Comparative analysis of labor market dynamics using Markov processes: An application to informality ☆

Mariano Bosch [a], William F. Maloney [b,*]

[a] Universidad de Alicante, Spain
[b] World Bank, United States

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ABSTRACT

This paper discusses a set of statistics for examining labor market dynamics in developing countries and offers a simple search model that informs their interpretation. It then employs panel data from Argentina, Brazil and Mexico to generate a set of preliminary stylized facts about patterns of sectoral transition and duration. Finally, it nests two competing views of the informal sector within the model and uses variation in the statistics across age and the business cycle to help discriminate between them. The results suggest that a substantial part of the informal sector, particularly the self-employed, corresponds to voluntary entry, although informal salaried work may correspond more closely to the standard queuing view, especially for younger workers.

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1. Introduction

Traditional static analysis of labor markets provides evidence on stocks of workers found in different labor market states, but can tell us little about where those workers arrived from, how long they will stay, or where they will go next. The importance of answering these questions and developing the tools to do so has been increasingly apparent in the mainstream literature, for example, on the causes of unemployment (whether due to shedding of labor by firms or reduced hiring) or the different motivations behind being unemployed vs. out of the labor force (see, for example, Flinn and Heckman, 1982; Blanchard and Diamond, 1992; Shimer, 2007). Increasingly, panel data sets are becoming available in developing countries, offering the potential for greater understanding of how their labor markets function and how they may differ from advanced country markets.

This paper makes three contributions in this direction. First, it offers a simple heuristic search model to aid in the interpretation of transitions and discusses a corresponding set of statistics based on the estimations of continuous time Markov transition processes. Second, it employs these techniques to study and compare labor market dynamics in Argentina, Brazil and Mexico, thus generating the first continuous time comparative work on labor markets in developing countries.[1] The estimates suggest broad commonalities among the three countries as well as some suggestive differences. In the process, we discuss how a statistic that conditions on both rate of separation and new matches in the destination sector has the interpretation of workers' revealed comparative advantage in a particular sector.

Third, we use these statistics to examine the particular question of the role of the informal sector, defined as workers lacking coverage by formal labor benefits, which accounts for a large share of the developing world work force. For example, the ILO (2002) argues that the sector accounts for 51% of non agricultural employment in Latin America, 65% in Asia, and 72% in sub Saharan Africa. One view, broadly analogous to the dual labor market literature in the US sees informality as disguised unemployment, receiving workers who have

* Corresponding author.
E-mail addresses: mbosch@merlin.fae.ua.es (M. Bosch), wmaloney@worldbank.org (W.F. Maloney).

[1] See also Bosch and Maloney (2005).

comparative advantage in formal sector jobs, but have lost or are unable to find one.[2] An alternative, more in the spirit of Lucas (1978) sees workers indifferent at the margin of formality and informality and transiting to take advantage of profitable opportunities arising in both sectors.[3] We nest the competing views on reasons for entry into the sector in our search model and discuss the implications for expected transition patterns.

This question offers a rich case study through which to view the strengths and weaknesses of these tools, but it is also of intrinsic interest. As the flow approach to modeling labor markets has become the standard in the literature, a new generation of search models has focused on developing countries, including the incorporation of an informal sector.[4] We therefore contribute to the limited supporting body of empirical stylized facts available upon which to anchor these models. From a policy point of view, understanding the nature of the sector is critical. If, for instance, the large fraction of developing country workers found in the informal sector shows dynamics similar to those of the unemployed, then the distortions in the formal sector are indeed large and the case for reform is compelling. If, however, they show dynamics closer to those of the formal sector, then the policy focus shifts to understanding the cost–benefit analysis that agents undertake in choosing among sectors, also with important policy implications (see, for instance, Levy, 2008).

Finally, we discuss the challenge to inference posed by the fact that these statistics are both reduced forms capturing comparative advantage considerations as well as the state of the markets, and aggregates across heterogeneous sectors. We therefore explore additional identification strategies arising from worker heterogeneity and the business cycle. The results indicate that a substantial part of the informal sector, particularly the self-employed, corresponds to voluntary entry although informal salaried work may correspond more closely to the standard queuing view, especially for younger workers.

2. A simple search model with informal jobs

This section presents a simple stylized model to illustrate these two views in a search context, and how they translate into the statistics we discuss. The model focuses on the direct transitions between formal and informal employment which are most likely to offer insight into the drivers of entry into informality. We are especially interested in isolating the parameters driving selection of one sector vs. another and, more specifically, the impact of market distortions on the estimated statistics.

Consider a three sector search and matching model with unemployment, formal, and informal jobs. Assume that there are h types of workers with a series of attributes that affect two parameters. The first is $a_{k,l}^h$ which reflects worker h in sector k's preference for, or ability to work in, sector l relative to all other possible destination sectors given wages and a particular state of the market.[5] In our model this ability translates into the capacity to generate work opportunities in sector l, superior to the present job in sector k. The second is s_k^h, which captures the search intensity of worker h in sector k. For instance, young people in general have a higher search intensity and corresponding turnover than older people. If sector k is comprised of young workers relative to sector l, we would expect higher turnover in sector k. For simplicity we

abstract from the firm side and focus on worker decisions to enter each of the two sectors.[6] Following the now standard search and matching models in the literature (see Pissarides, 2000) and given an interest rate of r, we can write the present discounted value of an informal job for type of worker h, I^h, as

$$rI^h = w_I + \theta_{I,F}^h(a_{I,F}^h, v_F, s_I^h)(F^h - I^h) + \lambda_I(U^h - I^h) \qquad (1)$$

Eq. (1) is straightforward to interpret. The instantaneous return for worker h holding an informal job is given by its wage, w_I, which for simplicity is assumed to be exogenous. While holding an informal job, the worker encounters profitable opportunities in the formal sector that give the worker higher value than the current job, that is, $I^h < F^h$. Due to the existence of search frictions in the labor market, these opportunities come stochastically at a rate $\theta_{I,F}^h(a_{I,F}^h, v_F, s_I^h)$, which is a function of the preference/ability of the worker to obtain a formal job, $a_{I,F}^h$, the search intensity of worker h in the informal sector, s_I^h, and the abundance of openings (vacancies) in the destination sector, v_F. We assume that $\theta_{I,F}^h(a_{I,F}^h, v_F, s_I^h)$ is increasing in all three arguments. When an opportunity materializes, the worker h transits to a formal job and quits the informal job. The net gain of this transition is represented by $F^h - I^h$. Finally, the last term of Eq. (1) shows the change in the value of the job if the worker is thrown into unemployment, which happens at a constant exogenous rate, λ_I. Let U^h represent the present discounted value of unemployment for worker h. Similarly, the present discounted value of holding a formal job for worker h, F^h, can be expressed as

$$rF^h = w_F + (\theta_{F,I}^h(a_{F,I}^h, v_I, s_F^h) + \phi_{F,I})(I^h - F^h) + \lambda_F(U^h - F^h) \qquad (2)$$

In this case formal workers earn a wage w_F. The specification in Eq. (2) is flexible enough to nest competing views of the drivers of inter-sectoral transitions and hence, the particular view of the role of the informal sector. In the absence of segmentation, a transition from a formal to an informal job may occur because, similar to the reverse flow, formal workers manage to find profitable opportunities in the informal market, $\theta_{F,I}^h(a_{F,I}^h, v_I, s_F^h)$. However, a segmenting distortion that artificially raises the relative wages in the formal sector (i.e. minimum wage) may generate that in the limit $\theta_{F,I}^h(a_{F,I}^h, v_I, s_F^h) = 0, \forall v_I \forall s_F^h$. That is, no formal worker can find profitable opportunities in the informal sector for any state of the market simply because $a_{F,I}^h$ is very low. We should only see transitions from formal jobs towards informality due to involuntary separations which occur at the rate $\phi_{F,I}$ in which case workers take up informal jobs in order to avoid unemployment. By a similar logic, the informal–formal transition rate $\theta_{I,F}^h(a_{I,F}^h, v_F, s_I^h)$ reflects queuing to access a superior job through two offsetting effects. First, the distortion reduces the number of positions opening in the formal sector, v_F, since higher wages reduce the firm's labor demand. Second, it increases the relative attractiveness of those openings. Translated into our model, the latter implies an increase in $a_{I,F}^h$.

If a worker is separated from either of the two sectors, a new job search starts in both sectors simultaneously. Given the generalized absence of unemployment insurance programs in developing countries, we assume the flow income when unemployed to be zero. We also assume that the worker accepts the first offer that arrives from either sector, that is $U^h < I^h$ and $U^h < F^h$. Further, the probability of transition towards formal or informal jobs depends on the same fundamentals as those driving the inter-sectoral flows, but

[2] See Fields (2006) for a guide to multi-sectoral models with informal jobs.
[3] See for instance, Magnac (1991), Rauch (1991), Loayza (1996), Maloney (1999), Maloney and Nuñez (2004) and De Paula and Scheinkman (2008).
[4] See Fugazza and Jacques (2004), Albrecht et al. (2009) and Zenou (2008).
[5] The idea that workers' relative endowments of characteristics determines their comparative advantage in different types of jobs appears in Lucas' (1978) discussion of choices between salaried work and self-employment, and explicitly in Rosen (1978), Heckman and Sedlacek (1985), Magnac (1991).

[6] To ensure profits for the firm (and vacancy posting) we assume that the productivity of the workers in each sector is above the corresponding wages. For more detailed search models with informal workers the reader is referred to Albrecht et al. (2009) and Zenou (2008).

the level may be different. The flow value from unemployment for a worker can be written as

$$rU^h = \theta^h_{U,I}(a^h_{U,I}, v_I, s^h_U)(I^h - U^h) + \theta^h_{U,F}(a^h_{U,F}, v_F, s^h_U)(F^h - U^h) \tag{3}$$

Closing the model requires imposing an arbitrage condition for the entry of firms in both markets to determine the number of vacancies in each sector. This free entry condition equalizes the cost of posting a vacancy with the expected return of the vacancy. Then, with knowledge of the set of parameters $a^h_{k,l}$ and s^h_k and the transition rates into unemployment λ_I and λ_F, and the involuntary transition rate into informality $\phi_{F,I}$, we can compute the endogenous transition rates across employment states $\theta^h_{F,I}(a^h_{F,I}, v_I, s^h_F)$ and $\theta^h_{I,F}(a^h_{I,F}, v_F, s^h_F)$ and the flows into employment, $\theta^h_{U,I}(a^h_{U,I}, v_I, s^h_U)$ and $\theta^h_{U,F}(a^h_{U,F}, v_F, s^h_U)$. Given these transition rates and normalizing the population to one, we can write the steady state levels of unemployment, u^h, formal employment, n^h_F, and informal employment, n^h_I, for worker type h as

$$u^h = \frac{\lambda_I n^h_I + \lambda_F n^h_F}{\theta^h_{U,I}(a^h_{U,I}, v_I, s^h_U) + \theta^h_{U,F}(a^h_{U,F}, v_F, s^h_U)}$$

$$n^h_F = \frac{\theta^h_{I,F}(a^h_{I,F}, v_F, s^h_I)n^h_I + \theta^h_{U,F}(a^h_{U,F}, v_F, s^h_U)u^h}{\theta^h_{F,I}(a^h_{F,I}, v_I, s^h_F) + \phi_{F,I} + \lambda_F} \tag{4}$$

$$u^h + n^h_F + n^h_I = 1$$

From Eq. (4) it is clear that comparisons of sector sizes can tell us little about the underlying nature of the labor market. A small formal sector, n^h_F, could reflect distortions limiting v_F and raising $a^h_{F,I}/a^h_{F,I}$, or a strong relative attractiveness of informal work. Further, as we note in the final section on patterns across the business cycle, movements in formal employment are consistent with a variety of labor force dynamics. Breaking these ratios into their component transitions can potentially offer more insights.

3. Estimation

Labor surveys allow us to observe the employment states of workers at discrete intervals. However, mobility can be viewed more realistically as a process in which state changes occur at random points in time and the movement between particular states is governed by continuous time Markov transition matrices (see Singer and Spilerman, 1976; Magnac and Robin, 1994; Fougère and Kamionka, 2003, 2008). Further, a new generation of studies has emphasized the need to convert discrete transition probabilities into continuous rates to correct from time aggregation biases (Shimer, 2007; Elsby et al., 2009).

We assume that the observed discrete-time mobility process is generated by a continuous-time homogeneous Markov process X_t defined over a discrete state-space $E = \{1,....K\}$ where K is the number of possible states (job sectors) in which a worker could be found. With observations on worker states at regular periodicity we construct a discrete time transition matrix $P(t, t + \Delta t)$ where $p_{k,l}(t, t + \Delta t) = Pr(X(t + \Delta t) = k | X(t) = l)$. The interpretation of $p_{k,l}$ is simply the probability of moving from generic state k to state l in one step (Δt). Discrete time matrices are straightforward to compute as the maximum likelihood estimator for $p_{k,l}$ is $p_{k,l} = m_{k,l}/m_k$, where $m_{k,l}$ is the total number of transitions from state k to state l and m_k the total number of observations initially in state k. As $\Delta t \to 0$, this gives rise to a $K \times K$ transition intensity matrix Q where

$$\frac{dP(t)}{d(t)} = QP(t) \tag{5}$$

whose solution is given by

$$P(t) = e^{tQ} \tag{6}$$

Equivalently, Q can be defined as

$$Q = ENE^{-1} \tag{7}$$

where $E = [e_1, ..., e_K]$, $N = \mathrm{diag}[\log(\alpha_1)/t, ..., \log(\alpha_K)/t]$, and α_i and e_i are respectively the eigenvalues and eigenvectors of $P(t)$.

For Q to be a proper intensity matrix, its elements have to satisfy

$$q_{k,l} = \begin{cases} q_{k,l} \in R^+, & l \neq k, \\ q_{k,k} = -\sum_{k=1,k\neq l}^{K} q_{k,l} \leq 0, & k = l \end{cases} \tag{8}$$

The $q_{k,l}$ elements can be interpreted as the instantaneous transition (hazard) rates from state k to state l. They correspond exactly to the $\theta_{k,l}$ parameters in the continuous time model of the previous section and we refer to them as the Q-statistic.

In practice, the estimation of continuous time transition matrices is subject to two major difficulties. First, a complex eigenvalue in Eq. (7) would give rise to a complex logarithm that has infinitely many branches since $\log(\alpha_i) = \log|\alpha_i| + i(\arg(\alpha_i) + 2\pi b)$ where $b = 0, \pm 1, \pm 2, \pm 3...$ is the number of possible branches. This is known as the aliasing problem and is a recurrent issue in the transition from discrete to continuous time. Second, it is possible that none of the solutions obtained for Q is compatible with the theoretical model expressed in Eq. (5) where the elements of Q have to satisfy the set of restrictions laid out in Eq. (8). This is known as the embeddability problem.

Geweke et al. (1986) show that both the aliasing and the embeddability problems interact in a way that it is possible to generate an algorithm to compute any intensity matrix Q corresponding to a given matrix P. We follow their Bayesian procedure for statistical inference on intensity using a diffuse prior (see Appendix I for details).[7] The method consists of drawing a large number of discrete time matrices from a previously defined "importance function," assessing their embeddability, and then constructing credible sets of the parameters or functions of interest using only the posterior distribution of those matrices that turn out to be embeddable. This method provides a very natural way of assessing the probability of embeddability as the proportion of the embeddable draws.

3.1. Controlling for likelihood of separation and measuring duration

A central aim of the paper is to move beyond estimating $\theta^h_{k,l}$ to obtain the other structural parameters of the model (s^h_k and $a^h_{k,l}$ for example). This requires putting more structure on $\theta^h_{k,l}(a^h_{k,l}, v_l, s^h_k)$. We borrow from the mainstream search and matching literature to do so, assuming that the number of matches is a function of the number of job searchers and vacancies in the market.[8] Traditionally, this matching function is increasing in both arguments, concave, and homogeneous of degree one. In particular, the empirical literature has shown that a log linear Cobb Douglas function fits the data well (Pissarides, 2000). Broadly in this spirit we can write the intersectoral transition rates as

$$\theta^h_{k,l}(a^h_{k,l}, v_l, s^h_k) = a^h_{k,l} s^h_k v^\eta_l \tag{9}$$

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[7] Kalbfleisch and Lawless (1985) develop an alternative procedure to estimate the continuous time matrices, however, this is only available for embeddable matrices.

[8] In this case we can abstract from job searchers since we consider that all workers (unemployed and employed) are searching for new jobs.

where the parameter η represents the concavity of the vacancies in the matching function and is assumed to be between 0 and 1.

In this setup, knowing s_k^h, v_l, and the transition rates among two sectors allows an estimation of $a_{k,l}^h$. We first calculate the *propensity* matrix, the *R*-statistic, whose elements are $r_{k,l} = -q_{k,l}/q_{k,k}$ for $k \neq l$, and which provides a measure of transition probabilities conditional on the general rate of turnover in the sector. Further, under the assumption of time homogeneity in the Markov process, the average duration in state k, d_k, is distributed exponentially with parameter $-q_{k,k}$. Hence, $E(d_k) = -q_{k,k}^{-1}$.[9]

The propensity nets out differential search rates across origin sectors and reflects a composite between the preference/ability to transit and the availability of vacancies in the destination sector. In the context of the model, if we assume that the total turnover rate is a function of the search intensity parameter, s_k^h,[10] the propensity rates between formal and informal employment can be written as

$$r_{k,l}^h = \frac{a_{k,l}^h s_k^h v_l^\eta}{s_k^h} = a_{k,l}^h v_l^\eta \qquad (10)$$

From Eq. (10) it is clear that obtaining a measure of $a_{k,l}$ requires further controlling for the state of the two destination markets. This is the intuition behind controlling for the size of the terminal sector proposed by Maloney (1999), and the adjustment for job creation in the destination sector suggested by Pages and Stampini (2006) and Duryea et al. (2006). Our model suggests that what we wish to control for is, in fact, job vacancies in the destination sector, v_l^η, whether new or old positions. We capture this by constructing a continuous time adjusted propensity *C*-statistic whose elements can be written as

$$c_{k,l}^h = \frac{r_{k,l}^h}{\dfrac{\sum\limits_{k=1,k \neq l}^{K} n_{k,l}^{h,*}}{\sum\limits_{l=1}^{K} \sum\limits_{k=1,k \neq l}^{K} n_{k,l}^{h,*}}} \qquad (11)$$

The numerator of Eq. (11) is the propensity to transit from sector k to sector l as defined in Eq. (10) and the denominator is a proxy of job openings in the destination sector. In particular $n_{k,l}^{h,*} = q_{k,l}^h n_{k}^{h,*}$ where $n_k^{h,*}$ is the stationary share of the population in sector k for worker type h and hence $n_{k,l}^{h,*}$ represents the stationary continuous time inflow into sector l from sector k for worker type h. The denominator of $c_{k,l}^h$ represents the continuous time inflow to sector l (from all other sectors) as a ratio of the inflows to all other sectors. Therefore, $c_{k,l}^h$ can be interpreted as the propensity of transiting from sector k to l, controlling for job openings in sector l. We assume that the denominator of Eq. (11) depends on the number of vacancies opened in the destination sector through the same functional form as the transition rates. Hence, we can write

$$c_{k,l}^h = \frac{r_{k,l}^h}{\dfrac{\sum\limits_{k=1,k \neq l}^{K} n_{k,l}^{h,*}}{\sum\limits_{l=1}^{K} \sum\limits_{k=1,k \neq l}^{K} n_{k,l}^{h,*}}} = \frac{a_{k,l}^h v_l^\eta}{v_l^\eta} = a_{k,l}^h \qquad (12)$$

Then the ratio of two bilateral $c_{k,l}^h$ returns the ratio of the preference/ability parameters among the two sectors, $\frac{c_{k,l}^h}{c_{l,k}^h} = \frac{a_{k,l}^h}{a_{l,k}^h}$.

Importantly, we argue that the *C*-statistic can be seen as the worker's probability of transiting from k into l over its probability of leaving sector k, relative to the analogous ratio for all the sectors. Thus, the *C*-statistic approximation of $a_{k,l}^h$ takes the same form as Balassa's (1965) measure of Revealed Comparative Advantage in trade where the measure is a

country's exports of a good over total exports relative to the global analogue. Thus, in the case of competitive markets where workers have allocated themselves freely across sectors, a high $c_{k,l}^h$ indicates that a worker in sector k has a comparative advantage in sector l. In addition, however, we should expect symmetry across sectors: whatever preferences or abilities led a worker who chooses k to have a comparative advantage in l should also lead to an equivalent measure of comparative advantage from l to k, $a_{k,l}^h \approx a_{l,k}^h$. To continue the trade analogy, the more two sectors are similar in the worker characteristics used "intensively," the more we should find them showing similar patterns of revealed comparative advantage. The same is true for two sectors that require very different skills as Lucas (1978) claimed was the case with self employment and salaried work. We would expect to find lower, yet still symmetrical $c_{k,l}^h$ values.

This symmetry would not necessarily be true in the presence of barriers to mobility where one sector dominates the other. As the model suggests, a segmenting distortion first, has the impact of reducing the number of positions in the sector in which it is enforced. This effect remains embodied in the *R*-statistic but is stripped out of the *C*-statistic. However, the distortion also alters the *C*-statistic by changing the relative attractiveness of formal and informal positions. If markets are segmented we should see relative *C*'s capturing largely unidirectional flows from informality into formality: Workers are born, enter informality, graduate to formality, and retire. Thus, the symmetry of the *C*'s offers a potential test between the two views of informality.

As the model suggests, however, important caveats apply. For example, despite the relatively high costs of firing workers in the region (see Botero et al., 2004; Heckman and Pages, 2004), involuntary separations do occur and firms do go bankrupt: Formal to informal flows are a composite of voluntary transitions, $\theta_{F,I}^h(a_{F,I}^h, v_I, s_F^h)$, and involuntary transitions, $\phi_{F,I}$. Hence, while symmetry in the relative *C*'s is suggestive of the expected indifference of a worker between the two sectors, it could potentially reflect a fortuitous combination of the two motives for transitioning. In particular, if the dominant formal–informal transitions are involuntary we would be overestimating the worker's preferences for informal jobs.

Further, the overlapping but differently centered distributions of ages across sector pairs suggest that the assumption of homogenous endowments, and therefore comparative advantage, within each sector is too strong. Hence, the aggregate statistics may mask an underlying heterogeneity that potentially alters their interpretation.

Our empirical strategy is, therefore, as follows. We first calculate the aggregate *Q, R* and *C*-statistics to identify broad stylized facts within and across countries. We then examine the two elements underlying the distinct views of the sector discussed above. We disaggregate by age, focusing on what the relative *C*'s reveal about changing sectoral preferences/abilities across the lifecycle. We then study transitions across the business cycle where movements in vacancies provide additional identification power to understand the degree of voluntariness in the transitions between formality and informality.

4. Data and country context

Argentina, Brazil, and Mexico were chosen to study because of the availability of the panel data and their relative importance, together accounting for 70% of the Latin American work force. In addition, they span a range of contexts of potentially segmenting labor market legislation and institutions that would lead to queuing, in particular, minimum wages and union power. We do not argue that they are representative of all Latin American countries, and we certainly cannot reflexively extrapolate to other parts of the world. Nonetheless these countries are not obviously outliers among developing countries (See Botero et al., 2004; Heckman and Pages, 2004) and hence their experience is likely to be relevant to a wide range of cases.

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[9] See Fougère and Kamionka (2008) for details.
[10] The implicit assumption here is that exit rates to all other sectors depend identically (and linearly) on the intensity parameter, s_k^h.

Table 1
Selected indicators of potentially segmenting legislation and institutions.

	Argentina	Brazil	Mexico
MW/median wage 1/	.33	.24	.34
MW kernel density 1/	Non binding	Binding	Non binding
Collective Relations 2/	.58	.38	.58

Notes: The table shows different indicators of institutions in the labor market for Argentina, Brazil and Mexico. 1/MW: Maloney and Nuñez (2004) 2/ Botero et al. (2004).

In practice, it is not always clear how legal norms and institutional features translate into functional behaviors. Table 1 presents a number of indicators that have been used in the literature to detect segmentation in these labor markets. For instance, the ratio of the minimum wage to median wage in Argentina and Mexico is 50% higher than it is in Brazil (.33, .34 .24 respectively). However, kernel density plots looking at the deformation of the wage distribution show that Brazil is by far the most deformed and Mexico the least (Maloney and Nuñez, 2004). Botero et al.'s (2004) measure of collective relations which captures union coverage and power is again half as high in Argentina and Mexico as in Brazil (.58 .58 .38 respectively). However, union power is exercised differently across countries. In many Mexican manufacturing sectors it appears dedicated toward featherbedding activity with little impact on wages (Maloney, 2009). On the other hand, Argentine unions appear more classically concerned with maintaining higher than market clearing remuneration and compress the wage distribution (Groisman and Marshall, 2005). Though classic conditional earnings regressions are not reliable since they cannot control for the unobserved job related effects (risk premia, independence, implicit training, subjective valuation of foregone benefits — see Magnac (1991), Maloney (1999)), studies examining the co-movements of relative earnings and sector sizes across time (which implicitly abstract from these unobservables) are suggestive that Argentina is more segmented than either Brazil or Mexico with the latter perhaps the least segmented.[11]

4.1. The surveys

To construct the continuous time matrices we employ three different surveys which compile information about labor status of workers and other relevant information. Because preliminary investigation suggested very different behavior among men and women, we focus solely on males between 16 and 60 years of age and leave females for later work.

4.2. Mexico

The Encuesta Nacional de Empleo Urbano (ENEU National Urban Employment Survey) conducts extensive quarterly household interviews in the 16 major metropolitan areas. The questionnaire is extensive in its coverage of participation in the labor market, wages, hours worked, etc. that are traditionally found in such employment surveys. The ENEU is structured so as to track a fifth of each sample across a five quarter period. We have concatenated panels from the first quarter of

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[11] Fiess et al. (forthcoming) find the negative co-movements of relative sectors sizes and remuneration between informal self employed and formal workers to point to segmentation in Argentina across their entire sample period, while both Mexico and Brazil show substantial periods of competitive markets (positive co-movement). For Mexico the period leading up to the 1995 crisis suggested a segmented market but on either side the markets behave very competitively. For Brazil, there is a brief period of positive co-movement suggesting competitive markets from 1995–1998 but a significant segmentation from 1983 to 1989. Gasparini and Tornarolli (2007), broadly following this methodology arrive at similar conclusions.

Table 2
Sample distribution across sectors and age.

	All	16–24	24–40	40–60
Argentina				
OLF	20	48	3	11
UNM	12	14	11	10
SE	21	5	23	31
I	13	16	14	9
F	35	17	50	38
Observations	13,866	4322	3983	5561
Brazil				
OLF	16	24	2	20
UNM	4	6	3	2
SE	20	9	24	28
I	15	18	13	12
F	45	42	58	38
Observations	1,189,651	411,337	376,590	383,906
Mexico				
OLF	16	34	3	11
UNM	4	5	2	3
SE	28	13	32	41
I	10	15	8	6
F	42	33	54	40
Observations	809,754	283,627	267,331	258,796

Notes: The table shows the share of the population in each of the five employment sectors for Argentina, Brazil and Mexico, OLF = Out of the Labor Force, UNM = unemployment, SE = informal self employment, I = informal salaried, F = formal salaried. Data for Argentina is drawn from the Permanent Household Survey (EPH), from May 1993 to October 2001. Data for Brazil is drawn from the Monthly Employment Survey (PME), from January 1983 to June 2001. Data for Mexico is drawn from the quarterly National Urban Labor Survey (ENEU) from 1987:Q1 to 2004:Q4.

1987 to the fourth quarter of 2004. Each individual contributed with two transition pairs (from first quarter to the forth and second to the fifth) giving rise to approximately 810,000 transitions.

4.3. Argentina

In a similar fashion for Argentina, we use the Encuesta Permanente de Hogares (EPH Permanent Household Survey), a panel covering the area of the Federal District and surroundings (Gran Buenos Aires), which accounts for approximately 60% of total Argentinian employment. The survey is conducted every 6 months (April/May and October) with a 25% rotation of the panel. As a consequence, each household is followed for two years at sampling intervals of six months. We employ panels from May 1993 to October 2001. The sample is notably smaller than the Mexican and Brazilian surveys and we can only study 13,900 transitions.

4.4. Brazil

The Pesquisa Mensal do Emprego (PME Monthly Employment Survey) follows monthly employment indicators. Households are interviewed four months in a row, and then re-interviewed eight months later. A quarter of the sample is renewed every month. Given this panel structure we can construct four yearly employment status transitions for each individual. We have put together 9 consecutive panels starting in February 1982. Each panel consists of 12 consecutive cohorts covering approximately 2 years in the period 1982–2001. The total number of transitions is 1,190,000.

4.5. Sectoral definitions

We follow the International Labour Organization (ILO) in dividing employed workers into three employment sectors: informal salaried (I), informal self employed (SE) and formal sector workers (F) see Bosch and

Table 3
Intensity matrix (*Q*-statistic): Argentina, Brazil and Mexico.

Argentina						Brazil						Mexico				
	OLF	UNM	SE	I	F		OLF	UNM	SE	I	F		OLF	UNM	SE	I	F
OLF	−0.390	0.249	0.006	0.106	0.028	OLF	−0.420	0.117	0.065	0.137	0.101	OLF	−0.451	0.141	0.035	0.180	0.095
	0.016	0.010	0.000	0.004	0.001		0.001	0.001	0.001	0.001	0.001		0.003	0.003	0.001	0.003	0.002
UNM	0.194	−1.175	0.267	0.546	0.169	UNM	0.391	−2.069	0.298	0.588	0.792	UNM	0.580	−2.246	0.222	0.814	0.630
	0.008	0.047	0.011	0.022	0.007		0.004	0.010	0.004	0.007	0.006		0.012	0.024	0.008	0.016	0.012
SE	0.023	0.148	−0.424	0.219	0.034	SE	0.082	0.052	−0.426	0.201	0.091	SE	0.034	0.026	−0.501	0.265	0.175
	0.001	0.006	0.017	0.009	0.001		0.001	0.001	0.001	0.001	0.001		0.001	0.001	0.002	0.002	0.001
I	0.042	0.358	0.258	−0.906	0.247	I	0.160	0.167	0.308	−1.102	0.468	I	0.099	0.099	0.259	−0.869	0.412
	0.002	0.014	0.010	0.036	0.010		0.002	0.003	0.002	0.004	0.002		0.001	0.002	0.002	0.003	0.002
F	0.004	0.089	0.025	0.092	−0.211	F	0.037	0.079	0.037	0.069	−0.223	F	0.023	0.045	0.055	0.093	−0.216
	0.000	0.004	0.001	0.004	0.008		0.000	0.001	0.000	0.001	0.001		0.000	0.001	0.000	0.001	0.001

Notes: The table shows the posterior means and standard deviations of the intensity matrix elements for Argentina, Brazil and Mexico for males following the procedure described in Section 3. Computations are based on 10,000 Monte Carlo draws. Posterior standard deviations are shown below coefficients. OLF = Out of the Labor Force, UNM = unemployment, SE = informal self employment, I = informal salaried, F = formal salaried. Data (see notes in Table 2).

Maloney (2005) for further details.[12] The remainder of the sample is divided into two non-employment groups identical to those in the advanced country literature: those out of the labor force (OLF), and the unemployed (UNM). As in the mainstream literature, the distinction between these two groups is made on the basis of whether the individuals are actively looking for a job. The sample was further divided into three age groups: between 16 and 24 years of age, 24 to 40, and above 40. Table 2 retrieves the summary of the population distribution among different sectors split according to age. The three surveys are sampled monthly for Brazil, quarterly for Mexico and biannually for Argentina and we compute yearly transitions as the common transition interval.

5. Patterns of mobility

Table 3 presents the posterior means and standard deviations of the estimated intensity matrix (*Q*-statistic) for all three countries. The posterior probabilities of embeddability (not reported) for Brazil and Mexico are all unity indicating embeddability for all different demographic subgroups. Argentina, however, shows probabilities of near unity for the overall matrix, but substantially less for subgroups of workers age 24–40 (.38).

The matrices in Table 3 show that the three labor markets are broadly of the same phylum, showing a high degree of commonality in almost any arbitrarily chosen transition, some of which are discussed in more detail below. The same is true with "stayers" along the diagonal. Fig. 1 presents the posterior means of the average duration in each sector together with the 95% credible sets (see Fougère and Kamionka, 2008). Durations differ significantly across sectors, as shown by non-overlapping credible sets, but are remarkably similar across countries: formal employment shows the highest duration (around 4.5 years) followed by self-employment (2 years), while duration in a salaried informal job is relatively short (1 year). As a notable difference across countries, Argentina shows substantially higher duration in unemployment than the other two countries, consistent with previously discussed evidence on labor market rigidity.

5.1. Transitions between formal and informal jobs

Fig. 2 provides graphical representation of the three sets of inter-sectoral transition rates corresponding to the raw intensities, *Q*-statistic, propensities, *R*-statistic, and propensities adjusted for job openings, *C*-statistic. Again, we report the 95% credible set for each transition rate. As noted above, there is a high degree of similarity in intensities across countries and across sectoral pairs. For instance, in all three countries, the transition rates (*Q*-statistic) between formal salaried-self-employment are small relative to informal salaried-self-employment flows and, especially, informal salaried-formal salaried flows. Second, this last set of flows is highly asymmetric: informal salaried-formal flows are several times higher than the reverse flow. However, this tentative support for a traditional queuing view largely disappears and in some cases is reversed in the *R*-statistics. This implies that the previous asymmetries in the *Q*-statistics were driven by the higher turnover (short duration) of the informal salaried compared to the formal salaried.

The rightmost panel of Fig. 2 shows that the picture changes importantly again when we further correct for the job openings in the destination sector (*C*-statistic). We see a high degree of symmetry in formal salaried-self employment flows and, with the exception of Brazil, in the formal–informal salaried flows. This is consistent with workers responding similarly in both directions to the relative availability of jobs in the destination sector. That is, workers transiting across these sectors do not show a strong pattern of comparative advantage in formality, but rather appear to be taking advantage of profitable opportunities arising in all sectors. However, it is the case that, with the exception of Mexico, the magnitudes of the *C*'s are substantially lower between self employment and formal salaried work than among the two salaried (F and I) and the two informal (I and
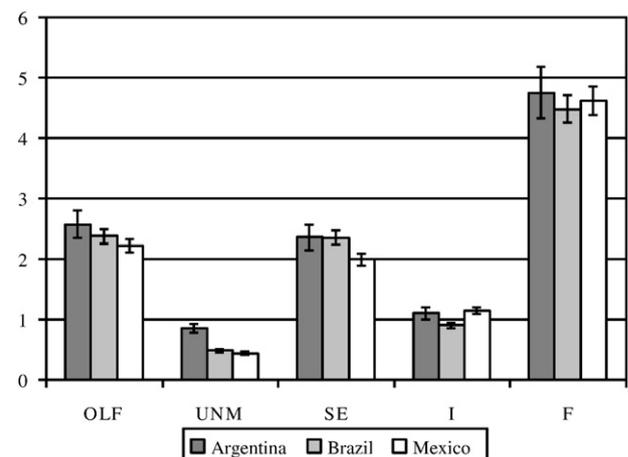

Fig. 1. Absolute mean duration in each sector in years. Notes: The figures show the average duration in years in each sector for Argentina, Brazil and Mexico as described in Section 3. Computations are based on 10,000 Monte Carlo draws. The error bars indicate the 95% credible sets. OLF = Out of the Labor Force, UNM = unemployment, SE = informal self employment, I = informal salaried, F = formal salaried. Data (see notes in Table 2).
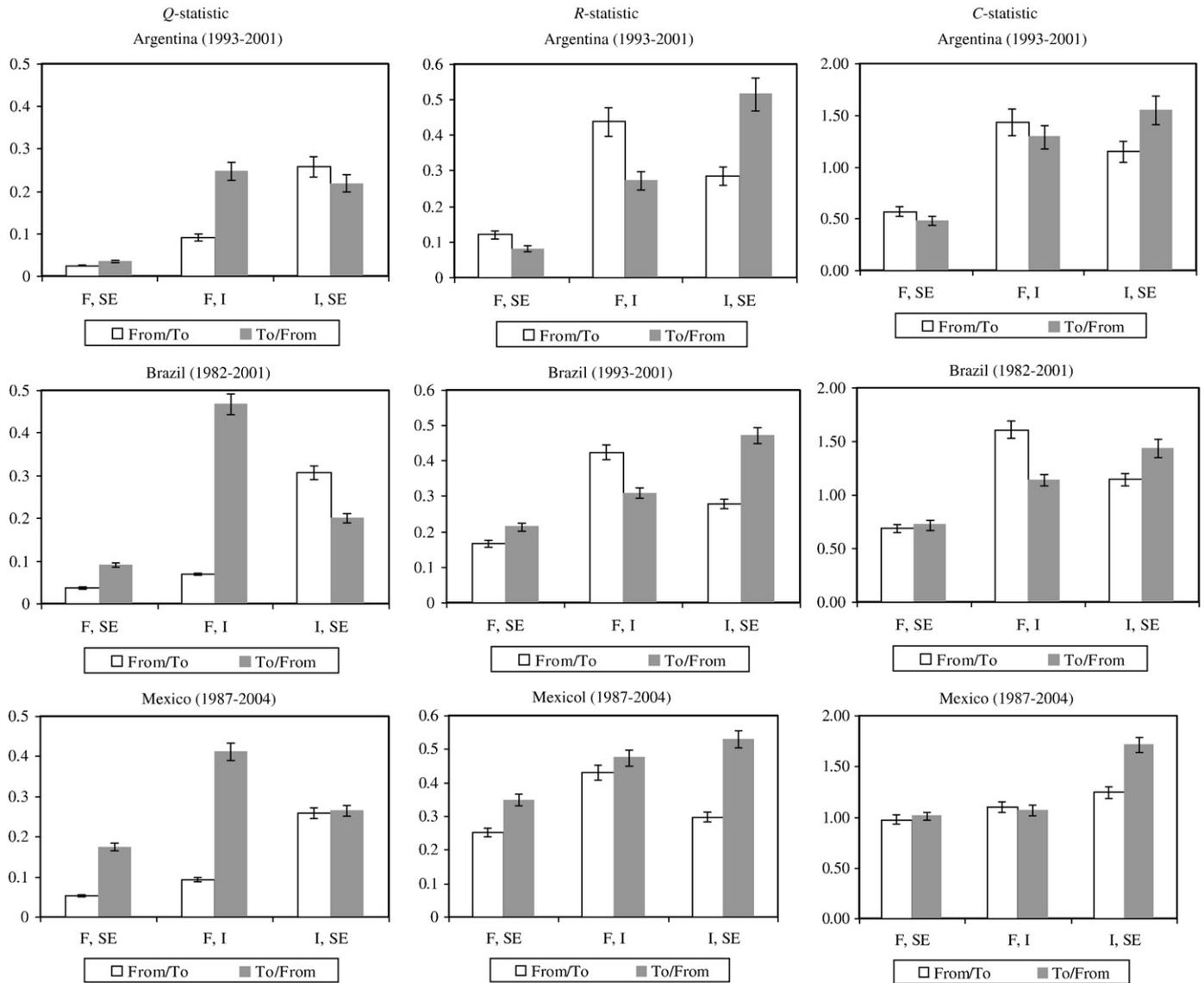
Fig. 2. Intensities, propensities and adjusted propensities among employment sectors. Notes: Figure shows the probabilities of transition among the Formal (F), Self employed (SE) and Informal Salaried (I) sectors. The Intensities (Q-statistic) Propensities (R-statistic) and Adjusted Propensities (C-statistic) further adjust by the availability of positions in the final sector and constitute a measure of revealed comparative advantage as described in Section 3. Computations are based on 10,000 Monte Carlo draws. The error bars indicate the 95% credible sets. Data (see notes in Table 2).

SE) sectors. This is consistent with salaried sectors being more similar in their demands for skills or qualities than self employment and formal salaried sectors. The roughly doubled values of $c_{F,SE}$ and $c_{SE,F}$ in Mexico suggest less differentiation/greater substitutability among these two sectors than elsewhere.

5.2. Differential patterns across age

The overlapping, but differently centered distribution of ages across sector pairs in Table 2 suggests that the assumption of homogenous endowments within each sector is too strong. It also presents an opportunity, however, as we are also able to use the observed patterns to help identify motivations for movement, drawing on analogous findings from the advanced country literature.

Table 4 reports the bilateral R and C ratios for the three sectors of employment by age group and reveals significant heterogeneity across age. Though not extremely sharp, the most dramatic differences in the R ratios are found in $r_{I,SE}/r_{SE,I}$ where young people show ratios two to three times higher than older people. This is followed by $r_{F,SE}/r_{SE,F}$ which, abstracting from an unusually high value for the

young in Argentina, shows older worker values roughly double those of younger workers. The ratio $r_{I,F}/r_{F,I}$ shows less variation across age groups, although even here, with the exception of Brazil, older

Table 4
Differences in bilateral propensities and adjusted propensities disaggregated by age.

		(SE−I)/(I−SE)		(I−F)/(F−I)		(F−SE)/(SE−F)	
		R-statistic	C-statistic	R-statistic	C-statistic	R-statistic	C-statistic
16–24	Argentina	3.17	1.55	0.54	0.79	1.95	0.58
	Brazil	2.62	1.14	1.48	0.65	0.56	0.61
	Mexico	3.85	1.40	0.84	1.02	0.43	0.84
24–40	Argentina	1.54	1.41	0.58	0.88	0.22	1.29
	Brazil	1.41	1.11	1.35	0.75	0.48	0.97
	Mexico	1.56	1.07	0.88	0.88	0.69	0.98
40–60	Argentina	1.17	1.27	0.69	1.15	1.89	1.31
	Brazil	1.10	1.13	1.32	1.26	0.93	1.36
	Mexico	1.06	1.24	1.06	1.14	1.05	1.08

Notes: The table shows the bilateral propensity (R-statistic) and adjusted propensity (C-statistic) ratios among the three employment sectors by age groups. SE = informal self employment, I = informal salaried, F = formal salaried. Data (see notes in Table 2).
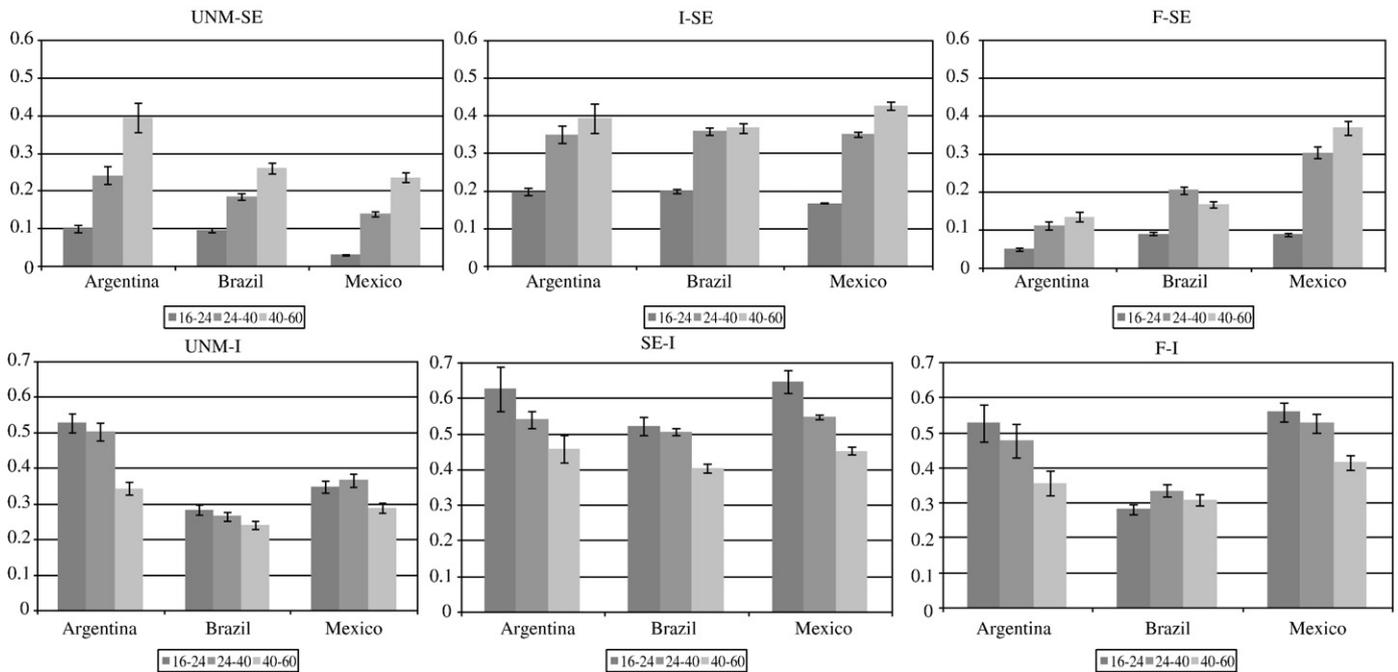
Fig. 3. Propensities into the three sectors of employment by age group. Notes: The figures show the propensity (*R*-statistic) to flow from unemployment into Formal salaried (F), Self employed (SE) and Informal Salaried (I) sectors for Argentina, Brazil and Mexico disaggregated by age, as described in Section 3. Computations are based on 10,000 Monte Carlo draws. The error bars indicate the 95% credible sets. Data (see notes in Table 2).

workers show values roughly 25–40% above young workers. The last of the three findings is broadly consistent with formal salaried work being more desirable. The more muted variation may be due to the offsetting effect of fewer vacancies, v_F, and greater preferences for formal work embodied in $a_{I,F}$.

The *C*-statistics allow us to examine the behavior of $a_{k,l}$ in more detail by stripping out the effect of vacancies and the patterns become substantially sharper. With the exception of Brazil, the same pattern remains, albeit muted, for $c_{SE,I}/c_{I,SE}$. However, $c_{F,SE}/c_{SE,F}$ now rises very dramatically from below .65 for 16–24 year olds in Argentina and Brazil to above 1.30 for 40–60 year olds in the same countries, and shows a more muted, but similar pattern for Mexico. These findings are consistent with older workers showing relatively greater preference/ability for self-employment. The exact opposite appears to be the case with $c_{I,F}/c_{F,I}$. In Argentina and Brazil young people show values of below 0.8 while older workers are above 1.10. Mexico, again, shows less variance. A consistent message emerges from the data. The two informal sectors are fundamentally different: As workers age, self-employment becomes relatively more attractive/feasible while informal salaried work becomes less so.

These findings resonate with the advanced country literature. Evans and Jovanovic (1989), attempting to explain the rising incidence of self employment with age, suggest that self employment is a relatively desirable sector but that credit constraints dictate that only older workers who have accumulated capital can enter. More generally, financial resources, on the job experience and having mature children who can help in the business, may all give older workers a comparative advantage in self employment.

It may be argued that the pattern observed, in fact, reflects that formal jobs are progressively less available to older workers who are perceived as less productive, and have less comparative advantage in the sector. Or, alternatively, that despite the high and age-escalating firing costs and seniority privileges documented as common in the region, older workers are disproportionately fired and seek refuge in self-employment, $\phi_{F,SE}$. However, after breaking apart the ratios, neither seems likely to be the case. In all three countries (see Fig. 3), the *R*-statistic for entry into self-employment from unemployment, from informal salaried and from formal salaried employment rises with age.

Meanwhile, transitions from unemployment, formal salaried and self employment to the other (salaried) informal sector broadly *decrease* with age. The two informal sectors clearly have distinct roles and, consistent with Evans and Jovanovic (1989), self employment does not seem to be an easy access retreat for young workers. Further, with the exception of Argentina, propensities into unemployment from formal jobs (not shown) are *decreasing* in age consistent with firing costs becoming more onerous with tenure, as are, with the exception of Brazil, transitions from formal to informal salaried work. In all, these patterns are more consistent with the accumulation of sufficient human and physical capital being a barrier to entry to self employment than the sector being primarily a refuge of discarded older workers.

Informal to formal transitions show the same increasing pattern in age and this, too, may be a function of experience and preferences. In
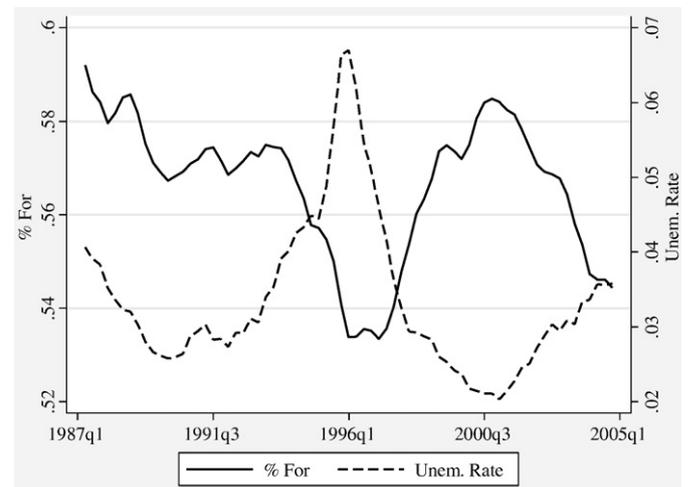

Fig. 4. Shares of formal informal sector and unemployment: (Mexico). Notes: The figure shows the quarterly share of formal employment constructed as number of formal workers over total employment and the unemployment rate (Unem. Rate) constructed as the number of unemployed workers over total labor force. Data is drawn from the quarterly National Urban Labor Survey (ENEU) from 1987:Q1 to 2004:Q4.
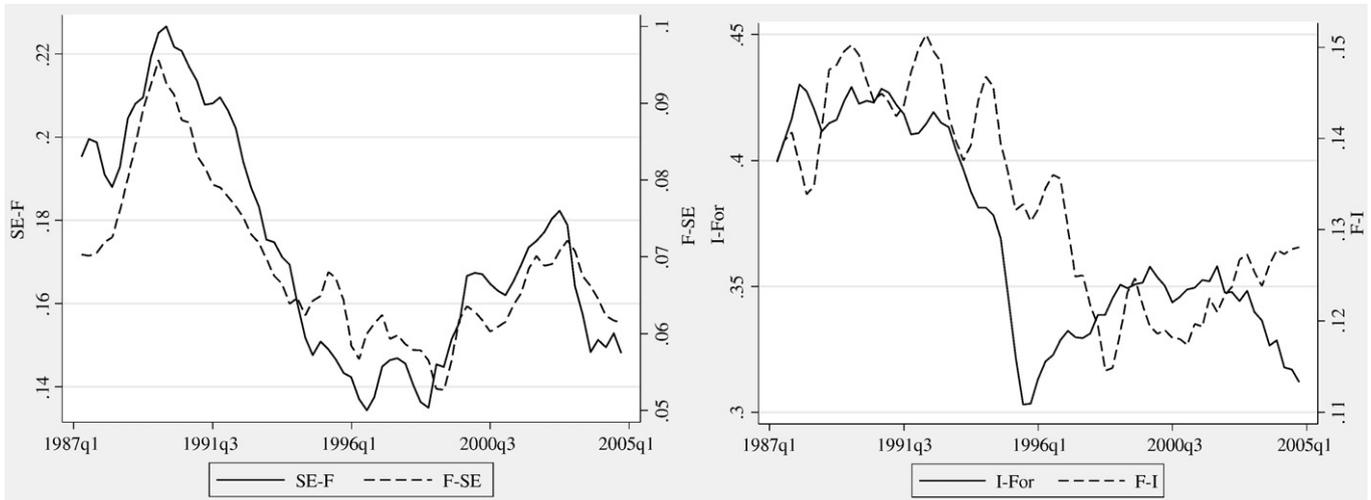
Fig. 5. Transitions rates between formality and informality: Mexico. Notes: The figures show the quarterly transitions rates (Q-statistic) between formality and the two sectors of informality as described in Section 3. Computations are based on 10,000 Monte Carlo replications for each quarter. SE = informal self employment, I = informal salaried, F = formal salaried. The original series were de-trended using an HP filter with parameter. Data (see notes in Fig. 4).

the presence of weak education systems, informal jobs provide training and experience for better jobs that they were not suitable for right out of school. On the preference side, these patterns may reflect obligations to work for a parent's informal firm while young, but then an increased premium placed on health benefits and job stability as the worker establishes a family. What is surprising is that an intrinsic preference for formal vs. informal work that we might expect with queuing does not influence the C-statistics more. This does not imply that there is no shortage of formal jobs for young people and hence no queuing — this effect has been stripped out in the C-statistics. It simply implies that the impact of earnings differentials between sectors on relative preferences does not appear dominant. Overall, the pattern of the young disproportionately entering the sector, in fact, from any sector combined with the high rates of turnover noted earlier is consistent with informal salaried work being a sector of entry in which young people queue, and use as a base to shop around other sectors, but then pass relatively rapidly on to preferred destinations.

5.3. Comparisons across countries

Beyond the large commonalities in the patterns discussed above we find country specific variations that offer some insights into how particular institutional arrangements map into labor market dynamics. First, Argentina's relatively high duration in unemployment, high rates of transition from unemployment into informal salaried work across both young and prime age, and low rates of entry into formal work are consistent with the high rates of unemployment seen across this period and more rigid labor markets as discussed in Section 4.

Table 5
Correlation of de-trended Intensities among employment sectors by age.

	F–I vs. I–F	SE–F vs. F–SE	SE–I vs. I–SE
All	0.24	0.70	0.56
Age			
16–24	−0.18	0.75	0.46
24–40	0.12	0.72	0.14
40–60	0.07	0.81	0.39

Notes: The figures shows the de-trended quarterly correlations between bilateral transition rates among the three employment sectors. SE = informal self employment, I = informal salaried, F = formal salaried. The original series were de-trended using an HP filter with parameter 1600 and then smoothed using a moving average filter with a three quarter window. Data for Mexico (see notes in Table 2).

Second, the low variance of the $c_{I,F}/c_{F,I}$ in Mexico across ages suggests the lowest degree of segmentation that would disproportionately ration formal jobs to the young, consistent with indicators suggesting that this is the market with the fewest nominal rigidities. Brazil presents a muddier picture. At the other extreme from Mexico, Fig. 2 shows that Brazil has the highest degree of $c_{I,F}/c_{F,I}$ asymmetry. Further, the age patterns show the highest asymmetry among the young and the prime aged. All are consistent with informal salaried work being relatively less desirable than formal work. The findings may be related to the important secular rise in informality across the period if part of this occurred due to lower arrival rates to formal employment for non prime age workers, both young and old.

5.4. Transitions across the business cycle

Focusing on patterns across age permitted inference based on differential values of $a_{k,l}^h$ but conditioned on job openings and assumed away involuntary transitions. Following transitions rates (Q-statistic) across the business cycle allows examining these components as they vary in response to the changing aggregate conditions of the economy. It thus offers a distinct and powerful window into understanding whether transitions among sectors are mostly voluntary or involuntary, and again, the appropriate model to think about informality.

Standard matching models in the Pissarides (2000) tradition predict that the stochastic shocks to overall productivity of the economy, p, that drive the business cycle increase vacancies and hence increase flows towards employment. This is consistent with the findings from the relatively integrated US market where job to job transitions are procyclical (Nagypal, 2008; Shimer, 2005).[13] In our model, if formal and informal markets offer comparable jobs and respond positively to a positive aggregate productivity shock, then we would also expect a positive correlation across bilateral flows (procyclical movements in both directions) since $\frac{\partial v_I}{\partial p} > 0, \frac{\partial v_F^F}{\partial p} > 0$ implies $\frac{\partial \theta_{F,I}}{\partial p} > 0, \frac{\partial \theta_{I,F}}{\partial p} > 0$.

On the other hand, the traditional segmentation view would argue that an expansion should, first, lead to a decline in the likelihood of an

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[13] Ideally, we would have data that permit studying job to job movement including those within a sector —which evidence from the US suggests is vast (Nagypal, 2008), but we do not. Magnac and Robin (1994) propose a technique for using duration data to identify between the two but this indicator is not available in our surveys. In the end, for the purposes of identifying patterns of interaction among the informal and formal sectors, this is not a major drawback.
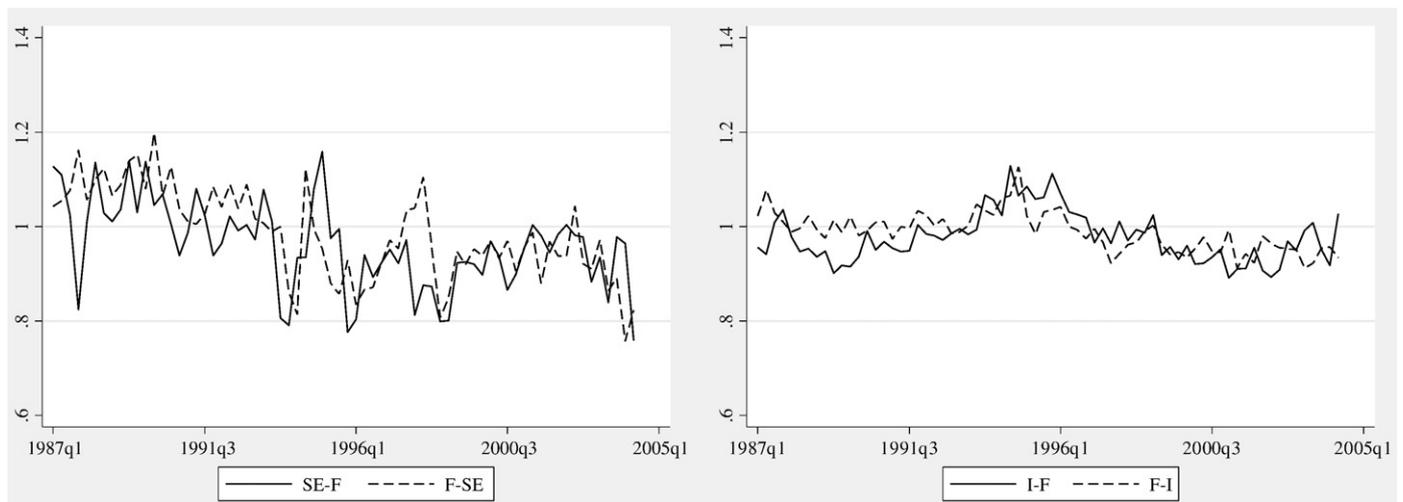
Fig. 6. Intersectoral C-statistics: Mexico. Notes: The figures show the adjusted propensities (*C*-statistic) between formality and the two sectors of informality as described in Section 3. Computations are based on 10,000 Monte Carlo replications for each quarter. SE = informal self employment, I = informal salaried, F = formal salaried. Data (see notes in Fig. 4).

involuntary transition from a formal job into an informal job, $\frac{\partial \varphi_{F,I}}{\partial p} < 0$. And second, the increased availability of more desirable formal sector jobs should lead to increased flows from informality towards formality. Both effects imply a negative correlation across bilateral transition rates.

Underlying comparative advantage is likely to remain more or less stable as worker abilities are likely to change little at business cycle frequencies. However, if at least part of the transitions towards informality are involuntary then there is likely to be some procyclical shift of preferences in favor of formal employment. We check below to see how important this may be.

In the interest of conserving space, we discuss in detail only the Mexican case while providing select corroborative results for Brazil. A similar analysis for Argentina is rendered difficult by the small sample size.[14] Our data for Mexico comprises 17 years from 1987 to 2004, a period that includes two crises and two recoveries.[15] As Fig. 4 shows, the share of the formal sector remained reasonably constant from 1987 to 1991 showing a slight decrease in the share of formality from 59% to 57% of total employment, despite a continued decrease in unemployment rate. Thereafter, it remains stable around that level up to the eve of the crisis at which point it bottoms out at 53%. After the devaluation, it began a sharp recovery, regaining its earlier highs by 2001. Finally, despite the fact that the 2001 recession was substantially milder than the Tequila Crisis, formality rates fell again to around 54%. These movements are largely mirrored by the movement of unemployment from 3% in 1989 to 8% during the crisis and then again down to the lowest levels in the sample in 2001, with a slight increase in the last three years of the sample. The increase in informality in both periods of high unemployment suggests a very traditional view of the role of the informal sector as a shock absorber for the formal sector and perhaps a kind of disguised unemployment.

However, the simple stock variables hide important information. Fig. 5 confirms the expected pro-cyclical transition rates from informality to formality. But, contrary to the view of the labor market as segmented, we find virtually identical pro-cyclical transitions from formality to informality, especially to self-employment. There is an unusually high transition rate from formal employment into self-employment during the 1987–1991 boom that mirrors the reverse

movement from the formal sector and that signals particularly strong re-matching between these two types of employment during that recovery. There is a decline in sector to sector search going into the crisis and then a recovery again mirrored, although more weakly, in the reverse transition. A lower, although still positive correlation, is found in the transitions between formal and informal salaried employment.

More systematically, Table 5 shows the HP filtered correlation between the formal–self-employment, formal–informal and informal–self-employment bilateral transition rates by age. For all groups, the de-trended correlation between formal employment and self-employment is positive and high indicating, again that, at least the corridor between self-employment and formal employment behaves like the voluntary job to job transitions found in the US. However, we do find supportive evidence for the segmented market view again for young workers in the negative correlation across bilateral flows between informal salaried and formal salaried work. Not only do the young enter disproportionally into informal salaried work from unemployment, but once in a formal job, they tend to return to informality in times of recession, as predicted by the segmented market view.

Fig. 6 shows the evolution of the bilateral *C*-statistics between formality and the two informal sectors. Since the *C*-statistics control for job openings, the residual time variance captures movements in $a_{k,l}^h$. We confirm that in fact, variation in $a_{k,l}^h$ is not a major driver of these patterns. The log variance of $c_{k,l}$ is between 8% and 20% of that of the equivalent $q_{k,l}$. The little variance we observe in $c_{I,F}$ and $c_{F,I}$ is consistent with the idea that formal jobs become slightly more preferred as segmentation increases during the downturn. It is also the case that $c_{F,SE}$ and $c_{SE,F}$ show little cyclical variation compared to $q_{F,SE}$ and $q_{SE,F}$, but do show a symmetrical downward trend suggesting less substitutability between the two sectors across time. Overall, the dominant movement in the transitions plotted appears driven by vacancies, with the very notable exception of young workers in informal salaried positions.

The results for Brazil (not shown) are broadly similar. Again, the de-trended correlation between the bilateral transition rates between formal employment and self employment is positive and high (0.64), and that between formal employment and informal salaried is positive but lower (0.31). Similarly, the log variance of $c_{k,l}$ is between 12% and 25% of that of the equivalent $q_{k,l}$ across employment sectors, indicating that, again, most of the time variation is generated by the fluctuation in vacancies. We also observe weaker correlations in the bilateral flows between formality and informal salaried positions for young workers (0.5 for 24–40 vs. 0.13 for less than 24).

Taken together, these results complement those of the previous section while also reinforcing an important caveat. First, the high

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[14] The maximum number of transition periods that we can generate for Argentina is 16 since the survey is biannual and our sample spans only 8 years from 1993 to 2001.
[15] In this case we take full advantage of the ENEU and compute the quarterly transition rates across employment status as described in Section 3. We also smooth the series using a moving average smoothing with a three quarter window.

cyclical correlation of flows confirms the argument from the age patterns of the relative C's that informal self employment is a sector offering comparable levels of utility to formal salaried work. The case is less clear for the informal salaried, especially the young. The negative cyclical correlations between formality and informal salaried for the young indicate significant queuing to access the formal sector and also warn that the C-statistics in this case are concealing non-trivial involuntary movements into informality that complicate their interpretation. While there are good arguments for why the increasing age pattern in relative C's reflects increasing comparative advantage informal work, these patterns also are driven to an undetermined degree by involuntary F–I flows.

6. Conclusion

This paper has employed a common methodology of estimating continuous time Markov processes on panel data from three countries with three purposes. First, we discuss a set of statistics that are potentially useful to analyze labor market flows and offer a very simple search model to interpret them.

Second, applying these tools to Argentina, Brazil and Mexico, we generate a broad set of proto-stylized facts about LDC labor market dynamics. We find a remarkable degree of similarity in sectoral duration and transition patterns across the three samples. We also find important differences that correspond, albeit loosely, to other comparative indicators of labor market rigidity.

Third, we employ these statistics to shed light on the debate over the nature and raison d'être of the large informal sector found in developing countries. To this end, we nest the different hypotheses within the context of the model and develop the implications for the values of our statistics. Exploring the patterns across age and across the business cycle, we argue that a substantial part of the informal sector, particularly the self-employed, corresponds to voluntary entry, although informal salaried work appears to correspond more closely to the standard queuing view, especially for young workers.

References

Albrecht, J.W., Navarro, L., Vroman, S.B., 2009. The effects of labor market policies in an economy with an informal sector. Economic Journal, Royal Economic Society 119 (539), 1105–1129.

Balassa, B., 1965. Trade liberalization and 'revealed' comparative advantage. The Manchester School 33, 99–123.

Blanchard, O., Diamond, P., 1992. The flow approach to labor markets. American Economic Review, American Economic Association 82 (2), 354–359 May.

Bosch, M. and W. F. Maloney (2005). "Labor Market Dynamics in Developing Countries: Comparative Labor Markets Analysis Using Continuous Time Markov Processes". Policy Research Working Paper 3583, World Bank., Washington, DC.

Botero, J.C., Djankov, S., La Porta, R., Lopez de Silanes, F., Shleifer, A., 2004. The regulation of labor. The Quarterly Journal of Economics 119 (4), 1339–1382.

De Paula, A. and J, A. Scheinkman (2008). "The Informal Sector, Third Version". PIER Working Paper No. 08-018.

Duryea, S.G., Marquez, C., Pages, and S. Scarpetta (2006). "For Better or for Worse? Job and Earnings Mobility in Nine Middle and Low- income Countries." Mimeo IDB. Subsequently published in Brookings Trade Forum 2006, 187–203.

Elsby, M., Solon, G., Michaels, R., 2009. The ins and outs of cyclical unemployment. American Economic Journal: Macroeconomics 1 (1), 84–110.

Evans, D.S., Jovanovic, B., 1989. An estimated model of entrepreneurial choice under liquidity constraints. Journal of Political Economy 95 (4), 657–674.

Fields, G.S., 2006. A guide to multisector labor market models. World Bank Labor Market Conference, Washington, DC, November 18–19, 2004.

Fiess, N. and M. Fugazza, and W. Maloney (forthcoming). "Informal Self employment and Macro Economic Fluctuations". Journal of Development Economics.

Flinn, C.J., Heckman, J.J., 1982. New methods for analyzing structural models of labor force dynamics. Journal of Econometrics 18, 115–168.

Fougère, D., Kamionka, T., 2003. Bayesian inference for the Mover-Stayer model in continuous time with an application to labour market transition data. Journal of Applied Econometrics, vol. 18(6). John Wiley & Sons, Ltd., pp. 697–723.

Fougère, D. and T. Kamionka (2008) "Econometrics of Individual Labour Market Transitions." in Laslo Matyas and Patrick Sevestre, The Econometrics of Panel Data: A Handbook of the Theory with Applications. 3 rd Edition. Springer, 2008, 865–905. Kluwer, Boston.

Fugazza, M., Jacques, J.F., 2004. Labor market institutions, taxation and the underground economy. Journal of Public Economics 88, 395–418.

Gasparini, L. and L. Tornarolli (2007). "Labor Informality in Latin America and the Caribbean: Patterns and Trends from Household Survey Micro data". Centro de Estudios Distributivos, Laborales y Sociales, Universidad Nacional de La Plata. Documento de Trabajo Nro 0.

Geweke, J., Marshall, R., Zarkin, G., 1986. Exact inference for continuous time Markov chain models. Review of Economic Studies 53 (4), 653–669.

Groisman, F., Marshall, A., 2005. Determinantes del Grado de Desigualdad Salarial en la Argentina: Un Estudio Interurbano. Desarrollo Económico 45 (178), 281–301 Jul. – Sep., 2005.

Heckman, J., Pages, C., 2004. Law and employment: lessons from Latin America and the Caribbean, NBER Conference Report. University of Chicago Press, Chicago.

Heckman, J., Sedlacek, G., 1985. Heterogeneity, aggregation, and market wage functions: and empirical model of self-selection in the labor market. Journal of Political Economy 93 (6), 1077–1125.

International Labour Organization, 2002. Women and Men in the Informal Economy: "A Statistical Picture" Geneva.

Kalbfleisch, J.D., Lawless, J.F., 1985. The analysis of panel data under Markov assumptions. Journal of the American Statistical Association 80, 863–871.

Levy, S., 2008. Good intentions, bad outcomes: social policy, informality, and economic growth in Mexico. Brookings Institution Press, Washington, DC.

Loayza, N., 1996. The economics of the informal sector: a simple model and some empirical evidence from Latin America. Carnegie Rochester Conference Series on Public Policy, 45. North Holland, pp. 129–162.

Lucas, R.E., 1978. On the size distribution of business firms. The Bell Journal of Economics 9 (2), 508–523 Autumn, 1978.

Magnac, T., 1991. Segmented or competitive labor markets. Econometrica 59 (1), 165–187.

Magnac, T., Robin, J.-M., 1994. An econometric analysis of labour market transitions using discrete and tenure data. Labour Economics 1, 327–346.

Maloney, W.F., 1999. Does informality imply segmentation in urban labor markets? Evidence from sectoral transitions in Mexico. World Bank Economic Review 13, 275–302.

Maloney, W.F., 2009. Mexican labor markets: protection, productivity and power. In: Levy, S., Walton, M. (Eds.), No Growth Without Equity? Inequality, Interests and Competition in Mexico. Palgrave Macmillan/World Bank.

Maloney, W. F. and J. Nuñez (2004). "Measuring the Impact of Minimum Wages." in J. Heckman and C. Pages eds. Law and Labor Markets: Lessons from Latin America, National Bureau of Economic Research and University of Chicago Press.

Nagypal, E., 2008. Worker reallocation over the business cycle: the importance of job-to-job transitions. Working Paper, Northwestern University.

Pages, C. and M. Stampini (2006). "Skills and Labor Mobility in Emerging Economies," mimeo, World Bank: Washington DC.

Perry, G., Maloney, W., Arias, O., Fajnyzlber, P., Mason, A., Saavedra, J., 2007. Informality: exit and exclusion. World Bank, Washington, D.C.

Pissarides, C., 2000. Equilibrium Unemployment Theory. MIT Press.

Rauch, J.E., 1991. Modelling the informal sector formally. Journal of Development Economics 35, 35–47.

Rosen, S., 1978. Substitution and division of labour. Economica 45, 235–250.

Shimer, R., 2005. The cyclicality of hires, separations, and job to job transitions. Federal Reserve of St. Louis Review 87 (4), 493–507 July/August.

Shimer, R. (2007). "Reassessing the Ins and Outs of Unemployment", NBER Working Paper No. W13421.

Singer, B., Spilerman, S., 1976. The representation for social processes by Markov models. American Journal of Sociology 82, 1–54.

Zenou, Y., 2008. Job search and mobility in developing countries, theory and policy implications. Journal of Development Economics 86, 336–355.