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Search Frictions, Financial Frictions and Labor Market Fluctuations in Emerging Economies

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Abstract

This paper examines the role of the extensive and intensive margins of work in the context of business cycles in emerging markets with a financial friction. The earlier literature analyzed the role of search frictions with only an extensive margin of work and showed that such a framework can address the distinguishable business-cycle characteristics of emerging markets such as highly volatile consumption, countercyclical net exports, highly volatile wages and pro-cyclical wages. One of our contributions is to show that in the presence of an endogenous hours choice, search frictions fail to predict not only these characteristics but also the positive co-movement of hours worked per worker and employment with output. This occurs due to the strong income effect on hours worked. On the other hand, introducing a financial friction, namely working capital, significantly increases the performance of the model and suggests frictions in both labor markets and financial markets are necessary for explaining emerging market business cycles.

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1 Introduction

A number of recent papers have drawn attention to the stylized facts of emerging market business cycles. In such economies not only is consumption highly volatile but it also fluctuates more than output. Furthermore, net exports are strongly countercyclical. Among other papers, Aguiar and Gopinath (2007) have attempted to reconcile these findings in the context of small open economy real business cycle models (SOE-RBC). They argue that for emerging markets, the cycle is the trend in that fluctuations in trend productivity can account for many of the business cycle puzzles. Their model yields the findings of highly volatile consumption and countercyclical net exports.

Yet one could argue that such features do not go far enough in terms of identifying the specific channels by which emerging economy business cycles arise. Neumeyer and Perri (2005) argued that financial or interest rate shocks propagate in emerging economies through a working capital requirement in that most firms in such economies finance current operating costs through short-term bank credit. Another difference between developed and emerging economy business cycles has to do with the behavior of labor market variables. In contrast to developed economies, wages are highly volatile and procyclical, as is the labor share. Boz et al. (2009) have examined models with search frictions to account for the labor market findings while Kabaca (2010) and Li (2011) seek to rationalize these movements in wages and labor share.

The contribution of this paper is to provide further evidence on the nature of labor market fluctuations in emerging economies. To accomplish this, we examine the implications of SOE-RBC models that allow for both an extensive and intensive margin in the hours choice. We consider a model which incorporates financial frictions in the form of a working capital constraint and search frictions in the labor market. However, we also allow for changes in the hours of work in addition to variation in labor market participation. Our motivation for doing so stems from the observed variation across the intensive margin involving hours worked for emerging market economies. By combining financial frictions with search frictions in a more realistic framework, we can rationalize the observed fluctuations in emerging economies in response to alternative shocks such as increases in their cost of borrowing.

The recent global financial crisis has witnessed a phenomenon whereby emerging market economies have seen increases in their unemployment rates. Figure 1 shows that employment in Mexico and Turkey fell after the crisis in 2008 and remained below its pre-crisis levels for more than a year. In addition, hours worked per worker in these countries displays the U-shaped movement as well. Not surprisingly, these countries faced difficulties to access funds in the international markets. Hence, our framework has the potential to account for the observed changes in emerging economies during the recent global financial crisis as much as accounting for emerging economy business cycles more generally.

We begin by showing that the variations in the intensive margin of labor (or hours per worker) are more significant in emerging markets than in developed markets. Furthermore, both intensive and extensive margins of work tend to display positive responses to changes in output in emerging economies whereas the intensive margin does not significantly respond to output fluctuations in developed markets. Previous literature studied the intensive and extensive margins in the context of search models for developed economies. Yedid-Levi (2009) and Merkl and Wesselbaum (2011), for example, show that hours per worker is a secondary source of variation in developed economies. Yedid-Levi (2009) further argues that differentiating the margins of labor is an essential step to understand comovements across sectors in a model with search and matching frictions. In a different vein, Seymen (2011) examines the role of the extensive versus intensive margins of work in the US and Germany for explaining the adjustment to cyclical shocks using a time-varying vector autoregression framework.

While changes in labor market participation (or employment) have been examined in the context of search models for emerging economies, previous work has essentially ignored changes in the intensive margin. Our findings suggest, however, that allowing for an endogenous intensive margin in a search context does not resolve the emerging market business cycle puzzles. This is due to a strong income effect on hours worked, which tends to mitigate the response of hours and wages in response to exogenous shocks. This income effect persists even if we utilize alternative forms of preferences which imply a smaller income effect (see Jaimovich and Rebelo (2009)). While search models also yield a large response of wages to the exogenous shocks, the income effect from variations in the hours of work tends to lessen this response. It is by allowing for financial frictions in the form of a working capital requirement that we can generate both the labor market implications and those arising in goods markets. Our findings suggest that there are important interactions arising from financial and search frictions in SOE-RBC models. Such interactions can jointly rationalize the observed responses of the key macroeconomic time series together with the labor market outcomes once we allow for workers to optimally choose their hours of work.

Our paper is also related to the literature that previously studied the role of search frictions on aggregate fluctuations in developed markets, mostly the US. Andolfatto (1996) and Merz (1995) show that these types of frictions have an amplification on labor market variables in a closed-economy business cycle models. They also emphasize that their impact on aggregate fluctuations of consumption and investment is minimal. We, here, find that this result also holds in SOE-RBC models, as opposed to findings in Boz et al. (2009). Even though interest rates are very volatile, search frictions insignificantly change the movements of output, consumption, and net exports when the intensive margin of labor is endogenous.

The rest of the paper is organized as follows. Section 2 documents the volatility and correlation statistics for employment and hours worked per worker in emerging markets. For comparison, the stylized facts on labor market fluctuations in developed markets are also included here. Section 3 presents the model with both search and financial frictions. Section 4 describes the calibration strategy, discusses the main findings of the model, and performs robustness analyses to parameters. Section 5 concludes.

2 Intensive and Extensive Margins of Labor Input in Emerging Markets

In this section, we present some evidence regarding variation in the labor input in emerging economies due to the intensive and the extensive margin of work. Table 1 shows the standard deviation of employment and hours as a fraction of the standard deviation of real output, the correlation of output with employment and hours as well as the correlation of employment and hours per worker for a set of emerging and developed economies. The detailed explanation on data description and their sources can be seen in the Appendix.

One of the interesting findings from Table 1 is that the relative standard deviations of employment and hours are reversed for emerging versus developed economies. In the developed economies, employment as a fraction of GDP varies more than hours per worker as a fraction of GDP for almost all countries except Austria and Germany. The average value of the relative standard deviation of employment is 0.92 versus 0.63 for the developed economies. By contrast, we find that the opposite of this finding holds for the emerging economies. For a country such as Turkey, this variation is nearly three times greater, and the average value of the standard deviation in employment is 0.74 versus 0.83 for hours per worker. This suggests that labor market behavior in emerging economies also features significant variation in the hours per worker in addition to changes in employment.[1]

A second finding from Table 1 is the significantly higher correlation of detrended real GDP with hours per worker for the emerging economies. We observe that this quantity is nearly twice as large as that in developed economies. Furthermore, the variation is due to countries such as Argentina, Mexico and Turkey for which we have typically observed large financial shocks and financial crises in the period since the 1980's or the 1990's.[2] AS we will show subsequently, such financial shocks can indeed turn out to be the reason behind

[1]Since data on hours per worker comes from manufacturing industry that tends to be more volatile than output, standard deviations of hours per worker for the whole economy might be lower than presented here. Nevertheless, it still suggests us that the variation in the intensive margin is more important in emerging markets relative to developed markets.

[2]For the case of Argentina and Mexico, the sample period includes the Tequila crisis of 1995 as well as the contagionary effects of the 1998 Russian crisis. Moreover, Argentina experienced the sovereign debt default of 2002. For Turkey, there are two major financial crises, the 1994 exchange rate crisis and the 2000-2001 banking and financial crisis. For a further discussion of the timing of the recessions associated with such crises, see Altug and Bildirici (2010).

such the significant correlations between real output and hours per worker when we allow for a friction in the form of a working capital requirement for firms.

A third finding that from Table 1 is that the correlation between employment and hours per worker is also positive in emerging economies and much larger than that for the developed economies. By contrast, there is a negative correlation between employment and hours per worker for many of the European economies such as Austria, France, Germany, Norway, and Ireland. These results suggest that the dynamics of labor markets in emerging economies may differ in significant ways from those of developed ones. In the previous literature, the role of the intensive margin has typically been ignored. Some of the previous literature has allowed for labor utilization and showed that the effort that each worker puts in during recessions may be lower than in booms due to time-varying labor utilization. Therefore, we can view the volatility of the intensive margin shown here to be a lower bound on the actual volatility of hours.

We also present evidence from quarterly data. Figure 1 plots the movements of the extensive and intensive margins in Mexico and Turkey during the recent global crisis and their own domestic financial crises. The starting dates of domestic crises are 1994Q4 and 2001Q1 for Mexico and Turkey, respectively. In addition, 2008Q4 is chosen to be the starting period for the recent global crisis for both countries. These are the quarters when GDP declined the first time after a series of quarters with positive growth.[3] The evidence from quarterly data supports the findings using from annual data. In particular, Figure 1 shows that both margins of labor input tend to move similarly, and follow a U-shape during both crises. Thus, both employment and hours per worker drop when output drops, and begin to improve after a couple of quarters.

One of the interesting features during these periods where output has fallen is that both countries had difficulties to finance their expenditures. During earlier domestic crises, a large increase in their default risk lowered their ability to borrow. In the current crisis, we also observe an increase in default risk as measured by their CDS spreads (see Figure 2), although this is typically less that in previous crises. In the current global crisis, what may have affected emerging economies such as Mexico and Turkey is the illiquidity in international financial markets, suggesting a decreased capability to borrow at longer horizons. While we do not have model features such as borrowing constraints or borrowing at different horizons, we include a financial friction in the form of working capital and show that it is crucial to generate the positive comovement between extensive and intensive margin of labor input consistent with the evidence presented here.

[3]Kaminsky and Reinhart (1999) also reports 1994Q4 to be the starting period for the balance-of-payment crisis in Mexico.

3 Model

This section describes a model which incorporates labor market search and matching frictions into an otherwise standard small open economy real business cycle (SOE-RBC) model with shocks to total factor productivity (TFP) and interest rates. We use a Mortensen-Pissarides type of search and matching framework which models employment, unfilled job vacancies and wage determination explicitly. In the light of the discussion above, we also incorporate the model with a financial friction, namely, working capital requirement, which requires the firm to pay a fraction of wage bill in advance. Moreover, the only asset traded in international financial markets is a non-state contingent real bond. Firms trade in this asset because of the presence of labor financing in advance as well as households for saving purposes.

3.1 The Firm's Problem

A continuum of a large number of competitive firms are producing a single tradable good at a world-determined price, which is normalized to one. Output is produced by a constant returns to scale production function: $y_t = A_t k_t^{\zeta}(n_t l_t)^{1-\zeta}$. For the inputs of production, firms hire labor in the form of workers, n_t, times hours per worker, l_t, and rent capital, k_t from households. As opposed to Boz et al. (2009), we allow intensive margin of the labor input, l_t to vary over time and to be chosen as an outcome of bargaining problem, the details of which will be given in a later section. This helps us to see the role of endogenous intensive margin of labor.

There are search frictions in the labor market: firms post a job vacancy, v_t and pay a recruiting cost, κ, for each vacancy every period. New matches are formed according to the matching technology, which is a function of posted vacancies and nonworking population: $M(v_t, 1-n_t) = \omega v_t^{\alpha}(1-n_t)^{1-\alpha}$.

The individual firm faces a market-driven job filling rate given during the recruiting process. We denote job filling rate as $\Psi(\theta_t) = \frac{M(v_t,1-n_t)}{v_t}$, where $\theta_t = \frac{v_t}{1-n_t}$ represents the market tightness, and assume that there is an exogenous breaking rate between workers and jobs, ψ. Then, employment evolves according to the following law of motion: $n_{t+1} = (1-\psi)n_t + \Psi(\theta_t)v_t$. According to this law of motion, a vacancy can become productive after a period of time elapsed and this implies the time consuming nature of recruitment for the firm.

Along with the labor market friction, firms are also subject to a working capital requirement. They need working capital loans to pay a fraction of their wage bill before output is available[4] and in order to do so they borrow from abroad in the very beginning of the pe-

[4]This could be considered as the equivalent version of having to pay labor before the sales are cashed out in an economy where there is a lag between production and cashing out the sales.

riod. This type of friction is widely used in macroeconomic papers since wage payments are an important item in the firms' operating expenses as opposed to capital payments (business profits) to household.[5] The fraction of the wage bill that has to be paid in advance is denoted by ϕ. Finally, firms use the same stochastic discount factor as households for the present value of future profits, which is $\Pi_{t,t+1} = \beta u_{c,t+1}/u_{c,t}$ where u_c is the marginal utility of consumption of which details are given in the next section.

Given the wage rate, w_t, employment, n_t, labor supplied per worker, l_t, an individual firm chooses how much vacancy to post, v_t and how much capital to rent, k_t, and solves the following dynamic problem:

$$\begin{aligned} V_t^F(n_t, \epsilon_t) &= \max_{v_t, k_t} \quad y_t - (1 + \phi(R_{t-1} - 1))w_t n_t l_t - r_t k_t - \kappa v_t \\ &\quad + E_t \Pi_{t,t+1} V_{t+1}^F(n_{t+1}, \epsilon_{t+1}) \\ s.t. \qquad n_{t+1} &= (1 - \psi)n_t + \Psi(\theta_t)v_t \end{aligned}$$

where r_t is the rental payment to households and $\epsilon_t = [\epsilon_t^A, \epsilon_t^R]$ is the exogenous state space, namely the shocks to the TFP and the interest rate, R_t, on the internationally-traded bond. Following Neumeyer and Perri (2005), firms pay R_{t-1} as interest for working capital loans since they are borrowed at the very beginning of the period before the consumption and investment decisions are made.[6]

The optimality condition for vacancies is:

$$\frac{\kappa}{\Psi(\theta)} = E_t \Pi_{t,t+1} \frac{\partial V_{t+1}^F}{\partial n_{t+1}} \tag{1}$$

Firms choose the number of vacancies such that the cost of posting an additional vacancy equals to the discounted expected future value of filling an additional vacancy conditional on the vacancy being filled, where the latter phenomenon occurs with a probability of $\Psi(\theta)$.

In addition, the envelope condition with respect to employment is:

$$V_n^F \equiv \frac{\partial V_t^F}{\partial n_t} = y_n - (1 + \phi(R_{t-1} - 1))w_t l_t + E_t \Pi_{t,t+1} \frac{\partial V_{t+1}^F}{\partial n_{t+1}}(1 - \psi) \tag{2}$$

This condition tells us that marginal value of an additional worker is the marginal product of one more worker, $y_n \equiv \frac{\partial y}{\partial n}$, minus the wage cost including the interest payments on working capital plus the asset value of not posting a new vacancy and enjoying the pre-existing relationship with the worker in the next period.

Additionally, the first-order condition with respect to capital is:

$$r_t = z_t \zeta k_t^{\zeta - 1}(n_t l_t)^{1-\zeta} = \zeta \frac{y_t}{k_t} \tag{3}$$

[5]See Christiano and Eichenbaum (1992) and Neumeyer and Perri (2005) for the macro implications of this type of frictions.

[6]Using the current interest rate, R_t, is not changing the results much since the interest rate is persistent.

This condition is standard and states that firms borrow capital from households to the extent that marginal product of capital is equal to the rental rate of capital.

3.2 The Household's Problem

The economy is populated with identical and infinitely-lived households on the interval $[0,1]$. Each household is considered as an extended family which contains a continuum of family members endowed with one unit of time. Each member derives utility from consumption c_t and leisure $1-l_t$ where the total time that is devoted to labor and leisure is normalized to one. Members in this family either work and supply l_t amount of labor or stay unemployed. Employed members earn w_t per hour which is determined by Nash bargaining along with the amount of working-hours.

The utility function for each member is assumed to be twice-continuously-differentiable and concave in consumption and leisure, and exhibits a constant relative risk aversion (CRRA). Here, we explore the effects of both separable and non-separable preferences in terms of consumption and leisure. The aggregate utilities for this family household are:

$$\textit{Separable Preferences:} \qquad u(.) = U(c_t) + n_t \varphi^e H(1-l_t) + (1-n_t)\varphi^u H(1)$$

$$\textit{Jaimovich-Rebelo (JR) Pref:} \qquad u(.) = n_t U(c_t - G(l_t)) + (1-n_t) U(c_t + \varphi^u)$$

where $U(c_t) = \frac{c^{1-\sigma}}{1-\sigma}$ and $H(l) = \frac{(1-l)^{1-\nu}}{1-\nu}$ are the utility derived from consumption and leisure, respectively, and $\sigma > 0$ is the elasticity of intertemporal substitution. We assume perfect risk-sharing against unemployment meaning that all family members pool their income and face the same prices for contingent consumption, which implies that the marginal rate of substitution in consumption is equated across employed and unemployed family members. This implies equal consumption levels for both employed and unemployed members in the case of separable preferences.

In addition to the standard separable preferences mostly used in search papers, we wish to evaluate results from Jaimovich-Rebelo (JR) preferences as well. These preferences are non-separable across consumption and leisure: $U(c_t - G(x_t, l_t)) = \frac{(c_t - \varphi^e l_t^\eta x_t)^{1-\sigma} - 1}{1-\sigma}$, $\eta > 1$, $\varphi > 0$ if the family member is employed. The second term in the utility function $G(x_t, l_t)$, expresses the disutility of labor which is twice-continuously-differentiable and convex function in hours per worker. In addition, $x_t = c_t^\gamma x_{t-1}^{1-\gamma}$ determines the strength of income effect on labor decisions depending on the parameter γ. Note that when $\gamma = 0$ these preferences show the same characteristics as in GHH preferences that eliminates income effect.[7] The issue of income effect is crucial in the case of emerging market business cycles because researchers showed that using preferences that exhibits high income effect on labor supply generates a

[7] See Greenwood et al. (1988).

counterfactual comovement of labor input with output in emerging markets.[8] Lastly, the utility function for the unemployed member is assumed to be $U(c_t + \varphi^u) = \frac{(c_t+\varphi^u)^{1-\sigma}-1}{1-\sigma}$.

Households, in the model, also supply capital to firms, k_t, at a rental rate r_t^k. In addition to labor and capital income, they earn interest from previous period's savings, $R_{t-1}b_{t-1}$, and get dividends from firms, π_t.

Given the wage rate, rental rate of capital, working hours, interest rates on bond, and the probability of finding a job, the household chooses consumption, c_t, investment, i_t, and bond holdings, b_t as in the following dynamic problem if the preferences are separable:

$$\begin{aligned} V_t^H(k_t, b_{t-1}, n_t, \epsilon_t) &= \max_{c_t, i_t, b_t} \quad u(.) + \beta E_t V_t^H(k_{t+1}, b_t, n_{t+1}, \epsilon_{t+1}) \\ s.t. \qquad c_t + i_t + b_t + \Phi(b_t) &= n_t w_t l_t + r_t^k k_t + R_{t-1}b_{t-1} + \pi_t \\ i_t &= k_{t+1} - (1-\delta)k_t + \Phi(k_{t+1}, k_t) \\ n_{t+1} &= (1-\psi)n_t + \Omega(\theta_t)(1-n_t) \end{aligned}$$

where $\Omega(\theta_t) \equiv \frac{M(.)}{1-n_t}$ denotes the probability of job finding rate. Quadratic convex cost functions, $\Phi(.)$ and $\Theta(.)$ make bond holdings and adjustments in investment costly. These are standard in SOE-RBC studies to make sure that the model exhibits stationary properties, particularly to solve the unit-root problem for bond holdings and to prevent excessive investment.[9] Lastly, capital stock depreciates at the rate of δ every period.

In the case of JR preferences, the household solves the same problem except that it has to take into account the consumption habit in preferences, x_t. In addition to those choice variables above, the agent now chooses the optimal x_t with an additional equality constraint that he faces: $x_t = c_t^{\gamma} x_{t-1}^{1-\gamma}$.

Regardless of the type of preferences, one can write the envelope condition with respect to employment as in the following:

$$V_n^H \equiv \frac{\partial V_t^H}{\partial n_t} = (u^e - u^u) + \lambda_t w_t l_t + \beta E_t \frac{\partial V_{t+1}^H}{\partial n_{t+1}}(1 - \psi - \Omega(.)) \tag{4}$$

where u^e and u^u denotes the utilities for employed and unemployed family members, respectively and λ_t represents marginal utility of consumption of a family member. This optimality condition captures the value of an additional worker to the household. The first term illustrates the net utility loss from being unemployed to being employed conditional on the level of the consumption. The second is the wage payments in marginal units as the effect of being employed on consumption and the last term is the discounted expected future value of an additional worker with a probability of staying employed.

[8]See Neumeyer and Perri (2005), Mendoza (2010), Li (2011) for further discussions on income effect.

[9]See Schmitt-Grohé and Uribe (2003) for more details.

In addition to the employment condition, we have the Euler equations for the optimal bond holdings and capital accumulation as in the standard SOE-RBC models:

$$1+\frac{\partial\Phi(b_t)}{\partial b_t} = \beta E_t[\frac{\lambda_{t+1}}{\lambda_t}R_t] \tag{5}$$

$$1+\frac{\partial\Theta(k_t,k_{t+1})}{\partial k_{t+1}} = \beta E_t[\frac{\lambda_{t+1}}{\lambda_t}(1+r_{t+1}-\delta-\frac{\partial\Theta(k_{t+1},k_{t+2})}{\partial k_{t+1}})] \tag{6}$$

These conditions tell us that bond holdings and capital are at their optimal level when their marginal cost is equal to marginal benefit to the households.

The different preferences we assume matter for the behavior of the marginal utility of consumption. When preferences are separable, the marginal utility of consumption for each family member is given by:

$$\lambda_t = c_t^{-\sigma} \tag{7}$$

This implies equal consumption across employed and unemployed since we assume that there is perfect risk sharing. However, in the case of JR preferences, equal marginal utilities do not necessarily imply equal consumption levels across employed and unemployed since labor enters the marginal utility of consumption:

$$\lambda_t = (c_t^e-\varphi^e l_t^\eta x_t)^{-\sigma}+\tau_t\gamma\frac{x_t}{c_t} \tag{8}$$

$$\lambda_t = (c_t^u+\varphi^u)^{-\sigma} \tag{9}$$

If we denote τ_t to be the marginal value of the consumption habit, then the optimal condition for the consumption habit, x_t, in JR preferences states that:

$$(c_t^e-\varphi^e l_t^\eta x_t)^{-\sigma}\varphi^e l_t^\eta+\tau_t = \beta E_t[(1-\gamma)\tau_{t+1}\frac{x_{t+1}}{x_t}] \tag{10}$$

3.3 Nash Bargaining

After the employment decision is made, wages and working hours per worker are set through a Nash Bargaining game between the firm and the worker as in the following manner:

$$(w_t,l_t) = \arg\max_{w,l} = (\frac{V_n^H}{\lambda_t})^\mu (V_n^F)^{1-\mu}$$

where μ is the bargaining power for the worker. The problem above is subject to the value of an additional worker to the firm and household derived earlier as equations (3) and (8), respectively. Here, V_n^H is divided by λ_t in order to express everything in terms of consumption units.

Taking the derivative with respect to wages, we have the *sharing rule* between the firm and the household, which states that the total matching surplus is shared between parties according to their bargaining power:

$$\frac{V_n^H/\lambda_t}{V_n^F} = \frac{\mu}{1-\mu} \tag{11}$$

We can also obtain the condition for the optimal level of working hours by taking the derivative with respect to hours per worker:

$$-\frac{u_l}{\lambda_t} = \frac{y_{nh}}{(1+\theta(R_{t-1}-1))} \tag{12}$$

where $u_l \equiv \frac{\partial u}{\partial l}$ and $y_{nh} \equiv \frac{\partial y}{\partial nh}$. This equation implies that at the optimum, the marginal loss of increasing one more labor hour in units of the consumption good has to be equal to the value of additional product the firm earns. Note that an additional labor-hour increases the value of production less than it would be if there were no working capital requirement because of the interest burden on the firms.

3.4 Equilibrium prices and allocation

Given the initial conditions and a sequence of exogenous interest rates, R_t, and A_t, a search equilibrium consists of a sequence of a state-contingent sequence of allocations $\{c_t, l_t, k_{t+1}, b_t, n_t, v_t\}$ and of prices $\{w_t, r_t\}$ such that

(i) the allocations solve the firm and household problems at the equilibrium prices,
(ii) the Nash Bargaining solutions are satisfied.
(iii) The market for capital clears, i.e, the demand for capital from firms is equal capital supplied from households: $k_t^{demand} = k_t^{supply} = k_t$.
(iv) Goods markets clear:

$$c_t + i_t + nx_t + \kappa v_t + \Phi(b_t) = y_t \tag{13}$$

which implies that the goods that are not spent on consumption, investment, the cost of recruiting activities or of bond holdings represent the net export for the economy.

4 Quantitative Analysis

The model is solved by log-linearizing the equilibrium conditions around the steady state,[10] which is then parameterized so that the deterministic steady state of the model matches several average ratios of macroeconomic aggregates of the Mexican economy documented in the literature. The period in the calibration is 1993Q1-2008Q4 for which we have quarterly data from OECD.

[10]We use the Dynare routine to solve the log-linearized equilibrium conditions. See Adjemian et al. (2011).

4.1 Calibration of Parameter Values

Parameter values. The values of the quarterly depreciation rate δ and the investment-output i/y determine the value of capital-output ratio $\bar{k}/\bar{y}$. The optimality condition for capital demand and the arbitrage condition for bond and capital holdings at the steady state, $\bar{R} = 1 + \bar{r}^k - \delta$, then yield the value of the real interest rate. We set $\delta = 0.25$ and $i/y = 0.21$ using Mexican data. Setting the capital and labor shares as $\zeta = 0.36$ and $1 - \zeta = 0.64$ together with the remaining parameters yields a value for the capital-output ratio as $\bar{k}/\bar{y} = 8.39$. The implied interest rate is then given by 1.79%. The capital-output ratio is equal to 2.10 at the annual frequency and is close to the annual finding for Mexico in Nehru and Dhareshwar (1993) that uses historical series covering 1950-1990. Although the labor share computed from labor compensation data seems to be less than the value we assume, the data do not take into account self-employed people and informal sector in Mexico. Researchers who adjusted labor share have found significant increases compared to announced ratio of labor compensation and value added output.[11]

For the parameters of preferences, the coefficient of relative risk aversion, σ, is set equal to 2. Second, the parameters ν and η govern the elasticity of labor supply in separable and JR preferences, respectively. For separable preferences, the elasticity is $\frac{1-\bar{l}}{\bar{l}}\nu^{-1}$ where $\bar{l}$ is the steady-state value of hours per worker whereas for JR preferences the elasticity is $\frac{1}{\eta-1}$. The intensive margin at the steady state, $\bar{l}$, is set to 0.32 which is the ratio of total hours worked from OECD and non-sleeping hours of economically active population. We set the Frisch elasticity of labor to 0.69 in the line with the estimate in Pistaferri (2003) and within the range of the findings of Blundell and Macurdy (1999).[12] This implies parameter values for ν and η as 3.08 and 2.45. The leisure weight coefficients, φ^e and φ^u, for separable preferences are determined using the optimality condition for hours worked and optimal wage equation at the steady state. These parameters affect the consumption ratios in JR preferences. The previous literature based on evidence for the US has suggested that the unemployed have a 15% lower consumption than the employed.[13] We set φ^e in JR preferences to 6.18 to match this ratio between the employed and unemployed. The parameter, φ^u, is then found to be -0.02 using the implied levels of consumption for the employed and unemployed at the steady state together with the equality of marginal utility of consumption across employed and unemployed. The parameter that governs the strength of income effect, γ, is assumed to be 0.5 which is a comprimise between no-income-effect and the full income-effect on labor supply decisions.

For the matching parameters, the natural breakup rate, ψ is set to 0.06 following the

[11] See Gollin (2002) for the critique of using labor compensation data, and Kabaca (2010) and Verd (2005) for adjusted labor share in Mexico.

[12] Blundell and Macurdy (1999) estimate the elasticity of labor supply to be in the range of [0.5,1].

[13] See Hall and Milgrom (2008), Shimer (2009) and Hall (2009).

estimates in Bosch and Maloney (2008) for Mexico. The steady state employment is set by the average proportion of the employed people in the economically active population over the period as in Andolfatto (1996) since the model only allows agents to choose between employment and non-employment. The average employment rate, $\bar{n}$, is 0.52 over the period taken. The steady state value of matches, $\bar{M}$ follows from $\bar{M} = \psi\bar{n}$. We then calculate vacancy at steady state, $\bar{v}$ assuming the job filling rate to be 0.7 following Boz et al. (2009), which implies an average vacancy duration of 45 days. The recruiting cost parameter, κ, is set to 0.12 so that recruiting costs, $\kappa\bar{v}$ will be only 1% of output following Andolfatto (1996). The elasticity of the matching rate with respect to aggregate vacancy, α needs to be the same as the bargaining power of the firm, $1-\mu$, in order for the wages implied by Nash bargaining to support the allocations obtained from social planner's problem (Hosios (1990)). Following Andolfatto (1996), α is set to 0.5 implying the same value for μ as well. Using the steady state values for matches, employment and vacancy, and the value of α, the matching efficiency ω is obtained as 0.21.

The working capital parameter, ϕ is set to be 1 as in Neumeyer and Perri (2005), which implies that workers have to be paid three months before the sales are cashed out. The net foreign asset ratio at the steady state, $\frac{\bar{b}}{\bar{y}}$, is calculated using the debt ratio from Lane and Milesi-Ferretti (2007) that estimates external wealth of countries. Net debt over GDP for Mexico is found to be -0.42 at annual rate, which implies -1.68 at quarter frequency. Note that, in our model, net foreign assets is the household's foreign bond holdings net of working capital loans of the country: $b_t - \phi w_t l_t$. Accordingly, foreign bond-output ratio is set to -0.98 which implies -0.24 at the annual frequency. The ratio of economic profit and output is found 0.0028 in the model which is different than zero due to the frictions in the labor market. The investment-output ratio at the steady state is found using the depreciation rate and capital stock following $\bar{i} = \delta\bar{k}$. Using the steady state values of profits, household earnings from output, investment, bond holdings and interest rate, we calculate the consumption-output ratio at the steady state as 0.75 that is close to the ratio of private consumption and output net of government spending, 0.77.

Finally, the functional form for the quadratic convex cost functions for bond holdings and capital adjustments can be written as $\Phi(b_t) = \frac{\phi^b}{2} y_t (\frac{b_t}{y_t} - \frac{\bar{b}}{\bar{y}})^2$ and $\Theta(k_t, k_{t+1}) = \frac{\phi^k}{2} k_t (\frac{k_{t+1}-k_t}{k_t})^2$ following the literature in small open economies. The cost parameter for bond holdings, ϕ^b, is set to be as small as 0.01 so that it does not change the business cycle volatilities but ensures that the model is stationary. For the parameter, ϕ_k, we follow the estimates in the literature and set it to 25, which implies an investment volatility nearly three times output volatility as observed in data.

Shock Processes. The recent literature has shown the importance of shocks to interest rate in the fluctuations in emerging markets.[14] Emerging markets differ from developed markets in terms of the behavior of the interest rate they face. Interest rates are countercyclical mainly because of default risk that is negatively correlated with the output. Following this literature, we assume that shocks to productivity (in logs) and interest rates (log of *gross* interest rate) are correlated simultaneously such that $\epsilon_t = [\epsilon_t^A, \epsilon_t^R]$ is drawn from an i.i.d normal bivariate distribution, $N(0, \Sigma)$, with zero mean and covariance, Σ. Each shock follows an independent AR(1) process:

$$\begin{array}{l} \widehat{A}_t = \rho_A \widehat{A}_{t-1} + \epsilon_{A,t} \\ \widehat{R}_t = \rho_R \widehat{R}_{t-1} + \epsilon_{R,t} \end{array} \qquad \Sigma_{\epsilon_t \epsilon_t'} = \begin{pmatrix} \sigma_{\epsilon_A} & \rho_{\epsilon_A,\epsilon_R}\sigma_{\epsilon_A}\sigma_{\epsilon_R} \\ \rho_{\epsilon_A,\epsilon_R}\sigma_{\epsilon_A}\sigma_{\epsilon_R} & \sigma_{\epsilon_R} \end{pmatrix}$$

We construct Solow residuals for the TFP shocks over the sample period in Mexico using the seasonally adjusted real GDP, total hours worked and capital stock series. Data on real GDP is from the OECD. The same data-set has total hours worked in manufacturing. In order to calculate hours worked in the overall economy, we first divide hours worked in manufacturing by the employment in manufacturing and then multiply total employment each quarter in Mexico. We take employment series from Neumeyer and Perri (2005) and extend it to 2008Q4 using the employment series from ILO.

The capital stock series is constructed using quarterly investment series from IFS and the investment perpetual method.[15] Having capital stock series and labor input, we now calculate the Solow residuals: $lnA_t = lnY_t - \zeta lnK_t - (1-\zeta) lnL_t$. The HP-filtered series yield the persistence as $\rho_A = 0.78$ and the standard deviation as $\sigma_A = 1.1\%$. The persistence is quite lower than the counterparts for developed countries. This raises a question about measurement problems in constructing these series. That is why we will also consider different shock processes in the sensitivity analysis in order to see if the results are robust to more persistent shocks.

For the interest rates, we have two different representative costs of borrowing: EMBI+ data set and real domestic interest rates on Mexican T-bills. EMBI+ data set from Uribe and Yue (2006) documents spreads for traded debt instruments for various countries including Mexico. Kabaca (2010) shows that the interest rates constructed using these spreads show a significantly smaller volatility than that of domestic rates. In fact, the standard deviation of Mexican rates from EMBI is around 0.55% at quarterly levels whereas the domestic rates are almost four times more volatile, 2%.[16] Although EMBI+ rates have

[14] See Neumeyer and Perri (2005), Arellano (2008), Mendoza (2010) on the role of interest rates in the output fluctuations in emerging markets.

[15] First, we take out the seasonal factors and then deflate the investment series by the GDP deflator. We calculate the initial capital stock using the steady state condition between investment and capital stock: $\bar{i} = \delta \bar{k}$. We take the average of the first ten observations of investment as the value of steady-state investment. The capital stock series is then generated using this initial stock value and investment series by taking into account of depreciation and capital adjustment costs.

[16] Here it is very crucial to take the quarterly yields on these bonds since (net) interest rates are not logged.

been widely used in the literature as the representative cost of borrowing, this discrepancy between two rates raise some questions on the other potential costs of external borrowing which EMBI+ ignores.[17] For these reasons, we take the volatility of EMBI+ rates as the lower bound of the volatility of the cost of borrowing and that of domestic rates as the upper bound. When we assume that shocks to interest rates have the same volatility as the productivity shocks, $\sigma_A = \sigma_R = 1.10\%$, the interest rates in the model represent a volatility very close to the average of standard deviations of the two interest rate series.

For the persistence of the shock to interest rate, ρ_R, domestic and EMBI-constructed rates show autocorrelation coefficients of 0.59 and 0.68, respectively. In our calibration, we set this parameter to 0.64, the average of those autocorrelation coefficients. We set the correlation parameter between shocks to productivity and interest rates, $\rho_{\epsilon_A,\epsilon_R}$, to the average correlation between interest rate and solow residual from two series of interest rates. With EMBI+ rates this correlation is -0.49 and with domestic rates, the correlation is -0.61.

4.2 Characterization of Equilibrium and Impulse responses

Without Working Capital. We now discuss the role of search and financial frictions and how endogenous decisions at the intensive margin affect the amplification that such frictions generate. We start by discussing the case with only search frictions to show their sole effects on the fluctuations as a response to shocks to productivity and interest rates. The key equation in the models with search frictions is the wage equation. Regardless of the separability in preferences, we can write down the optimal wage equation combining the share rule with the equations (1), (2) and (4):

$$w_t l_t = \mu(y_n + \kappa\theta_t) + (1-\mu)\frac{u^u - u^e}{u_c} \tag{14}$$

The above condition tells us that labor income of the employed (wage bill per job) is a combination of the worker's contribution to output at the margin – which is the marginal productivity and the average savings in vacancy costs – and the worker's outside option, which is the foregone leisure at the units of marginal consumption, depending on the bargaining power of the household. The second term which makes wage equation different from that in the standard RBC model becomes much more important in a model with interest rate shocks. As a response to a negative productivity shock, for example, interest rates

Therefore, taking the annualized value at the quarterly frequency will mistakenly increase the volatility of interest rates by four times.

[17] These might include the limited and varying access to financial markets, exchange-rate risk exposure in the eyes of domestic agents, strategic issuance of bonds and withdrawals from financial markets. For example, recently, Fostel and Geanakoplos (2008) shows that an emerging market asset can have leverage cycles because of asymmetric information problems in the financial markets even when the price of the debt does not chang for that particular assets.

tend to increase which causes a larger drop in consumption than in the case with just productivity shocks[18]. As a result, the wage bill falls not only because marginal productivity decreases but also because the worker's outside option drops due to a higher marginal utility of consumption. In other words, the expected value of staying unemployed and searching for a job next period becomes smaller.

However, note that the amplification of this mechanism on wages depends on the changes in the hours per worker, l_t. Movements in the hours per worker will affect the fluctuations in wages not only through its effect on the wage bill but also through its effect on marginal consumption. In order to illustrate this point, now, we explore the optimal decision for the intensive margin. The log-linearized version of equation (8) for each form of utility can be expressed as below:

$$\widehat{l}_t = \frac{\widehat{A}_t + \zeta \widehat{k}_t - \zeta n_t - \sigma \widehat{c}_t}{\tilde{\nu} + \zeta} \qquad \text{(separable preferences)} \qquad (15)$$

$$\widehat{l}_t = \frac{\widehat{A}_t + \zeta \widehat{k}_t - \zeta n_t - \widehat{x}_t}{\nu - 1 + \zeta} \qquad \text{(JR preferences)} \qquad (16)$$

where $\tilde{\nu} = \frac{\bar{l}}{1-\bar{l}}$ and $\nu - 1$ are the inverse of labor supply (Frisch) elasticities in separable and JR preferences, respectively. The difference in these equations come from the strength of the income effect they have on the labor supply decisions. This effect is captured by $\sigma \widehat{c}_t$ in separable preferences and is stronger than in JR preferences where $\widehat{x}_t = \gamma \widehat{c}_t + (1-\gamma)\widehat{x}_{t-1}$. The impulse responses in Figure () show us that hours per worker increases as a response to a shock to interest rates in the model with separable preferences. This also generates an increase in output when the interest rate goes up. This result is inconsistent with the data where both output and hours per worker tend to be decreasing during the periods with higher interest rates in emerging markets.

Note that this counterfactual result makes wages more responsive to interest rates. In order for the wage bill to fall, the wage has to decrease sharply as a response to interest-rate shocks. The wage response is still high when we take the intensive margin as fixed. Thus, the wage responds more in these cases at the expense of movements in the intensive margin. On the other hand, when we take JR preferences which results in a smaller income effect on the intensive margin, the wage response becomes much smaller, too. Therefore, intensive margin plays an important role in the contribution of search frictions on wage fluctuations.

With Working Capital. Although JR preferences reduces the income effect on labor supply, the impulse responses still show a slight increase in hours per worker as a response to a positive shock in interest rates. One can further decrease the strength of the income effect but, as we will show in the sensitivity analyses, this will result in a large drop in

[18] See Neumeyer and Perri (2005) for details on the effect of interest rates on consumption

the response of wages. Instead, we here show that the presence of a financial friction, namely, working capital, dominates the income effect on labor supply and predicts the right movements for hours per worker. In the presence of a working capital requirement, equation (12) can be rewritten as:

$$\widehat{l}_t = \frac{\widehat{A}_t + \zeta\widehat{k}_t - \zeta n_t - \widehat{x}_t - \frac{\phi(\bar{R}-1)}{1+\phi(\bar{R}-1)}\widehat{R}_t}{\nu - 1 + \zeta} -$$

Since $\phi > 0$, the above equation implies that a positive shock to interest rates will have a negative effect on hours per worker. This suggests that demand for labor in the model economy as a response to a positive interest-rate shock is lower in the case with working capital than before. In fact, impulse responses in the presence of working capital shows that hours per worker tends to decrease as a response to an interest rate shock in the second period. This generates an output drop after an increase in the interest rate consistent with the data. Notice that the model with working capital also increases the responsiveness of wages to interest rates significantly. This result can be seen through the wage equation in the model with working capital. If we denote $w_t^1 l_t^1$ as the wage bill in equation (10), the wage bill in the presence of working capital, $w_t^2 l_t^2$ will be:

$$w_t^2 l_t^2 = \frac{w_t^1 l_t^1}{1 + \mu\phi(R_{t-1} - 1)}$$

Therefore, introducing working capital not only affects the composition of the wage bill between wages and hours per worker but also makes labor income more responsive to shocks. As a result, wages become more volatile without sacrificing movements in hours per worker.

For the other impulse responses, it is worth to note the responses of employment as well. With separable utility, the responses of employment to TFP and interest shocks differ from those with JR preferences. The weaker response in hours per worker with separable preferences tend to produce weaker responses in employment to TFP shocks. Conversely, the strong response in hours per worker to interest rate shocks with these preferences leads to a strong positive response to employment although the economy faces higher interest rates. On the other hand, JR preferences (both the case with or without working capital) tend to produce better employment responses to both shocks. Preferences play an important role also for the responses of consumption to TFP shocks. With no income effect, the larger response of hours per worker than those with separable preferences has to be compensated by a larger increase in consumption. This is because leisure decisions enter in the marginal utility of consumption with JR preferences and the only way to decrease this loss in utility is to increase consumption sharply.

4.3 Quantitative Results

We summarize the results from simulations of various versions of the model in Tables 2 and 3. We first simulate the model with only search frictions with a fixed intensive margin as in Boz et al. (2009). We, then, continue with results from endogenizing intensive margin for both types of preferences. In doing this, our aim is to analyze how much search frictions contribute to fluctuations in emerging markets discussed in earlier sections, particularly highly volatile consumption, real wages and labor share, procyclical wages, labor input and labor share, countercyclical net exports and the positive correlation between intensive margin and extensive margin of employment. We, lastly, simulate the model with working capital to investigate the effect of a financial friction on these fluctuations over search frictions.

Fixed and Endogenous Intensive Margin. The first column in Table 2 shows the business cycle moments in data for Mexico. The second and third columns then reports the implications of the standard frictionless SOE-RBC model and the search model with a fixed intensive margin and separable preferences. When hours per worker is taken constant as in Boz et al. (2009), search model can explain some distinguishable characteristics of the fluctuations in emerging markets such as countercyclical interest rates, very procyclical and highly volatile consumption and countercyclical net exports. However, SOE-RBC, alone, with fixed labor input does a similar job in terms of these fluctuations. The contribution of search frictions on these fluctuations is then minimal.

Table 2 shows that the search model has a stronger effect on the response of labor market variables compared to the standard SOE-RBC. These findings are similar with those of Andolfatto (1996) and Merz (1995), which find significant contribution of search frictions to the fluctuations in the labor market rather than goods market. For example, the third column shows a significant increase in wage volatility compared to the one in SOE-RBC. However, as we have shown above, wages here are the only variable to respond in the wage bill per job since the intensive margin is fixed. Nevertheless, the search model gives a momentum to the labor share whereas this is constant in the frictionless SOE-RBC model.

Although search frictions seem to amplify the responses of labor market variables, particularly wages and labor share under separable utilities, the results change considerably when we let the intensive margin respond endogenously. The last column shows that the model implies a large income effect and consequently a very strong positive correlation between interest rates and hours per worker, which is the opposite of what we observe in data. This makes interest rates no longer countercyclical even though productivity and interest rate shocks are negatively correlated because an increase in hours per worker as a response to an increase in interest rates tends to have a positive impact on output. As a result, the cyclical properties of the search model fails to predict the ones in the data. Since wages and hours tend to be weakly correlated with output, labor share becomes countercyclical in this model whereas it is significantly procyclical in the data. In addition, wages become more volatile at the expense of counterfactual movements in the intensive margin.

Another failure of the models with separable preferences is the poor performance of employment fluctuations. With an income effect, employment tends to be positively correlated with interest rates whereas they are negatively correlated in the data. Large increases in hours per worker as a response to a positive increase in interest rates makes it profitable for firms to post more vacancies and enjoy the high willingness of consumers to supply labor. These failures with separable preferences shows that it is important to understand the intensive margin decisions in order to assess the contribution of search frictions to the fluctuations in emerging economies.

Baseline Model. The results with JR preferences can be seen in Table 3. Our baseline model (the second column) that has JR preferences and working capital improves the implications of the model significantly. With a reduced income effect due to JR preferences and a more effective labor demand due to working capital, the model can mimic the cyclical properties of the variables that are related to the labor market as well as the ones commonly discussed in the literature such as private consumption and net export.

In the baseline model, the comovement between hours per worker and interest rates has the right sign and consequently interest rates and output are negatively correlated. For comparisons, we include the results from the frictionless SOE-RBC model and the results from the model with only search frictions under JR preferences. The baseline model does a better job in terms of generating countercyclical interest rates. The model also performs well in terms of the comovement of the extensive margin of labor input. As we have mentioned earlier, the models with separable preferences have a relatively difficult time in explaining the comovement between interest rates and employment. The baseline model not only corrects this but also can explain the positive correlation between the extensive and intensive margins of labor that we displayed in Table 1.

The high volatility of wages in emerging markets is noted in Kabaca (2010) and Li (2011). The baseline model here can explain such highly volatile wages thanks to the presence of both search and financial frictions. In terms of the comovement with output, the model overpredicts the procyclicality of wages with output. However, we should mention that they become more procyclical with current output in the data when the leads of wages are considered. For example, the correlation between current output and wages after two quarters is 0.56 compared to 0.40, contemporaneous correlation. We leave this lagging property of wages for future research and focus on the volatility in wages in this paper since they present a strikingly higher volatility in emerging markets than in developed markets.

The baseline model can also address the volatility in consumption relative to output volatility. Consumption is more volatile than output and very procyclical in emerging markets which tends to generate countercyclical net exports in these economies. The model predicts consumption to be more volatile than output along with a strongly procyclical consumption and, as a result, a negative correlation between net exports and output. Compared to alternatives, the cyclical properties of these series improve in the baseline model.

Since the model can explain highly volatile wages and produces the right sign of comovement of labor market variables with output, the labor share becomes more volatile as in the data than in alternatives. The model can address more than half of the variation in the labor share and procyclicality with output for this variable. The part that is not explained in this model is related to employment fluctuations. The model can only explain around one-third of the employment fluctuations due to search frictions. Boz et al. (2009) introduces shocks to matching efficiency, ω, which increases the volatility for this variable.

One failure of the model is the underestimation of output volatility. As we discussed earlier, this could stem from the measurement problems in producing shocks using data. In the sensitivity analysis, we will use higher volatility for the shocks assuming that output can be explained fully by these shocks and analyze the results compared to baseline model.

The differences in the results between the third and fourth column gives us a better understanding of the sole contribution of search frictions to fluctuations in emerging markets. As in the case with the fixed intensive margin, the main contribution of search frictions is its impact on variables related to labor markets as opposed to a frictionless model. Search frictions can produce movements in employment and the labor share. In addition, wages become more volatile than in the frictionless model. However, without working capital, the model underestimates the volatility in wages, labor share and output, the negative correlation between interest rate and hours per worker, and the positive correlation between intensive and extensive margins of labor input. The reader might question the contribution of working capital as opposed to just lowering the strength of income effect further. Hence, to address this question, a discussion on the sensitivity of the parameter that governs the strength of income effect,γ, follows.

4.4 Sensitivity Analysis

The Strength of the Income Effect: The results in Table 3 suggest that with a smaller income effect, the models tend to explain the data moments better compared to results with separable preferences. In addition, with working capital, this effect on equilibrium labor hours is even minimal. Then the natural question is how much a lower income effect than assumed is here can explain fluctuations in the data without working capital. Here, the aim is not only to analyze the sensitivity of the models to the parameter governing the strength of the income effect on labor market outcomes. It is also to analyze the contribution of the working capital requirement while generating the right comovement of labor market variables with interest rates.

The fifth column in Table 3 reports the results from a model with only search frictions and a much smaller value for the parameter, γ. With $\gamma = 0.001$ compared to $\gamma = 0.5$, the model generates better comovement of labor variables with interest rates; however, it produces wages and which are much less volatile and hours per worker much more volatile relative to the data and to the baseline model with working capital. In fact, by lowering this parameter, the labor share does not change significantly whereas the model with working capital can explain considerably more volatility in the labor share. Additionally, with a very small income effect, hours per worker and total hours tend to move almost one-to-one with output, which is not consistent with the data. On the other hand, the baseline model produces less cyclical hours and wages movements closer to the data.

Robustness to Shocks: In this section, we analyze how robust the results are to different shock processes. We calibrate shock parameters so that they match particular data moments in Mexico as an alternative to estimates used in the previous models. We do this since there are some potential measurement problems in constructing Solow residuals. Specifically, TFP estimates from the data face measurement problems affecting factor shares, utilization rates on factors, and adjustment costs on capital.

The calibration technique used to find alternative parameters are follows. We assume that the persistence of productivity shocks, ρ_A, is the same as in the US and set this parameter to 0.95, which implies a persistence of output not higher than in the data.[19]. The standard deviation of the shock to productivity is set to match the output volatility in Mexico.[20] Therefore, $\sigma_{\epsilon_A} = \sigma_{\epsilon_R} = 1.55$. Lastly, the correlation between shocks is calibrated to match the correlation between output and interest rates which results in $\rho_{\epsilon_A, \epsilon_R} = -0.66$.

The last column in Table 3 shows the implications of the baseline model with these alternative parameters in the shock processes. The results change only insignificantly for variables related to the labor market, which implies the findings analyzed above do not depend on the shock process we estimated in the quantitative analyses. The more significant effect of these shocks appears on the fluctuations of goods market variables such that, with more persistent TFP shocks and more volatile shocks, the model produces more volatile

[19]In the data, the autocorrelation of output is 0.84 and the model presented here with the assumed persistence of productivity predicts this number to be 0.76, which is better than the prediction with the estimated persistence, 0.67.

[20]This type of identification analysis for productivity parameters has been often used in RBC analysis. See, for example, Greenwood et al. (1988), Mendoza (1991) and Neumeyer and Perri (2005)

and cyclical consumption and net exports consistent with data.

5 Conclusion

The implications of small open economy RBC models for explaining emerging market business cycles have been studied extensively in recent years. Many of these studies have concentrated on the implications of such models for generating the observed responses of key macroeconomic variables. Yet increasingly researchers and policy-makers are interested in understanding the cyclical response of labor market variables in emerging economies. During the recent global financial crisis, it is well known that emerging market economies have seen increases in their unemployment rates despite the absence of a negative domestic shock such as an exogenous shock to productivity. In our framework, changes in the cost of borrowing coupled with a friction such as a working capital requirement can lead to changes to both employment and hours of work. Hence, our framework has the potential to account for the observed changes in emerging economies during the recent global financial crisis as much as accounting for emerging economy business cycles more generally.

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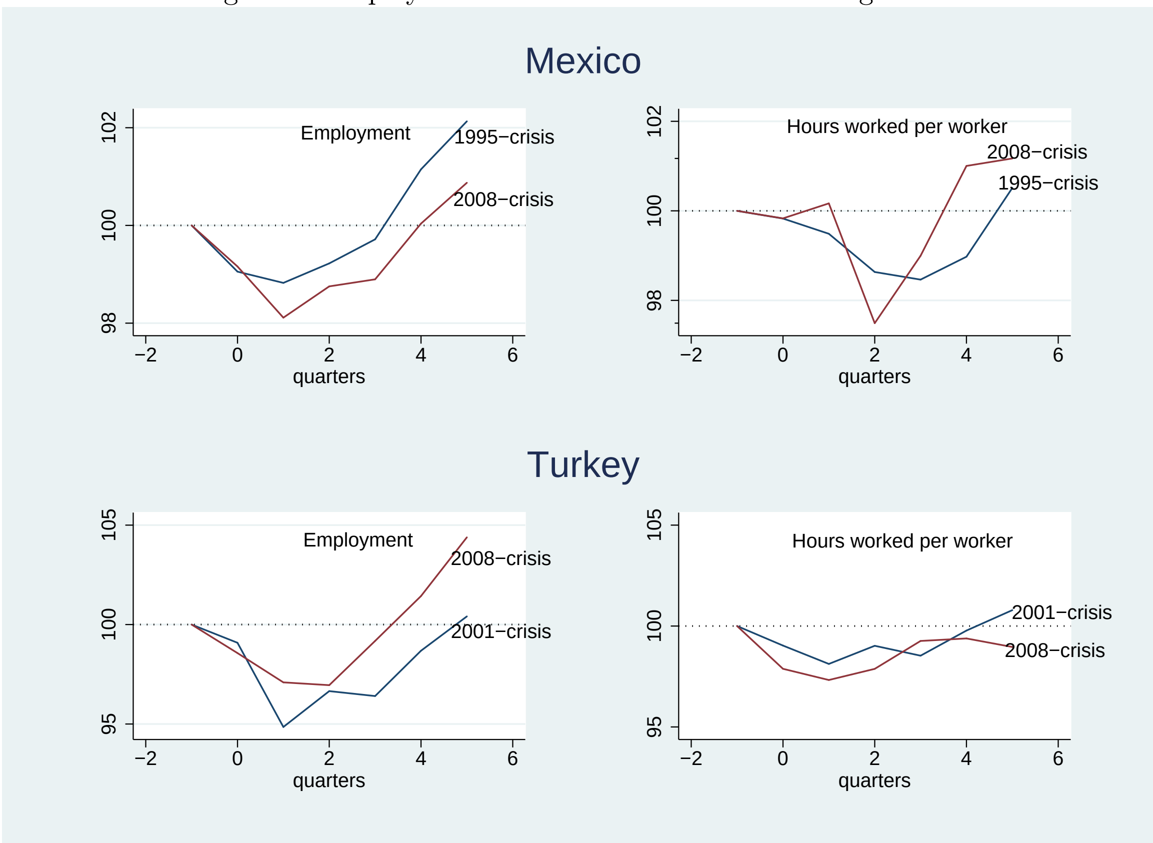
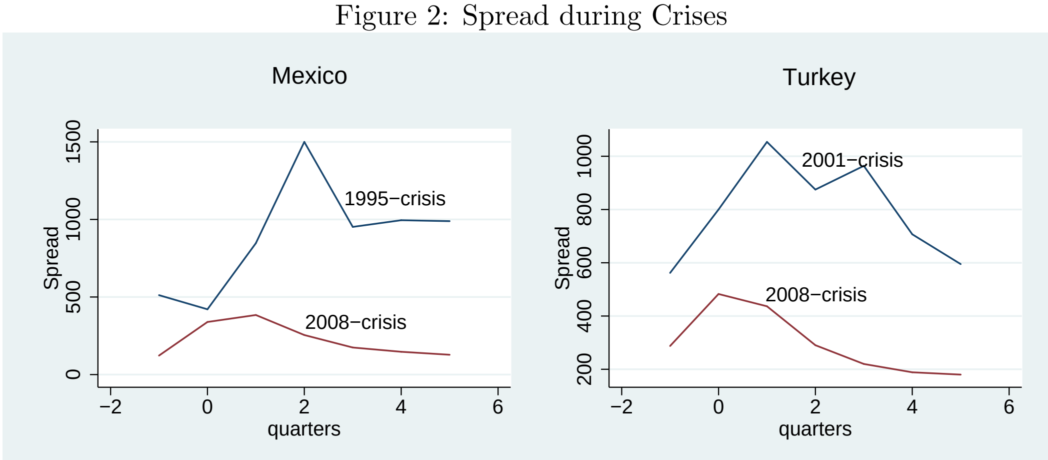
Figure 1: Employment and Hours Per Worker during Crises



Note: Data is quarterly and seasonally adjusted. Period zero is the quarter when the crisis starts. The value in one quarter before crisis started is scaled to 100.

Figure 2: Spread during Crises



Note: CDS data are used for 2008 spreads. This dataset start only after 2002. For earlier crises, we used JP-Morgan EMBI+ spreads from Uribe and Yue (2006) dataset.

Figure 3: Impulse Responses

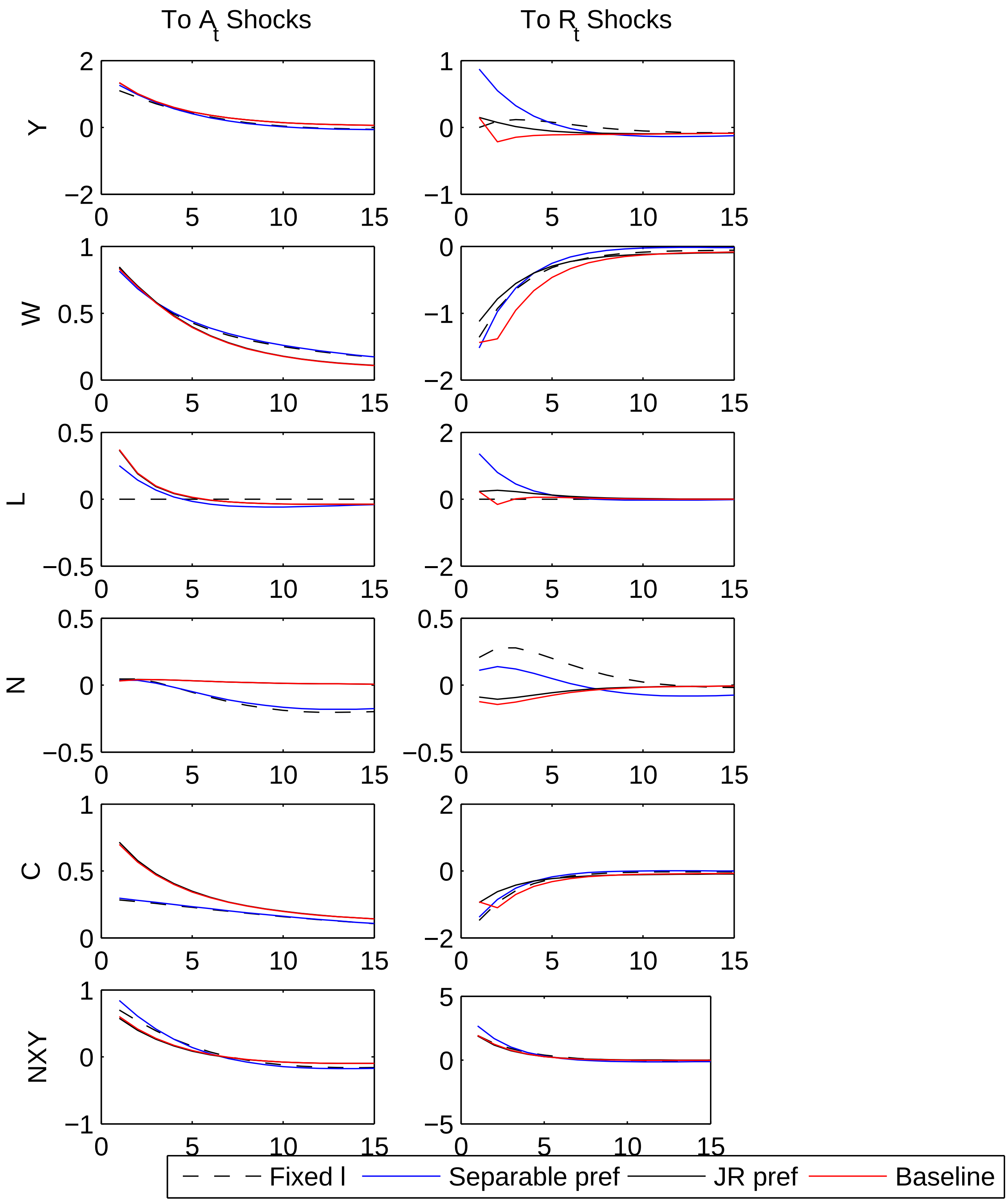


Table 1: Movements in Employment and Hours Worked Per Worker

	$\frac{\sigma(e)}{\sigma(y)}$	$\frac{\sigma(h)}{\sigma(y)}$	$\rho(e,y)$	$\rho(h,y)$	$\rho(e,h)$		$\frac{\sigma(e)}{\sigma(y)}$	$\frac{\sigma(h)}{\sigma(y)}$	$\rho(e,y)$	$\rho(h,y)$	$\rho(e,h)$
EMs						DMs					
Argentina	0.61	0.45	0.67	0.84	0.54	Australia	1.00	0.42	0.47	0.31	0.40
Costa Rica	1.06	0.49	0.09	-0.12	0.18	Austria	0.87	0.92	0.58	-0.31	-0.61
Czech Rep.	0.63	0.16	0.39	0.01	0.01	Canada	0.72	0.28	0.85	0.37	0.05
Egypt	0.99	2.65	0.69	0.44	-0.06	Denmark	0.94	0.74	0.50	0.28	0.18
Hungary	0.77	1.01	0.36	0.29	0.27	Finland	0.93	0.42	0.80	0.54	0.02
India		0.26		0.40		France	1.05	1.01	0.62	0.02	-0.30
Israel	0.47	0.47	0.73	0.33	0.02	Germany	0.67	0.84	0.71	0.02	-0.10
Korea	0.69	0.86	0.81	0.46	0.16	Greece	0.63	0.55	0.06	0.05	0.12
Mexico	0.51	0.20	0.77	0.72	0.67	Iceland	0.76	0.73	0.57	0.09	0.41
Peru	1.14	1.13	0.27	0.18	-0.08	Ireland	0.73	0.44	0.63	-0.32	-0.33
Turkey	0.48	1.47	0.49	0.56	0.08	Italy	0.99	0.58	0.45	0.43	0.15
Average	**0.74**	**0.83**	**0.53**	**0.37**	**0.18**	Netherlands	0.92	0.30	0.64	-0.13	-0.06
Average*	**0.71**	**0.65**	**0.51**	**0.37**	**0.21**	Norway	0.99	0.64	0.49	0.23	-0.31
						Spain	1.63	0.87	0.94	0.10	0.13
						Sweden	1.28	0.86	0.59	0.53	-0.01
						USA	0.67	0.51	0.88	0.69	0.55
						Average	**0.92**	**0.63**	**0.61**	**0.18**	**0.02**

Note: The data is HP-filtered using annual smooth parameter, 6.25. The variables are GDP (y), employment (e), and hours worked per worker (h). See the Appendix for data sources.

Table 2: Parameter Values

Parameter	Value	Explanation	Parameter	Value	Explanation
I. Preferences			*III. Production*		
β	0.98	discount factor	ζ	0.36	capital exponent
σ	2	relative risk aversion	ϕ	1	working capital fraction
Separable					
ν	3.08	labor curvature	*IV. Shocks*		
φ^e	3.80	coefficient of leisure (emp.)	ρ_A	0.78	persistence of A_t
φ^u	-0.32	coefficient of leisure (unemp.)	ρ_R	0.64	persistence of R_t
JR pref			$\rho_{\epsilon_A,\epsilon_R}$	-0.55	correlation between shocks
η	2.45	labor curvature	σ_{ϵ_A}	0.011	std. deviation of A_t
φ	4.38	coefficient of leisure	σ_{ϵ_R}	0.011	std. deviation of R_t
φ^e	6.18	coefficient of leisure (emp.)			
φ^u	-0.02	coefficient of leisure (unemp.)			
II. Search			*V. Other*		
α	0.5	elasticity of job matches	φ^b	0.01	bond holding cost
ω	0.21	matching efficiency	φ^k	25	capital adjustment cost
κ	0.12	unit cost of posting vacancy	δ	0.025	depreciation rate
ψ	0.06	job separation rate	$\frac{\bar{b}}{\bar{y}}$	-0.98	steady-state bond holdings
μ	0.5	bargaining power			

Table 3: Results with Separable Utility

	Data	RBC Fixed l	Search Fixed l	Search Endo. l
STANDARD DEVIATION				
Output	2.39	1.31	1.34	1.38
Net Exports	2.25	1.96	1.87	2.67
Labor Share	3.56	0.0	1.34	0.98
STANDARD DEVIATION (RELATIVE)				
Consumption	1.26	1.45	1.35	1.23
Wage	1.79	1.00	1.64	1.68
Hours per worker	0.24	0.0	0.0	1.08
Employment	0.43	0.0	0.31	0.17
Total hours	0.61	0.0	0.31	1.13
CORRELATION WITH Y				
Int. Rate	**-0.48**	-0.52	-0.48	**0.21**
Consumption	**0.89**	0.67	0.61	**-0.03**
Net Exports	**-0.73**	-0.20	-0.08	**0.53**
Wage	0.40	1.0	0.77	0.14
Hours per worker	0.58	0.0	0.0	0.38
Employment	0.57	0.0	0.01	0.55
Total hours	0.68	0.0	0.01	0.42
Labor Share	**0.47**	0.0	0.32	**-0.39**
CORRELATION WITH R				
Hours per worker ,l	**-0.28**	0.0	0.0	**0.98**
Employment, n	**-0.48**	0.0	0.57	**0.54**
Corr(n, l)	**0.48**	0.0	0.0	**0.60**

Table 4: Results with JR preferences

	Data	Baseline Model	RBC	Search Only	Sensitivity (a)	Sensitivity (b)
STANDARD DEVIATION						
Output	2.39	1.59	1.45	1.48	1.82	2.39
Net Exports	2.25	1.93	1.86	1.94	1.82	2.93
Labor Share	3.56	**2.01**	0.0	**1.27**	1.43	2.95
STANDARD DEVIATION (RELATIVE)						
Wage	**1.79**	**1.74**	**0.87**	**1.46**	1.15	1.79
Total hours	0.61	0.35	0.30	0.29	0.44	0.30
Hours per worker	0.24	0.28	0.30	0.24	0.39	0.21
Employment	0.43	0.16	0.0	0.14	0.11	0.16
Consumption	1.26	1.10	1.14	1.14	1.11	1.29
CORRELATION WITH Y						
Int. Rate	-0.48	-0.48	-0.41	-0.43	-0.52	-0.48
Wage	0.40	0.75	0.96	0.76	0.80	0.82
Total hours	0.68	0.82	0.57	0.76	0.99	0.76
Hours per worker	0.58	0.76	0.57	0.47	1.00	0.57
Employment	0.57	0.69	0.0	0.62	0.75	0.82
Labor Share	0.47	0.48	0.0	0.34	0.46	0.57
Consumption	0.89	0.75	0.67	0.69	0.86	0.85
Net Exports	-0.73	-0.10	-0.02	-0.07	-0.21	-0.34
CORRELATION WITH R						
Hours per worker, l	**-0.28**	**-0.13**	**0.30**	**0.29**	-0.50	-0.16
Employment, n	**-0.48**	**-0.81**	0.0	-0.79	-0.81	-0.75
Corr(n, l)	**0.48**	**0.32**	0.0	**-0.38**	0.70	0.33

JR preferences are used in all models here. The baseline model has both search frictions and working capital with the calibrated parameters described in the text. "Search Only" stands for the baseline model without working capital. Column (a) lists the results from a "search only" model with $\gamma = 0.001$ and column (b) shows the results from the baseline model with alternative shock process described in the text.

Table 5: **Appendix for Data**

	Period	GDP	Employment	Hours	Employment (Manufacturing)
Emerging Markets					
Argentina	1981-2008	IFS	ILO	ILO	
Costa Rica	1981-2008	UN	ILO	ILO	
Czech Rep.	1991-2008	OECD	OECD	ILO	
Egypt	1997-2008	UN	ILO	ILO	
Hungary	1995-2008	OECD	OECD	ILO	
India	1981-2006	UN		ILO	
Israel	1995-2008	OECD	ILO	ILO	
Korea	1981-2008	OECD	OECD	ILO	
Mexico	1993-2008	OECD	OECD	INEGI	INEGI
Peru	1992-2008	UN	ILO	ILO	
Turkey	1988-2008	OECD	TURKSTAT	TURKSTAT	TURKSTAT
Developed Markets					
Australia	1981-2008	OECD	ILO	ILO	
Austria	1994-2008	OECD	OECD	OECD	OECD
Canada	1981-2008	OECD	OECD	OECD	OECD
Denmark	1981-2008	OECD	OECD	OECD	OECD
Finland	1981-2008	OECD	OECD	OECD	OECD
France	1981-2008	OECD	OECD	OECD	OECD
Germany	1991-2008	OECD	OECD	OECD	OECD
Greece	1981-2008	OECD	ILO	ILO	
Iceland	1981-2008	OECD	ILO	ILO	
Ireland	1981-2008	OECD	OECD	ILO	
Italy	1981-2008	OECD	OECD	OECD	OECD
Netherlands	1992-2008	OECD	OECD	OECD	OECD
Norway	1981-2008	OECD	OECD	OECD	OECD
Spain	1981-2008	OECD	ILO	ILO	
Sweden	1987-2008	OECD	OECD	OECD	OECD
United States	1981-2008	OECD	ILO	ILO	

Note: Since data from most of the emerging market start after 1980s, we take observations after 1981 for developed markets, as well. Hours represent hours per worker for countries from which data are sourced from the ILO. These observations in the ILO come from establishment survey in industrial activities. For the other countries, data are the total hours in manufacturing. We divide total hours by total employment in manufacturing to find hours worked per worker. For countries in which total hours represent the work among employees, we use total number of employees in manufacturing.

Employment is the civilian employment. For Argentina, employment data is from Neumeyer and Perri (2005) until 2002. We then extend the data using the observations in the ILO. For Turkey, employment data represent the number of employees in the overall economy. The national source releases employment data including unpaid family workers. However, the strong cultural practices might hinder the real labor market outcomes as a response to output variations. This is why we exclude family workers. In the other countries, this is not an issue because this type of employment constitute a very small part of employment.