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Labor markets and productivity in developing countries*

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Abstract

In middle-income countries, the informal sector often accounts for a substantial fraction of the urban labor force. We develop a general equilibrium model with matching frictions in the urban labor market, the possibility of self-employment in the informal sector, and scope for rural-urban migration. We investigate the effects of different types of growth on wages and the informal sector, and the extent to which labor market institutions can influence aggregate productivity. We quantify these effects by calibrating the model to data for Mexico.

JEL classifications: J40, O10

Keywords: informal sector, urban unemployment, dual economies, matching frictions

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1 Introduction

This paper is addressed at a critical question for development economics: how do labor markets and productivity interact in poorer countries? At present, we know relatively little about how changes in sectoral productivity will translate into labor market outcomes. We know even less about the effects of labor market institutions on aggregate productivity and sectoral structure. In this paper, we introduce a small-scale general equilibrium model that can be used to address these questions, examine its ability to match the data, and explore its implications.

The model is developed with middle-income countries especially in mind. It features an urban manufacturing sector, an urban informal sector, and rural agriculture. Underemployment arises because of matching frictions in the formal sector labor market. In equilibrium, workers not employed in the formal sector can choose between self-employment in the informal sector, and working in the agricultural sector. The model is sufficiently rich to incorporate not only different types of productivity shock, but various important aspects of developing country labor markets. These include continual mobility between sectors, employment protection, recruitment costs, company taxes, and inefficiency in the worker-job matching process and the overall allocation of labor.

Until recently, matching frictions have rarely been applied to the study of developing countries. Yet there are few obvious reasons why labor markets in middle-income countries should have less substantial matching frictions than labor markets in richer countries. There are a few empirical studies which have estimated matching functions for middle-income countries, including Rama (1998) for Tunisia, and Berman (1997) and Yashiv (2000) for Israel. Our paper goes further, by exploring whether a general equilibrium model with matching frictions can account for a wide range of outcomes we see in the aggregate data.

Our first set of research questions relates to the size of the informal sector. We calibrate the model to data for Mexico, a middle-income country where the informal sector is often estimated to represent at least 30% of the urban workforce. Our paper shows that matching frictions can account for an informal sector of this size if workers receive a large share of the match surplus, or recruitment costs are high.

Our second set of research questions will explore the implications of the model in more detail. We use the calibrated model to explore the equilibrium responses to various experiments. We quantify the effects of different types of sectoral productivity shock on wages, underemployment, sectoral structure, urbanization and national income. We carry out a similar analysis for changes in company taxation. We also consider effects in the other direction, from labor markets to aggregate outcomes: how do labor market institutions influence sectoral structure, labor income and overall productivity?

The various labor market parameters within the model allow a wider range of experiments than simpler models in the Harris and Todaro (1970) tradition. The matching model has the further advantage that the urban wage is endogenously determined, rather than fixed for reasons outside the model. The traditional assumption of a rigid urban wage is clearly problematic for any analysis that relates productivity and labor markets over the medium run.

It is worth noting some other strengths of the matching approach. As we discuss in the next section, mobility within the urban labor market is often thought to be high in middle-income

countries. Matching models capture these transitions between labor market states in a clean way, and one that lends itself to a general equilibrium analysis. A related strength is that many of the parameters and outcomes in a matching model, such as transition probabilities, can be measured in the data. Our calibration of the matching model will use recent microeconometric studies to pin down some of the structural parameters.

The remainder of the paper is organized as follows. Section 2 discusses some of the related literature and the background to this paper. Section 3 briefly describes the model and characterizes its steady-state, while section 4 considers the comparative statics. Section 5 describes the assumptions used in the calibration and investigates whether matching frictions can account for a large informal sector. Section 6 reports equilibrium responses to changes in structural parameters, before section 7 concludes.

2 Background

The interactions between labor markets and productivity are central to a range of issues in development economics. Since the poor typically earn most of their income from labor, the mechanism that translates productivity changes into labor market outcomes should be central to any study of "pro-poor" or "shared" growth. Yet the best-known growth models can rarely accommodate different types of growth, and have relatively little to say on how growth translates into the labor income of the poor. Furthermore, although many developing countries seem to be characterized by inefficient labor market outcomes, there is still considerable uncertainty about their origins and consequences.

2.1 The informal sector

It is widely acknowledged that, in many developing countries, a significant fraction of the urban labor force is engaged in low-wage, low-productivity occupations. These constitute the distinct "informal sector" discussed by Lewis (1954), Hart (1973) and the 1972 ILO Employment Mission to Kenya (ILO, 1972), and the subject of much subsequent research. The relevant activities are those for which capital requirements and entry barriers are low, so that self-employment provides an alternative to more conventional salaried employment.

The existence of a large informal sector is important for a number of reasons. It suggests that labor may be inefficiently utilized. It also raises the possibility that the informal sector will be left behind by economic growth and policy initiatives, if these primarily benefit workers in the formal sector. The descriptive literature on development policy sometimes calls for "labor-intensive" growth, but the associated discussions are typically atheoretical. This literature does not always acknowledge the interdependence of sectors, or seek to clarify the origins of underemployment.

If we are to address these questions, a general equilibrium analysis is essential (Thorbecke 1973). We argue that a useful starting point is the Mortensen-Pissarides approach, established in a series of papers by those authors, and summarized in Pissarides (2000). The structure of our model is a simple variation on Pissarides (2000), adapted to the context of a middle-income country. We assume that firms in the formal sector use capital, and must comply with

mandatory severance payments; unemployment is redefined as informal sector self-employment, which does not require capital; and there is now an outside opportunity, namely the possibility of work in agriculture.

Our assumptions about the informal sector are worth discussing in more detail. As in the "dualist" view of developing country labor markets, we view informal sector activities as marginal forms of self-employment, made possible by low entry costs.[1] These assumptions are consistent with evidence for Mexico. Micro-enterprises with no more than five employees account for roughly half of nonfarm employment (Martin 2000). An official survey of small businesses in 1992 found that one-fifth had existed for less than a year, and of those, almost 90 percent consisted of an owner working alone or with only one employee (Fleck and Sorrentino 1994). 60 percent of informal sector businesses had no fixed address outside the home, and more than 80 percent had not sought credit to finance their operations. Other evidence confirms more directly that start-up costs for micro-enterprises are low in Mexico. In sectors such as construction and personal services, the start-up costs are less than half the monthly earnings of a low-wage worker (McKenzie and Woodruff 2006).

The dualist view also emphasizes that informal sector activities provide an unofficial safety net in the absence of state-provided unemployment insurance. Again, this is consistent with evidence for Mexico. The official rate of unemployment during 1991-99 was just 3.7%, and the unemployed tended to be relatively well educated (Martin 2000, Table 7). This relates to a common view of developing country labor markets, namely that open unemployment is a luxury that the low-skilled cannot afford. When the low-skilled cannot find work in the formal sector, they turn to the informal sector rather than remain unemployed (Martin 2000).

Some aspects of the traditional dualist view can be questioned, however. In some accounts, the informal sector is regarded as a staging post, informal sector workers devote much of their time to job search, and turnover is limited. It is worth noting that our model can accommodate a wider range of possibilities. When we calibrate the model to data for Mexico, we find that workers in the informal sector devote only a small fraction of their time to looking for formal sector employment, and there is continual mobility between the informal and formal sectors. This emphasis on mobility is consistent with recent longitudinal studies for Mexico by Maloney (1999, 2002), Gong and van Soest (2002) and Gong et al. (2004). They show that mobility is high even relative to developed countries, in contrast to the older view that the formal and informal sectors are rigidly segmented.

Our emphasis on matching frictions, and the stylized way that we model the agricultural sector, suggest that our model is most relevant to middle-income countries. In poorer countries, with substantial poverty in rural areas, the effects of growth are likely to be heavily influenced by the organization and institutions of agriculture.[2] The theoretical and quantitative analysis in this paper does not address these issues. Our modelling choices are more appropriate to

[1] Note that we are locating the origins of the informal sector in the workings of the urban labour market, rather than in regulatory and institutional constraints emphasized in de Soto (1989) and Loayza (1996). Our model can capture these in a reduced-form way, as raising the cost of opening a formal sector vacancy; we discuss this issue later in the paper.

[2] The importance of these considerations has been made clear by, for example, empirical research on the effects of technical progress in agriculture, especially the Green Revolution, on rural poverty in India. See Basu and Mallick (2005) for some relevant discussion.

countries where the rural sector accounts for a lower share of total employment, and where urban labor market frictions are perhaps more likely to resemble those in developed countries.

2.2 Related literature

Having sketched some features of the model, we now contrast it with some previous contributions. Our analysis is squarely in the long-standing dual economy tradition, in which an urban, non-agricultural sector coexists with a sizeable agricultural sector.[3] More specifically, we assume that the urban and agricultural sectors operate within a small open economy. This simplifies the analysis because the prices of the urban and rural goods are then exogenously fixed by world prices. In fact, one interpretation of our analysis is that we take the standard 3 x 2 specific factors model from trade theory, and replace the usual assumption of a Walrasian labor market with the Mortensen-Pissarides approach based on matching frictions.[4]

One of the most influential dual economy models is that of Harris and Todaro (1970), and there is a sense in which our paper is a development of their analysis. It is therefore useful to describe briefly the 2 x 2 version of the Harris-Todaro model introduced by Corden and Findlay (1975). Consider a small open economy with two sectors, in which both goods can be traded internationally at world prices. One sector is urban non-agriculture, and the other rural agriculture. There are two factors, capital and labor, each in fixed supply. There are constant returns to scale and perfect competition in each sector, and factors receive their marginal products. Perfect intersectoral capital mobility means that the returns to capital are equalized between the two sectors.

If labor is perfectly mobile between sectors and wages are flexible, we have the textbook 2 x 2 trade theory model. Instead, the Harris-Todaro model assumes that the urban wage is exogenously fixed above the market-clearing level. This generates urban unemployment. If workers are risk neutral, and jobs in the urban sector are allocated by a lottery in each period, the long-run migration equilibrium occurs when expected incomes in the two sectors are equal. Formally, the equilibrium condition is $uz + (1-u)\bar{w}_m = w_a$ where u is the (endogenous) urban unemployment rate, $z \geq 0$ is unemployment income, $\bar{w}_m$ is the fixed urban wage and w_a the market-clearing rural wage.

The Harris-Todaro version of the 2 x 2 model has some interesting properties. It can explain why rural-urban migration persists even in the face of high urban unemployment: workers are willing to bear unemployment risk because locating in the city brings the possibility of higher wages. Combined with migration, this leads to powerful and sometimes counter-intuitive general equilibrium effects. For example, a productivity improvement in the urban sector can generate extra rural-urban migration and therefore increase the number of unemployed. This is the "Todaro paradox", where urban employment creation is not accompanied by any decline in the number of unemployed workers.

[3] For surveys of the dual economy literature with an emphasis on growth, see Kanbur and McIntosh (1988) and Temple (2005).

[4] Our paper is therefore related to previous work that embeds labor market search frictions in trade models, as in Davidson et al. (1999), Helpman and Itskhoki (2007) and Waelde and Weiss (2006). These papers are primarily theoretical and are often focused on the extent to which standard trade-theoretic results continue to apply. Unlike our paper, they do not consider quantitative implications in detail.

The elegance of the Harris-Todaro model comes at a price. The assumption that the urban wage is exogenously fixed above the market-clearing level is unattractive, especially if we want to study the long-run consequences of productivity shocks. It is also intellectually unsatisfying. Given that underemployment seems pervasive in the developing world, appealing to an institutionally determined urban wage appears simplistic. Although powerful trade unions or minimum wage legislation may play a role in some poorer countries, this is unlikely to be the case everywhere, and a more general explanation seems desirable.[5]

These points are not new, and papers by Agénor (2004, 2005a, 2005b, 2005c), Bencivenga and Smith (1997), Brueckner and Zenou (1999), Calvo (1978), Eicher (1999), Krebs and Maloney (1999), Laing et al. (2005), MacLeod and Malcomson (1998), Moene (1988) and Stiglitz (1974, 1976, 1982) all develop models in which the urban wage is endogenously determined. Relative to most of these papers, our analysis will investigate quantitative implications in more detail, including the extent to which our model can match important aspects of the data.

Among the earlier contributions, the analysis of MacLeod and Malcomson (1998) is especially close in spirit to the present paper. They analyze a two-sector model in which workers can be motivated by either efficiency wages or bonus schemes (performance pay). One sector is relatively labor-intensive, and so can be interpreted as a rural agricultural sector. In equilibrium, the two sectors may use different reward schemes, and this generates a rural-urban wage differential. They simulate the response of this economy to a fall in the cost of creating urban sector jobs, and examine the implications for unemployment, total output, wages in the two sectors, and the Gini coefficient. The model and quantitative analysis is innovative, but their simulations consider fewer experiments, and proceed under simpler assumptions, than in the current paper.

In formal terms, there is an especially direct connection between our analysis and one class of models for developed country labor markets.[6] As noted above, our model extends the Mortensen-Pissarides approach by making an outside opportunity available to workers, namely the possibility of work in agriculture. This is similar to matching models with an endogenous labor force participation decision, as in Garibaldi and Wasmer (2005) and Haefke and Reiter (2005). The main conceptual difference in our model is that the value of the outside opportunity is endogenous, rather than simply an exogenous value of leisure, and will vary with the extent of agricultural employment.

The application of matching models to developing country labor markets is now proceeding rapidly. Perhaps the paper closest to ours is Albrecht et al. (2007), who not only develop a model with matching frictions, but explore its quantitative implications. Their model is richer than ours in several dimensions, especially in allowing for heterogeneity across workers in formal sector productivity, and in worker-firm matches. The model is sufficiently complex that it has to be studied mainly by numerical methods. In contrast, we derive a wide range of analytical results, and our model also differs by incorporating a role for rural-urban migration, an endogenous capital stock in the formal sector, and variable search intensity.

[5] For our main focus, Mexico, minimum wages appear to have been too low to be a binding constraint on the formal sector (Bell 1997). This suggests the reasons for Mexico's large informal sector must be sought elsewhere.

[6] Pissarides (2000), Rogerson et al. (2005) and Yashiv (2007) provide recent surveys of search and matching models applied to developed country labor markets.

Bosch (2006) and Zenou (2008) also construct models with a more sophisticated approach to the informal sector than we adopt here, but do not allow for agriculture as an outside opportunity. In this respect, our analysis is closer to Laing et al. (2005), Sato (2004) and Zenou (2005), all of which locate an urban labor market with matching frictions within a dual economy. Our paper differs from these by providing an extensive quantitative analysis, and by exploring the ability of the model to match the data. We also give more emphasis to the effects of changes in tax rates and labor market parameters, such as matching efficiency, on a range of outcomes, including aggregate productivity.

3 The model

We now begin to describe a specific factors (3 x 2) model of a small open economy with two sectors, urban and rural, that has been modified so that the urban labor market is non-Walrasian. One commodity is produced by the urban sector using labor and capital, and the other by rural agriculture using labor and land. The outputs of the urban formal sector and the rural agricultural sector can each be traded on world markets at an exogenous relative price. We treat agricultural output as the numeraire, and choose units for urban output such that its price can also be normalized to one.

As is common in the dual economy literature, we model the rural (agricultural) sector as perfectly competitive, and characterized by constant returns to scale and full employment. The structure of the urban sector is more complicated. Urban workers are either employed by a firm in the formal sector, or self-employed in the informal sector. While working in the informal sector, workers can also look for jobs in the formal sector, with a variable degree of search effort. Workers and job vacancies are matched as in the standard Mortensen-Pissarides approach, and the match surplus that arises will be divided according to a Nash bargain.

We assume that the economy is populated by a continuum of identical workers of measure one. Let the two sectors be indexed by i with $i = a$ denoting agriculture and $i = m$ denoting the urban (manufacturing) sector, and let L_i, K_i and k_i be the mass of workers, the capital stock and the capital stock per employed worker in sector i respectively. The capital stocks are sector-specific, and so agricultural "capital" can be interpreted as land.

Informal sector workers account for a proportion u of the urban labor force. For simplicity, we often call this the urban unemployment rate, and use the term "unemployment" as a convenient shorthand for the informal sector.[7] Note that $L_a + L_m = 1$, while formal sector employment is given by $(1 - u)L_m$. The capital-labor ratios in the two sectors are $k_a = K_a/L_a$ and

$$k_m = K_m/((1 - u)L_m) \tag{1}$$

respectively.

All workers are risk neutral. In agriculture, each worker produces $g(k_a)$ where $g(k_a)$ is the agricultural production function in intensive form. The worker is paid a wage w_a and obtains

[7] This usage is less casual than it may seem. It relates to "productivity definitions" of unemployment in which workers are classified as unemployed when below a threshold level of productivity. This is sometimes a more relevant definition of unemployment for developing countries. The absence of unemployment insurance means that open unemployment is rare and mainly confined to the educated and well-off.

a utility stream $w_a + x_a$ where $x_a > 0$ indicates a preference for living in rural areas. Since the agricultural sector is perfectly competitive we can write

$$w_a = g(k_a) - g'(k_a)k_a = w_a\left(\overset{+}{L}_m; \overset{+}{K}_a\right) \tag{2}$$

where $g'(k_a) = r_a$ is the rental cost of the fixed factor in agriculture. The semi-colon in the r.h.s. of (2) separates endogenous variables from exogenous variables, and we use this notation throughout the paper.

3.1 The urban labor market

Here we take a variant of the standard matching framework described in Pissarides (2000) to allow for capital, severance pay and taxes, and the outside option of working in agriculture.[8] We allow informal sector workers to choose their level of search intensity. The motivation for including endogenous search intensity is to allow discouraged worker effects: as the informal sector becomes large, and job-finding probabilities low, informal sector workers may devote relatively little time to active search.

The treatment of matching is standard. At each instant, the number of matches between informal sector workers and formal sector vacancies will be described by a constant-returns-to-scale matching function $m(suL_m, vL_m; M)$ where suL_m is total search effort, and vL_m is the number of vacancies. The exogenous shift parameter M is used to index matching efficiency.

3.2 The informal sector

In the informal sector, each worker receives a utility stream given by $z - \sigma(s; z, \Pi)$. Here z represents a fixed level of output associated with full-time self-employment, while σ is the cost associated with searching for a formal sector job (perhaps foregone output) and Π is a multiplicative shift parameter that indexes exogenous influences on search costs. These search costs $\sigma(s; z, \Pi)$ and the marginal costs of search $\sigma_s(s; z, \Pi)$ are assumed to be increasing in s, z, and Π. There are no entry costs associated with the informal sector, which is consistent with the evidence cited in section 2 above.

Informal sector workers must decide how actively to search for a formal sector job. Different workers will face different probabilities of being matched with a vacancy, if they search with different levels of intensity. Suppose an informal sector worker indexed by i, and with a present value of future earnings U_i, searches at intensity s_i while all others search at intensity s. If the present value of working in the formal sector is W, and the discount rate is r,

$$rU_i = z - \sigma(s_i; z, \pi) + \bar{q}_i(W - U_i) + \dot{U} \tag{3}$$

where $\bar{q}_i$ is the job-finding hazard rate, and is assumed to be proportional to s_i.[9] Equating each

[8] Since the modelling assumptions are standard, our exposition is relatively brief. A longer version can be found in Satchi and Temple (2006), which also analyzes the case where efficiency-wage considerations determine the allocation of the match surplus.

[9] Hence, since total search effort is suL_m and the total number of matches is $L_m m(su, v)$, we must have $q_i = s_i m(su, v)/(su)$.

worker's marginal search costs and expected benefits, and imposing symmetry, yields:

$$s\sigma_s(s) = \bar{q}(W - U) \tag{4}$$

$$rU = z - \sigma + s\sigma_s(s) + \dot{U} \tag{5}$$

where we have dropped the i subscripts to denote the symmetric outcomes.

We now allow for rural-urban migration. We make the standard assumption that migrants from agriculture first enter the informal sector. For now, we will assume that the urban sector ("the city") is initially small, so that migration flows from agriculture to the city, denoted f, are positive. Migration in either direction involves a cost $B + b|f|$, where the parameter b represents a congestion effect in the level of migration.[10] The migration equilibrium condition is that agricultural workers are indifferent between staying in agriculture and migrating:

$$w_a + x_a + r(B + bf) = rU \tag{6}$$

3.3 Formal sector employment

Production in the formal sector is undertaken by one-worker firms. Once matched with a firm in the formal sector, a worker receives a wage w_m. The firm-employee match continues until its productivity is destroyed by a firm-specific shock, which means that production is no longer profitable. This job destruction occurs at an exogenous Poisson rate λ, at which point the worker moves back into the informal sector. The firm makes a severance payment P to the departing employee, which we include because of its importance in the Mexican labor market.

Under these assumptions, the asset value of formal sector employment W can be written as:

$$rW = w_m + \lambda(U - W + P) + \dot{W} \tag{7}$$

3.4 Urban firms

We now consider the asset values for firms. To enter production, a new firm must post a vacancy. This involves a flow cost c for the duration the vacancy is open. It is important to note that we interpret the act of posting a "vacancy" more broadly than usual. In the developing country context, it may not involve a formal advertisement or use of a labor exchange, but instead the engagement of time and resources in alternative ways of recruiting workers. These could include the use of senior workers or employment brokers to identify employees through social networks, a possibility noted in Collier (1975) and Mazumdar (1983). These costs could also be seen as a reduced-form for more general costs of firm entry, associated with entry barriers or regulation.

[10] When migration costs B are strictly positive, there are multiple equilibria. An equilibrium in which no further migration will take place is given by $w_a + x_a + \chi rB = rU$ where in general χ can take any value in the interval $[-1, 1]$. For example if agriculture is initially small and workers migrate from the city to agriculture, then migration will cease when $w_a + x_a - rB = rU$, so $\chi = -1$. This does not affect the baseline calibration, where we effectively infer a value for $x_a + \chi rB$, but does affect the comparative statics results and is discussed further where appropriate. Unless otherwise stated, we will either proceed with the assumption that $B = 0$ or describe the equilibrium with $\chi = 1$.

The (endogenous) Poisson rate q at which vacancies are filled is given by:

$$q = \frac{1}{vL_m} m\left(suL_m, vL_m\right) = m\left(\frac{1}{\tau}, 1\right) = \frac{\bar{q}}{s\tau} \tag{8}$$

where $\tau \equiv v/su$ measures labor market tightness. Note that $q(\tau; M)$ and $\tau q(\tau; M) = m(1, \tau; M)$ are respectively decreasing and increasing in τ.

Once a vacancy has been filled, the firm agrees a wage w_m with the worker. The firm hires capital k_m at each instant that the worker is employed, ceasing to hire the capital once the match is destroyed. The firm's output is given by $A_m f(k_m)$ where A_m is a TFP parameter and $f(k_m)$ is the intensive form of a standard constant returns production function. We also include corporate taxes in the model. The corporate income and payroll tax rates are given by t_c and t_p respectively, and we treat severance payments as tax exempt.

Under these assumptions J, the asset value of a filled job to a firm, can be written as:

$$rJ = (1 - t_c)\left[A_m f(k_m) - (1 + t_p)\, w_m\right] - r_c k_m - \lambda(J + P) + \dot{J} \tag{9}$$

where r_c is the cost of renting capital. The first-order condition for the capital-labor ratio is

$$(1 - t_c)\, A_m f'(k_m) = r_c \tag{10}$$

which implies

$$rJ = (1 - t_c)\, y(k_m) - (1 + t_w)\, w_m - \lambda(J + P) + \dot{J} \tag{11}$$

where $y(k_m) \equiv A_m f(k_m) - A_m k_m f'(k_m)$ and for later simplicity we are defining $t_w \equiv (1 - t_c)(1 + t_p) - 1$.

Given that we assume free, instantaneous entry into the creation of vacancies, the present-value of a vacancy V is always zero. Since $rV = -c + q(J - V) + \dot{V}$, free entry implies:

$$J = \frac{c}{q} \tag{12}$$

The match surplus must be allocated between workers and firms, and we use the standard Nash bargaining assumptions to determine the formal sector wage.[11] Using the parameter $\beta \in (0, 1)$ to index worker bargaining power, we obtain:

$$(1 - \beta)(1 + t_w)(W - U) = \beta J \tag{13}$$

For simplicity we assume that the relevant disagreement point, and hence the bargained wage, are independent of severance payments: if workers "walk away" from the bargaining process, the firm is not liable to make the severance payment. Under this assumption, equation (13) holds continuously, including outside the steady-state, even under continuous renegotiation. Otherwise, we would need to distinguish an "outside" wage, bargained before employment, from a (higher) inside wage that would be bargained after employment has begun, when workers

[11] The working paper version of this research, Satchi and Temple (2006), also analyzes a second case, in which efficiency-wage considerations determine the allocation of the surplus.

would be eligible for severance pay.[12] We avoid the distinction because it would make the calibration unnecessarily complex, and would also make it harder for the model to explain the low formal sector wage premium that we see in the Mexican data.

3.5 Steady state

We now characterize some properties of the steady-state. We set migration flows $f = 0$ in the migration condition (6) and impose $\dot{U} = \dot{W} = \dot{V} = \dot{J} = 0$ in the asset value equations. We also require that in steady state, the inflows and outflows for the informal sector ("unemployment") must balance:

$$\lambda(1-u) = m(su, v; M) = us\tau q(\overset{-}{\tau}, \overset{+}{M}) \tag{14}$$

Noting that (4), (8), (12) and (13) imply

$$\sigma_s(\overset{+}{s}; \overset{+}{z}, \overset{+}{\Pi}) = \frac{1}{1+t_w}\frac{c\tau\beta}{1-\beta} \tag{15}$$

we can see that $\tau = \tau\left(\overset{+}{s}; \overset{+}{z}, \overset{+}{\Pi}, \overset{-}{c}, \overset{-}{\beta}, \overset{+}{t_w}\right)$, and hence from (14) that $u = u\left(\overset{-}{s}; \overset{+}{\lambda}, \overset{-}{M}, \overset{-}{z}, \overset{+}{c}, \overset{+}{\Pi}, \overset{+}{\beta}\right)$.

Noting the positive relationship between s and τ in (15), we can now analyze the steady-state by reducing the model to two equations in two endogenous variables. Writing $\zeta(s; z, \Pi) = z - \sigma(s; z, \Pi) + s\sigma_s(s; z, \Pi)$ we derive

$$w_a\left(\overset{+}{L_m}; \overset{+}{K_a}\right) + x_a + rB = \zeta(\overset{+}{s}; z, \Pi) \tag{16}$$

$$\frac{r+\lambda}{1-\beta}\left(\frac{c}{q(\overset{-}{\tau}; \overset{+}{M})}\right) = (1-t_c)y(k_m) - (1+t_w)\zeta(\overset{+}{s}; z, \Pi) + t_w\lambda P \tag{17}$$

where (16) comes from (5) and (6); and (17) from (5), (7), (11), (12) and (13).

In a variant of the basic model, we open the urban sector to international flows of capital, so that the capital stock in this sector is endogenously determined. Hence the basic model could be seen as capturing a short-run effect, holding the capital stock constant, while the model with an open capital account allows long-run adjustment to take place. The behaviour of k_m then depends on whether the capital account is closed or open. When the capital account is open, the steady-state marginal product of capital is equal to the world interest rate and hence the formal sector capital-labor ratio k_m is exogenously given. For either version of the model, we can use (1) and the equations above to substitute for τ and k_m in (16) and (17). We can then describe the system in terms of these two equations and two unknowns, s and L_m.

In standard matching models, the steady-state is unique and saddle-path stable. Our specification of the urban labor market follows those models closely, and migrants respond to utility differences between the urban and rural sectors in a way that should be stabilizing. When the fixed cost of migration is zero ($B = 0$) and the equilibrium is unique, we would therefore expect either version of the model to have similar stability properties, and this is confirmed in Appendix A.

[12] For a discussion of this distinction see Pissarides (2000).

4 Comparative statics

For simplicity, the following comparative statics are derived under the assumption that migration is costless ($B = 0$) and the equilibrium is unique. In the more general case, when the fixed migration cost B is strictly positive, there may be no migration flows in response to a parameter change, depending on the size of the shock.[13]

The migration condition (16) and the job creation condition (17) describe two curves in (s, L_m) space. Putting search intensity s on the horizontal axis, the migration condition is upward sloping. The job creation curve is downward sloping with a closed capital account, and vertical with an open capital account. We provide an example in figure 1, for the effects of an increase in urban TFP. Many of our comparative static results are derived in the same way, but some of the results for the closed capital account are obtained using two curves in an alternative (s, k_m) space. The details of the arguments are described in a separate appendix, available on request.

In studying effects on the formal sector wage, we use two alternative expressions for formal sector labor income (including expected severance pay) that apply under Nash bargaining. The first writes $w_m + \lambda P$ as a weighted average of the worker's outside option and the marginal product of labor, as in Merz (1995) for example, while the second uses the outside option plus a share of the total match surplus. The worker's share of the surplus differs from the bargaining parameter β due to the presence of taxes; (13) implies that the two are related by $\tilde{\beta} = \beta/(1 + t_w - t_w\beta)$. The model with taxes then implies:

$$w_m + \lambda P = (1 - \tilde{\beta})rU + \tilde{\beta}(MPL - t) = rU + \tilde{\beta}S$$

where $t = t_w w_m + t_c MPL$ is the total tax payment per filled job, $MPL(= y)$ denotes the marginal product of labor before tax and $S = \left((r + \lambda)/(1 - \tilde{\beta})\right)(c/q(\tau))$ is the total match surplus.

The comparative statics are summarized in Table 1. Several points are worth briefly noting. (1) The question marks in the table represent genuine ambiguity, in that the relevant effects may be positive or negative, depending on the parameterization. (2) The results for z assume that $\sigma_z < 1$ in equilibrium.[14] (3) The effects of a change in search costs Π on u and $(1 - u)L_m$ are obtained under the assumption that the elasticity of search costs $\sigma(s; z, \Pi)$ with respect to s is constant. (4) Since severance payments P form a transfer, they only have an effect in this model due to their treatment by the tax system. We treat P as exempt from payroll tax but not deductible from corporate tax. Since $t_c > t_p$ in our calibration, an increase in severance payments adversely affects job creation.[15] (5) In qualitative terms, changing the payroll tax

[13] For example, suppose we are in an equilibrium where past migration has occurred from agriculture to the city and therefore $w_a + x_a = rU - rB$. A small positive shock to agricultural productivity will lead to reverse migration, if $w_a' + x_a - rB \leq rU$ where w_a' is the new rural wage. Since the urban sector remains the same size, and the shock to agricultural productivity does not otherwise affect the urban labour market, the urban sector and the present value of unemployment remain unaffected. For migration to occur here, the agricultural wage would have to rise by more than $2rB$, and then migration would cease when $w_a + x_a - rB = rU$.

[14] That is, at any equilibrium level of search s, an increase in z holding s constant results in an increase in $z - \sigma$, the net income of informal sector workers. Otherwise, in the case of an open capital account, an increase in z would lead to a smaller city.

[15] Making the payments tax deductible would reverse their effects, but could be associated with perverse incentives: repeated severance payments, based on firing and rehiring, might become a tax-efficient way for companies to transfer income to workers.

rate t_p usually has effects similar to changing the corporate income tax t_c unless the severance payment is high. Again, this reflects the tax treatment of severance payments.[16]

We now discuss some of the comparative statics in more detail. First, we consider the effects of a productivity shock in either the agricultural sector (an increase in A_a) or the formal sector (an increase in A_m). Not surprisingly, agricultural and formal sector wages rise in both cases. The share of the informal sector in the urban labor force (u) does not increase, and may fall. Looking just at an improvement in agricultural TFP, the size of the city L_m falls, as does formal sector employment $(1-u)L_m$ and the absolute number of workers in the informal sector uL_m. The search intensity (s) of those remaining in the informal sector does not fall, and may increase.

The effects of an increase in formal sector TFP are more complex. Although the shock reduces the urban unemployment rate, the improvement in prospects also encourages rural-urban migration, as in the Harris-Todaro model. The city increases in size, and agricultural wages rise, so that the incidence of poverty is reduced; but total unemployment does not necessarily fall, leaving open the possibility of a Todaro paradox. Another effect of increased productivity in the formal sector is that workers in the informal sector search more actively.

Overall, then, favourable productivity shocks outside the informal sector reduce, or leave unchanged, the relative importance of the informal sector in urban employment. Growth in the formal sector may increase the absolute number of people in the informal sector, because of the migration response. Agricultural growth will be labor-intensive, but urban growth may not.

The table also shows that increases in company taxes or severance payments have the opposite effects to a rise in formal sector TFP, because they discourage formal sector job creation. An increase in the productivity of the informal sector (z) lowers search intensity, increases the size of the informal sector, and drives up wages, by improving the outside option available to workers. The associated migration response increases the size of the city, but formal sector employment could fall now that the informal sector has become more attractive.

When the capital account is open, an improvement in matching efficiency, a decrease in vacancy costs or search costs, and a decrease in the job destruction rate all have the expected effects. The informal sector contracts in relative terms, while wages increase, and the size of the city and total formal sector employment also increase. But the story is more complicated when the urban capital stock is treated as fixed. Any increase in formal sector employment will lower the capital-labor ratio and exert downwards pressure on wages in the short run. This effect may be strong enough to reduce the welfare of informal sector workers. Although not inevitable, counter-intuitive results of this form will be seen in our calibration below, and also extend to changes in the job expiry rate (λ) and the cost of posting vacancies (c). Similarly, counter-intuitive results for wages and the size of the city can obtain following an increase in search costs (Π). In this case, as the effect on the job creation condition is unambiguous, the level of search is bound to fall. In all these cases, the effects on the relative importance of the

[16] For conventional values of the elasticities in the matching function, a sufficient condition for changes to the tax rates to have qualitatively similar effects is that the severance payment P should account for less than half of expected labour income from employment (that is, $P < w_m/\lambda$). This requirement is comfortably met in our later empirical application. It is possible to derive a necessary and sufficient condition which is weaker but more complex, and that holds in our empirical application for any choice of the matching elasticity. Details are available on request.

informal sector, and total employment in the formal sector, remain in line with intuition.

5 Parameter choices

This section describes the assumptions under which the model is calibrated. We will be interested in whether the calibrated model can match the size of the informal sector seen in the data for Mexico in the early 1990s, ahead of NAFTA, without requiring implausible assumptions about structural parameters. We have chosen Mexico because its informal sector is sizeable and often studied, and may reflect labor market rigidities, as argued by Kose et al. (2005). We use recent and detailed microeconometric studies of the Mexican labor market to determine values for some of the structural parameters, and to constrain some of the equilibrium outcomes, in order to infer parameters that are less easily observable. Where necessary, we also draw on studies of matching frictions in middle-income countries, notably the work of Yashiv (2000) on Israel.

We want the model to yield an informal sector that accounts for 30% ($u = 0.30$) of the urban workforce. This is based on the estimate of Gong and van Soest (2002) for the Mexican economy of the early 1990s. We discuss this choice in more detail, later in this section. The agricultural employment share L_a is set to be 0.28, based on ILO data for 1990.

Since workers can choose to locate in agriculture, and firms can choose to create new formal sector vacancies, it is not obvious that matching frictions will be enough to yield an informal sector of this size. If we are to investigate this question, the choice of parameters for a baseline calibration becomes more than usually important. In order to see whether the model can match the data under reasonable assumptions, we will infer the required allocation of the match surplus directly from the baseline of the calibrated model, rather than use the more standard approach in which the division of the surplus is treated as known.

In particular, we constrain the model's equilibrium to match the observed size of the agricultural sector, and estimates of wage differentials from recent microeconometric studies. We then infer the worker bargaining strength β needed to match the size of the informal sector seen in the data, after imposing the cost of holding open a vacancy. Fundamentally, what the calibration requires is that the costs of job creation are high enough to place a brake on formal sector recruitment, even when a large fraction of the urban labor force is underemployed.

To anticipate our main results, matching frictions can give rise to an informal sector as large as 30% of the urban labor force in two possible cases. Either (1) workers must receive a relatively large share of the match surplus, or (2) the costs of holding a vacancy open must be sufficiently high. These restrictions are needed to limit recruitment by formal sector firms to the required level, even when there is substantial underemployment. Our calibration will follow the first approach, assuming that workers receive most of the surplus, based on evidence in Yashiv (2000). We discuss whether these requirements are realistic towards the end of the section.

The main parameter assumptions are listed in Table 2. The calibration assumptions and procedure are described in more detail in a technical appendix, available on request. Here, we discuss our choices only briefly, starting with the annual real interest rate, set at 4%. Our

results are relatively insensitive to this choice. This is because where r appears in the equilibrium solution, it always appears in the form of an effective discount rate $r + \lambda$ where λ is the hazard rate for job destruction. The plausible range of variation for the real interest rate r is low relative to the hazard rate.

5.1 Matching and informal sector search

For simplicity, we specialize to a Cobb-Douglas matching function $m(su, v) = M(su)^{\gamma}v^{1-\gamma}$.[17] We need to choose the elasticity γ. The evidence most relevant to middle-income countries is probably the study of Israeli labor market data by Yashiv (2000). He finds an average elasticity of 0.48 for 1975-9, but a much lower figure for the 1980s, perhaps reflecting nonlinearities in the matching process. We set the elasticity γ to 0.50 in line with the earlier finding, and also because it is a standard choice in calibrations for developed countries.

For the costs associated with search intensity s, we specialize to

$$\sigma(s, z) = z\Pi s^{\phi}$$

This has the following interpretation: z is the income associated with full-time self-employment in the informal sector, but a proportion of a worker's time, given by $h(s) = \Pi s^{\phi}$, is devoted to searching for a job in the formal sector. Hence $zh(s)$ is the income foregone in the process of search. Our calibration will assume $\phi = 2$ based on the empirical analysis of search effort in Yashiv (2000). Without loss of generality, we choose units for search intensity such that its initial level can be normalized to one.

5.2 The formal sector

Some choices for the formal sector are relatively straightforward. The monthly job expiry rate λ is set at 0.06 based on Gong and van Soest (2002). Together λ and u pin down steady-state matches $m = \lambda(1 - u)$ as a fraction of the urban workforce. We take the baseline corporate tax rate for the early 1990s to be 35%, and the payroll tax rate to be 10%, from Iqbal (1994). We ignore state taxes and depreciation allowances for simplicity.

One of the most important parameter choices is that for β, the parameter which indexes the bargaining strength of workers. In the absence of direct observation, this is usually set to 0.50 by convention. We prefer to treat β as unknown and infer a value from the calibrated model. To do this, we use findings in Yashiv (2000, Table 3). Using data for Israel, he estimates the firm's asset value of a match as a percentage of its average output, obtaining figures in the region of 15%. If we constrain the model equilibrium to reproduce a similarly low asset value of a match, this effectively pins down β to be around 0.70, so that workers are assumed to receive the majority of the match surplus. We discuss this in more detail below.[18]

[17] The assumption of constant returns is consistent with empirical evidence for developed countries, as reviewed by Petrongolo and Pissarides (2001). The use of Cobb-Douglas can be justified by the elegant theoretical microfoundations provided by Stevens (2007).

[18] The required allocation of the surplus may seem more reasonable when efficiency wage considerations play a role, as in Satchi and Temple (2006). One remaining problem with an efficiency-wage approach is that it is hard to know what constitutes a plausible set of parameter values (for example, the probability that shirking is detected). Here we concentrate on Nash bargaining, given its simplicity and its prominence in the matching

Once we assume that workers have substantial bargaining power, we can readily match other features of the Mexican labor market under reasonable assumptions. We assume that the cost of holding open a vacancy is equal to 40% of the baseline formal sector wage. This choice implies that the average duration of a vacancy is 23 days, and that average hiring costs are equal to about 9 days' wages. This order of magnitude for hiring costs is similar to findings in Yashiv (2000, p. 1309) and the microeconomic evidence for unskilled and semi-skilled workers cited in Nickell (1986, p. 475). For further comparison, our assumptions imply that the ratio of recruiting costs to formal sector output is about 1.2%. This compares with the use of 1% for the US economy in Andolfatto (1996). The implied mean vacancy duration of 23 days is somewhat shorter than the figure of 36 days that Brenčič (2007) obtains for Slovenia. It is also shorter than in the US calibrations of Andolfatto (1996) and Merz (1995), which used 45 days based on a study of the Dutch labor market by van Ours and Ridder (1992). Hence, the model calibrated to Mexican data can yield a sizeable informal sector without needing to assume that vacancies remain unfilled for an unrealistic length of time.

Given the mean vacancy duration we can infer the matching efficiency index M. We set the severance pay parameter P to be four times the monthly wage. This is motivated by Mexico's labor market regulations: in essence, a firm that dismisses a worker without just cause must pay the worker three months' salary plus twenty days of salary for each year worked (see Capelleja 1997). Our estimate of the monthly job expiry rate implies an average job duration of almost 17 months in the formal sector, so that setting P at four times the monthly wage is a reasonable approximation.[19]

5.3 Wage differentials

Microeconometric estimates of the wage premium in the Mexican formal sector, relative to the informal sector, suggest that it is low after controlling for worker characteristics, at least for unskilled workers. Aleman-Castilla (2006, p. 50) finds that informal and formal sector hourly wages are almost exactly equal for our time period, and hence we assume that informal sector productivity z is equal to the formal sector wage. In fitting Mexican data, one attractive aspect of our model is that workers will strictly prefer the formal sector even when there is no wage premium, because formal sector labor income is raised by expected severance pay.

Using labor force survey data for 1991 we find that the formal sector wage is roughly 80% higher than the rural wage. This assumption is broadly in line with the computable general equilibrium model of Mexico due to Venables and van Wijnbergen (1993), who assumed that the marginal product for unskilled labor in urban areas was twice that in rural areas.

With the formal sector-rural wage premium at 80%, even the informal sector wage is greater than the rural wage. This is consistent with the observations of Gregory (1980) and Mazumdar (1976) that productivity and/or the wage in the informal sector may often exceed that in agriculture. In order to match the rural population observed in Mexico, our calibration then requires migration costs B and the direct utility cost of living in the city x_a to be sufficiently

literature.

[19] Given that severance payments are always proportional to salaries, the lump-sum P is forced to rise or fall in proportion to the formal sector wage when studying how the economy responds to a parameter change.

high to deter migration. A necessary condition is that $x_a + \chi rB > 0$ where the parameter χ is that described in footnote 10. We infer the value of $x_a + \chi rB$ in the calibration exercise but cannot separately identify the values of B and x_a. Later in the calibration, we examine the robustness of our results to heterogeneity in x_a.

5.4 Production technologies

We also need to specify the technologies in the formal and rural sectors. We choose both to be Cobb-Douglas for simplicity, with constant returns to scale, and impose the output-labor elasticities for the formal sector and the agricultural sector. Here we face a problem common to other modellers of the Mexican economy, namely that the aggregate capital share provided in the national accounts seems too high at around 70% (for discussion of this, see Kehoe and Kehoe 1994). This is also true of UNIDO data on the capital share for the Mexican manufacturing sector, which makes a rigorous choice of technology parameters difficult. Rather than choose the relevant parameters freely, we use the same choices as Imam and Whalley (1985), a calibration of the Harris-Todaro model using Mexican data.[20]

We choose units for agricultural output so that we can normalize the agricultural TFP parameter to unity. Without loss of generality, we also normalize to unity the initial stocks of capital and land, and then infer the level of TFP in the formal sector that is needed for the equilibrium of the model to replicate the observed sectoral employment structure.[21]

5.5 Matching the size of the informal sector

At the baseline, the urban informal sector accounts for 7.8% of GDP. This compares reasonably well with an earlier survey-based estimate for Mexico, cited in Martin (2000), which concluded that the corresponding share of GDP was 10.4% in 1980. In contrast, we find that the model significantly over-predicts the share of agriculture in GDP when compared to the national accounts data. This might be explained in terms of home production or subsistence agriculture, the output of which is not fully captured in the national accounts.[22]

In the remainder of this section, we discuss whether the calibrated model can give rise to an informal sector employment share of 30% and an agricultural employment share of 28% under reasonable assumptions. To match the agricultural employment share requires a substantial disutility of urban living, almost exactly equal to the rural wage at the baseline. This is needed to ensure that a substantial fraction of the population remains in agriculture, despite the higher wage available in the urban informal sector. Note that this result is essentially determined by

[20] The current model does not have a one-to-one correspondence between the formal sector's input elasticities and its factor shares, given that formal sector labour does not receive its marginal product; we briefly discuss this issue in a technical appendix available on request.

[21] Strictly speaking, we infer urban TFP multiplied by the relative price of formal sector output. In the calibration, this quantity has to move to offset any change to the levels of land and urban capital, given that we constrain the model's equilibrium to match the observed sectoral structure. This means that equilibrium outcomes such as relative wages are independent of the scale of the fixed factors: any change in scaling only affects the absolute level of wages and output.

[22] Moreover, the data on employment allocations may overstate the proportion of effective labour allocated to agriculture. These and other relevant considerations are discussed in Gollin et al. (2004), Parente et al. (2000) and Schmitt (1989).

the data rather than the structure of the model. It arises because of the sizeable gap between the informal sector wage and the rural wage that appears to be present in the data for Mexico.

To reproduce the informal sector employment share, we assume that workers receive a high share of the match surplus. This is more tightly connected to the structure of the model and our use of Nash bargaining. Given that structure, the high degree of bargaining power of workers follows from our decision to use the evidence in Yashiv (2000) to constrain the asset value of a match relative to the output of the firm. One advantage of this assumption is that the model can then generate a large informal sector even if recruitment costs are relatively modest.

We also note that, in the current model, flow costs of posting a vacancy can be interpreted (in reduced-form) as the flow value equivalent of a sunk cost associated with firm entry. Hence business regulations, such as restrictions on entry, could increase the effective cost of holding open a vacancy. Since this increases the cost associated with formal sector job creation, this interpretation would make it easier for the model to match the data.

5.6 Some further implications

We now discuss some implications of our parameter choices. Given the rapid turnover between the informal sector and the formal sector observed in Mexico, no wage premium for the formal sector, and a low discount rate, the utility levels of formal sector and informal sector workers are similar at the baseline steady-state. The formal sector "utility premium" $(W-U)/U$ is very small, just 0.5% at baseline. Hence the informal sector, although less productive, yields lifetime utility similar to that obtained in the formal sector. This result is consistent with some of the available evidence for Mexico, which suggests that the different urban sectors are well integrated and not fundamentally distinct in terms of their desirability (for example, Bosch and Maloney 2005). The similarity in asset values indicates that, in the case we consider, informality is less interesting as a cause of poverty, and more as a cause of low productivity.[23]

The preceding discussion points to a shortcoming of our model, at least in its application to Mexico. One view of developing country labor markets distinguishes between two tiers of self-employment (Fields 1990). The lower tier is a staging post for salaried work in the formal sector, as in our paper, and the upper tier corresponds to forms of self-employment that may be actively preferred to the formal sector, which our model omits. For example, some individuals may accumulate capital and human capital while working in the formal sector, and then quit voluntarily to set up their own business. Fajnzylber et al. (2006) and Maloney (1998, 1999, 2002) emphasize the relevance of the upper tier to understanding the Mexican informal sector. In contrast, McKenzie and Woodruff (2006) use a detailed survey of micro-enterprises in Mexico to show that the capital requirements for entry are low in many sectors. This suggests that entry into an upper tier would have to be restricted in other ways, for example by requiring specific human capital.

Nevertheless, in calibrating the model, we should be careful to avoid identifying the informal

[23] Sethuraman (1976) pointed out that the consequences of the informal sector for overall resource allocation and productivity were too often overlooked. Looking across countries, Maloney (1998, 2002) shows that there is a strong inverse association between industrial labour productivity and the extent of self-employment. This suggests that labour markets, sectoral structure and productivity are tightly connected, even though the direction of causality remains unclear.

sector with all forms of self-employment. As discussed above, our baseline calibration assumes that the informal sector represents 30% of the urban workforce. This figure corresponds to the job-type definition of informality used by Gong and van Soest (2002), in which the self-employed are classified as informal sector workers only if their firm has no employees. Any entrepreneur with at least one employee is placed in the formal sector category. This yields a smaller informal sector than the combined share of self-employment and employment in micro-enterprises, which is reported by Maloney (2002) to be close to 50% for Mexico; hence, the difference between the two could partly reflect an upper tier to the informal sector.

From this perspective, our model and calibration effectively aggregates salaried employees and business owners into one formal, capital-intensive sector. The informal sector continues to represent forms of self-employment that are associated with low productivity, and accounts for a smaller share of the urban workforce than the combined share of self-employment and micro-enterprises. This is an imperfect solution, but modelling an upper tier explicitly is a difficult task, given the extent of worker heterogeneity likely to be involved.[24] We have followed previous studies in folding the upper tier of the informal sector into the formal sector, which simplifies the analysis throughout the paper.

Finally, a brief digression on the appropriate output concepts. For the formal sector, there is a distinction between gross output and factor incomes, because of recruitment costs and taxes. For this sector, our model implies:

$$Y_m - \frac{r+\lambda}{\lambda} cvL_m = r_c K_m + (w_m + \lambda P)(1-u)L_m + T$$

where T denotes total tax revenues. This says that net formal sector output (the left-hand-side) is equal to factor incomes (the right-hand-side) plus tax revenues. When net output in the formal sector is added to agricultural output and informal sector output, we have a measure of domestic output (GDP). At the baseline, corporate tax revenues account for 20.5% of GDP.

When the capital account is open, aspects of the model economy such as domestic output can respond dramatically to parameter changes. We interpret this as a long-run effect, since it treats the domestic capital stock as endogenous. It is essential, however, to distinguish between GDP and GNP in assessing the effects of a given experiment. This is because the response of domestic output to a parameter change will usually differ from the response of domestic factor incomes. Although labor income and land rentals may change, capital income for domestic residents is fixed: their capital income is simply equal to their holdings of capital multiplied by the world return. Any increase in domestically generated capital income will accrue to foreign owners of capital, and this implies that changes in GNP may be much smaller than those in GDP.[25]

[24] Fields (1990) noted the difficulty in constructing a model with several tiers to the informal sector, and the possibility of capital accumulation prior to entering the upper tier. One of his suggestions was to use Markov chains to link the sectors, which could be seen as a reduced-form for the explicit modelling of transitions that we adopt in this paper. See also Krebs and Maloney (1999).

[25] We can easily compute changes in national income (GNP) for parameter experiments with an open capital account: to calculate the new value of GNP, we hold the capital income accruing to domestic residents at its initial level, and then add the new value of labour income. To allow simple presentation of the results in terms of percentage changes, we assume that GDP equals GNP at baseline (net foreign assets are initially zero, and there are no cross-border labour services).

6 Equilibrium responses

Having described our baseline, we now turn to a set of experiments. We investigate how changes in structural parameters affect the labor market equilibrium, wage differentials and search intensity, the sectoral structure of output and employment, and total output, all relative to the baseline outcomes. Since the model is stylized, the exercise is only intended as illustrative. For simplicity, we assume tax revenues are redistributed in lump-sum fashion, and continue to abstract from considerations that include heterogeneity in worker productivity, female nonparticipation in the labor force, off-farm employment in rural areas, and international emigration.[26] This simplicity ensures that our assumptions and mechanisms are relatively transparent, and we can relate the findings directly to the comparative static results established earlier in the paper. At the same time, the calculations should be seen as indicative of orders of magnitude, rather than forming a definitive assessment of particular policy choices.

In the experiments we carry out, reallocations of employment across sectors will influence aggregate productivity. These reallocations can have sizeable effects, because our baseline implies that the marginal product of labor in the formal sector is roughly 1.5 times that in the informal sector and 2.7 times that in agriculture. (The presence of matching frictions and taxes means that workers in the formal sector receive only about two-thirds of their marginal product in the baseline equilibrium.) Reallocating labor from sectors where its marginal product is relatively low will typically raise aggregate output and total factor productivity. Whenever the Hosios condition is not met, and abstracting from taxes, this has the potential to raise social welfare.

From a welfare point of view, the relative size of the formal sector is also likely to be of interest. An expansion in the formal sector could have beneficial effects beyond those we model here, including better opportunities for specialization and training, and greater income security, as discussed in the 1995 *World Development Report* (World Bank, 1995, p.18). Given the frequent discussion of the phenomenon of "jobless growth", in which the formal sector does not expand, the consequences of productivity shocks for the size of the formal sector may be of especial interest.

We first consider productivity changes. For agricultural TFP and then formal sector TFP, we look at the effect of raising TFP by 20%. To put this in perspective, it represents a long-term increase. At the annual rate estimated for the whole Mexican economy by Klenow and Rodriguez-Clare (1997), it would take about twenty years to achieve.

The first experiment we consider is a 20% increase in agricultural TFP. The results are shown in Table 3. As expected, given fixed commodity prices, agricultural employment and output increase substantially, but there is some reduction in the output of the formal and informal sectors. With an open capital account, the city is simply scaled down in size, with the urban capital-labor ratio, unemployment rate, matching rate, and wage premia all independent of rural TFP. If the capital account is closed, the urban unemployment rate decreases and the informal

[26] Levy and van Wijnbergen (1994, p. 268) argue that rural-urban migration has been the main driving force in Mexico's rapid urban growth, with the number of such migrants far in excess of the number emigrating to the USA. Nevertheless, emigration to the USA increased rapidly over the 1990s and is likely to have had important effects on the Mexican labour market (for example, Hanson 2005). Allowing for international migration would be an interesting extension of this paper's model.

sector contracts, while aggregate output rises by approximately 1.9%. Total labor income falls, because fewer workers are employed in the city.

In the second experiment, reported in Table 4, we increase formal sector TFP by 20%. Importantly, the relative size of the informal sector (the "urban unemployment rate") falls sharply. Agricultural and informal sector employment contract, while employment and output in the formal sector expand: at least in this calibration, an increase in formal sector productivity pulls workers out of the informal sector. The formal sector wage premium increases sharply, and informal sector workers devote a much higher proportion of their time to search. Wages and total labor income rise, especially in the open capital account case. This is because the direct effect of the increase in urban TFP is amplified by capital inflows: the formal sector capital-labor ratio must rise until the return on capital is back at its baseline value, the world real interest rate.[27] When the capital account is open, GDP roughly doubles in response to the 20% increase in urban TFP, but much of this increase in GDP is returned to foreign owners of capital. GNP rises by 57%, partly due to higher tax revenues.

We now consider the effects of varying some of the key labor market parameters. We first look at an increase in matching efficiency (the shift parameter M in the matching function) of 20%. To what extent is better matching associated with improved outcomes in the urban and rural labor markets? Table 5 quantifies the reduction in the urban unemployment rate, while formal sector output and employment expand. Our earlier comparative statics indicated that the effect on wages is ambiguous when the capital account is closed. We find an example of this counter-intuitive result here: better matching increases formal sector employment, but this reduces the capital-labor ratio sufficiently that wages fall slightly. Opening the capital account switches off this effect, and so wages rise. In either case, aggregate output and national income increase. With an open capital account, the effect of better matching on labor income is substantial: labor income rises by 3.1%. This partly reflects a general equilibrium effect: better matching in the urban labor market raises rural wages by 3.8%.

Our final experiments relate to company taxes. Table 6 shows the effect of reducing the corporate tax rate from 35% to 30%. This has a modest effect when the capital stock is held fixed; GNP rises by 0.32%. The effect is much larger when the capital account is open: at this point capital flows into the economy, formal sector output increases sharply, the informal sector contracts, and the long-run effect of a lower corporate tax rate is higher tax revenues. Overall, GNP rises by around 11% in response to the tax cut. In Table 7, we show the effects of reducing the payroll tax rate from 10% to 5%. Again, the effects are modest when the capital stock is fixed, but when the capital account is open, the long-run effects include higher formal sector output, a contraction in the informal sector, and an increase in overall tax revenues.

We can also analyze the effect of a revenue-neutral tax change. If the payroll tax rate is decreased from 10% to 5%, this requires an offsetting increase in the corporate tax rate of 1.26 percentage points for the closed capital account case, and just 0.52 percentage points for the open capital account case. This revenue-neutral change is found to increase total GNP by 0.32% and 0.90% respectively. The effect on wages is slightly stronger, and total labor income rises by

[27] With Cobb-Douglas technologies, this effect will be especially powerful when the urban capital exponent θ is high, because the required factor increase in the capital-labour ratio is equal to the factor increase in urban TFP raised to the power $1/(1-\theta)$.

1.83% and 2.78% respectively.

Finally, given the strong response of city size in some of the experiments, we briefly discuss the possibility that location preferences (captured in x_a) may be heterogeneous across the population of workers. This is a straightforward extension of our analysis. Assume that x_a has a distribution function $F(x_a)$ which is continuous and strictly increasing over its entire support. Let x_a^* be the preference parameter of the agricultural worker who is indifferent to migrating. All workers with $x_a < x_a^*$ will live in the city, while those with $x_a \geq x_a^*$ will live in rural areas, so

$$F(x_a^*) = L_m$$

Given our assumptions about $F(.)$ then x_a^* can be expressed as a continuous function of L_m, $x_a^*(L_m)$. We can then replace x_a with x_a^* throughout the previous analysis. In describing the steady-state, the only change to the analysis in section 4 is that the migration condition becomes:

$$w_a\left(\overset{+}{L}_m;\overset{+}{K}_a\right) + x_a^*(L_m) + rB = \zeta(\overset{+}{s};\overset{+}{z},\overset{+}{\Pi}) \tag{18}$$

To implement this idea in the calibration, we need to specify a distribution for $F(x_a)$. We have experimented with a normal distribution in which the variance is imposed, while the mean is treated as an unknown parameter that can be inferred from the observed size of the city. Introducing heterogeneity in this way influences the responsiveness of city size to parameter changes, but the effects on responses of other variables are generally modest.

7 Conclusions

Agénor (1996, 2004, 2005a), Fields (1984) and Freeman (1992) have argued strongly that too little attention has been paid to the interactions between labor markets and aggregate development. In this paper, we have described a simple general equilibrium framework in which an urban labor market with matching frictions is embedded in a 3 x 2 specific factors model, with an urban sector and an agricultural sector. This specification of the urban labor market is attractive in that it unifies the analysis of labor markets and underemployment for developed and developing countries.

We find that matching frictions in the urban labor market can account for a sizeable informal sector under reasonable assumptions. Taking the example of Mexico, informal sector employment is often estimated to account for at least 30% of the urban labor force. Our calibration shows that this can be explained solely in terms of matching frictions, provided either that workers receive a relatively large share of the match surplus, or that recruitment costs are significant.

The model allows us to consider a range of questions of central importance to development economics, while acknowledging the interdependence of sectors. These questions include the effects of different types of growth on employment, the informal sector, sectoral structure, urbanization, labor income and total output. We have also studied the effects of labor market parameters and company taxes on equilibrium outcomes, including sectoral structure and aggregate productivity. Even relatively modest changes can have sizeable effects, especially for

total labor income.

It would be straightforward to extend this model in various ways. By incorporating heterogeneity in worker productivity, we could adapt this paper's model to consider distributional issues, including the effects of growth on inequality. More ambitiously, further work could improve on our analysis by developing a richer model of the informal sector, perhaps incorporating several tiers to self-employment, and the role of business regulation and start-up costs. Finally, since our analysis suggests that labor market institutions can have significant effects on aggregate outcomes in middle-income countries, there is a case for examining the same effects for poorer countries. That is likely to require a more complex approach to the urban labor market and the rural sector than we have developed here.

A Stability

This Appendix establishes that the equilibrium is saddle-path stable when $B = 0$ for both versions of the model (closed versus open capital account). When $B > 0$ there is a continuum of equilibria (see footnote 10) and hence perturbations will cause a shift from one equilibrium to another.

For the stability analysis, a natural assumption is that the instantaneous change in the urban labor force is given by

$$\dot{L}_m = \theta \left(rU - (w_a + x_a) \right) \tag{19}$$

which might follow if the parameter b, introduced in the discussion preceding equation (6), is strictly positive. Note that our results on stability do not rely on the linearity in (19). It is also important to note that U in equation (19) represents the welfare of a worker in urban unemployment who does not migrate, so that (5) continues to describe the evolution of U.

In equation (11), $y(k_m)$ is output per filled job less the rental cost of capital; this can also be interpreted as the marginal product of labor. With an open capital account k_m and hence $y(k_m)$ will be exogenously determined by the world real interest rate. With a closed capital account, since $y(k_m)$ is an increasing function of capital per employed worker and the urban capital stock is fixed, it can also be expressed as a decreasing function of formal sector employment $E_m = (1-u)L_m$. We use $y(\underset{-}{E}_m)$ to denote this decreasing function.

With a closed capital account it can be shown that:

$$\frac{(r+\lambda)}{1-\beta} J = (1-t_c) y(\underset{-}{E}_m) - (1+t_w)\, \zeta(\underset{+}{\tau}) + t_w \lambda P + \frac{1+\beta t_w}{1-\beta} \dot{J} \tag{20}$$

Note that from standard properties of the matching function, $q(\tau)$ and $\tau q(\tau)$ are respectively decreasing and increasing in τ. It is also possible to show that search intensity s, ζ and J are all increasing functions of τ. So from (20), $\dot{\tau}$ is an increasing function of both τ and E_m. With an open capital account, since $y(k_m)$ is exogenous, $\dot{\tau}$ is just an increasing function of τ. We also note that $\dot{U}$ is an increasing function of U and a decreasing function of τ.

The evolution of formal sector employment is given by

$$\dot{E}_m = mL_m - \lambda E_m = s\tau q(\tau) \left(L_m - E_m \right) - \lambda E_m \tag{21}$$

Finally we consider the instantaneous change in the size of the city, $\dot{L}_m$. The two endogenous variables that determine this are (positively) the present value of urban unemployment U and (negatively) the agricultural wage, where the latter is an increasing function of city size L_m.

These arguments combine so that, after taking a first order linear approximation around the steady state, we obtain a system of the following sign pattern in the variables τ, U, L_m and E_m:

$$\begin{pmatrix} \dot{\tau} \\ \dot{U} \\ \dot{L}_m \\ \dot{E}_m \end{pmatrix} = A \begin{pmatrix} \tau \\ U \\ L_m \\ E_m \end{pmatrix} \text{ where } A = \begin{pmatrix} + & 0 & 0 & A_{41} \geqslant 0 \\ - & + & 0 & 0 \\ 0 & + & - & 0 \\ + & 0 & + & - \end{pmatrix}$$

where $A_{41} = 0$ when the capital account is open, and $A_{41} > 0$ when it is closed.

We want to show that there are two eigenvalues with negative real part corresponding to the two predetermined variables L_m and E_m, and two eigenvalues with positive real part corresponding to the jump variables τ and U, so that the system is saddle-path stable and determinate. This is clear by inspection for the open capital account case, where $A_{41} = 0$ and A is triangular, so the eigenvalues are just the diagonal elements of A.

With a closed capital account where $A_{41} > 0$, the proof is slightly more involved. The result follows because the sign pattern implies the following two statements: (i) $\det(A) > 0$ (ii) $f'\left(\frac{A_{11}+A_{22}}{2}\right) < 0 < f'\left(\frac{A_{33}+A_{44}}{2}\right)$, where $f(\lambda) \equiv \det(A - \lambda I)$ is the characteristic polynomial, a quartic with a positive sign on the λ^4 term. Since $\frac{A_{33}+A_{44}}{2} < 0 < \frac{A_{11}+A_{22}}{2}$,(ii) implies that f has a turning point either side of the vertical axis. This means that at least one of its roots must have a negative real part and one must have a positive real part. However, since $\det(A) > 0$, there must then be two roots with positive real value, and two with negative, so the system is saddle-path stable. Note that unlike the open capital account case, the roots may be complex, and so we cannot rule out cyclical adjustment patterns.

B Efficiency

As is well known, matching frictions imply the presence of nonpecuniary externalities to decisions by workers and firms, and so the market equilibrium will typically be inefficient. In standard models, the decentralized equilibrium is efficient only under the well-known Hosios (1990) condition. Ignoring taxes, which we do here for simplicity, the surplus must be allocated so that the worker's share (β in our notation) is equal to the elasticity of the matching function with respect to su.[28]

The Hosios condition also ensures efficiency in our model. This is not surprising, given the similarity between our setup and developed country models with endogenous participation in which efficiency can be established under the same condition (Garibaldi and Wasmer 2005). One difference in our analysis is that, when the Hosios condition is not satisfied, the level of search intensity can be inefficiently high (and the city too large) when the capital account is closed. This contrasts with the standard result that search intensity is inefficiently low when the

[28] The impact of taxes on efficiency is directly analogous to that in the standard matching models described in Pissarides (2000).

Hosios condition is not satisfied. Our result follows from the congestion effect that arises when a factor of production is in fixed supply; in the case of an open capital account, the standard result holds.

Another difference from the model of Garibaldi and Wasmer (2005) is that when there is a fixed migration cost, $B > 0$, both the decentralized steady state and the steady state obtained by the social planner will depend on the initial size of the city. The mapping between initial conditions and the resulting steady state is identical for the social planner and the decentralized equilibrium if and only if the Hosios condition is satisfied.

To see this, note that the decentralized equilibrium is affected by initial conditions as follows. If the city is initially "too small" then workers will migrate from agriculture to the city until we have

$$w_a\left(L_m; K_a\right) + x_a + rB = \zeta(s; z, \Pi) \tag{22}$$

Conversely, if the city is initially too large, equilibrium requires

$$w_a\left(L_m; K_a\right) + x_a - rB = \zeta(s; z, \Pi) \tag{23}$$

There is also an intermediate case where no migration occurs, where the urban labor market is in equilibrium and

$$w_a\left(L_m; K_a\right) + x_a - rB < \zeta(s; z, \Pi) < w_a\left(L_m; K_a\right) + x_a + rB.$$

We assume that the social planner can engineer a flow of workers f from agriculture to the city, with associated migration costs $B + b \mid f \mid$ per migrant. We first consider the case where the city is initially small and so $f > 0$; we consider other cases later. In addition, we have the usual other two control variables: search intensity s and vacancy creation, which can be seen as choosing τ. The state (or stock) variables are unemployment u and the size of the city $L_m = 1 - L_a$ which presents the social planner with the following constraints:

$$\dot{L}_a = -f \tag{24}$$

and

$$\frac{d}{dt}\left\{(1-u)L_a\right\} = \lambda(1-u) - m + f$$

which gives

$$\dot{u} = \lambda(1-u) - su\tau q(\tau) + \frac{1-u}{1-L_a}f \tag{25}$$

Subject to the constraints (24) and (25), we make the standard assumption that the social planner maximises the present discounted value of the total income of domestic factors of production:

$$Y = \int_0^\infty \left[Y_a(L_a) + L_a x_a - Bf - bf^2 + (1-L_a)\left\{1-u)y_m^X + u\left(z - \sigma(s,z)\right) - cv\right\}\right] e^{-rt} dt \tag{26}$$

which implies the current value Hamiltonian is:

$$\begin{aligned} H &= Y_a(L_a) + L_a x_a - Bf - bf^2 + (1 - L_a)\left[(1-u)\, y_m^X + u\,(z - \sigma(s;z)) - csu\tau\right] \\ &\quad + \mu\left[\lambda(1-u) - su\tau q(\tau) + \frac{1-u}{1-L_a} f\right] - \psi f \end{aligned} \tag{27}$$

where ψe^{-rt} and μe^{-rt} are the costate variables for L_a and u respectively, $Y_a(L_a)$ is agricultural production, and $L_a x_a$ is the utility benefit of living in rural areas, which we interpret as income for simplicity, and the quantity

$$y_m^X = A_m f(k_m) - X A_m f'(k_m) k_m$$

is formal sector output per worker in the closed capital account case ($X = 0$) and the marginal product of labor in the open capital account case ($X = 1$).

This quantity y_m^X will be the aspect of formal sector output that a social planner seeks to influence. When the capital account is open, domestic allocations do not affect the capital income that accrues to domestic residents. Hence, the social planner can disregard capital income in solving for the optimum allocation. With a closed capital account, the social planner cares about the entirety of formal sector output, given that capital is domestically owned and the return on this capital may vary.

Noting that k_m is exogenous (endogenous) when $X = 1$ ($X = 0$) it is useful to note that

$$\frac{\partial}{\partial u}\left\{(1-u) y_m^X\right\} = \frac{\partial}{\partial L_a}\left\{(1-L_a) y_m^X\right\} = -y(k_m) \tag{28}$$

for $X = 0, 1$ where (as in the main text) $y(k_m) = A_m f(k_m) - A_m f'(k_m) k_m$ or the marginal product of labor.

The maximum principle applied to (27), using (28), then leads to a set of first order conditions that determine the steady state conditions obtained by the social planner. By comparing these with their decentralized equivalents, it can be shown that efficiency is achieved if and only if the surplus in the decentralized equilibrium is shared according to:

$$(1-\eta)\,(W - U) = \eta\,(J - V) \tag{29}$$

where η denotes the elasticity of the matching function with respect to search effort su.[29] In the decentralized equilibrium the surplus is shared according to the bargaining parameter β, so it is efficient only under the well-known Hosios (1990) condition that $\beta = \eta$.

In the alternative case where the size of the city is initially too large relative to the equilibrium, f is now negative for the social planner and we replace the migration costs term $-Bf$ in equations (26) and (27) with $+Bf$. This results in a migration condition for the social planner that is

$$w_a(L_a) + x_a - rB = z - \sigma(s;z) + \frac{\eta cs\tau}{1-\eta}$$

Again the decentralized equilibrium is efficient if and only if the Hosios condition holds. A

[29] For the full details of the derivation, see Satchi and Temple (2006).

similar argument can be made for the intermediate case: whatever the initial conditions, the decentralized equilibrium will replicate the social planner's outcome if and only if the Hosios condition holds. Finally, it is straightforward to show that this remains the case when x_a is heterogeneous across the population.

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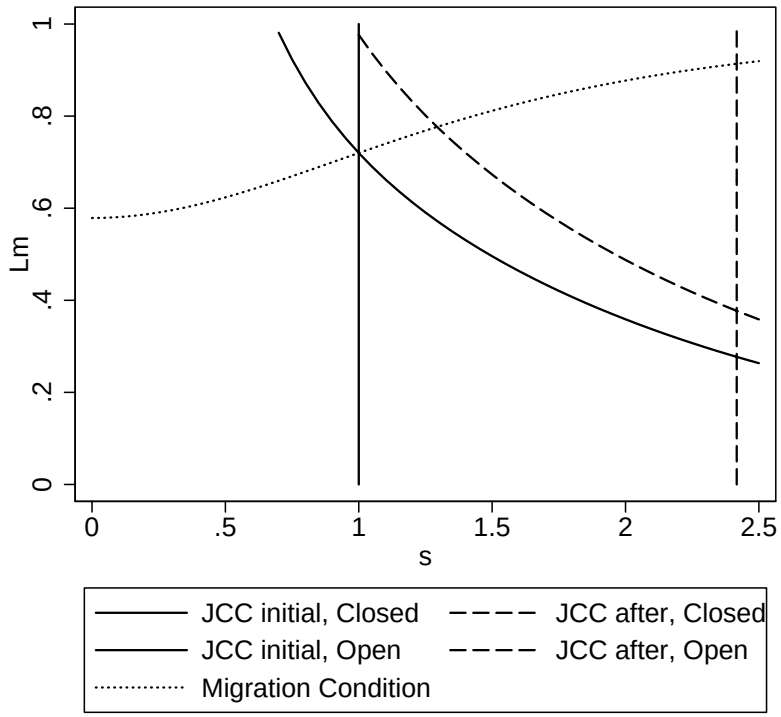

Figure 1 – Comparative statics for an increase in urban TFP

Notes

This figure illustrates the comparative static results associated with a 20% increase in TFP in the urban sector, with either a closed or open capital account. The dotted, upward sloping line corresponds to the migration condition. It is the same for both the open and closed capital account, and does not move in response to the shock. The job creation curve (JCC) is downward sloping (closed capital account) or vertical (open capital account) and moves in the indicated direction in response to the increase in urban TFP.

Table 1. Comparative statics with a closed/open capital account

Rise in : / Effect on:	A_a	A_m	z	M	c	λ	Π	x_a	t_c	P
Migration Condition	$\longrightarrow$	$=$	$\longleftarrow$	$=$	$=$	$=$	$\longleftarrow$	$\longrightarrow$	$=$	$=$
Job Creation Curve	$=$	$\longrightarrow$	$\longleftarrow$	$?/\longrightarrow$	$?/\longleftarrow$	$?/\longleftarrow$	$\longleftarrow$	$=$	$\longleftarrow$	$\longleftarrow$
s	$+/=$	$+$	$-$	$?/+$	$?/-$	$?/-$	$-$	$+/=$	$-$	$-$
u	$-/=$	$-$	$+$	$-$	$+$	$+$	$+$	$-/=$	$+$	$+$
L_m	$-$	$+$	$+$	$?/+$	$?/-$	$?/-$	$?/-$	$-$	$-$	$-$
w_a	$+$	$+$	$+$	$?/+$	$?/-$	$?/-$	$?/-$	$-$	$-$	$-$
w_m	$+$	$+$	$+$	$?/+$	$?/-$	$?/-$	$?/-$	$+$	$-$	$-$
$(1-u)L_m$	$-$	$+$	$?$	$+$	$-$	$-$	$-$	$-$	$-$	$-$

Table 2. The assumptions used in the calibration

Constrained parameters/baseline outcomes	Value	Source
Exponent on labour (agriculture)	0.37	Imam and Whalley (1985)
Exponent on labour (formal sector)	0.42	Imam and Whalley (1985)
Agricultural employment share (La)	0.28	ILO LABORSTA, data for 1990
Informal sector share of urban labour (u)	0.30	Gong and van Soest (2002)
Annual interest rate (r)	0.04	Standard
Matching function elasticity (γ)	0.50	Standard
Monthly job separation rate (λ)	0.06	Gong and van Soest (2002)
Corporate tax rate	0.35	Iqbal (1994, Appendix, fn.11)
Payroll tax rate	0.10	Iqbal (1994, Appendix)
Firm asset value of match relative to average productivity	0.15	Yashiv (2000, Table 3)
Vacancy posting cost relative to formal sector wage	0.40	See text
Severance pay/formal sector wage	4.00	Capelleja (1997) – see text
Search cost elasticity (φ)	2.00	Yashiv (2000, p. 1311)
Formal sector wage/rural wage	1.80	ILO LABORSTA, data for 1991
Formal sector wage/informal sector wage	1.00	Aleman-Castilla (2006, p. 50)

Table 3. The effects of raising agricultural TFP by 20%

	Baseline	New (Closed)	New (Open)
Urban unemployment rate	0.30	0.27	0.30
Vacancy rate	0.06	0.06	0.06
Matching rate	0.04	0.04	0.04
Formal-informal wage ratio	1.00	1.03	1.00
Urban-rural wage ratio	1.80	1.76	1.80
Search (% of time, informal sector)	0.13	0.16	0.13
Tax revenues/GNP	0.20	0.20	0.18
Agricultural labour (% of total)	0.28	0.34	0.37
Formal sector (% of total)	0.50	0.48	0.44
Informal sector (% of total)	0.22	0.18	0.19
Agricultural wages (% increase)		5.26	0.00
Formal sector wages (% increase)		2.85	0.00
Total labour income (% increase)		-0.80	-5.57
Agricultural output (% increase)		29.60	33.56
Formal sector output (% increase)		-2.07	-13.05
Informal sector output (% increase)		-21.35	-13.05
Tax revenues (% increase)		-2.05	-13.05
Overall GDP (% increase)		1.91	-4.95
Overall GNP (% increase)		1.91	-1.23

Table 4. The effects of raising TFP in the formal sector by 20%

	Baseline	New (Closed)	New (Open)
Urban unemployment rate	0.30	0.23	0.10
Vacancy rate	0.06	0.07	0.11
Matching rate	0.04	0.05	0.05
Formal-informal wage ratio	1.00	1.08	1.54
Urban-rural wage ratio	1.80	1.69	1.32
Search (% of time, informal sector)	0.13	0.21	0.74
Tax revenues/GNP	0.20	0.22	0.33
Agricultural labour (% of total)	0.28	0.22	0.09
Formal sector (% of total)	0.50	0.60	0.82
Informal sector (% of total)	0.22	0.18	0.09
Agricultural wages (% increase)		15.29	109.86
Formal sector wages (% increase)		8.11	54.32
Total labour income (% increase)		12.20	74.84
Agricultural output (% increase)		-8.02	-35.30
Formal sector output (% increase)		29.25	151.18
Informal sector output (% increase)		-26.79	-86.94
Tax revenues (% increase)		29.31	151.20
Overall GDP (% increase)		18.35	100.16
Overall GNP (% increase)		18.35	57.12

Table 5. The effects of raising the matching efficiency index M by 20%

	Baseline	New (Closed)	New (Open)
Urban unemployment rate	0.30	0.27	0.24
Vacancy rate	0.06	0.05	0.05
Matching rate	0.04	0.04	0.05
Formal-informal wage ratio	1.00	0.98	1.00
Urban-rural wage ratio	1.80	1.78	1.74
Search (% of time, informal sector)	0.13	0.12	0.15
Tax revenues/GNP	0.20	0.21	0.22
Agricultural labour (% of total)	0.28	0.28	0.26
Formal sector (% of total)	0.50	0.53	0.56
Informal sector (% of total)	0.22	0.19	0.18
Agricultural wages (% increase)		-0.62	3.82
Formal sector wages (% increase)		-1.86	0.48
Total labour income (% increase)		-0.56	3.13
Agricultural output (% increase)		0.37	-2.18
Formal sector output (% increase)		1.77	10.83
Informal sector output (% increase)		-10.92	-19.79
Tax revenues (% increase)		1.61	10.68
Overall GDP (% increase)		0.65	6.29
Overall GNP (% increase)		0.65	3.20

Table 6. Reducing the corporate tax rate from 35% to 30%

	Baseline	New (Closed)	New (Open)
Urban unemployment rate	0.30	0.29	0.19
Vacancy rate	0.06	0.06	0.08
Matching rate	0.04	0.04	0.05
Formal-informal wage ratio	1.00	1.00	1.13
Urban-rural wage ratio	1.80	1.79	1.62
Search (% of time, informal sector)	0.13	0.13	0.26
Tax revenues/GNP	0.20	0.18	0.23
Agricultural labour (% of total)	0.28	0.28	0.20
Formal sector (% of total)	0.50	0.52	0.65
Informal sector (% of total)	0.22	0.21	0.15
Agricultural wages (% increase)		1.07	24.88
Formal sector wages (% increase)		0.25	12.61
Total labour income (% increase)		0.89	19.31
Agricultural output (% increase)		-0.63	-12.23
Formal sector output (% increase)		1.16	42.71
Informal sector output (% increase)		-4.98	-40.01
Tax revenues (% increase)		-12.26	23.84
Overall GDP (% increase)		0.32	26.57
Overall GNP (% increase)		0.32	11.29

Table 7. Reducing the payroll tax from 10% to 5%

	Baseline	New (Closed)	New (Open)
Urban unemployment rate	0.30	0.29	0.27
Vacancy rate	0.06	0.06	0.06
Matching rate	0.04	0.04	0.04
Formal-informal wage ratio	1.00	1.02	1.03
Urban-rural wage ratio	1.80	1.78	1.76
Search (% of time, informal sector)	0.13	0.14	0.16
Tax revenues/GNP	0.20	0.20	0.21
Agricultural labour (% of total)	0.28	0.27	0.26
Formal sector (% of total)	0.50	0.52	0.54
Informal sector (% of total)	0.22	0.21	0.20
Agricultural wages (% increase)		2.51	5.85
Formal sector wages (% increase)		1.59	3.39
Total labour income (% increase)		2.10	4.83
Agricultural output (% increase)		-1.44	-3.29
Formal sector output (% increase)		1.32	7.83
Informal sector output (% increase)		-3.95	-10.54
Tax revenues (% increase)		-3.16	3.09
Overall GDP (% increase)		0.41	4.44
Overall GNP (% increase)		0.41	2.21