Emerging Market Business Cycles: The Role of Labor Market Frictions*

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Abstract

This paper shows that labor markets in emerging economies are characterized by large fluctuations in wages and subdued fluctuations in employment. We find that a real business cycle model of a small open economy that embeds a Mortensen-Pissarides type of search-matching frictions can account for these regularities. Moreover, search-matching frictions help amplify the countercyclical interest rate shocks leading to a greater response of consumption and current account to those shocks. This inherent amplification goes a long way in accounting for higher consumption variability relative to output and countercyclical current account that characterize emerging market business cycles.

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1 Introduction

Recent evidence emphasizes the role of labor markets in understanding macroeconomic dynamics specific to emerging markets including recovery from financial crises and business cycles.[1] The class of emerging market business cycle models, however, has largely remained silent about the impact of labor market dynamics on those of consumption and the current account.[2] This paper aims to fill this gap by, first, systematically documenting the business cycle properties of labor market variables (i.e., real earnings, unemployment, hours worked) for emerging market economies and comparing them to those of developed economies; and, second, exploring the role of Mortensen-Pissarides (Mortensen and Pissarides (1994), Pissarides (2001)) (MP) type of search-matching frictions in a small open economy business cycle (SOE-RBC) model. Using this framework, we study the joint interaction of search-matching frictions with the dynamics of consumption and the current account. We find that this interaction helps explain not only the labor market dynamics that are unique to emerging markets but also other salient characteristics of business cycles in emerging markets, such as higher variability of consumption relative to output and strongly countercyclical current account.

Our empirical analysis reveals that in emerging economy labor markets, the fluctuations in prices are large while those in quantities are subdued. In particular, real wages, on average, are almost twice as variable as output and have a positive correlation with contemporaneous output (0.38). Conversely, the variability of employment is about half the variability of output. These regularities stand in contrast with the industrialized economies where wages are less variable than output and less procyclical while the variability of employment is close to that of output.

To account for the aforementioned regularities, we propose a SOE-RBC model where the unemployment, unfilled job-vacancies and employer-employee relationships are explicitly modeled and wage is determined by these relationships. Such analysis requires a deviation from the frictionless labor market run by a Walrasian auctioneer. Unemployed workers take time to find a job and necessarily experience an unemployment spell. Employers have to pay a cost when creating a vacancy to find a suitable worker.

The search-matching frictions, such as the cost of search and matching process, the congestion and trading externality effects, are especially important for emerging market economies. For ex-

[1]See Bergoeing, Kehoe, Kehoe and Soto (2002), Kehoe and Ruhl (2009).

[2]Perhaps one exception is Neumeyer and Perri (2005) who do not focus on labor markets per se but document labor markets statistics such as the variability and cyclicality of employment and total hours worked.

ample, high transportation costs may lead to regional mismatch; low penetration of internet and communication technology may create lags in communication and asymmetry of information between workers and employers. Finally the underdeveloped legal system might induce uncertainty and cause difficulties in contract enforcement.[3]

MP type framework in which the labor market is characterized by a two-sided search captures labor market frictions well, because this framework naturally embeds these frictions in the context of a matching function which generates new hires from existing vacancies and unemployment while leaving a fraction of jobs unfilled and some of the workers unemployed. In this framework, the wage is determined by the bargaining between workers and employers given the prevailing market conditions, and business cycle dynamics depend on the fluctuations in employment and unemployment.

Besides the labor market characteristics we document in this paper, emerging markets typically experience large swings in interest rates, which tend to be high during economic downturns due to the rising default risk premium.[4] Therefore, our model economy is subject to two types of shocks: TFP shocks and international interest rate shocks.[5] As in standard SOE-RBC models, the household is able to borrow and save using a risk-free international bond. However, this instrument does not help smooth consumption in this environment because of the presence of countercyclical interest rate shocks. The high interest rates during recessions make future consumption cheaper and improve incentives to save despite low TFP and low output. As a result, the household does not borrow as much from the rest of the world in the face of a negative TFP shock leading to a decline in consumption.

However, as discussed later, countercyclical interest rate shocks without the working capital constraints are not able to generate strongly countercyclical current account in a standard model with spot labor market. On this front, the search-matching frictions further amplify the effects

[3]We do not compare the severity of search-matching frictions between the two country groups in the data or in our model. This is mainly because these frictions cannot be identified by one data series or by one single parameter. In the data, the closest variables that might capture these frictions could be the time it takes to fill a vacancy, unemployment duration or estimates for labor adjustment costs. The evidence on these series suggest mixed results. As for our model, there are several parameters that are related to these frictions and increasing the severity using some of the parameters generate more emerging market like business cycles while we find the opposite results with other parameters. See Section 4.4

[4]This is in contrast with the developed economies experiences where interest rates tend to be acyclical. See Neumeyer and Perri (2005), Uribe and Yue (2006) for more discussions on interest rate shocks in emerging markets.

[5]The contemporaneous correlation between real wages and country interest rates tends to be negative (-0.38 when wage is measured as in overall sectors or -0.27 if measured by manufacturing wages). However, this correlation is only slightly negative in developed economies (-0.09) (see Li, 2010), suggesting a role for interest rate shocks in explaining wage fluctuations in emerging markets.

of TFP and interest rate fluctuations, hampering consumption smoothing. This is because, first, employment cannot react instantaneously, and with the Cobb-Douglas matching function large adjustments in the number of vacancies posted are not optimal. Second, in the face of a negative TFP shock that is coupled with a positive interest rate shock, labor becomes less productive compared to nonmarket activities and the discounted future surplus of matching becomes lower. This leads to lower vacancy posting, which, in turn, contributes to higher unemployment in the following periods. The rising future unemployment rate and the possibility of becoming laid off and going through a necessary unemployment spell raise workers' incentives to save more and, consequently, result in a larger increase in current account and a greater fall in consumption. Therefore, in our baseline scenario that incorporates search-matching frictions along with countercyclical interest rate shocks, consumption smoothing of the household is greatly impeded, contributing to a consumption profile that is more variable than income and current account dynamics that are strongly countercyclical as in the data.

The second but important contribution of our search-matching model is that it improves significantly upon the canonical SOE-RBC model with regards to accounting for higher variability of wages relative to output and, also, the correlation of wages with output.[6] The standard RBC model with spot labor markets implies that the wages are perfectly positively correlated with output as the wages are equal to the marginal product of labor in equilibrium. Our numerical results show that when we feed the same shock processes, the standard model generates a relatively low level of wage variability and perfect correlation with output that are at odds with the data. In the search-matching model, wage is determined not only by the current marginal product of employment, but also the value of being unemployed, enjoying high leisure in the current period and searching in the following period. The fact that the value of being unemployed is not perfectly correlated with output leads to a lower but much more realistic procyclicality of wages in the search-matching model. Moreover, as labor market condition worsens and consumption drops substantially during economic downturns, the nonmarket activity becomes less attractive and the expected returns from searching again in the next period fall. Therefore, workers' threatening point in wage bargaining drops significantly, leading to a highly responsive wage.

Last, in an illustrative exercise, we show how incorporating matching efficiency shocks further bring the model dynamics closer to data. Our motivation to explore the effects of matching efficiency

[6]Using Mexican wage and employment data, Garcia-Cicco (2009) explores the extent in which a real business cycle model can explain the data. He concludes that the model's main failure is to explain wage and employment fluctuations despite the inclusion of various exogenous shocks.

shocks is based on the observations about the special labor market dynamics that arise during Sudden Stops.[7] During Sudden Stops, real exchange rate depreciations generate large reallocations across sectors (e.g., from nontradable goods sectors to tradable goods sectors (Kehoe and Ruhl, 2009) or from investment goods sector to consumption goods sector (Benjamin and Meza, 2007)). The different nature of jobs across sectors may make successful matching more difficult during these periods of massive sectoral reallocations. This difficulty can be captured by a reduction in the technical efficiency of the matching function at the aggregate level. By extending our baseline search-matching model to capture these changes, we show that these matching efficiency shocks can help bring the wage variability predicted by the model further closer to data and, more importantly, account for the high variability of unemployment as observed in the data.

This paper connects two strands of the literature – the emerging markets business cycles literature and the search-matching literature. On the emerging market business cycles side, Mendoza (1991, 1995) and Correia, Neves and Rebelo (1995), among others provide the early contributions. More recently, Neumeyer and Perri (2005) and Uribe and Yue (2006) study the role of countercyclical interest rate shocks in emerging markets that are amplified through the working capital constraints. These papers, however, are largely silent about labor market dynamics. In addition, as Oviedo (2005) shows, a real business cycle model that embeds countercyclical interest rate shocks can account for the higher variability of consumption relative to output and countercyclical trade balance only when the model is subject to highly variable interest rate fluctuations, which are amplified through working capital constraints. In our paper, countercyclical interest rates work through a different channel and lead to amplification even without working capital constraints. We view this feature as an important step forward, because as Mendoza and Yue (2010) point out, working capital loans have to be rather small in the calibrated model in order to be consistent with the observed ratios of bank credit to private sectors as a share of output in emerging markets. In our model, negative TFP shocks coupled with higher interest rates have a more persistent effect on the economy via search-matching frictions as labor input does not adjust instantaneously and searching and matching are costly. This gives rise to a higher degree of savings as the uncertainty spreads out into the future. Therefore, consumption drops substantially and the current account becomes highly countercyclical. In addition, our paper goes a long way in accounting for the regularities of the labor markets.[8]

[7] "Sudden Stops," a term coined by Calvo (1998), refer to sudden reversals in capital inflows that are typically accompanied by sharp declines in output, asset prices and the price of nontradable goods relative to tradables.

[8] Our results do not undermine the importance of financial frictions, terms of trade shocks or trend shocks high-

Other recent contributions to this literature include Aguiar and Gopinath (2007), Garcia-Cicco, Pancrazzi and Uribe (forthcoming), Boz, Daude and Durdu (2008), Mendoza (2010), among others. Our paper complements these studies by incorporating the special interaction of labor market dynamics with consumption and the current account. As for analyzing labor markets, Li (2009) presents the first contribution on this front by documenting the cyclical wage movements in emerging markets. Unlike our setup, Li (2009) considers a hybrid utility function that allows for flexible parameterization of the income effects on labor supply in a spot labor market model to account for the higher variability and procyclicality of wages. In addition, in Li's framework, interest rate shocks work through a working capital requirement, affecting labor demand directly. Our framework is the first paper that models labor market frictions explicitly and that quantitatively explores the role of search-matching frictions in explaining the behavior of wages, consumption, and the current account simultaneously.

On the closed-economy macroeconomics side, the MP search-matching model has been widely used. In this literature, Andolfatto (1996) and Merz (1995) were among the first to incorporate the labor search-matching into standard closed-economy business cycle models. They find that introducing two-sided search in the labor market to an RBC model improves its empirical performance in explaining U.S. business cycles along several dimensions. Overall, however, Andolfatto (1996) finds that the variabilities of macroeconomic variables decline with the exception of employment. Our findings are roughly inline with those of Andolfatto, in particular, our search-matching model without countercyclical interest rate shocks does not improve variabilities markedly compared to the standard RBC model.

The rest of the paper is organized as follows. Section 2 documents the business cycle properties of labor market variables both for emerging economies and developed economies, as well as empirical evidence motivating the matching efficiency shock. Section 3 lays out our model. Section 4 explains our calibration, solution, and main quantitative findings. Section 5 extends the model to analyze matching efficiency shocks. Finally, Section 6 concludes.

lighted by earlier studies. On the contrary, our paper complements these studies by proposing an additional amplification/transmission mechanism through which external shocks (TFP, terms of trade, etc.) can feed into variability in consumption and real wages. Our model with the search-matching frictions amplifies the effect of external shocks on consumption and trade balance fluctuations, and, more importantly, help explain highly variable wage that we observe in the data.

2 Empirical Evidence on Emerging Economy Labor Markets

In this section, we document the business cycle properties of key labor market variables, in particular real earnings, the unemployment rate, and employment level for a group of emerging market economies.[9] In a nutshell, we find that the variability of prices, i.e., real earnings, is strikingly high in emerging markets and this kind of variability is absent in the case of quantity variables such as employment, unemployment and hours worked.

Table 1 reports the statistics related to real earnings. The median standard deviation of real earnings, calculated by deflating the nominal earnings by the CPI is significantly greater than the standard deviation of real output, with the ratio between the two being 1.62. The real earnings are procyclical as evidenced by a correlation of 0.38 with contemporaneous output. To check the robustness of these findings, we also report real earnings variability relative to manufacturing output variability, the nominal earning variability and the real earnings variability calculated by using the PPI deflator. Manufacturing output is more variable than GDP for all countries, therefore, the median real earning variability relative to manufacturing output variability falls to 1.00 from 1.62.[10] The nominal wages behave similar to real wages in the sense that they are highly variable. Finally, when using the PPI to calculate real earnings instead of the CPI, we find high earning variabilities for every country and, in fact, these variabilities become even higher than those calculated using the CPI based real earnings.[11]

The first three columns of Table 2 report the statistics regarding the unemployment rate while the remaining three report those for employment.[12] The correlations of these two variables with output deliver consistent results, the median correlation of unemployment with output is -0.46 while that for employment is 0.39. Unemployment appears to have higher variability than employment but note that we are reporting percentage deviations. Since we consider the unemployment rate (as opposed to unemployment), this variable is already normalized by the labor force leading to higher percentage deviations from the mean. The median standard deviation of the unemployment rate is 9.64 while that for employment is 0.58 relative to the standard deviation of output.[13]

[9] We use data at quarterly frequency and our sample selection criterion for emerging markets is availability of quarterly data. For example, we excluded Argentina from our sample because the data are available only at semi-annual frequency. U.S. is excluded since we focus only on small open economies. All series are deseasonalized using U.S. Census Bureau's X-12 ARIMA, and then HP-filtered with a smoothing parameter of 1600 after taking the logarithm when appropriate. See the Data Appendix for more details on sources and calculations.

[10] Note that the difference between the two country groups remains.

[11] The median correlation between the real earnings series calculated using the CPI and PPI is 0.57.

[12] We analyze employment data in addition to the unemployment rate because unemployment statistics suffer from several deficiencies including the inaccurate measurement of discouraged workers.

[13] In addition, we report a set of statistics for hours worked in manufacturing sector in columns 1-3 of Table 3 and

A broad comparison between emerging market economies (EMEs) and developed economies can be made based on the results reported in the aforementioned tables. The high variability of real earnings emerges as an EME-specific result, this variability for developed economies is lower than real output for the CPI based definition of real earnings. As for the other definitions, the developed economies also display much lower variability and less procyclicality in their real earnings compared to EMEs. The variabilities of unemployment rate and employment normalized by output variability are somewhat higher in developed countries compared to EMEs as suggested by Table 2. These two variables also are more procyclical in developed economies. Similarly, hours worked in manufacturing and aggregate hours worked appear to be somewhat more procyclical in developed economies compared to EMEs.

To our knowledge, the only study that provides statistics on labor markets in the emerging market business cycles literature so far is Neumeyer and Perri (2005). Our findings on employment and hours are roughly in line with theirs; they also find that employment and hours are less variable and less correlated with output in emerging markets.[14] In this paper, we conduct a more comprehensive analysis than Neumeyer and Perri (2005) by reporting real earnings and unemployment rate statistics. In addition, we expand the set of emerging markets used in the calculation of employment, unemployment rate, and earnings statistics and we also expand the set of industrialized countries that is used as a comparison group. Expanding the emerging markets set for hours worked is difficult because the relevant data are available for only a few countries. Nevertheless, we report the comparison of available statistics of working hours in the Appendix.

Some research has suggested that the relatively lower variability in emerging markets' employment statistics could be due to a relatively high portion of employees working in the public sector, given the less variable public sector employment. In particular, Kydland and Zarazaga (2002) argue that public sector employment in Argentina often serves as unemployment insurance. Although Argentina is not included in our sample, this might still be an issue for other emerging market economies we consider. For this reason, we investigate if there are emerging market economies that have data on the decomposition of public and private employment. For Turkey, this decomposition

approximate aggregate hours worked in columns 4-6 of the same table. Hours worked in manufacturing normalized by the standard deviation of output has a variability of 1.58. Similarly, aggregate hours worked variability approximated in the aforementioned fashion when normalized by output variability is 1.24. Also in terms of correlations with output, these two statistics yield similar results, 0.57 and 0.47.

[14] Our statistics are not fully comparable with those reported by Neumeyer and Perri (2005) because they report labor market statistics using semi-annualized data to make all other countries comparable with Argentina. Our statistics are based on quarterly data.

is available during 2000-2006 at quarterly frequency.[15] We compare the variabilities of the public and private sector employment and find that, contrary to the previous finding mentioned above, public sector employment is in fact more variable (3.12 vs. 1.77 percent). It is difficult to argue that the public sector employment does not function as unemployment insurance in these countries based on seven years of data only for one country, but the limited data does not confirm the initial expectation of the public sector being less variable.

Finally, it is worth noting that an important difference between these two country groups is the size of the informal sector and therefore the size of the working population that is not included in most of our data. In fact, OECD (2008) reports that the informal sectors in Hungary, Korea, Mexico and Turkey are quite substantial with the number of employees in informal jobs reaching or exceeding 20 percent of total non-farm employment in all four countries.[16] These ratios appear to be larger than those for the developed small open economies.[17]

We argue that the informal sector being larger in emerging markets is not detrimental to our empirical analysis. First, part of our data for quantities of EMEs (employment, unemployment rate) are constructed based on household surveys implying that those data would capture the informal sector. Second, although our data on earnings are based on establishment surveys and therefore do not include the informal sector, we conjecture that the difference between these two country groups regarding wages would be even larger if our data were able to capture the informal sector. OECD (2008) documents the earnings distribution of full-time, non-farm employees for the formal and informal sectors for Mexico and Turkey. Based on their estimates of these distributions, we find that earnings in the informal sector are more variable than those in the formal sector. Specifically, the standard deviation of earnings in the formal sector is 0.89 (0.54) while that in the informal sector is 1.13 (0.90) in Mexico (Turkey). Hence, if the informal sector were to be included in our analysis of the earnings, we would have found an even stronger contrast between emerging markets and developed economies.

[15]The data source is TURKSTAT.

[16]This is based on the informal employees defined as those not registered for mandatory social security.

[17]Although not exactly comparable with these ratios, OECD (2004) documents that the "black hours worked as a portion of white working hours" for Denmark, Norway, and Sweden are 3.8 percent, 2.6 percent and 2.3 percent, respectively, significantly smaller than the aforementioned figures for emerging markets.

3 Model

Our model nests a labor market search-matching framework into a, otherwise, standard SOE-RBC. There is an infinitely-lived representative household, which consists of employed workers and unemployed workers at each point in time, and also a continuum of identical competitive firms. Job matches result from a Cobb-Douglas matching technology given by $M(u_t, v_t) = \omega u_t^{\alpha} v_t^{1-\alpha}$, where ω governs the matching or allocative efficiency, u_t and v_t stand for the unemployment rate and the vacancies posted by the firms in period t, respectively. The vacancy to unemployment ratio, $\theta_t = \frac{v_t}{u_t}$, captures the market tightness. There is a flow cost, κ, associated with posting a vacancy, as firms often have to put out job advertisement and undertake screening and reviewing processes. The probability that a searching worker finds a job is $\phi(\theta_t) = \frac{M(u_t,v_t)}{u_t} = \omega_t \theta_t^{1-\alpha}$. Correspondingly, the probability that an employer succeeds in filling a vacancy is given by $\frac{M(u_t,v_t)}{v_t} = \frac{\phi(\theta_t)}{\theta_t}$. Existing employer-worker pairs end at an exogenous break-up rate ψ.

To keep the analysis simple and allow minimum deviation from the standard SOE-RBC model, we consider a large extended family scenario. That is, even though some family members are employed, and others are searching for a job, they all pool the income together for equal consumption. Another interpretation is that markets for the idiosyncratic unemployment risk are complete so that family members can fully diversify this risk using state-contingent claims. Under this assumption, the household's optimization problem can be represented by a social planner's problem. That is, the wage determination is repressed and the social planner maximizes the welfare using a one-period non-state contingent international bond that facilitates the borrowing and lending in the international financial markets. The interest rate on the bond holding is exogenous and subject to shocks. Markets for aggregate TFP and interest rate shocks are incomplete. In the following section, we return to discuss the decentralized economy with employed workers, unemployed workers and firms, and wage is determined by the Nash Bargaining between workers and firms.

3.1 Social Planner's Problem

We lay out the social planner's problem in a recursive form. For each period t, the aggregate state is captured by endogenous state variables (bond holdings, b_t, and unemployment rate, u_t); as well as the vector of exogenous state variables, ε_t, whose elements will be discussed shortly. $s_t = \{b_t, u_t, \varepsilon_t\}$ summarizes the state space of the economy at each point in time.

The representative agent derives utility from consumption and leisure through a time-separable constant relative risk aversion (CRRA) utility function. $U(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma}$ denotes the utility derived from consumption, and the $H(1-l_t) = \frac{(1-l_t)^{1-\nu}}{1-\nu}$ gives the utility derived from leisure. σ specifies the CRRA coefficient, and ν governs the elasticity of labor supply. The per-period utility function, thereby, is $U(c_t) + \varphi^i H(1-l_t),\ i = E, U$ for employed and unemployed workers respectively, which implies that the value of leisure depends on the employment status.

The population is normalized to one. The production is carried out using a Cobb-Douglas production technology, $y_t = F[k, (1-u_t)l_t, z_t] = z_t k^{\zeta}[(1-u_t)l_t]^{1-\zeta}$, where ζ represents the capital share of production. z_t denotes the total factor productivity (TFP), which is subject to shocks denoted by ε^z, e.g., $z_t = (1+\varepsilon_t^z)z$. l_t denotes indivisible labor supply (following Hansen (1996)). Workers either work and supply l amount of labor or stay unemployed. That is, to simplify the analysis, we focus on the dynamics of the extensive margin of labor supply. k denotes time-invariant capital stock with zero depreciation rate. Note that our strategy of considering time invariant capital stock is in line with some of the earlier small open economy models by Mendoza and Smith (2006), Durdu and Mendoza (2006), and Durdu et al. (2009), among others. We resort to this strategy mainly to make a global solution possible by containing the size of the state space. Intuitively, in doing so, we restrict the role of interest rate shocks to mainly intertemporal substitution of consumption and savings. Since our main motivation is to explore how the behavior of international borrowing feeds into consumption and wage dynamics, this simplification is not detrimental to our analysis. The so-called "Fisher separation," which is present in this class of models, induces consumption and borrowing decisions to be largely independent of investment and capital accumulation. To the extent that the output fluctuations due to investment fluctuations can be captured by larger TFP shocks in an environment without investment, we conjecture that shutting down of investment would not distort consumption and debt dynamics.

The economy is subject to another exogenous shock – innovations in the interest rate, ε_t^r. The exogenous state space is, thereby, given by $\varepsilon = [\varepsilon^z, \varepsilon^r]$. The social planner chooses a state-contingent plan of consumption, bond holdings, unemployment, and the number of vacancies to solve the following optimization problem:

$$
\begin{aligned}
V(b_t, u_t, \varepsilon_t) = \max_{c_t, b_{t+1}, u_{t+1}, v_t} & \; U(c_t) + (1-u_t)\varphi^E H(1-l) + u_t \varphi^U H(1) \\
& + \beta(c_t)\mathbb{E}_t V(b_{t+1}, u_{t+1}, \varepsilon_{t+1}) \\
\text{s.t. } c_t + b_{t+1} + \kappa v_t & \leq F(k, (1-u_t)l, z_t) + b_t(1+r_t), \\
u_{t+1} & \geq [u_t - M(u_t, v_t)] + (1-u_t)\psi, \\
b_{t+1} & \geq \bar{B}.
\end{aligned}
\tag{1}
$$

$\beta(c_t)$ denotes the endogenous discount factor, which we introduce to induce stationarity to bond holdings. Using Epstein's (1983) stationary cardinal utility formulation, this function boils down to $\beta(c_t) = (1+c_t)^{-\gamma}$, where γ is the elasticity of the rate of time preference.[18] The optimal choices of c_t, b_{t+1}, u_{t+1} and v_t are as follows:

$$
\begin{aligned}
\beta(c_t)\mathbb{E}_t U'(c_{t+1})(1+r_t) &= U'(c_t) - \mu_t \\
U'(c_t)\kappa &= \beta(c_t) M_{2,t} \mathbb{E}_t[-\frac{\partial V(b_{t+1}, u_{t+1}, \varepsilon_{t+1})}{\partial u_{t+1}}],
\end{aligned}
$$

where μ_t denotes the multiplier associated with the borrowing constraint and $M_{2,t} = (1-\alpha)\phi(\theta_t)/\theta_t$. The first equation governs the intertemporal substitution of consumption. The second equation equates the marginal cost of posting an additional vacancy to the marginal benefit, i.e. the discounted future value created by the marginal job match, as a vacancy can only be turned into a job with a one-period lag.

The Envelope condition implies that the total surplus associated with one marginal match is:

$$
-\frac{\partial V(b_t, u_t, \varepsilon_t)}{\partial u_t} = \varphi^E H(1-l) - \varphi^U H(1) + U'(c_t)F_2 l + (1-\psi-M_{1,t})\beta(c_t)\mathbb{E}_t[-\frac{\partial V(b_{t+1}, u_{t+1}, \varepsilon_{t+1})}{\partial u_{t+1}}]
$$

where $M_{1,t} = \alpha\phi(\theta_t)$. The first two terms of the right hand side capture the net loss in the utility of leisure to the newly employed worker compared to being unemployed. The third term stands for the contribution to output that results from one more worker measured in marginal utility terms, and the last term measures the continuation value of future employment.

[18] Mendoza (1991) introduced preferences with endogenous discounting to small open economy models. Other formulations used for this purpose can be found at Schmitt-Grohe and Uribe (2003).

3.2 Decentralized Economy with Wage Determined by Nash Bargaining

In the social planner's problem, wage is absent and the social planner decides and implements the Pareto optimal allocations. In this section, we analyze a decentralized world, where the sequence of wage rates $\{w_t\}$ is determined by the Nash Bargaining between workers and firms. Important deviations of our model from the standard Mortensen-Pissarides type of search models (e.g., Shimer, 2005) are that the production technology has curvature, the household is risk-averse with access to international financial markets and the economy is subject to shocks to the interest rate at which they can borrow from the rest of world. In our setting, the markets for aggregate shocks are incomplete but the household may partially insure against these shocks through precautionary savings.[19]

It is important to understand the externality generated by each side of the labor market, for both employers and firms. When the number of vacancies posted by the firms increases, there is a positive externality for workers who are actively seeking a job and a negative externality for firms that are trying to fill up a position. More specifically, an individual household takes the probability of being hired, $M/u = \phi(\theta)$, as given without considering the impact of its own employment on the general market tightness. Similarly, the individual firm takes the probability of filling a vacancy, $M/v = \phi(\theta)/\theta$, as given.

Household. Let V_t^H denote the value of the representative household at period t. The household owns the firms. In this "large" family, every family member enjoys the same level of consumption regardless of his employment status. Suppose that the value of being employed is given by E_t, and the value of being unemployed and actively searching for a new job is U_t. For the household, the following relationship holds:

$$-\frac{\partial V_t^H}{\partial u_t} = E_t - U_t. \tag{2}$$

We can obtain the marginal value associated with an additional job from the following household optimization problem. Given the wage rate, interest rate and the prevailing probability of finding

[19] Markets for aggregate shocks are incomplete mainly because uncontingent bonds are not sufficient to fully hedge away aggregate shocks.

a job, the household solves the following optimization problem:

$$\begin{aligned} V^H(b_t, u_t, \varepsilon_t) &= \max_{c_t, b_{t+1}} U(c_t) + (1-u_t)\varphi^E H(1-l) + u_t \varphi^U H(1) \\ &\quad + \beta(c_t)\mathbb{E}_t V^H(b_{t+1}, u_{t+1}, \varepsilon_{t+1}) \\ \text{s.t.} \quad c_t + b_{t+1} &\leq \pi_t + w_t l(1-u_t) + b_t(1+r_t), \\ u_{t+1} &= u_t(1-\phi(\theta_t)) + (1-u_t)\psi, \\ b_{t+1} &\geq \bar{B}. \end{aligned}$$

With a similar interpretation as in the Social Planner's problem, we can lay out the Envelope condition as follows:

$$-\frac{\partial V_t^H}{\partial u_t} = \varphi^E H(1-l_t) - \varphi^U H(1) + U'(c_t) w_t l + \beta(c_t)\mathbb{E}_t(-\frac{\partial V_{t+1}^H}{\partial u_{t+1}})[(1-\phi(\theta_t) - \psi].$$

Firms. Firms are owned by the household and therefore discount expected future profits according to the same stochastic discount factor as the household, $\rho_{t,t+1} = \beta(c_t)U'(c_{t+1})/U'(c_t)$. Given the wage rate and the probability of filling a vacancy, the firms choose the optimal number of vacancies to be posted to maximize their profits:

$$V^F(u_t, \varepsilon_t) = \max_{v_t, u_{t+1}} F(k, (1-u_t)l, z_t) - w_t l(1-u_t) - \kappa v_t + \mathbb{E}_t \rho_{t,t+1} V^F(u_{t+1}, \varepsilon_{t+1})$$

subject to the law of motion that governs employment:

$$u_{t+1} = u_t - v_t \frac{\phi(\theta_t)}{\theta_t} + (1-u_t)\psi.$$

The Envelope theorem implies the standard job-creation condition

$$-\frac{\partial V^F(u_t, \varepsilon_t)}{\partial u_t} = F_{2,t} l_t - w_t l_t + \mathbb{E}_t \rho_{t,t+1} \frac{\partial V^F(u_{t+1}, \varepsilon_{t+1})}{\partial u_{t+1}}(1-\psi),$$

and the first order condition w.r.t. v_t implies

$$\kappa = \frac{\phi(\theta_t)}{\theta_t} \mathbb{E}_t \rho_{t,t+1} \frac{\partial V^F(u_{t+1}, \varepsilon_{t+1})}{\partial u_{t+1}}. \tag{3}$$

Putting the above two equations together, one can equivalently write

$$-\frac{\partial V^F(u_t,\varepsilon_t)}{\partial u_t} = F_{2,t}l - w_t l + (1-\psi)\frac{\kappa\theta_t}{\phi(\theta_t)}.$$

That is, the marginal value the firms associate with filling one more position is given by the marginal product of an extra worker net of the wage cost plus the asset value of activating one more job and enjoying a pre-exiting relationship with a worker in the next period. Let J denote the value of filling a position and Q the value of posting a vacancy. Then,

$$-\frac{\partial V^F(u_t,\varepsilon_t)}{\partial u_t} = J_t - Q_t. \tag{4}$$

Nash Bargaining. Wages of new and existing workers are set by a period-by-period Nash bargaining. Assuming that employed workers' bargaining power is $\xi \in (0,1)$, the matched worker-firm pair negotiates over wage by solving the following Nash Bargaining problem:

$$\max_{w_t}(E_t - U_t)^{\xi}(J_t - Q_t)^{1-\xi}.$$

At the optimum, the firms and the household divide the total matching surplus according to the Nash Bargaining power of each party.

$$J_t - Q_t = \frac{1-\xi}{\xi}\frac{E_t - U_t}{U'(c_t)}. \tag{5}$$

Combining Equation (5) with Equations (2), (3) and (4), we have the wage determination,

$$w_t = \xi(F_{2,t} + \frac{\kappa\theta_t}{l}) + (1-\xi)\frac{\varphi^U H(1) - \varphi^E H(1-l)}{lU'(c_t)}. \tag{6}$$

Equation (6) implies that the wage is determined not only by the marginal product of labor $F_{2,t}$, but also the value of staying unemployed and searching in the next period. In other words, the wage is a convex combination of the maximum value to a firm that succeeds in activating a job and the minimum value necessary for the household to send an unemployed worker to a new employment relationship. The second term in the first bracket of Equation (6) can be further rewritten as:

$$\xi\frac{\kappa\theta_t}{l} = (1-\xi)\frac{\phi(\theta_t)\beta(c_t)}{l}\mathbb{E}_t\frac{(E_{t+1} - U_{t+1})}{U'(c_{t+1})},$$

which captures the value of forward-looking aspect of reentering the job market and possibly getting employed in the next period. The last term in Equation (6) is the value of leisure associated with being unemployed in units of marginal consumption. As consumption increases, the marginal utility of leisure in consumption terms becomes more valuable, and workers demand a higher wage to compensate the same amount of hours worked. These two terms together constitute the value of being unemployed, enjoying more leisure, and searching again next period. In addition, as well known in the search-matching literature, in order for the decentralized equilibrium to correspond to the social planner's result, Hosios (1990) condition has to hold: $\alpha = \xi$. That is, the bargaining power of firms must correspond to the elasticity of the matching technology with respect to recruiting effort.[20]

4 Quantitative Analysis

4.1 Calibration

Parameters. We calibrate our model to quarterly Mexican data. Given the scarcity of data on labor markets for many of the emerging markets including Mexico, we utilize information from other emerging market countries when needed, and also take some of the standard parameter values directly from the existing literature. The implied parameter values are listed in Table 4. The average world interest rate is set to 1.74%, the average of EMBI yields for Mexico over the sample period (see below for further details). The risk aversion parameter σ is 2 as commonly used in the literature. We calibrate the consumption-gross output ratio to be $c^*/y^* = 0.693$ for Mexico. Since our model does not have investment or government expenditures, we subtract a fixed amount of $1 - 0.693$ from the budget constraint to capture the share of investment and government expenditures in output. The Frish elasticity of labor supply is set to 0.6, which is within the range of $[0.5, 1]$ found in the literature based on micro evidence (see Blundell and Macurdy, 1999). According to the OECD Annual Hours and Productivity data, an average worker in Mexico spent 32% of their non-sleeping time on market activities. Therefore, the working hours l is set to 0.32. Given our utility function and the intertemporal (Frish) labor supply elasticity, the implied elasticity of leisure, ν, is set to 3.54 using $(\frac{1-l}{l})\nu^{-1} = 0.6$.

We set the natural breakup rate, ψ, to 0.06, based on the range of estimates provided in Bosch and Maloney (2008) for Mexico. Based on the unemployment rate data for Mexico for the period

[20] See the Mathematical Appendix for the proof on this.

$1988-2006$, we set the steady-state unemployment rate to 8.21% so that the mean unemployment rate in the stochastic steady state matches the average unemployment rate in the data.[21] Combining this information with the natural breakup rate implies a steady state value of 0.0551 for matches formed, $m^* = (1-u^*)\psi$. There is little direct evidence on the probability that a vacant position becomes an active job by the end of the quarter. We assume job finding rate, $\frac{\phi(\theta)}{\theta} = 0.7$, slightly lower than Andolfatto (1996), which implies an average vacancy duration of 45 days.

The recruiting expenditure to GDP ratio, κv^*, is assumed to be as small as 0.01 in line with Andolfatto (1994). In this case, the unit cost of posting a vacancy becomes $\kappa = 0.01/v^* = 0.127$. We set the capital share parameter ζ to 0.36 following the RBC literature. To be more precise, in a search economy, the labor's share of output is given by $(1-\zeta)-[1-(1-\sigma)\beta(c_t)]\kappa v^*/(\beta(c_t)\sigma)$. Our parameters imply this expression to be 0.63, very similar to the standard value in the literature and also to $(1-\zeta)$.

The elasticity of the matching rate with respect to aggregate unemployment rate, α, needs to be the same as the bargaining power ξ, in order for the wages implied by Nash bargaining to support the allocations obtained from the social planner's problem. We follow Andolfatto (1994) and set α to 0.5. Given the values for v^*, m^*, u^*, and α, we can calculate the matching efficiency parameter, ω, using the steady state condition $\omega = \frac{m^*}{u^{*\alpha} v^{*(1-\alpha)}} = 0.687$.

The remaining parameters φ^E and φ^U are determined by imposing the following conditions. First, although labor is indivisible in our model, we still assume that the normal efficiency condition of hours worked holds in equilibrium (i.e., marginal disutility of labor equals the marginal product of labor). The second restriction comes from the model's optimality condition for unemployment.

Shock processes. In the benchmark case, we consider TFP shocks and interest rate shocks as in Neumeyer and Perri (2005) and Uribe and Yue (2006). We estimate a joint VAR process using the TFP and interest rate data, in particular, Solow residuals and EMBI yields.[22] We construct interest rate series by deflating the EMBI yields by adaptive U.S. inflation. We then feed in the corresponding transition probability matrix and shock realizations using Tauchen and Hussey's (1991) quadrature procedure to our model. Emerging market economies typically face relatively variable and countercyclical real interest rates mainly due to the default risk that is negatively correlated with output (see Neumeyer and Perri (2005), Uribe and Yue (2006)). In our calibration,

[21] In the data from International Financial Statistics, the unemployment rate for Mexico is 3.65%. Notice that due to precautionary savings incentives, the unemployment rate in the stochastic steady state is lower than that in the deterministic steady state.

[22] See the appendix for TFP calculation for further details. EMBI yields for Mexico cover 1993Q4:2008Q4.

interest rate and TFP shocks are negatively correlated with a correlation of -0.8.

The VAR representation of the shock processes and their estimates are summarized below:

$$\varepsilon_t = RHO \cdot \varepsilon_{t-1} + e_t \tag{7}$$

where

$$\varepsilon_t \equiv \begin{bmatrix} \varepsilon^z \\ \varepsilon^r \end{bmatrix}, \quad RHO = \begin{bmatrix} \rho_z & \rho_{z,r} \\ \rho_{r,z} & \rho_r \end{bmatrix}, \quad e_t \equiv \begin{bmatrix} e_t^z \\ e_t^r \end{bmatrix}.$$

$$RHO = \begin{bmatrix} 0.61 & -0.17 \\ 0.19 & 0.69 \end{bmatrix}, \quad covar(e_t e_t') = \begin{bmatrix} 0.0004 & -0.00048 \\ -0.00048 & 0.0009 \end{bmatrix}.$$

4.2 Solution

We solve for the recursive competitive equilibrium using a value function iteration algorithm. As a first step, we solve for the social planner's problem (Equation (1)) discretizing the bond grid in [-1.0, 4.0] interval with 200 equidistant nodes and the unemployment grid in [0.02, 0.07] interval with 20 equidistant nodes. Our solution is robust to the number of nodes used in each grid. Once we derive the decision rules, we use the decentralized equilibrium conditions to evaluate the wage function.

4.3 Main Findings

Our main results are summarized in Table 5 where we list the business cycle moments. The first column shows the respective moments in the data. For comparison, the second column documents the moments implied by the canonical RBC-SOE model with TFP and interest rate shocks, featuring widely-used Greenwood, Hercowitz and Huffman (1988) (GHH) preferences.[23] The remaining columns reveal the results of the search-matching model. The difference between these remaining columns is the shock processes. The fourth column reports our baseline results. To isolate the impact of TFP and interest rate shocks, we also report the moments of the scenarios after shutting down one shock at a time. The scenarios only with TFP shocks, and with only interest rate shocks are reported in columns five and six, respectively. We discuss the main dynamics of our search-

[23] In some sense, we want to give the standard RBC-SOE the best chance, as GHH preference is found to be crucial in generating high consumption volatility and countercyclical trade balances that characterizes emerging market business cycles (see Correia et al. 1995). The recursive formulation of the social planner's problem of the canonical SOE-RBC are presented in Appendix D.

matching model and then compare its implications with those of the canonical RBC model. Finally, Figure 2 shows the limiting distributions of bond holdings and unemployment in the baseline model with search-matching frictions. As these graphs illustrate, the solution delivers ergodicity in both of these dimensions.

The first column of Table 5 suggests that the defining features of the emerging market economy business cycle are preserved in our Mexican data set. In particular, consumption is more variable than income, and current account-output ratio is countercyclical. As for the labor market variables, as thoroughly discussed in Section 2, wage is procyclical and more variable than income, unemployment is countercyclical and highly variable.

Canonical SOE-RBC. First, we consider a canonical RBC model in which we feed in the same TFP and interest rate shock processes as in our baseline search-matching model. As shown in column two, the model falls short of explaining the key emerging market regularities regarding consumption and the current account. In particular, it generates a consumption profile that is significantly less variable than output and a weakly countercyclical current account. This is because, as pointed out by Oviedo (2005), the RBC model with interest rate shocks can explain these two regularities only when the variability of interest rate shocks is high and the impact of interest rate shocks is amplified through a working capital constraint. Most importantly, the RBC model with GHH preferences falls short of accounting for wage dynamics. It yields wages that are significantly less variable than those in the data and also that are perfectly correlated with output, as the wage is tightly connected to the marginal product of labor in a spot labor market.

SOE-RBC with search-matching frictions. Second, we study the business cycle implications of our search-matching model. When search frictions are present, employment cannot adjust instantaneously in the face of shocks, leaving the vacancy as the only tool that can be adjusted instantaneously. However, these new vacancies can only turn into employment with a lag. Moreover, with the Cobb Douglas matching technology, it is not optimal to post a large number of vacancies all at once especially when the existing vacancy-unemployment (v-u) ratio is high. Therefore, compared to the canonical RBC, labor market frictions hamper the consumption smoothing desired by the household.

To take a closer look at these dynamics, we report the impulse responses to a negative one-standard-deviation TFP shock coupled with a one-standard-deviation positive interest rate shock in Figures 3 and 4. In the face of the negative TFP shock at time t, even though workers are less productive, the firms cannot reduce employment on impact because the unemployment rate, u_t, is a state variable inherited from the previous period and existing matches end at an exogenous and fixed separation rate. However, the firms can reduce the vacancies created in that period, v_t, leading to fewer matches through the matching technology, and consequently a higher unemployment rate u_{t+1} in the following period. As suggested by the impulse responses, after the initial period, with the negative TFP shock dying out gradually, firms increase vacancies and eliminate the stock of unemployment.

Our baseline model that incorporates search-matching frictions along with interest rate shocks generates a consumption profile that is more variable than income and strongly countercyclical current account dynamics, which are consistent with the empirical observations. Both labor market frictions and countercyclical interest rates play important roles. First, as explained above, search-matching frictions imply that the changes in the vacancies are reflected in employment with at least a one-period lag. Moreover, firms choose to adjust vacancies only gradually given the Cobb-Douglas matching function. Therefore, the unemployment risk is long-lasting, causing higher savings and further decrease in current consumption. Second, when TFP is low, interest rates are likely to be high. These high interest rates also increase the incentives of the household to save and benefit from this high interest rate period despite the low output. Therefore, consumption falls dramatically.

To further elaborate the mechanics of the model, we make the following comparisons. The 'RBC' column in Table 5 can be thought as one in which only the external adjustment through borrowing and saving amplifies the effect of TFP shocks. In this case, the model generates a weakly countercyclical current account (-0.13) implying that in the face of a negative TFP shock, the household increases its savings due to high interest rates that tend to be coupled with the negative TFP shock. This leads to a fall in consumption but the drop is no larger than the decline in output. With a large adjustment in the labor supply, wage variability remains low ($\sigma(w)/\sigma(y)$=0.71) and consumption is less variable than income ($\sigma(c)/\sigma(y)$=0.52). In our baseline model with labor frictions, in the face of a negative TFP shock, consumption declines more. This is because considering the impact of lower vacancies and implied higher unemployment in the following period, the household increases its savings at time t more than they would under the RBC scenario. Hence the current account becomes more countercyclical in our baseline model with search-matching frictions ($\rho(y, ca/y) = -0.46$) than RBC ($\rho(y, ca/y) = -0.13$). To finance higher savings, consumption needs to fall even further at time t.

The larger consumption drop generated in our baseline model leads to a larger decline in wages. This is because the equilibrium wage is a convex combination of marginal product of labor and the value of remaining unemployed and searching in the next period,

$$w_t = \xi(F_{2,t} + \frac{\kappa\theta_t}{l}) + (1-\xi)\frac{\varphi^U H(1) - \varphi^E H(1-l)}{lU'(c_t)}.$$

A low consumption in bad times leads to an increase in the marginal utility of consumption that reduces the net gain of leaving the negotiation process and enjoying more leisure (the second term in the Equation above). Moreover, a much tighter job market during the downturn makes it harder to find a job successfully in the next period, lowering workers' threatening point in the wage bargaining. Overall, wages are significantly more variable in the search-matching model. In addition, the fact that the value of being unemployed is not perfectly correlated with output leads to a lower procyclicality of wages in the search-matching model, which constitutes another improvement to the prototype SOE-RBC models. The model also does a good job in delivering a substantial increase in the unemployment rate coupled with a decline in the vacancy rate, consistent with the "Beveridge Curve."

The "Only Prod" column reports the results of a scenario in which only aggregate productivity shocks are prevalent and consumption smoothing is inhibited due to the existence of search-matching frictions. In this case, external adjustments are useful for consumption smoothing because of the absence of countercyclical interest rate shocks. The model generates less variable consumption and procyclical current account adjustments, as the household borrows from (lends to) the rest of the world during an economic downturn (boom). Overall, we conclude that search-matching frictions coupled with countercyclical interest rate shocks are crucial for the model to match the data in terms of consumption, the current account and wages.

The "interest rate shocks only" scenario helps us isolate the role of countercyclical interest rate shocks. It shows that these shocks contribute to generating higher variability for the labor market variables. At the same time, our model with only interest rate shocks generates countercyclical vacancies and slightly procyclical unemployment that appear at odds with the data. The positive correlation of unemployment with output seems puzzling at first sight. If there are no TFP shocks and the only source of output fluctuations is changes in employment, it seems counterintuitive to have higher output when unemployment is high. This puzzle is resolved when we think that the correlation reported in Table 5, $\rho(y, u) = 0.10$ is in fact $\rho(y_t, u_{t+1})$, that is, the correlation of the choice of unemployment at time $t+1$ with output at time t. In the production function however, $y_t = F(k, (1-u_t)l; z_t)$. Therefore y_t would be perfectly negatively correlated with u_t but its correlation with u_{t+1} would be the negative of the autocorrelation of u. As reported in Table 5, $\rho(u, u_{-1}) = -0.10$ while $\rho(y, u) = 0.10$.

Our search-matching model implies a negative and small autocorrelation for vacancies as well. Since we do not have vacancy data for any EMEs, we cannot judge whether this is an inability of the model to account for emerging economies' labor market dynamics. However, the evidence provided by Shimer (2005) (Table 1) suggests a strong positive autocorrelation (0.94) for vacancies in the case of the U.S. labor markets. Other variables in our model are positively persistent but less persistent than observed in the data. This implies that the responses of the labor market variables to shocks are short-lived, as also shown in the impulse functions plotted in Figure 4.

The improvements introduced by the search-matching model outlined in long-run moments are also evident in short-run dynamics. Figure 3 reveals that the model does a remarkably good job in delivering large contractions in output and consumption along with a large positive reversal in the current account.

4.4 Sensitivity Analysis

We now discuss our sensitivity analysis that examines the importance of parameters related to the search-matching frictions. The results are presented in Table 6. First, we reduce the unit cost of posting a vacancy, κ, from 0.127 to 0.1. As the search cost of firms is lowered, more vacancy would be posted one period after a negative TFP shock, inducing more rapid reversion of the vacancy and consequently, unemployment. Since the prospect of being unemployed and searching in the next period is not as bad as in the baseline case, the household builds less savings. Hence, consumption drops less and the current account does not increase as much. In addition, compared to the baseline scenario, workers' threatening point of wage bargaining becomes higher due to the higher possibility of finding a job in the following period and a higher value of leisure in consumption terms. Therefore, wage variability relative to that of output becomes lower.

In the second experiment, we raise the natural separation rate, ψ, from 6% to 8%. Similar to the previous sensitivity analysis, raising ψ decreases the workers' continuation value of being currently employed as the employment duration becomes shorter. For the firm, the continuation value of posting a vacancy is also reduced as an existing match may end with a higher probability. Ceteris paribus, the total surplus from a successful new match decreases with the higher natural breakup rate. Hence, vacancy responds less to exogenous shocks, and consequently, unemployment rate also becomes less responsive. Both vacancy and unemployment becomes less variable and more persistent compared to the benchmark case. Consistent with the slightly more stable labor market, the variabilities of consumption and wage decline.

Next, we examine the importance of the matching efficiency parameter, ω, by raising it to 0.85 from 0.778. In this case, more matches are formed for the same pair of unemployment and vacancy, which implies that the search friction becomes less severe. The results indicate that both consumption and wage become less variable and the current account becomes weakly countercyclical. In an extreme case when matching is infinitely efficient, the probability of finding a job and filling a vacancy is close to one.[24] An unemployed worker would still experience a necessary unemployment spell but only for one period. Therefore, vacancy and unemployment both revert quickly, increasing the variability of both variables and reducing the risk of unemployment. As a consequence, the household does not need to reduce its consumption as much in response to a negative TFP shock, which, in turn, implies a lower wage reduction than in the benchmark scenario due to the increased bargaining power.

Finally, we examine the importance of the workers' Nash bargaining weight, ξ. In order for the decentralized equilibrium to be the first best, the elasticity of matching function with respect to unemployment, α, also has to change accordingly with ξ. As shown in the last column of Table 5, when ξ and α increase from 0.5 to 0.7, unemployment rate varies less while vacancy varies more. This is because matching is more sensitive to unemployment and less so to vacancy. Moreover, as shown in the wage determination in Equation (6), as workers' bargaining power increases, the equilibrium wage gets closer to the maximum value to a firm of a filled vacancy and move further away from the minimum value necessary for an unemployed worker to join a new employment relationship.

As we discussed in the introduction, the evidence as to whether labor market frictions are more or less severe for emerging markets compared to developed economies is mixed in the data.[25] In line with this mixed evidence, our sensitivity analysis delivers mixed results. When we make labor market frictions less prevalent by reducing the cost of posting a vacancy or increasing matching efficiency, the household can enjoy both more stable wage and consumption, and the current account

[24] In this case, the matching function would become $M(u_t, v_t) = min(u_t, v_t)$ and as long as u and v do not substantially deviate from each other, the probability of finding a job or filling a vacancy is close to one.

[25] As mentioned earlier, laws that make firing and hiring difficult, contribute to the rigidity of labor markets for emerging economies. However, some evidence suggests that labor unions might be less powerful in poorer countries, which may contribute to the flexibility of labor markets in those countries.

becomes less countercyclical making the business cycle more like those in developed economies. For the case of the higher separation rate and the higher bargaining power of the workers, it is difficult to tell whether these scenarios generate results that are closer to developed countries or to the emerging economies. Therefore, we cannot draw robust conclusions as to whether labor market frictions are more or less prevalent for emerging markets. However, these sensitivity exercises show that our results are generally robust to the changes in the key search-matching parameters. Hence, MP type search frictions appear to better characterize the labor markets of emerging market economies than the Walrasian labor markets.

5 Matching efficiency shocks

In our baseline model, the allocative or matching efficiency, ω, is a fixed parameter. In this section, we explore the quantitative implications of introducing a random disturbance ε_t^{ω} to the matching efficiency. More specifically, we add shocks ε^{ω} to our matching function $M_t = \omega_t u_t^{\alpha} v_t^{1-\alpha}$, $\omega_t = (1 + \varepsilon_t^{\omega})\omega$. For a given pair of u_t and v_t, fluctuations in ω_t affect the number of matches formed. These matching efficiency shocks could be allowed to interact with the other fundamental shocks as in Andolfatto (1996).[26] We consider these shocks and their interaction with the other shocks of the economy to be particularly relevant for emerging economies, as these countries often experience structural changes and cross-sectoral reallocations during large economic fluctuations. Moreover, the labor markets tend to be more segmented across sectors in developing countries (see Agenor and Montiel (2008)). In fact, resources are often not instantaneously mobile or perfectly substitutable across different sectors. Even within sectors but across establishments, different jobs involve various skills and may require specific training. If the aggregate shocks affect different sectors in an asymmetric way, the difficulties associated with searching and matching with jobs from different sectors can be interpreted as an efficiency loss at the aggregate level.

Empirically, matching efficiency shocks can be motivated by the following observations regarding the Sudden Stop episodes. Kehoe and Ruhl (2009) document that substantial reallocations, which are often costly, take place from nontradable to tradable goods sectors following Sudden Stops. For example, in the aftermath of the Mexican crisis in 1994-1995, massive sectoral reallocations took place as the depreciation of real exchange rate drove down the relative price of nontradable goods. In the case of Mexico, the employment share of traded goods sector in total employment stopped

[26] When calibrated to the U.S., Andolfatto (1996) finds that including matching efficiency shocks changes the variability of wage in the opposite direction than desired.

following a downward sloping trend and even rose somewhat after the crisis. Figure 1 shows that similar patterns of cross-sectoral allocations are observed in other Sudden Stop episodes: e.g., Chile 1981-84, 1998-99 and Colombia 1998-99.[27,28] Moreover, Benjamin and Meza (2007) argue that the Sudden Stops raise the cost of imported intermediate input in the investment sector and often lead to reallocation of labor from investment sector to the consumption sector suggesting that there are differential effects on the labor variables across sectors. We study the potential impact of matching efficiency shock on the business cycle variables when matching across sectors are inherently more difficult than matching within sectors.

Unfortunately, data on the direct measures of new hires and vacancy rate do not exist for emerging economies making it impossible to estimate matching efficiency shocks. However, Andolfatto (1996) estimates a joint VAR(1) process of productivity shock and matching efficiency shock using the U.S. data and shows that the innovations to the matching shock is almost ten times the innovations to the technology shock and these two shocks are positively correlated. In line with this observation, we experiment with matching efficiency shocks that are positively correlated with TFP shocks. That is, at the aggregate level, times of high matching efficiency are associated with economic expansions and periods of low reallocation efficiency are accompanied by economic downturns. Our calibration strategy with regards to the matching efficiency shocks is to pin down ρ_ω and $var(e^\omega)$ in order to match $\sigma(u)$ and $\rho(y, u)$. Specifically, the standard deviation of the innovation to the matching efficiency shock is set to be 10%, with a persistence parameter of 0.6, and the correlation with the innovation to TFP is 0.5.[29] Other ingredients of the VAR involving the matching efficiency shock were set to zero.

The results with matching efficiency shocks are presented in Table 7. The first column copies the baseline scenario results, the second column reports the findings of the scenario with matching efficiency shocks that are positively correlated with TFP and finally the last column documents the case with uncorrelated matching efficiency shocks. In the positively correlated matching efficiency shock scenario, since the matching efficiency is likely to be low when TFP is low, as discussed before,

[27] We date the Sudden Stops using the definition by Gallego and Tessada (2008): a period that a. annual capital flow falls at least two standard deviation below its sample mean at least once; b. begins as the first time the annual drop in capital flow is one standard deviation below the sample mean and c. ends when it rises one standard deviation above the mean. The employment data is obtained from International Labour Organization. We categorize the agriculture, mining, manufacturing and utility supply as the tradable sector and construction and services as the nontradable sector.

[28] Net job creations also display similar dynamics. Using the sectoral job creation and destruction data provided by Haltiwanger et al (2004), we find that the ratio of net job creations in the tradable sector relative to that in the nontradable sectors increases in both Mexico and Brazil in the aftermath of crises.

[29] We also analyzed a case when the correlation of matching efficiency shocks and TFP is set to zero.

the stock of unemployment can be eliminated at a slower pace. This generates a more persistent unemployment (notice that the autocorrelation of unemployment (0.31) is higher than the baseline case (0.10)) and a significantly higher variability for unemployment and vacancy (16.24 and 14.56 compared to 3.24 and 5.59 in the baseline case). If the matching efficiency is low, the firms cut vacancies significantly because the probability of forming a match is smaller while the cost of keeping the vacancy is constant. Hence, vacancies fall dramatically leading to higher unemployment with one period lag. In the scenario with uncorrelated matching efficiency shocks, the only significant difference is with regard to the correlation of unemployment with output that becomes closer to zero. This is intuitive as the uncorrelated matching efficiency shocks lead to a decoupling of the matching process from the TFP process.

The conventional search models of closed economies have difficulty in generating the high unemployment rate variability found in the data, unless the replacement rate is high.[30] In our model extended to include matching efficiency shocks, an adverse matching efficiency shock directly reduces the job creation rate and leads to higher unemployment rate for the following period. Given that the steady state level of unemployment is about 8% and the other factor inputs are fixed, one percentage point rise of unemployment rate leads to only 0.056 percentage decrease of output, which is about one twentieth the size of the change in unemployment. This implies that the matching efficiency shock, itself, can lead to high relative variability of unemployment rate (relative to output) without affecting the variability of output and consumption significantly.

6 Conclusion

In this paper, we showed that a SOE-RBC model with search-matching frictions in the labor market can perform well in accounting for the dynamics of consumption, the current account and the wages simultaneously. Our quantitative results showed that our model improved upon the standard RBC model in many dimensions underscoring the dynamic interaction of search-matching frictions along with countercyclical interest rates in accounting for emerging markets stylized facts. As an illustrative extension, we augmented our baseline model to include shocks to the matching efficiency. With this feature, we showed that the model brought the unemployment variability significantly closer to data.

Exploring emerging market labor market dynamics using general equilibrium models is ripe for

[30] See Marcus and Manovskii (2005) and Nakajima (2008) for a detailed explanation.

further research. This paper showed how far the modeling of the transitions from unemployment-employment (extensive margin) takes us in terms of explaining the key regularities. Another area to explore is the fluctuations in the hours worked by an employed worker (intensive margin). Although data on hours worked is scarce in many emerging market economies, our findings seem to suggest a less pronounced variability in emerging markets compared to developed economies.

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A Mathematical Appendix

Efficiency condition for the decentralized economy. Let the total surplus of a match be denoted by S_t defined by $S_t = J_t U'(c_t) + E_t - U_t$. Then by Nash bargaining, we have the value of filling a job as a fraction of total surplus $J_t = (1-\xi)\frac{S_t}{U'(c_t)}$. From the social planner's problem, the total surplus of a job match $S_t = -\frac{\partial V(k,u_t,\varepsilon_t)}{\partial u_t} = -V_{2,t}$. In addition, we know that

$$V_{2,t} = -\varphi^E H(1-l) + \varphi^U H(1) - U'(c_t)F_{2,t}l - \eta_t(1-\psi-\alpha\phi(\theta_t))$$

and η_t is the expected marginal aggregate benefit of an additional job match $\eta_t = -\beta(c_t)\mathbb{E}_t V_{t+1,2}$. Substitute it back and rearrange the terms we get

$$S_t = \varphi^E H(1-l) - \varphi^U H(1) + U'(c_t)F_{2,t}l + (1-\psi-\alpha\phi(\theta_t))\beta(c_t)\mathbb{E}_t S_{t+1}$$

In terms of J_t

$$\begin{aligned} J_t &= \frac{(1-\xi)}{U'(c_t)}[\varphi^E H(1-l) - \varphi^U H(1) + U'(c_t)F_{2,t}l] + (1-\psi-\alpha\phi(\theta_t))\mathbb{E}_t\frac{\beta(c_t)U'(c_{t+1})}{U'(c_t)}J_{t+1} \\ &= \frac{(1-\xi)}{U'(c_t)}[\varphi^E H(1-l) - \varphi^U H(1) + U'(c_t)F_{2,t}l] + (1-\psi-\alpha\phi(\theta_t))\frac{\kappa\theta_t}{\phi(\theta_t)} \end{aligned}$$

Also, the flow profit of an active job is $\pi_t = \max_k F(\frac{k_t}{n_t}, l; z_t) - r_t\frac{k_t}{n_t} - w_t l = F_2(\frac{k_t}{n_t}, l; z_t)l - w_t l$.The value transition equations are:

$$\begin{aligned} J_t &= \pi_t + \mathbb{E}_t\rho_{t,t+1}[(1-\psi)J_{t+1} + \psi Q_{t+1}] \\ Q_t &= -\kappa + \mathbb{E}_t\rho_{t,t+1}[\phi(\theta_t)/\theta_t J_{t+1} + (1-\phi(\theta_t)/\theta_t)Q_{t+1}] \end{aligned}$$

By free-entry $Q_t = 0$ for every t. This implies

$$\kappa = \frac{\phi(\theta_t)}{\theta_t}\mathbb{E}_t\rho_{t,t+1}J_{t+1}$$

Therefore,

$$J_t = \pi_t + (1-\psi)\mathbb{E}_t\rho_{t,t+1}J_{t+1} = F_{t,2}l_t - w_t l_t + (1-\psi)\frac{\kappa\theta_t}{\phi(\theta_t)}$$

Based on the above equation, wage, thus, can be written as

$$
\begin{aligned}
w_t &= F_{2,t} + \frac{1}{l}[(1-\psi)\frac{\kappa\theta_t}{\phi(\theta_t)} - J_t] \\
&= F_{2,t} + \frac{1}{l}[(1-\psi)\frac{\kappa\theta_t}{\phi(\theta_t)} - \frac{(1-\xi)}{U'(c_t)}[\varphi^E H(1-l) - \varphi^U H(1) + U'(c_t)F_{2,t}l] - (1-\psi-\alpha\phi(\theta_t))\frac{\kappa\theta_t}{\phi(\theta_t)}] \\
&= \xi F_{2,t} + \frac{1}{l}[\alpha\kappa\theta_t - (1-\xi)\frac{\varphi^E H(1-l) - \varphi^U H(1)}{U'(c_t)}] \\
&= \xi F_{2,t} + \frac{1-\xi}{l}[\frac{\alpha\kappa\theta_t}{1-\xi} - \frac{\varphi^E H(1-l) - \varphi^U H(1)}{U'(c_t)}]
\end{aligned}
$$

Therefore, in order for the decentralized economy result to correspond to the social planner's result, we need $\alpha = \xi$. That is, the bargaining power of firms equals the elasticity of the matching technology with respect to recruiting effort.

B Data Appendix

The dates in square brackets are the beginning date of a data series and the end date is 2007 unless otherwise stated. Our sample period is 1976-2007. All detrending is done using the HP filter with a smoothing parameter of 1600 and deseasonalizations are done using the U.S. Census Bureau's X-12. Only those series that seemed to have seasonality were deseasonalized.

GDP

All data are from the International Financial Statistics (IFS). Availability varies across countries. Countries that have the data for the entire sample: Australia, Austria, Canada, Finland, France, Israel, Japan, Korea, Norway, Spain, Sweden.[31]

Countries with shorter samples: Belgium [1980], Brazil [1991], Chile [1980], Denmark [1977], Ecuador [1991], Hungary [1995], Ireland [1997], Malaysia [1988], Mexico [1980], the Netherlands [1977], New Zealand [1982Q2], the Philippines [1981], Portugal [1977], Turkey [1988].

Manufacturing Output

Manufacturing output data are in real terms and from Haver Analytics. Data for the entire sample are available for Australia, Austria, Chile, Norway and Spain. For others, the availability varies: Belgium [1990], Brazil [1991], Canada [1981], Denmark [1985], Ecuador [1990], Finland [1995], Hungary [1997], Ireland [1980], Israel [1990], Mexico [1980], New Zealand [1987Q2], Philippines [1998], Portugal [2000], Sweden [2000], Turkey [1985].

Aggregate Hours, Manufacturing Hours, Employment

All countries: Hours worked data are available only for the manufacturing sector. We report a set of statistics using those data. In addition, we approximate aggregate hours worked by multiplying the hours worked per worker in manufacturing by total employment. Some countries do not report hours worked per worker but only total hours worked in manufacturing. In that case, we divide total hours in manufacturing by the number of employees in manufacturing to approximate hours worked per worker.

Australia, Austria, Canada, Finland, Japan: All series are from OECD and available for the entire sample.

Brazil: Monthly hours worked in manufacturing is from OECD [1992] and 1987Q1-1991Q4 was calculated using data from the Confederation of Industries. Civilian employment data are from Neumeyer and Perri (2005) for 1991-2002 and 2003-2007 was extrapolated using "formal employ-

[31] In the calculation of the GDP standard deviation for Israel, we excluded 1976-1980 because of large fluctuations observed in this period.

ment" series from Ministerio do Trabalho e Emprego (MTE) assuming that civilian employment grows at the same rate with formal employment. Employment in manufacturing are from MTE.

Chile, Malaysia, The Netherlands, Philippines: No data is available on hours worked. Employment data is from IFS and start at different years for these counties, Netherlands [1984], Chile [1983Q3], the Philippines [1992], Malaysia [1998].

Ecuador: No data is available on hours worked. Employment data is short in quarterly frequency, available in IFS only for 2000-2003 and therefore was not included in the employment statistics.

Hungary: All series are from OECD. Hours worked per worker in manufacturing are available starting 1984, civilian employment and employment in manufacturing from 1992.

Ireland: Weekly hours worked in manufacturing per worker is from OECD (entire sample). However, the number of employees in manufacturing data start in 1998 and therefore, total hours worked in manufacturing could be calculated only starting in 1998. The number of employees in manufacturing and civilian employment are also from OECD [1998].

Israel: Hours worked in manufacturing data are from International Labor Organization (ILO) and covers the entire sample (series named weekly hours actually worked in non-agricultural activities per worker). Employment is from IFS [1992]. Number of employees in manufacturing was not available.

Korea: Monthly hours worked in manufacturing is from OECD [1993]. Number of employees in manufacturing and total employment are from the Korean Statistical Institute [1976].

Mexico: Employment data are from Neumeyer and Perri (2005) covering 1987-2001. We used two different data for monthly hours worked in manufacturing, from INEGI [1980] and from OECD [1987]. The data from OECD is an index (2000=100) and is used in the calculation of the statistics related to the hours worked in manufacturing. The series from INEGI is in units of hours and is used to compute the approximate aggregate hours worked as explained above. Number of employees in manufacturing data are from INEGI [1987].

New Zealand: Hours worked in manufacturing data are from ILO [1980] (series called weekly hours actually worked in non-agricultural activities per worker). Employment and employment in manufacturing are from OECD [1985Q4].

Norway: All series are from OECD and available for the entire sample except hours worked manufacturing that starts in 1988Q2.

Sweden: All series are from OECD and available for the entire sample except hours worked manufacturing that starts in 1987.

Turkey: Total hours worked in manufacturing is from OECD [1977]. Number of employees in manufacturing and total employment are from TURKSTAT [1988Q4] and are semi-annual (April and October) in 1988Q4-1999Q4 and quarterly afterwards. The semi-annual series were used to calculate quarterly series using linear interpolation.

Unemployment Rate

From OECD: Austria [1976], Belgium [1976], Brazil [1981], Canada [1976], France [1976], Japan [1976], Korea [1976], Mexico [1987], the Netherlands [1987], Norway [1986], Sweden [1976], Turkey [1976].

From the Economist Intelligence Unit: Australia [1993], Chile [1993], Ecuador [1998], Finland [1993], Hungary [1994], Ireland [1997Q4], Israel [1996], Malaysia [1998], New Zealand [1993], the Philippines [1993], Spain [1993].

Earnings

From OECD: Brazil and Mexico's earnings statistics are reported in OECD both in real and nominal terms, and we deflate all other countries' data by the corresponding countries' CPI. For Australia, Brazil, New Zealand, and Spain, earnings statistic captures all activities, for Belgium and France it captures the private sector. For all other countries, it is the earnings only for manufacturing. Data for the entire sample is available for Canada, Denmark, Finland, Germany, Ireland, Japan, Norway, and Sweden. For other countries, availability varies: Australia [1983Q4], Belgium [1996], Brazil [1989], France [1996], Hungary [1995], Korea [1992], Mexico [1980], New Zealand [1987], Spain [1981], and Turkey [1990]. Nominal earnings data for Brazil and Mexico start in 1994Q3 and 1980Q1, respectively.

From ILO: Chile [1982], Israel [1985], the Philippines [2001].

From IEO: Ecuador [1993].

Prices

All CPI data used to deflate earnings are from IFS and are available for the entire sample period with the exception of Brazil [1980].

All PPI data used to deflate earnings are from Haver Analytics. Data for the entire sample are available for Australia, Canada, Korea, Spain, Sweden. For others, the availability varies: Austria [1996], Belgium [1980], Brazil [1991Q4], Chile [2003Q2], Denmark [1985], Ecuador [1998], Finland [1995], Hungary [1986], Ireland [1995], Israel [1980], Mexico [1981], New Zealand [1977Q4], Norway [2000], Philippines [2000], Portugal [1995], Turkey [1986].

C TFP computation

Assume that output (Y_t) can be represented by the following Cobb-Douglas production function:

$$Y_t = K_t^{\alpha}(h_t L_t)^{1-\alpha} A_t,$$

where K_t is the capital stock in year t, L_t is labor which is augmented its relative efficiency due to schooling (h_t), and A_t is TFP.

We constructed the capital stock series using the perpetual inventory approach following Easterly and Levine (2001). In particular, the law of motion for the capital stock is given by:

$$K_{t+1} = K_t(1-\delta) + I_t,$$

where I_t denotes investment and the rate of depreciation of the capital stock which is set equal to 0.07. In steady state, the initial capital-output ratio is:

$$k = \frac{i}{g+\delta},$$

where i is the steady state investment-output ratio and g the steady state growth rate. In terms of data, we use annual investment data from the Penn World Tables, version 6.2. In order to calibrate k, we approximate i by the country's average investment-output ratio in the first ten years of the sample and g by a weighted average between world growth (75%) and the country's average growth in the first ten years of the sample. The initial capital level K_0 is obtained by multiplying the three-year average output at the beginning of the sample.

For labor, we use the labor force implied by the real GDP per worker and real GDP (chain) series from the Penn World Tables. In order to calibrate human capital h_t, we follow Hall and Jones (1999) and consider h to be the relative efficiency of a unit of labor with E years of schooling. In particular, h is constructed by:

$$h = e^{\varphi(E)},$$

where $\varphi(\cdot)$ is a function that maps the years of schooling into efficiency of labor with $\varphi(0) = 0$ and

$\varphi'(E)$ equal to the Mincerian return to schooling. We assume the same rates of return to schooling for all countries: 13.4% for the first four years, 10.1% for the next four, and 6.8% for all years of schooling above eight years (following Psacharopoulos, 1994). The data on years of schooling is obtained from the Barro-Lee database and linear extrapolations are used to complete the five-year data.

Output per worker is given by:

$$\frac{Y_t}{L_t} = \left(\frac{K_t}{L_t}\right)^{\alpha} h_t^{1-\alpha} A_t$$

Taking logs and reorganizing terms yields:

$$\ln(A_t) = \ln(Y_t) - \ln(L_t) + \alpha\big(\ln(k_t) + \ln(L_t)\big) + (1-\alpha)\ln(h_t).$$

D Canonical SOE-RBC

The recursive representation of the social planner's problem in the canonical SOE-RBC model is:

$$
\begin{aligned}
V(b_t, \varepsilon_t) = \max_{c_t, b_{t+1}} u(c_t, l_t) + \beta(c_t)\mathbb{E}_t V(b_{t+1}, \varepsilon_{t+1}) \\
\text{s.t. } c_t + b_{t+1} \leq F(k, l_t, z_t) + b_t(1 + r_t), \\
b_{t+1} \geq \bar{B}.
\end{aligned}
$$

where l_t stands for labor supply. Per-period utility is takes the GHH form, $u(c_t, l_t) = \frac{(c_t - \chi l_t^{\eta})^{1-\sigma}}{1-\sigma}$ where $\frac{1}{\eta - 1}$ captures the elasticity of labor supply. Under the spot labor market, wage equals the marginal product of labor and marginal rate of substitution between consumption and leisure.

We use the same values for all preference related parameters as in our baseline search-matching model as documented in Table 4. The only additional parameter that appears in the canonical SOE-RBC is η which we set to 1.455 following Mendoza (1991). As mentioned in the text, we feed in the same TFP and interest rate shocks as in our baseline search-matching framework.

Table 1: Real earnings

	$\sigma(W)$	$\sigma(W)/\sigma(Y)$	$\rho(W,Y)$	$\sigma(W)/\sigma(Y^{man})$	$\sigma(W^{nom})$	$\sigma(W^{PPI})$
Emerging Markets:						
Brazil	6.92	4.19	0.27	2.11	5.30	7.14
Chile	1.77	0.61	0.13	0.47	1.92	2.81
Ecuador	7.16	3.36	0.53	0.99	-	-
Hungary	1.36	1.31	0.36	0.39	1.45	2.43
Israel	3.72	1.82	0.40	1.46	5.57	4.86
Korea	3.63	1.42	0.81	0.83	3.16	4.66
Malaysia	-	-	-	-	-	-
Mexico	5.20	2.22	0.56	1.48	8.75	5.92
Philippines	1.53	0.55	-0.33	0.54	1.46	3.06
Turkey	10.43	3.05	0.19	2.31	7.34	12.00
Mean:	**4.64**	**2.06**	**0.32**	**1.18**	**4.23**	**5.36**
Median:	**3.68**	**1.62**	**0.38**	**1.00**	**3.16**	**4.76**
Developed Markets:						
Australia	1.95	1.47	0.36	0.79	1.72	2.61
Austria	0.75	0.74	0.23	0.27	0.65	1.19
Belgium	0.64	0.53	-0.20	0.35	0.80	2.05
Canada	0.90	0.58	-0.24	0.23	1.31	2.40
Denmark	0.96	0.67	0.07	0.28	0.91	2.42
Finland	1.67	0.80	0.27	0.62	1.56	1.81
Ireland	1.58	0.96	-0.11	0.44	1.28	2.73
Netherlands	-	-	-	-	-	-
New Zealand	0.98	0.87	0.25	0.36	1.17	1.65
Norway	1.67	1.08	0.13	0.87	1.76	6.49
Portugal	-	-	-	-	-	-
Spain	1.19	1.05	-0.23	0.46	1.46	2.08
Sweden	1.54	1.10	0.25	0.59	1.06	2.22
Mean:	**1.19**	**0.84**	**0.04**	**0.45**	**1.23**	**2.50**
Median:	**1.54**	**0.96**	**0.13**	**0.46**	**1.28**	**2.40**

Notes: This table shows 1) standard deviation of real earnings, 2) standard deviation of real earnings as a ratio of output standard deviation, 3) correlation of real earnings with output, 4) standard deviation of real earnings as a ratio of manufacturing output standard deviation, 5) standard deviation of nominal earnings, 6) standard deviation of real earnings calculated using the PPI instead of CPI. All series are HP-filtered using a smoothing parameter of 1600. See Data Appendix for more information about data sources and coverage.

Table 2: Unemployment rate and employment

	$\sigma(U)$	$\sigma(U)/\sigma(Y)$	$\rho(U,Y)$	$\sigma(E)$	$\sigma(E)/\sigma(Y)$	$\rho(E,Y)$
Emerging Markets:						
Brazil	12.26	7.43	-0.49	1.20	0.73	0.54
Chile	11.01	3.77	-0.67	1.68	0.58	0.28
Ecuador	16.26	7.63	-0.55	-	-	-
Hungary	5.29	5.09	-0.25	1.21	1.16	0.12
Israel	5.73	2.81	-0.67	1.15	0.56	0.51
Korea	5.26	2.06	0.01	1.60	0.63	0.87
Malaysia	8.27	3.28	-0.42	1.26	0.50	0.39
Mexico	14.70	6.28	-0.78	1.16	0.50	0.50
Philippines	8.01	2.90	-0.35	1.49	0.54	0.38
Turkey	27.18	7.95	0.10	1.42	0.64	0.39
Mean:	**11.40**	**4.92**	**-0.41**	**1.42**	**0.64**	**0.39**
Median:	**9.64**	**4.43**	**-0.46**	**1.26**	**0.58**	**0.39**
Developed Markets:						
Australia	8.76	6.59	-0.66	1.24	0.93	0.65
Austria	9.65	9.55	-0.00	0.80	0.79	0.11
Belgium	10.10	8.35	-0.37	-	-	-
Canada	8.64	5.54	-0.04	1.16	0.74	0.67
Denmark	-	-	-	0.64	0.45	0.40
Finland	4.29	2.06	-0.13	1.71	0.82	0.73
Ireland	9.77	5.96	-0.5	-	-	-
Netherlands	14.7	10.14	-0.52	1.45	1.00	0.33
New Zealand	7.94	7.03	-0.60	1.42	1.26	0.22
Norway	9.36	6.04	-0.14	1.09	0.70	0.39
Portugal	10.76	7.27	-0.51	1.87	1.13	0.46
Spain	6.46	5.72	-0.27	1.47	1.30	0.79
Sweden	6.30	4.50	-0.19	1.23	0.88	0.47
Mean:	**8.89**	**6.56**	**-0.33**	**1.25**	**0.91**	**0.47**
Median:	**9.06**	**6.31**	**-0.32**	**1.24**	**0.88**	**0.46**

Notes: This table shows 1) standard deviation of unemployment rate, 2) standard deviation of unemployment as a ratio of output standard deviation, 3) correlation of unemployment rate with output, 4) standard deviation of employment, 5) standard deviation of employment as a ratio of output standard deviation, 6) correlation of employment with output. All series are HP-filtered using a smoothing parameter of 1600. See Data Appendix for more information about data sources and coverage.

Table 3: Hours worked: manufacturing and aggregate

	$\sigma(H_m)$	$\sigma(H_m)/\sigma(Y)$	$\rho(H_m, Y)$	$\sigma(H_a)$	$\sigma(H_a)/\sigma(Y)$	$\rho(H_a, Y)$
Emerging Markets:						
Brazil	3.42	2.07	0.57	2.71	1.61	0.54
Chile	-	-	-	-	-	-
Ecuador	-	-	-	-	-	-
Hungary	1.83	1.76	0.23	-	-	-
Israel	-	-	-	2.35	1.15	0.47
Korea	1.83	0.72	0.32	2.16	0.85	-0.42
Malaysia	-	-	-	-	-	-
Mexico	3.70	1.58	0.78	1.72	0.74	0.59
Philippines	-	-	-	-	-	-
Turkey	4.83	1.41	0.59	5.82	1.70	0.41
Mean:	**3.12**	**1.51**	**0.50**	**2.95**	**1.23**	**0.32**
Median:	**3.42**	**1.58**	**0.57**	**2.35**	**1.24**	**0.47**
Developed Markets:						
Australia	2.98	2.24	0.72	2.21	1.66	0.68
Austria	1.88	1.86	0.37	1.25	1.24	0.22
Belgium	-	-	-	-	-	-
Canada	3.05	1.96	0.74	1.57	1.01	0.71
Denmark	-	-	-	-	-	-
Finland	3.10	1.49	0.68	2.44	1.17	0.65
Ireland	2.24	1.37	0.48	1.54	0.94	0.55
Netherlands	-	-	-	-	-	-
New Zealand	3.19	2.82	0.43	1.70	1.50	0.40
Norway	2.31	1.49	0.35	1.69	1.09	0.38
Portugal	-	-	-	-	-	-
Spain	2.72	2.41	0.68	1.85	1.64	0.66
Sweden	2.98	2.13	0.68	1.89	1.35	0.68
Mean:	**2.72**	**1.97**	**0.57**	**1.79**	**1.29**	**0.55**
Median:	**2.98**	**1.96**	**0.68**	**1.70**	**1.24**	**0.65**

Notes: This table shows 1) standard deviation of hours worked in manufacturing, 2) standard deviation of hours worked in manufacturing as a ratio of output standard deviation, 3) correlation of hours worked in manufacturing with output, 4) standard deviation of aggregate hours worked, 5) standard deviation of aggregate hours worked as a ratio of output standard deviation, 6) correlation of aggregate hours worked with output. All series are HP-filtered using a smoothing parameter of 1600. See Data Appendix for more information about data sources and coverage.

Table 4: Calibrated Parameters

Parameter	Value	Explanation	Source
Preferences:			
σ	2	relative risk aversion	literature
β	0.983	steady-state discount factor	inverse of gross real interest rate
ν	3.54	elasticity of leisure	Frisch elasticity of labor supply is 0.6
φ^E	1.1599	coefficient of leisure in utility (employed)	calculation
φ^U	0.1915	coefficient of leisure in utility (unemployed)	calculation
Production Technology:			
z	1	total factor productivity	normalization
ζ	0.36	capital's share in output	literature
Search Technology:			
ω	0.778	matching efficiency	$\omega = \frac{m^*}{u^{*\alpha} v^{*(1-\alpha)}}$
α	0.5	elasticity of matching function	Petrongolo and Pissarides (2001), Shimer (2004)
κ	0.127	unit cost of posting vacancy	recruiting expenditure as 1% of GDP
ψ	0.06	natural breakup rate	Bosch and Maloney (2008)
ξ	0.5	bargaining power	the same as α
Other:			
r	1.74	world interest rate	EMBI data
$\overline{b}$	-1/3	steady state bond holdings	data

Notes: This table shows the parameter values used in the analysis.

Table 5: Business Cycle Moments

	Data	RBC	Search and Matching		
			Baseline	Only Prod	Only Int Rate
Standard Deviation					
$\sigma(c)$	3.02	0.88	2.98	1.76	2.93
$\sigma(y)$	2.40	1.69	2.20	2.23	0.00
$\sigma(u)$	14.70	n.a.	3.24	2.10	3.04
$\sigma(v)$	n.a.	n.a.	5.59	3.90	5.51
$\sigma(w)$	5.20	1.20	3.67	1.86	2.46
$\sigma(\theta)$	n.a.	n.a.	17.53	10.34	15.62
$\sigma(w)/\sigma(y)$	2.22	0.71	1.67	0.83	n.a.
$\sigma(c)/\sigma(y)$	1.26	0.52	1.35	0.79	n.a.
Correlation with y					
$\rho(y, ca/y)$	-0.75	-0.13	-0.46	0.97	-0.09
$\rho(y, u)$	-0.78	n.a.	-0.68	-0.26	0.10
$\rho(y, v)$	n.a.	n.a.	0.51	0.16	-0.41
$\rho(y, w)$	0.56	1.00	0.83	0.82	0.01
$\rho(y, \theta)$	n.a.	n.a.	0.77	0.33	0.16
$\rho(u, v)$	n.a.	n.a.	-0.94	-0.96	-0.95
Autocorrelation					
$\rho(c)$	0.70	0.75	0.53	0.87	0.56
$\rho(y)$	0.75	0.64	0.65	0.67	1.00
$\rho(ca/y)$	0.72	0.41	0.40	0.65	0.45
$\rho(u)$	0.84	n.a.	0.10	-0.32	-0.10
$\rho(v)$	n.a.	n.a.	-0.33	-0.65	-0.52
$\rho(w)$	0.85	0.64	0.50	0.54	0.34
$\rho(\theta)$	n.a.	n.a.	0.40	0.09	0.27

Notes: This table shows the business cycle moments. The columns show the moments in the data, in the RBC model with Walrasian labor markets, in the baseline search-matching model with shocks to TFP and interest rate, the search-matching model only with TFP shocks, and the search-matching model only with interest rate shocks. This table shows that in the data wage is more variable than income, unemployment is countercyclical, consumption is more variable than income, current account-GDP ratio is countercyclical. The baseline scenario accounts for these regularities reasonably well.

Table 6: Sensitivity Analysis

	Baseline	$\kappa = 0.1$	$\psi = 0.08$	$\omega = 0.85$	$\xi = 0.7$
Standard Deviation					
$\sigma(c)$	2.98	2.73	2.89	2.70	2.88
$\sigma(y)$	2.20	2.20	2.21	2.20	2.20
$\sigma(u)$	3.24	3.79	2.79	3.71	1.75
$\sigma(v)$	5.59	5.86	4.77	5.69	6.62
$\sigma(w)$	3.67	3.61	3.49	3.61	4.02
$\sigma(\theta)$	17.53	23.17	15.04	17.91	9.41
$\sigma(w)/\sigma(y)$	1.67	1.64	1.57	1.64	1.82
$\sigma(c)/\sigma(y)$	1.35	1.23	1.30	1.22	1.30
Correlation with y					
$\rho(y, ca/y)$	-0.46	-0.23	-0.53	-0.23	-0.54
$\rho(y, u)$	-0.68	-0.63	-0.67	-0.66	-0.79
$\rho(y, v)$	0.51	0.48	0.50	0.51	0.66
$\rho(y, w)$	0.83	0.86	0.82	0.86	0.69
$\rho(y, \theta)$	0.77	0.79	0.75	0.81	0.75
$\rho(u, v)$	-0.94	-0.93	-0.94	-0.96	-0.91
Autocorrelation					
$\rho(c)$	0.53	0.52	0.55	0.52	0.58
$\rho(y)$	0.65	0.65	0.65	0.65	0.65
$\rho(ca/y)$	0.40	0.37	0.40	0.38	0.42
$\rho(u)$	0.10	-0.06	0.15	-0.02	0.56
$\rho(v)$	-0.33	-0.38	-0.26	-0.35	0.16
$\rho(w)$	0.50	0.52	0.51	0.53	0.54
$\rho(\theta)$	0.40	0.43	0.42	0.45	0.40

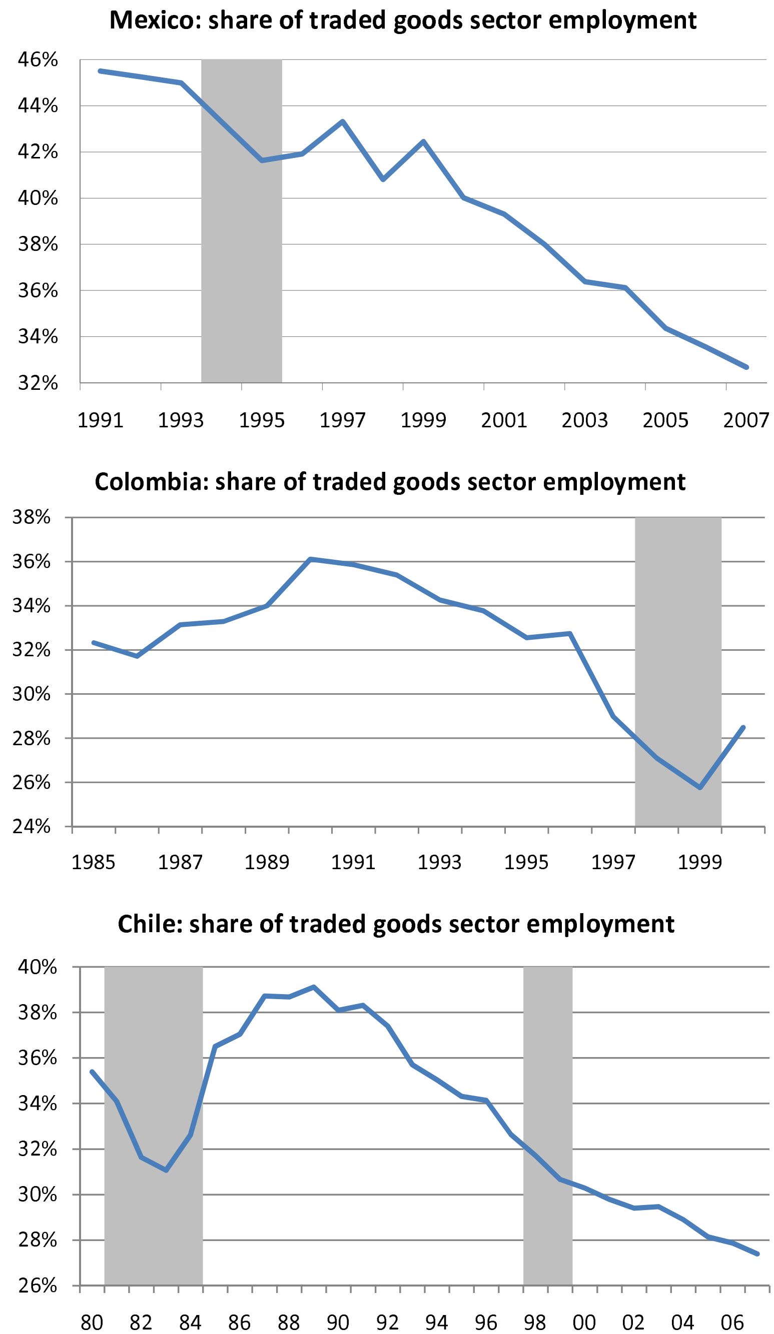
Notes: This table shows the results of the sensitivity analysis. The columns show the moments of the baseline case and those of the scenarios with $\kappa = 0.1$, $\psi = 0.08$, $\omega = 0.85$, and $\xi = \alpha = 0.7$.

Table 7: Matching Efficiency Shocks

	Baseline	w/ MES	
		$\rho(\varepsilon^z, \varepsilon^\omega) = 0.5$	$\rho(\varepsilon^z, \varepsilon^\omega) = 0$
Standard Deviation			
$\sigma(c)$	2.98	2.84	2.87
$\sigma(y)$	2.20	2.37	2.26
$\sigma(u)$	3.24	16.24	15.59
$\sigma(v)$	5.59	14.56	13.96
$\sigma(w)$	3.67	4.31	4.00
$\sigma(\theta)$	17.53	33.02	30.31
$\sigma(w)/\sigma(y)$	1.67	1.82	1.77
$\sigma(c)/\sigma(y)$	1.35	1.20	1.27
Correlation with y			
$\rho(y, ca/y)$	-0.46	-0.20	-0.34
$\rho(y, u)$	-0.68	-0.57	-0.20
$\rho(y, v)$	0.51	-0.01	0.01
$\rho(y, w)$	0.83	0.88	0.78
$\rho(y, \theta)$	0.77	0.76	0.49
$\rho(u, v)$	-0.94	-0.34	-0.29
Autocorrelation			
$\rho(c)$	0.53	0.51	0.50
$\rho(y)$	0.65	0.68	0.64
$\rho(ca/y)$	0.40	0.41	0.37
$\rho(u)$	0.10	0.31	0.32
$\rho(v)$	-0.33	-0.32	-0.28
$\rho(w)$	0.50	0.52	0.51
$\rho(\theta)$	0.40	0.50	0.51

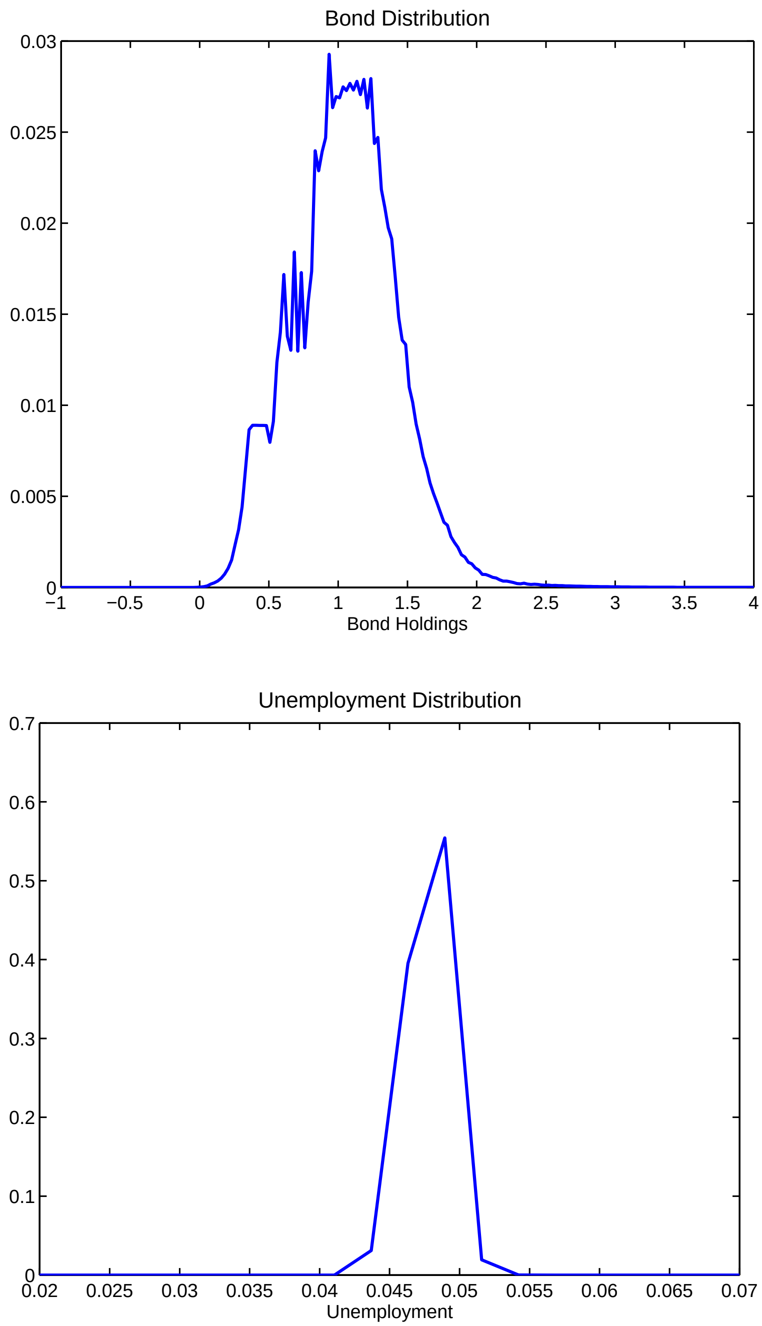
Notes: This table shows the results of the setup with shocks to the matching efficiency. The columns show the moments of the baseline case and those of the scenarios with procyclical ($\rho(\varepsilon^z, \varepsilon^\omega) = 0.5$) and acyclical ($\rho(\varepsilon^z, \varepsilon^\omega) = 0$) matching efficiency shocks.

Figure 1: Sectoral Decomposition of Employment



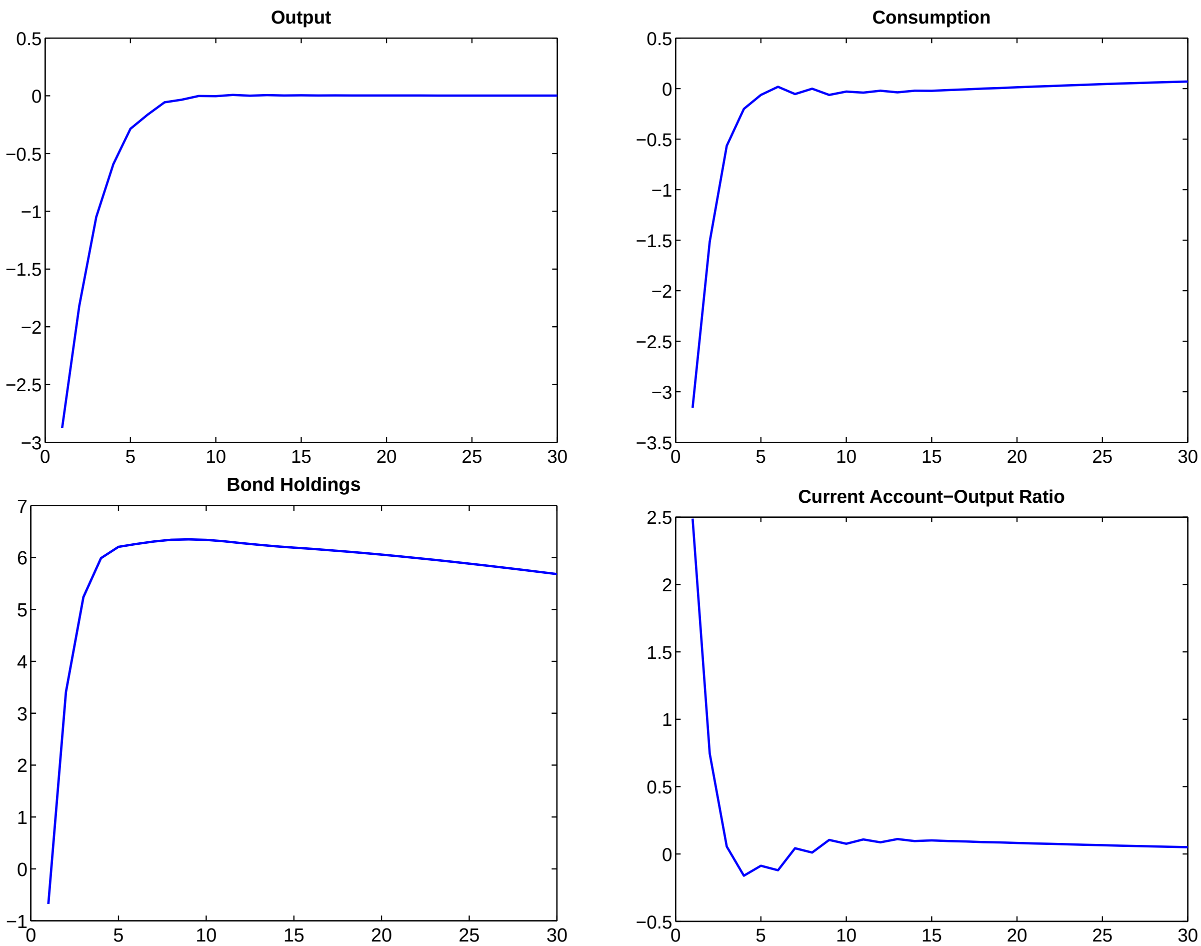
Notes: Shaded areas show the corresponding sudden stop episodes in respective countries.

Figure 2: Limiting Distributions



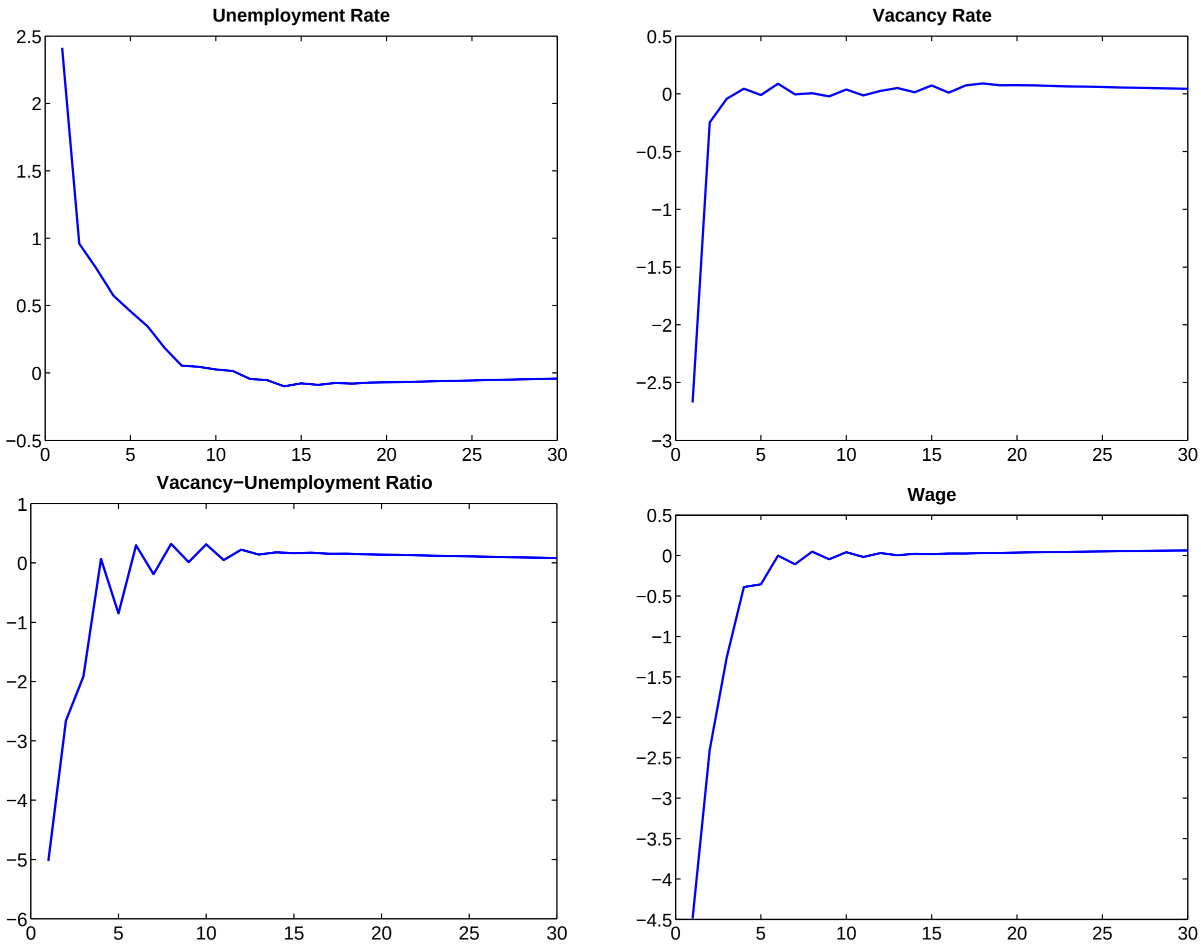
Notes: The charts plot the limiting distributions of bond holdings and unemployment.

Figure 3: Impulse Response Functions: Main Macroeconomic Variables



Notes: The figures show the impulse responses of main macroeconomic variables in response to simultaneous one-standard-deviation negative TFP and positive interest rate shocks.

Figure 4: Impulse Response Functions: Labor Market Variables



Notes: The figures show the impulse responses of main macroeconomic variables in response to simultaneous one-standard-deviation negative TFP and positive interest rate shocks.