equal to j and zero otherwise (i.e. when $y_t^{ij,s}$ corresponds to movers rather than stayers). $e_t^{ij,s}$ is the regression residual.

[2]Note that, we need to drop either destination or fixed effect for one choice (i.e. normalize the choice specific values). Otherwise, the regression matrix becomes singular because only the value differences between choices are identifiable from the choice data. We dropped the destination fixed effect for the choice i = 1.

The structure of the moving cost matrix $\delta^{ij,s}$ is flexible. Workers pay an entry cost that is a function of the destination sector and workers' original formality status. Thus, we assume the following moving cost structure:

$$(9) \quad \delta^{ij,s} = \begin{cases} \Delta_1^{j,s}, \text{from an informal sector to formal } j \text{ without changing the main industry,} \\ \Delta_2^{j,s}, \text{from a formal sector to informal } j \text{ without changing the main industry,} \\ \Delta_3^{j,s}, \text{from any informal sector to formal } j \text{ while changing the main industry,} \\ \Delta_4^{j,s}, \text{from any formal sector to formal } j \text{ while changing the main industry,} \\ \Delta_5^{j,s}, \text{to informal } j \text{ while changing the main industry (from any sector),} \end{cases}$$

where i is the origin sector and j is a formal or informal destination sector, such as informal manufacturing or formal services. As mentioned, the main industries are: 1. Agriculture and Mining, 2. Manufacturing, 3. Transportation and Utilities, 4. Trade, 5. Service, and 6. Inactive. Each main industry (except "Inactive") consists of an informal sector and a formal sector[3].

Then, the j-specific term or the destination fixed effect, $\Lambda_t^{j,s}$, is equal to

$$(10) \quad \Lambda_t^{j,s} = \frac{\beta}{\nu} E_t V_{t+1}^{j,s} - \frac{\beta}{\nu} E_t V_{t+1}^{1,s},$$

the i-specific term or the origin fixed effect, $\Gamma_t^{i,s}$, is equal to

$$(11) \quad \Gamma_t^{i,s} = -\frac{\beta}{\nu} E_t V_{t+1}^{i,s} - \frac{1}{\nu} \Omega_t^{i,s} + \log(L_t^{i,s}) + \frac{\beta}{\nu} E_t V_{t+1}^{1,s},$$

[3]For example, if a worker moves from informal manufacturing to formal manufacturing (that is, without changing the main industry), she faces the moving cost $\Delta_1^{j,s}$. If a worker moves into informal manufacturing from formal services, she faces the moving cost $\Delta_5^{j,s}$. If a worker moves from formal manufacturing to formal service she faces the moving cost $\Delta_4^{j,s}$.

and the bilateral resistance term, $\delta^{ij,s}$, is equal to

$$(12) \quad \delta^{ij,s} = -\frac{1}{\nu} C^{ij,s}.$$

Finally, using destination and origin fixed effects, we construct the option value term, $\Omega_t^{i,s}$, as

$$(13) \quad \frac{1}{\nu}\Omega_t^{i,s} = -\Lambda_t^{i,s} - \Gamma_t^{i,s} + \log(L_t^{i,s}).$$

The remaining parameters $\eta^{i,s}$ and ν are calibrated in the second stage. After calibrating, $\eta^{i,s}$, and the production functions, the model can be fully parameterized.

Stage 2: Calibrating the Production Functions

After estimating the labor supply parameters in Stage 1, the production functions have to be parameterized to derive the labor demand (wage) equations. Without loss of generality, we normalize the productivity parameter to unity for formal workers, $a^{j,s} = 1$ for formal sector j. Also by assumption, the informal productive multiplier is equal to $a^{k,s} = w_t^{k,s}/w_t^{j,s}$, which can be pinned down from observed average wages. The Cobb-Douglas labor share can be pinned down from the ratio of an industry's wage bill over the industry's value added (which come from national input-output tables). The wage equation multiplier $\tilde{A}^i$ is calibrated such that the aggregate labor allocation reflects the observed average wage in the data from each country. Finally, the fixed utility parameters η^i can be calibrated by matching the simulated labor allocations with the labor allocations observed in the data. The simulation methodology is similar to Artuc, Chaudhuri and McLaren (2010) and based on a shooting algorithm. In the simulations, we consider a counterfactual tariff reduction in the manufacturing sector that implies a 30% price reduction in manufactured goods prices.

4 Data

The structural estimation outlined in the previous section is conducted with data from Labor Force Surveys (LFS) from Brazil, and Mexico. A common feature of these surveys is a rotative panel structure that permits the construction of employment transition matrices. For both countries, we restrict the sample to individuals between 15 and 65 years of age. Again, the industries are aggregated into five sectors: i) Agriculture, Mining, Construction and Utilities, ii) Manufacturing, iii) Commerce, iv) Hotels and Restaurants, and v) Other Services. Each sector is further divided into formal and informal. A worker is considered formal if she/he is registered in the social security system. Additionally, there is a residual sector that captures individuals who are either unemployed or out of the labor force, the aforementioned "inactive" sector.

The "Encuesta Nacional de Ocupacion y Empleo" (ENOE) is used to compute the transition matrices for Mexico. The ENOE is a household survey that collects detailed information on labor force status, wages, occupational and demographic characteristics. It is collected quarterly since 2005, and it is representative at both the national and state levels. The sample size is around 120,260 households in each quarter. Each household is interviewed in five consecutive quarters. In each quarter, one fifth of the sample (e.g., households in their fifth interview) is replaced. We construct the transition matrix by looking at the first and fifth interview. We derive six year-on-year transition matrices, the first matrix reflecting transitions between 2005 and 2006 and the most recent between 2010 and 2011.

The "Pesquisa Mensal de Emprego" is the Brazilian LFS. The survey collects detailed information of Brazil's labor market and is representative of only six metropolitan (urban) regions. Each wave of the survey has approximately 120,000 individuals. The panel structure consist on each household being interviewed 12 times over an 18 months period. In each wave of the survey, we identify individuals in their first interview and we follow them a year later at

the time of their fifth interview. Similar to the other two countries, we derive four year-on-year transitions matrices that cover the period between 2007 and 2011.

As mentioned in the introduction, the two countries analyzed herein cover a large range of informality rates observed in Latin America. Existing estimates suggest that the informal sectors in Mexico are large relative to other countries in the region, whereas Brazil tends to have lower informality rates than other Latin American economies. According to existing calculations for the case of Mexico, the size of the informal sector represents about 60% of employed salaried male workers and 55% of females. Brazil's informality appears to be below the average of Latin America, with a rate of informality of about 32% of employed males and 33% for females [4].

Table 1 presents summary statistics of the data used for the estimation outlined in the previous section. In Mexico, the size of the informal sector (59.9% of the employed workers) and the employment shares (60.45%, which corresponds to a residual sector of 39.55%) are also consistent with estimates found in the literature. For example, Bosch and Maloney (2010) report an informal sector of 38% and a residual sector of 20%. However, their sample includes only men in urban areas (using the "Encuesta Nacional de Empleo Urbano," ENEU, from 1984-2004). Although we use the ENOE, which is representative of both urban and rural areas, with our sample of men in urban areas we obtain similar rates as Bosch and Maloney (2010). Nonetheless, it is noteworthy that the residual sector for both urban and rural male workers in our data is almost exactly 20%, whereas the informality rate of 49.0% is unsurprisingly much higher than the 38% for urban males, because self-employment (without social security coverage) is more common in rural areas. Table 1 also shows the employment shares across industries and formality status. The industry with the largest proportion of informal workers is agriculture, mining, construction and utilities. In Brazil, the sector has about 1.2 informal

[4]See Campos-Vázquez and Knox(2010), they refer to a sample from years 2002-2004. See also Table 2.1 in Perry *et al*(2007).

workers per formal worker [5].

The size and composition of the residual sector is important because it is associated with the highest transition counts. Table 2 shows transitions between industries, and Table 3 shows transitions between the formal and informal sectors. Table 2 confirms that workers move more often in and out from the residual sector than across sectors in both countries. However, the sectors to which workers move in from the residual sector differ across countries. Workers in the residual sector are more likely to move into services than to other sectors.

The transition patterns in and out of informality in Mexico are notably different from the patterns observed in the Brazilian data. Table 3 suggests that the entry point to employment in Mexico is through the informal sector, as the probability of moving from the residual sector to the informal sector (17.95% and 12.03%, respectively) is greater than the probability of moving from the residual sector to the formal sector (5.04% and 0.92%, respectively). In contrast, Brazilian workers in the residual sector tend to move with relatively similar probabilities into the informal (7.15%) and formal (8.63%) sectors. Furthermore, Brazilian formal workers tend to have a higher probability of moving to the residual sector (8.61%) than to the informal sector (4.86%), whereas in the other two countries the transition probabilities from formal employment to informality are close to 14%. Finally, informal-sector workers from Mexico move with a higher probability to the residual sector (18.54% and 13.73%, respectively) than to the formal sector (10.46% and 3.42%, respectively), which is not the case in Brazil (where the probability of moving into the residual sector from informality is 18.20% compared to 24.63% for entering the formal sector).

As described in sub-section 3.1, the simulation exercises (presented in the following section) require information on key parameters, including labor shares and consumption shares by

[5]Note that the number for Brazil corresponds to urban areas only.

sector for each country. Complementary data sources were required to compute these parameters. The labor shares were defined as the ratio of the wage bill over total value added for each sector, and the consumption shares as the share of each sector in total consumption. These parameters were calculated from input-output (IO) tables from Mexico and Brazil. We used the IO table of 2003 for Mexico, and 2005 for Brazil. Average formal and informal wages in Mexico and Brazil were calculated with data from the Labor Force Surveys (LFS). The parameters for the simulations are shown in Table 4. The wages in each country-sector are expressed as a ratio of each country's average wage.

5 Results

The proposed estimations and simulations provide two sets of results. The first concerns the estimates of labor mobility costs. To be more precise, the PPML estimations provide estimates of workers' perceived entry costs associated with movements across industries of employment as well as with movements in and out of informality. In turn, the simulations utilized the estimated entry costs to analyze the effect of a price reduction affecting the manufacturing industry. As will become apparent, this industry might play a key role in the formalization of labor markets in developing countries.

5.1 Estimates of Labor Mobility Costs: Entry Costs and Formalization

Table 5 shows the estimates of labor mobility costs. To be more precise, it reports normalized entry costs [6]. As explained above in Section 3, Table 5 presents estimates of C/ν. Assuming that ν=1, and given that the literature normalizes wages by the average real wage,

[6]The z-statistics are reported inside parentheses. All coefficients in Table 5 are statistically significant. For the simulations we assume that this moving cost is zero

the estimates should be interpreted as mobility (entry) costs in terms multiples of the average real wage in each country. Moreover, without loss of generality, the normalized labor mobility costs, C/ν, allows identification of the relative cost of switching from informal to formal status across industries [7].

There are three results in common for both countries. First, for an average informal worker it is less costly to become formal while staying in the same industry. Industry-specific skills might explain this finding. Second, the highest moving entry costs are related to two sources of mobility frictions, namely moving from informal to formal and across industries. That is, acquiring new industry-specific skills adds to the cost of becoming formal. In both countries, becoming formal by moving from any sector into restaurants and hotels represents the highest cost among all possible mobility choices covered by the model. This does not necessarily imply that the skills demanded in the hospitality industries are more sophisticated than those in other industries. Rather, the results theoretically reflect the workers' expected costs of entering those industries, which might be due to the loss of expected wages due to less sophisticated skills than those demanded in other industries. Third, the lowest entry costs are associated to switching from formal to informal status within the same sector. Restaurants & hotels and "other services" have the lowest cost of switching from formal to informal.

In Mexico manufacturing is an stepping-stone for moving into formal jobs. This result suggests that manufacturing might be a key for the formalization of developing-country labor markets. The estimated entry costs into formal manufacturing from informal employment in Mexico is 4.90 times the average wage. In Mexico, an average informal worker would also perceive that "other services" is a stepping-stone sector, which is reflected in the low estimated entry cost into formal employment of 4.89 times the average wage. In urban Brazil, however,

[7] Before discussing the results, note that we do not attempt to estimate β. The model is not designed to estimate rates of time preference, and although it could be done in principle, in practice it turns out that the time preference parameter is very poorly identified. Following the tradition in the literature, we impose a value equal to 0.95.

"commerce" is the stepping-stone sector for moving into formal employment, with an estimated entry cost of about 4.64 times the country's average wage, but manufacturing is not far behind with an estimate of 4.94 that is quite close to the estimate for Mexico. The latter estimate is quite close to the estimates for manufacturing entry costs in Mexico. Having established the similarities and contrasts between Brazil and Mexico in terms of their labor mobility entry costs, the following section puts these estimates to work for the simulations of the effects of a shock that would permanently reduce the price of the final goods of the key industry, the manufacturing sector, by 30%.

5.2 Simulations: The Effects of Trade Liberalization

To simulate the effects of a trade shock, the analysis assumes the following: 1) Units are chosen so that the domestic price of each good at date $t = -1$ is unity. Given the available free parameters and without loss of generality, 2) there are no tariffs on any sector besides the manufacturing sector at any date. 3) The world price of manufacturing output is 0.7 at each date, and the world price of all other tradable goods is equal to unity in each date. 4) There is initially a specific tariff in manufacturing at the level of 0.3 per unit, so the domestic price of manufactures is equal to unity. 5) The initial tariff is expected to be permanent and the economy is initially at the corresponding steady state consistent with that expectation. 6) At date $t = -1$, however, after that period's moving decisions have been made, the government announces that the tariff will be removed beginning on period $t = 0$ (so the domestic price of manufactures fall from unity to 0.7 on that date), and this liberalization is expected to be permanent.

We computed the perfect-foresight path of the adjustment following the liberalization announcement. The simulated adjustment process continues until the economy effectively reaches the new steady state. This requires that each worker –taking the time path of wages in all

sectors as given– optimally decides at each date whether or not to switch sectors, while taking into account workers' own idiosyncratic or personal shocks. This computation yields a time path for the allocation of workers, and is, therefore, the time path of the wage, since the wage in each sector at each date is determined by market clearing conditions from equation (6), given the number of workers initially employed in each sector. Of course, the time path of wages so generated must be the same as the time path that each worker expects. Cameron *et al.* (2007) shows that this equilibrium exists and is unique.

Figure 1 shows the evolution of labor shares across the five economic sectors in Mexico.[8] Labor reallocation across economic sectors in Mexico is marked by a steady reduction of employment in manufacturing that begins right after the tariff reform, while the labor shares of the other sectors rise. The employment share of manufacturing slowly approaches a new steady state that is lower than the initial one. The rest of Figure 1 shows that all sectors experience increases in labor shares, but services and agriculture experience the largest gains. Interestingly, the restaurants & hotels sector seems to be unaffected by the trade reform, while commerce only experiences a marginal increase in its labor share.

Figure 2 shows that after the trade reform, workers in the residual sector gradually enter the informal sector. Informal employment as a share of the working age population increases after the reduction of the import tariff on manufactured goods. The new equilibrium is two percentage points higher than the initial one. The initial steady state of informal employment (as a share of the working age population) is around 36%, and after the trade reform, informal employment grows gradually to the new steady state of 38%. The share of formal employment stays fairly constant after the trade reform; the difference is approximately 0.0022 percentage points.

[8]The five economic sectors plus the residual sector add to one. The residual sector includes unemployed and inactive workers.

Figure 3 shows the adjustment path of real wages in Mexico. By construction, the formal-informal wage gap within each sector remains constant through the entire path to the new steady state. Real wages increased in all sectors, except manufacturing, precisely because the reduction of the price of manufactures reduced the aggregate price level. Consequently real wages in the non-manufacturing sectors increase suddenly, reaching a peak in the year immediately after the trade reform. Thereafter real wages outside of manufacturing begin a slow decline as workers move across sectors in search of higher real wages (thus raising the supply of workers in the receiving industries) prior to reaching the new steady state at a higher level than in the initial state. In manufacturing, initially real wages drop substantially right after the reform as labor demand in that industry falls with its price, but then they recover gradually as some workers who were previously employed in manufacturing exit the sector. The manufacturing real wage eventually reaches a new steady state that is below the initial level of the industry's real wage.

Figures 4 to 6 show similar results for Brazil. Informal employment increases slightly after the initial tariff reduction. The new equilibrium is one percentage point higher than the initial steady state. Most of the new entrants to the informal sector come from the residual sector. Similar to Mexico, after the tariff reduction, real wages decline to a new steady state, while real wages increase in all other sectors. Agriculture and "other services" are the sectors that absorbed most of the workers entering from the residual sector and those that are displaced from manufacturing.

In sum, the simulations show that total employment increases, which is evidenced by declines in the share of the residual sectors. Mexico and Brazil experience an increase in the share of total employment of 2.53 and 1.00 percentage points respectively. These dynamics are explained by the initial abrupt decline in the price of manufactured goods. The drastic drop in the price of manufactures explains the initial jump in real wages in other industries. How-

ever, once workers start moving into these sectors (from manufacturing and inactive status) real wages gradually converge downwards to the new steady state, which is still higher than the initial state. Similarly, the initial drop in the real wages in manufacturing is explained mainly by the abrupt reduction of 30 percent in the prices of the manufacturing sector in the reform year, and the gradual recovery in real wages is triggered by the exit of workers toward other sectors. In other words, the immediate impact of trade liberalization is thus a reduction in the relative price of manufacturing goods, which increases the opportunity cost of inactive individuals. Given the cost structure of the economy and the rational forward-looking behavior of workers, inactive individuals choose to enter the labor force, but mainly through the informal sector due to its lower entry costs than those associated with formal employment. These results suggest that the informal sector is the stepping stone for entrants into the labor market.

6 Conclusions

This paper studied the labor-market implications of changes in relative prices that could be brought about by trade reforms or any other shock with permanent relative-price effects. From the point of view of developing countries, the enormous literature on informal employment has grown precisely because of the relatively large share of informal employment in developing countries. The main contribution of the analyses presented above was to estimate labor mobility costs faced by workers, which were then used to simulate the dynamic adjustment path of the labor markets in two developing countries that appear to represent the range of informality rates observed in Latin America. The estimation of the labor mobility costs relied on a structural-empirical model that built upon the existing literature on discrete choice models, including Hotz and Miller (1993) and Artuc, Chaudhuri and McLaren (2010). In addition, following McFadden (1973), the model was estimated with a PPML estimator, which simplified the empirics relative to what is proposed in the existing literature.

Regarding the empirical results on labor mobility costs, the evidence suggests that the highest mobility costs are associated with formalization and changes in the industry of employment. It appears that formalization is less costly when workers enter formality within the same industry. These results are consistent with labor mobility costs being associated with industry-specific skills, otherwise entry costs into formal employment would not vary across industries. Likewise, switching industries or employment status appears to be less costly when entering informal employment. This result played an important role in the empirical simulations of the effect of a 30% decline in the price of manufactured goods.

Total employment increases after the tariff reduction in the simulations. Yet informal employment increases more than formal employment, as the share of the inactive working-age population falls. That is, the reduction in the tariff raises the expected real wage in non-manufacturing wages, thus raising the opportunity cost of remaining out of the labor market. At the time of writing, we are not aware of any other study that has highlighted this mechanism as an important element for understanding why the size of the informal sector can rise after trade liberalization.

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Table 1: Employment Shares						
Mexico						
	All		**MEN**		**WOMEN**	
sector	*Formal*	*Informal*	*Formal*	*Informal*	*Formal*	*Informal*
Agriculture/Mining/Constr	1.79	11.74	3.32	23.00	0.46	1.94
Manufacturing	5.67	4.24	8.16	4.92	3.50	3.65
Commerce	3.60	8.41	4.77	7.64	2.60	9.08
Restaurants/Hotels	1.10	2.58	1.26	1.97	0.96	3.11
Other Services	12.06	9.27	13.47	11.51	10.83	7.32
Total	*24.22*	*36.24*	*30.98*	*49.04*	*18.35*	*25.10*
Residual	39.55		19.99		56.56	
Informal /(Formal+Informal)	–	*59.94*	–	*61.28*	–	*57.77*
Brazil						
	All		**MEN**		**WOMEN**	
sector	*Formal*	*Informal*	*Formal*	*Informal*	*Formal*	*Informal*
Agriculture/Mining/Constr	2.42	3.14	4.60	6.42	0.49	0.24
Manufacturing	7.56	3.11	11.44	3.13	4.13	3.09
Commerce	6.94	5.38	8.60	6.86	5.47	4.07
Restaurants/Hotels	1.70	1.15	1.90	1.26	1.52	1.06
Other Services	17.45	11.77	18.16	9.94	16.83	13.39
Total	*36.07*	*24.55*	*44.70*	*27.61*	*28.44*	*21.85*
Residual	39.38		27.70		49.70	
Informal /(Formal + Informal)	–	*40.50*	–	*38.18*	–	*43.45*

Author's calculation based on the Labor Force Surveys. The denominator in all the reported shares is the working age population, ages 15-65. The informality rate is the ratio of informally employed workers divided by the sum of formally and informally employed workers. The sum of the shares of informal plus formal employment plus the share in the residual sector equals 100. Employment shares computed with all LFS years pooled. Mexico covers data from 2005 to 2010, and Brazil from 2007 to 2011. Urban and Rural areas included in Mexico; Brazil does not include rural areas.

Table 2: Transition Matrix							
Mexico							
Origin/Destination	*Agri/Mining/ Construction*	*Manufacturing*	*Commerce*	*Rest/Hotels*	*Other Services*	*Residual*	*Total*
Agri/Mining/Construction	75.37	3.29	2.98	0.58	5.23	12.55	100.00
Manufacturing	4.79	66.28	6.32	1.48	6.98	14.16	100.00
Commerce	3.23	5.27	63.13	2.18	7.89	18.30	100.00
Rest/Hotels	1.94	3.74	7.13	59.69	7.34	20.16	100.00
Other Services	3.22	2.85	4.02	1.20	76.46	12.24	100.00
Residual	4.23	3.59	5.93	2.13	7.08	77.04	100.00
Brazil							
Origin/Destination	*Agri/Mining/ Construction*	*Manufacturing*	*Commerce*	*Rest/Hotels*	*Other Services*	*Residual*	*Total*
Agri/Mining/Construction	72.49	5.17	4.39	0.66	8.67	8.63	100.00
Manufacturing	2.47	69.38	8.50	0.99	7.76	10.90	100.00
Commerce	1.88	7.22	68.81	2.01	9.24	10.85	100.00
Rest/Hotels	1.21	3.37	7.17	68.01	7.85	12.39	100.00
Other Services	1.40	2.26	2.82	0.59	84.08	8.85	100.00
Residual	1.61	3.23	4.37	1.16	9.96	79.67	100.00

Author's calculations based on Labor Force Surveys.
Transition matrix using the average number of worker in the period.
The residual sector includes unemployment and inactive workers.
Sectors include both formal and informal workers.

Table 3: Transition Matrix Between Formal and Informal Sectors				
Mexico				
Origin/Destination	*Formal*	*Informal*	*Residual*	*Total*
Formal	77.89	14.08	8.03	100
Informal	10.46	71	18.54	100
Residual	5.04	17.95	77	100
Brazil				
Origin/Destination	*Formal*	*Informal*	*Residual*	*Total*
Formal	86.53	4.86	8.61	100.00
Informal	24.63	57.17	18.20	100.00
Residual	8.63	7.15	84.22	100.00

Author's calcutaions based on Labor Force Surveys.
Transition matrix using the average number of worker in the period.
The residual sector includes unemployment and inactive workers.

Table 4: Simulation Parameters						
Mexico						
	Agr/Min	Manuf	Commerce	Hotels	Services	Residual
Formal Wage	1.076	0.930	0.865	0.819	1.278	–
Informal Wage	0.747	0.792	0.867	0.860	1.044	–
Formal Labor	0.018	0.057	0.036	0.011	0.121	0.396
Informal Labor	0.117	0.042	0.084	0.026	0.093	
Consumption Share	0.035	0.311	0.144	0.053	0.457	–
Production Labor Share	0.230	0.338	0.241	0.271	0.382	–
Brazil						
	Agr/Min	Manuf	Commerce	Hotels	Services	Residual
Formal Wage	1.189	1.176	1.022	0.915	1.164	–
Informal Wage	0.751	0.795	0.802	0.697	0.970	–
Formal Labor	0.024	0.076	0.069	0.017	0.175	0.394
Informal Labor	0.031	0.031	0.054	0.012	0.118	
Consumption Share	0.106	0.316	0.083	0.076	0.419	–
Production Labor Share	0.349	0.441	0.439	0.168	0.633	–

Author's calculation based on the Input-Output tables, Labor Force Surveys and Social Security data. Country-sector wages are expressed as multiples of each country's average wage. Consumption shares are equal to national consumption of products from each sector divided by total national consumption. Production Labor Shares are equal to the wage bill paid by each sector divided by the value added of each country-sector.

Table 5: Entry Costs								
Mexico								
From	*To*	*Type*	*Agr/Min*	*Manu*	*Commerce*	*Hotels*	*Services*	*Residual*
Formal	Informal	Within sector	1.00	1.06	1.13	0.47	0.69	-
			(10.12)	*(11.45)*	*(12.48)*	*(3.32)*	*(10.44)*	-
Informal	Formal	Within sector	3.09	2.97	3.17	3.22	2.92	-
			(30.19)	*(34.54)*	*(36.26)*	*(22.61)*	*(45.81)*	-
Informal	Formal	Between sectors	5.78	4.90	4.70	6.04	4.89	1.29
			(52.09)	*(72.73)*	*(62.02)*	*(48.53)*	*(83.25)*	*(47.19)*
Formal	Formal	Between sectors	3.65	2.94	2.78	4.83	3.03	1.26
			(34.69)	*(42.71)*	*(36.77)*	*(30.79)*	*(48.70)*	*(26.00)*
Any	Informal	Between sectors	3.44	2.80	2.44	3.35	2.46	-
			(89.90)	*(54.55)*	*(63.88)*	*(53.11)*	*(64.40)*	-
Brazil								
From	*To*	*Type*	*Agr/Min*	*Manu*	*Commerce*	*Hotels*	*Services*	*Residual*
Formal	Informal	Within sector	0.86	1.17	1.03	0.74	0.80	-
			(5.12)	*(8.01)*	*(7.90)*	*(2.86)*	*(8.07)*	-
Informal	Formal	Within sector	2.76	3.22	2.99	3.22	3.19	-
			(17.01)	*(24.51)*	*(25.56)*	*(15.52)*	*(33.79)*	-
Informal	Formal	Between sectors	5.90	4.94	4.64	6.36	4.61	1.81
			(41.22)	*(50.79)*	*(47.93)*	*(39.54)*	*(54.34)*	*(37.29)*
Formal	Formal	Between sectors	3.66	2.67	2.58	4.92	2.88	1.02
			(30.1)	*(34.55)*	*(32.52)*	*(28.57)*	*(40.61)*	*(13.65)*
Any	Informal	Between sectors	4.19	2.98	2.77	3.89	2.55	-
			(41.54)	(34.69)	(39.14)	(28.30)	(44.55)	-

z-statistics are reported inside parentheses. The coefficients are multiples of each country's national average wage.

Table 6 : Average Wage			
	Mexico*		
	Formal	*Informal*	*Informal/Formal*
Agri/Mining/Construction	34.78	21.69	0.62
Manufacturing	28.56	23.14	0.81
Trade/Commerce	25.74	25.18	0.98
Rest/Hotels	21.97	25.54	1.16
Other Services	45.81	32.26	0.70
Mean	31.37	25.56	0.86
	Brazil**		
	Formal	*Informal*	*Informal/Formal*
Agri/Mining/Construction	4.85	2.41	0.50
Manufacturing	4.79	2.83	0.59
Trade/Commerce	3.67	2.79	0.76
Rest/Hotels	3.03	2.01	0.66
Other Services	4.91	4.32	0.88
Mean	4.25	2.87	0.68

Author's calculation based on the ENOE.
*Local currency, prices of 2005. Average value in 2010.
** Data from PME harmonized CEDLAS, PPP USD 2005. Average 2007/12

Figure 1: Sectoral Labor Allocation − MEX

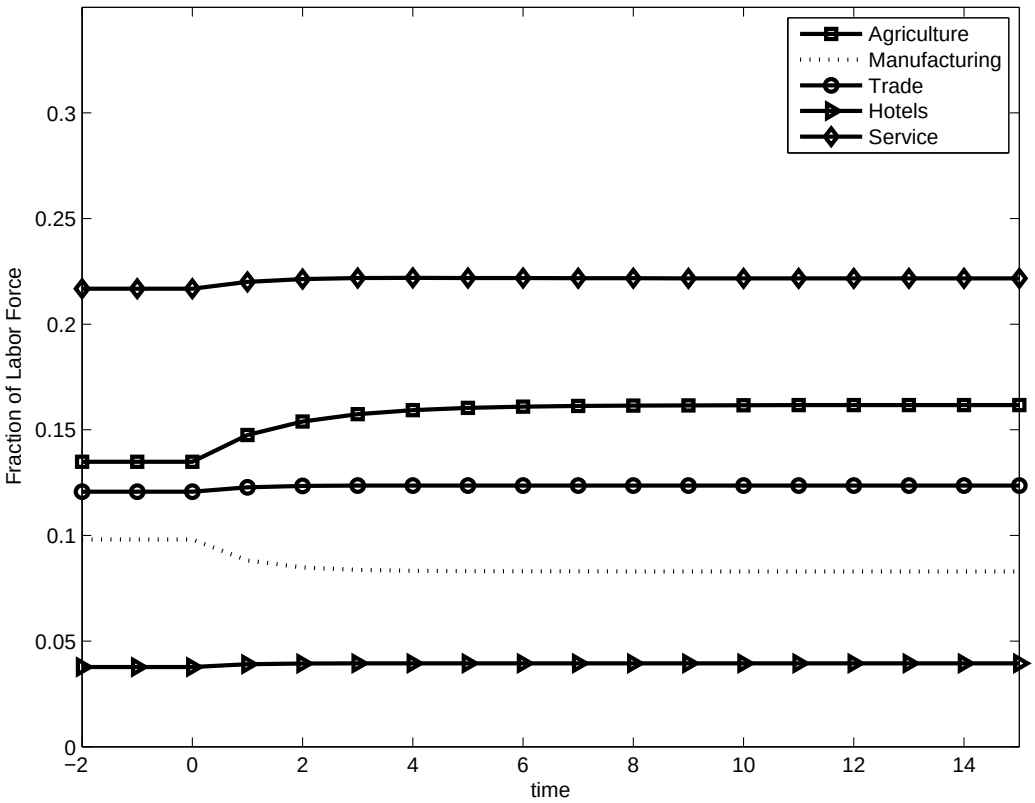

Figure 2: Formal Labor Allocation − MEX

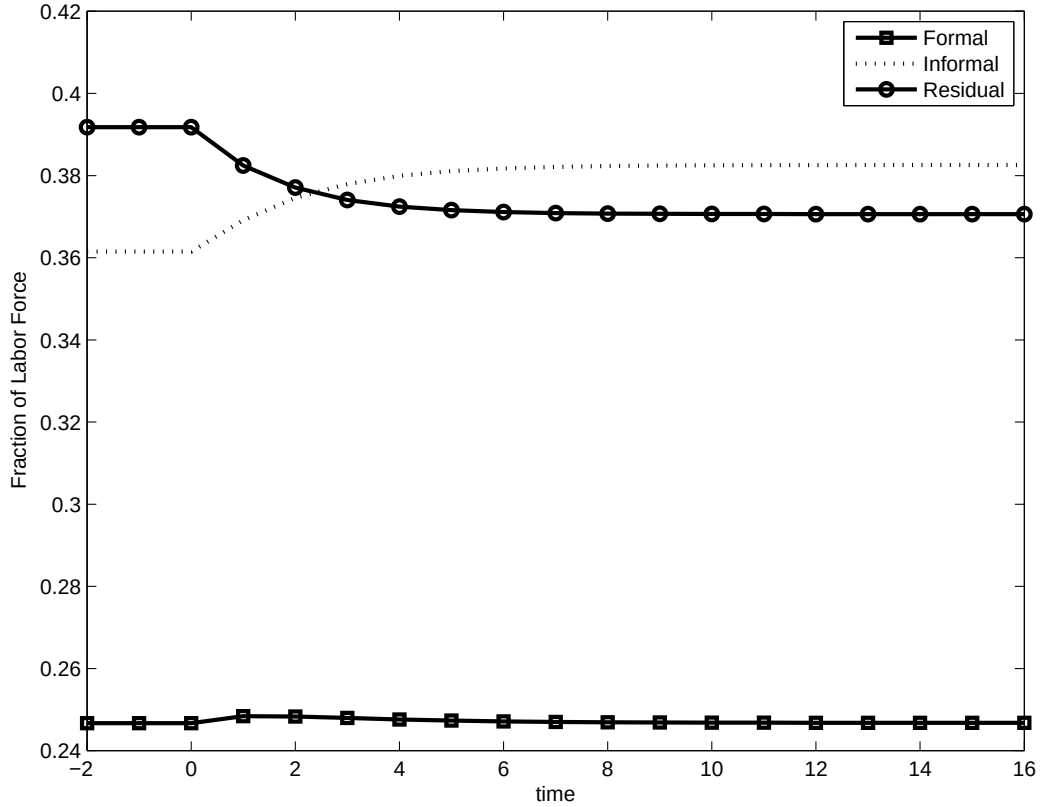

Figure 3: Wages − MEX

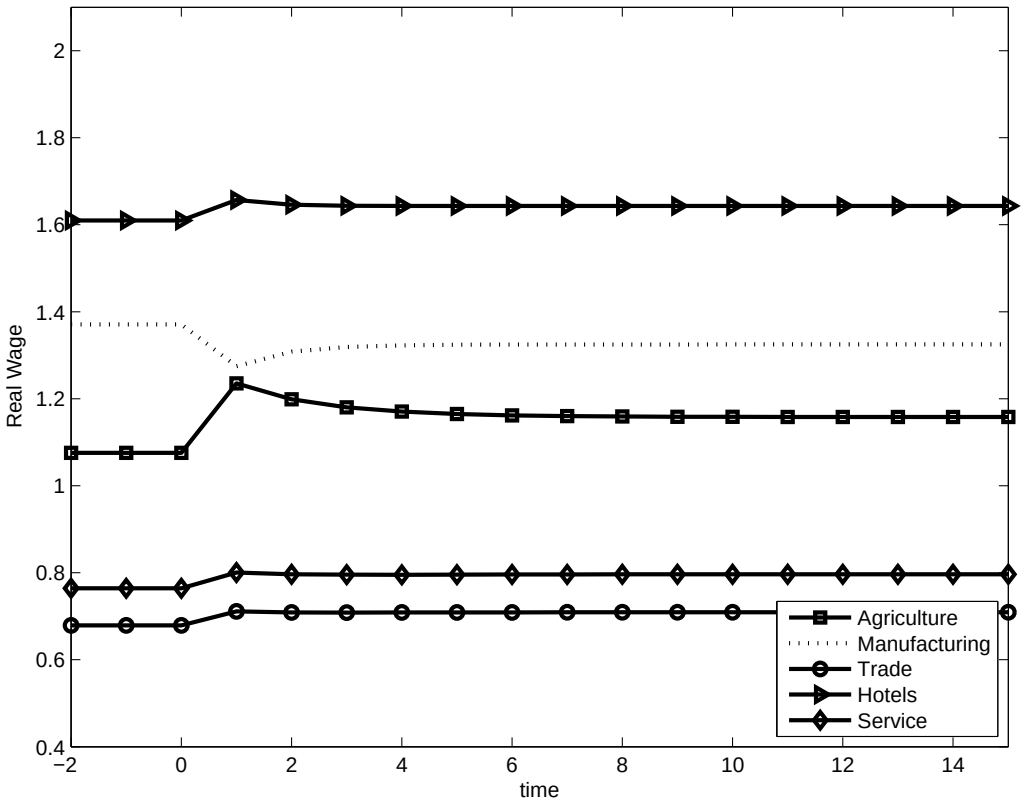

Figure 4: Sectoral Labor Allocation − BR

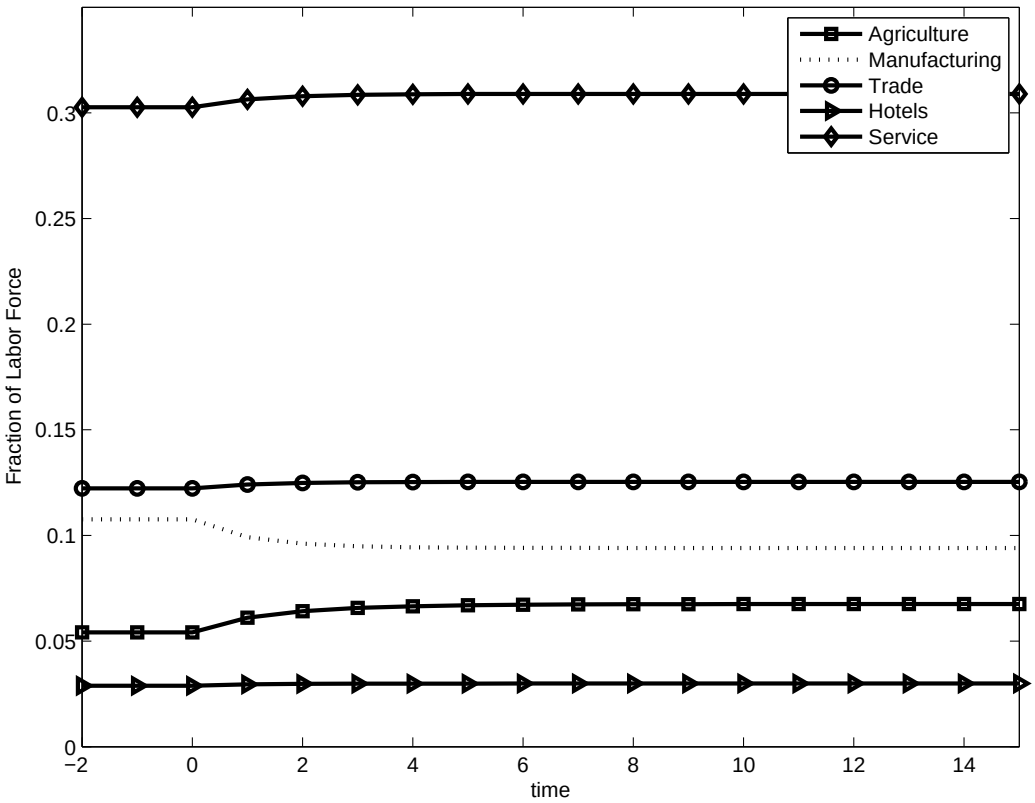

Figure 5: Formal Labor Allocation − BR

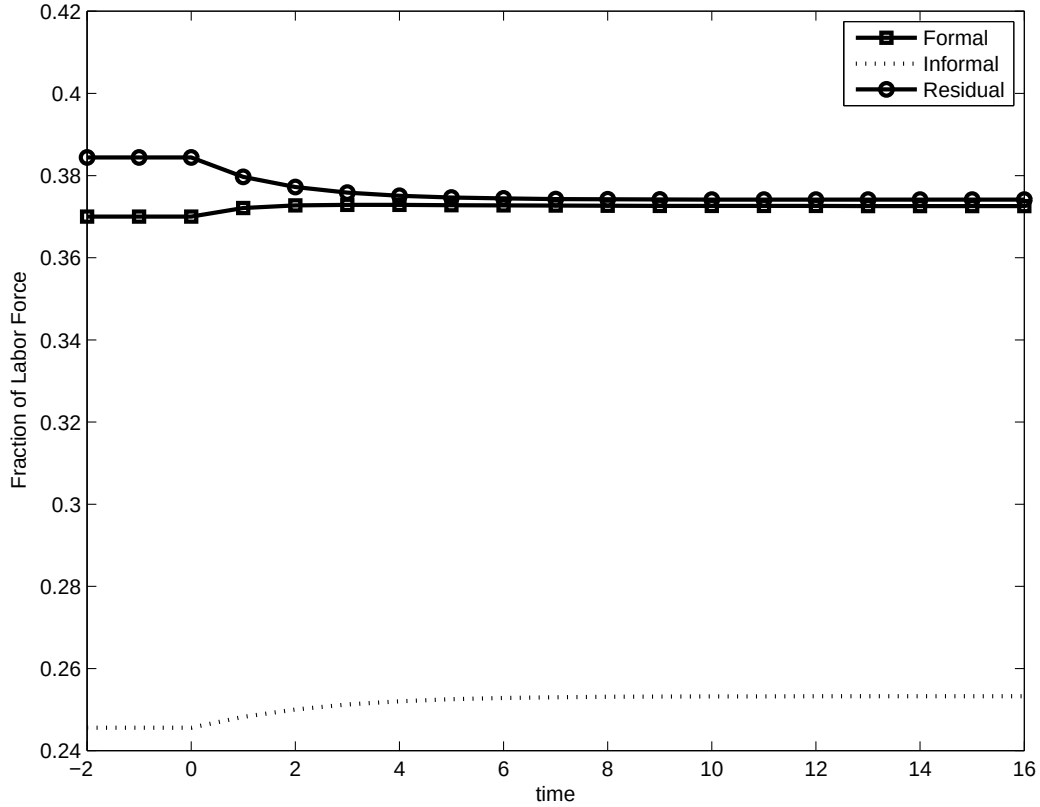

Figure 6: Wages − BR