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Reconciling the Relevance of Labor Market Institutions in Search and Matching Models with International Evidence

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Abstract

This paper examines whether search and matching frictions in labor markets can account for cross-country differences in business cycle properties. The particular interest is the joint effect of two institutional variables, employment protection and the replacement income of unemployed workers. I first document an empirical regularity that higher degrees of employment protection and/or lower replacement rates are associated with larger standard deviations of real wages relative to those of unemployment in OECD members. However, there is a positive correlation between employment protection and replacement rates implying that the net effect of the systematic difference in these institutional variables could be ambiguous. I then show that modern macroeconomic models with search and matching frictions are broadly consistent with the stylized fact: the models predict that higher firing costs and/or lower replacement rates raise the wage volatility relative to that of unemployment. I find that this result is robust to alternative setups of non-labor markets. Finally, I find that the effect of the above institutions on inflation is minor.

JEL classification: E24; E31; E32; J63; J64; J88
keywords: search and matching frictions, labor market institutions, cyclicalities, real wage, unemployment.

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1 Introduction

Economic analyses exploiting search and matching frictions in labor markets have flourished since Mortensen and Pissarides published a series of theoretical studies on equilibrium unemployment (*e.g.* Mortensen and Pissarides (1994)). The framework was soon transplanted to a real business cycle setting by Merz (1995). Shimer (2005) and Hall (2005) extensively examined the cyclical behavior of labor markets exhibiting search and matching frictions in partial equilibrium contexts. More recent studies, such as Walsh (2005) and Trigari (2009), introduced search and matching frictions in labor markets into the New-Keynesian models and examined the effect on inflation dynamics.

As the search and matching framework is canonical in the theoretical literature on unemployment, we might reasonably expect it to be able to account for cross-country differences in the cyclical behavior of labor markets. A line of literature, represented by Thomas (2006), Abbritti and Weber (2010) and Campolmi and Faia (2011), investigates this focusing on differences in labor market institutions across countries. However, the approaches in existing literature tend to highlight just one institutional feature and may thus be considered inadequate for looking at the relevance of the institutional system as a whole to labor market cyclicalities. In addition, they often presume a particular macroeconomic framework, *e.g.* New-Keynesian economics, *a priori* and do not examine whether their model predictions are robust to changes in this.[1]

In this paper, I undertake the task of measuring how well labor market institutions can explain cross-country differences in business cycle properties within search and matching models. My primary focus is the joint effect of employment protection and the replacement income of unemployed workers on labor market cyclicalities. I also examine the effect on inflation, in line with established practice. I begin by documenting observed cross-country differences in

[1] An exception is Walsh (2005). However, he only evaluates the effect of changes in non-labor market parameters on output and inflation.

the cyclical behavior of labor markets across OECD members along with differences in labor market institutions. Then I examine whether macroeconomic models with search and matching frictions in labor markets can replicate the stylized facts. I also check the robustness of my theoretical predictions by switching the platform of the macroeconomic model on which the search and matching frictions are loaded.

Throughout the analysis, I select the standard deviation of real wages relative to that of unemployment, denoted by σ_w/σ_u, as the representative measure of the cyclical behavior of labor markets. There are several advantages to using this measure. First, the cyclicality of unemployment and real wages is a central issue in labor search theory. For example, Shimer (2005), Hall (2005) and Hagedorn and Manovskii (2008) dispute how models with search and matching frictions should be calibrated so as to match the volatility of unemployment. Hall emphasizes the importance of real wage rigidities, which intrinsically reduce the real wage volatility; meanwhile, Hagedorn and Manovskii take a different route that preserves the observed volatility of real wages. There is thus a rich store of findings in the literature on search and matching models against which the analysis of this paper can be usefully evaluated. Second, by taking the ratio of the standard deviations, I attempt to eliminate the effect of exogenous disturbances, *e.g.* productivity shocks, as much as possible from the raw data. The analysis may therefore be expected to convey purer information on the endogenous propagation effect of labor market institutions on business cycles.[2]

The result of this paper is two-fold. First I find that the degree of employment protection and the replacement rate are factors empirically relevant to the cyclical behavior of labor markets among OECD members: the standard deviation of real wages relative to that of unemployment tends to rise in countries with high degrees of employment protection and low replacement rates. I also find that there is a general tendency for countries with high degrees of employment

[2]Some studies, *e.g.* Thomas (2006), compare the variance of one particular economic variable across countries. This method is potentially flawed as the historical magnitude of the exogenous disturbances, which could be significantly different across countries, affects the variance.

protection to have high replacement rates. This correlation implies a degree of ambiguity in the net effect of systematic differences in the labor market institutions.

Next, I demonstrate that my model is broadly consistent with the empirical findings: higher firing costs and lower replacement rates are associated with relatively greater volatility in real wages than in unemployment in models with the search and matching frictions in labor markets. I find that this prediction is robust to orthodox changes in how we set up the non-labor market structure: whether I adopt a real business cycle (RBC hereafter) framework or New-Keynesian framework is almost irrelevant to the behavior of labor markets. I thus conclude that, in the search and matching framework, firing costs and the replacement income of unemployed workers are independent factors influencing the cyclical behavior of labor markets. On the other hand, these institutions have a much smaller effect on the inflation-output trade-off, a traditional Phillips curve relation.

The virtue of this paper is that I take explicit account of systematic differences in labor market institutions. Thomas (2006) and Campolmi and Faia (2011) draw out some novel implications about the effects of firing costs and replacement rates. However, both studies consider labor market institutions in only one dimension, resulting in a failure to account for the correlation of the institutional variables observed in the data. Abbritti and Weber (2010) considers institutions that cause unemployment rigidities and wage rigidities simultaneously. However, there is some inconsistency between the paper's modeling of unemployment rigidities and its data analysis: while the model does not contain endogenous firing, in its data analysis, employment protection is picked as the representative measure of unemployment rigidity. On the other hand, I incorporate firing costs and replacement rates jointly and build a clear connection between my model analysis and my empirical strategy. This setup enables me to draw a more accurate picture on the effect of labor market institutions on the cyclical behavior of labor markets.

The remaining structure of the paper is as follows. Section 2 documents a stylized fact concerning cross-country differences in the cyclical behavior of labor markets and how they are related to labor market institutions. Section 3 sets up the base model with an emphasis on the labor market institutions discussed in section 2. Section 4 presents the results of my model simulation and section 5 describes the background of the results. Section 6 presents some sensitivity analyses, and I offer concluding remarks in section 7.

2 A stylized fact among OECD members

This section documents a stylized fact on the relation between labor market institutions and the cyclical behavior of labor markets. Our sample covers OECD members for which time series data on unemployment and real wages[3] are available from the 1980s.

The analysis begins with the selection of a measure that conveys economically meaningful information on the cyclical behavior of labor markets. In this paper, I select as the proxy for the cyclicality of labor markets the standard deviation of real wages relative to that of unemployment, denoted by σ_w/σ_u. This measure sheds light on the relative importance of the price adjustment channel to the quantity adjustment channel in labor markets. Moreover, matching observed volatilities of real wages and unemployment is a common aim in much of the search and matching literature. Hence, we can evaluate the empirical result of this paper (as well as the theoretical result described in the later sections) against a store of related findings from previous studies. Finally, this measure is expected to convey purer information on the endogenous propagation effect of labor market institutions than the variance of a single economic variable. Remember it is difficult to distinguish the endogenous propagation effect from the effect of exogenous disturbances, such as productivity shocks, when investigating the variance of a single economic variable. This problem could be serious when there are substantial variations in

[3]We use data on real wages in the manufacturing sector because nominal wage data for other sectors are available only for a few countries in the OECD database. When constructing real wages, we deflate nominal wages by the CPI excluding food and energy.

the historical magnitude of exogenous disturbances across countries. By dividing the standard deviation of real wages by that of unemployment, I attempt as far as possible to eliminate the effect of exogenous disturbances.

As for labor market institution variables, there are a number of candidates. Restrictions on firing would affect job flows and the behavior of unemployment. The replacement income of unemployed workers would affect real wage dynamics and employment decisions through the effect on reservation wages. Another prevailing view is the importance of the degree of unionization. The list can be expanded further. For example, Bank of Japan (2010) points out that active labor market policies targeting unemployed workers, such as job training, reduce the cost of unemployment thereby increasing job mobility.[4]

I first check the cross-country variation in the labor market institution variables listed above. I take the indicator of employment protection (EP), which is a proxy of firing costs, from OECD.stat, while replacement rates, union density, union coverage and expenditures on active labor market policies (RR, UD, UC and ALMP respectively) are from Nickell (2006). The replacement rate is the ratio of unemployment benefit to the wage income of employed workers. Union density and union coverage are, respectively, union members divided by total employment, and workers covered by collective agreements normalized by total employment. The active labor market policies measure is computed as expenditure on government programs to help unemployed workers find jobs, as a percentage of GDP. These measures are available from the 1980s to the mid 2000s. Each figure in Table 1 is the unweighted average of the relevant time series.

In line with the findings of the empirical analysis below, my primary focuses are the em-

[4]I sidestep the issue of wage rigidities here. There is a plenitude of studies that raise the importance of wage rigidities to account for the volatility of unemployment. However, Pissarides (2009) finds that wages of newly hired workers are flexible and argues that search and matching models should preserve this observed wage flexibility as only the wages of new matches are relevant to job creations. I also find that the calibrated model in this paper has slightly a smaller real wage volatility than that seen in data. Therefore, I consider wage rigidities to be of questionable relevance to the search and matching framework.

countries	EP	RR	UD	UC	ALMP
Australia	1.07	24.5	40.7	80.0	0.45
Belgium	2.71	48.2	53.8	90.0	1.26
Canada	0.75	53.6	34.0	36.0	0.54
Denmark	1.91	72.4	76.9	69.0	1.51
Finland	2.15	51.5	73.9	95.0	1.21
France	2.94	59.1	11.9	93.5	1.05
Germany	2.73	38.1	31.0	91.0	1.20
Ireland	0.96	42.6	49.4	N.A.	1.46
Italy	2.97	19.2	39.9	82.5	1.24
Japan	1.66	29.5	25.7	22.0	0.16
Netherlands	2.51	69.7	26.7	85.0	1.56
Norway	2.75	58.9	57.0	70.0	0.87
Sweden	2.74	82.8	82.4	87.5	2.05
Spain	3.33	69.1	12.5	77.0	0.65
UK	0.64	23.2	39.2	47.0	0.56
U.S.A	0.21	28.3	15.9	17.5	0.20

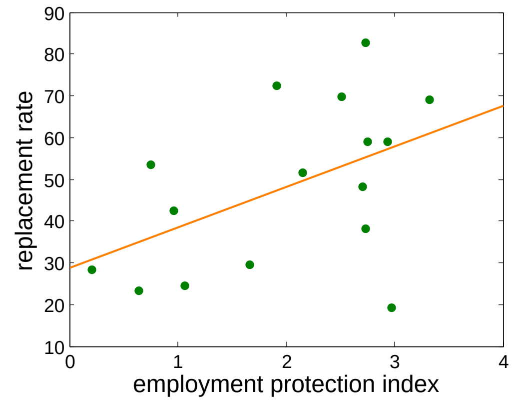

Table 1 & Figure 1: Labor market institutions by countries

ployment protection index and the replacement rate. As can be seen in Table 1, there are wide ranges of variation in both employment protection (EP) and the replacement rate (RR). The employment protection index is as low as 0.2 for the United States, with relatively low figures also observed in the United Kingdom and Canada. In contrast, much stricter employment protection is witnessed across Western Continental Europe: the index is typically more than two for countries within this block. Meanwhile, replacement rates[5] vary from 20% to 80% across the countries.

Figure 1 points that countries with strict employment protection tend also to have high replacement rates. However, the correlation is not so strong and there are substantial variations in replacement rates for countries with the similar level of employment protection. This will

[5]The unemployment benefit referred to in this index is the benefit granted to unemployed workers in their first year of unemployment. Also, the statistics is the average over three family situations and two earning levels. (See Nickell (2006).)

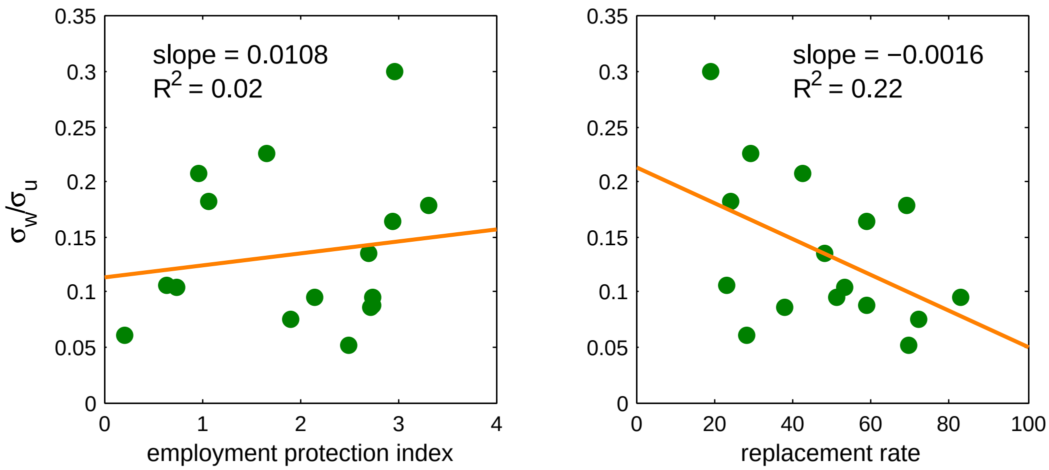

Figure 2: Bivariate relations between cyclicality and institutions in labor markets

help to identify the marginal effect of the employment protection and the replacement rate on the cyclical behavior of labor markets.

I now examine the relation between the standard deviation of real wages relative to that of unemployment and labor market institutions.[6] First, I examine the bivariate relations between σ_w/σ_u and each labor market institution variable. It turns out that the bivariate relations are not especially strong. Figure 2 indicates hardly any correlation between the employment protection index and σ_w/σ_u. Replacement rates are negatively and more strongly correlated with σ_w/σ_u. However, I could not reject the null hypothesis that the slope coefficient is zero.

These results may imply that the degree of employment protection and the replacement income of unemployed workers are irrelevant to the cyclical behavior of labor markets. However, another hypothesis is that there are multiple forces causing fluctuations in labor markets and the simple bivariate regressions failed to isolate the marginal effect of each of the labor market institution variables.

To obtain a more complete picture, I regress σ_w/σ_u against sets of labor market institution

[6]I compute the standard deviation of real wages and unemployment based on Hodrick-Prescott filtered cyclical components. As in many existing articles, I apply the smoothing parameter 1600 to all series. However, I obtain similar results both qualitatively and quantitatively for different smoothing parameters such as 6400.

variables. The results are shown in the first two columns of Table 2. I find that the coefficients on the degree of employment protection and the replacement rate are statistically significant. The effect of stricter employment protection is positive while that of a higher replacement rate is negative.

To check robustness, I also regress the σ_w/σ_u ratios for pairs of OECD members against labor market institution variables ratios for the same pairs of OECD members (OLS regressions in columns 3 and 4 and two-stage least square regressions in columns 5 and 6 in Table 2).[7] The results again support the relevance of employment protection and the replacement rate in explaining cross-country differences in σ_w/σ_u. The results are robust to endogeneity problems of regressors as the results of two-stage least squares show. In these estimations, as instrument for the employment protection and replacement rates, I use their own values in 1972.[8]

The above result allows us to establish that the degree of employment protection and the replacement income of unemployed workers are systematically correlated with the cyclical behavior of labor markets: increasing the degree of employment protection and reducing replacement rates raise real wage volatility relative to that of unemployment.[9]

The overall effect of systematic differences in labor market institutions across countries may be somewhat obscured by the positive correlation between the degree of employment protection and the replacement rate. According to the empirical result shown in Table 2, raising the strictness of employment protection offsets the impact of raising the replacement rate on σ_w/σ_u. I will revisit this issue of systematic correlations in section 4.

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[7] Campolmi and Faia (2011) takes the same strategy and I follow their method.

[8] I implement two-stage least squares only for the ratio equations because, for this method, statistical inferences are based on asymptotic theory. I judge that the size of the sample for the level equations is not sufficient to guarantee the accuracy of statistical inferences for two-stage least squares.

[9] It would be also interesting to examine how unionization affects the performance of labor markets as some empirical analyses find union-related variables to be relevant to business cycles. For example, Rumler and Scharler (2009) finds that high union density increases output volatility whereas the degree of coordination in wage bargaining affects inflation volatility. However, I do not find strong evidence for the relevance of union related variables for the standard deviation of real wages relative to that of unemployment. I thus omit these variables for my current purposes.

variables	OLS level	OLS level	OLS ratio	OLS ratio	2SLS ratio	2SLS ratio
	method and level/ratio					
EP	0.0347^{*}	0.0647^{**}	0.1815^{**}	0.3178^{**}	0.1302^{**}	0.2057^{**}
	(0.0193)	(0.0275)	(0.0596)	(0.0690)	(0.0629)	(0.0887)
RR	-0.0025^{**}	-0.0023^{*}	-0.4860^{**}	-0.4690^{**}	-0.5574^{**}	-0.5337^{**}
	(0.0008)	(0.0012)	(0.0822)	(0.1064)	(0.1197)	(0.1379)
UD		0.0004		-0.0690^{**}		-0.0055
		(0.0009)		(0.0337)		(0.0619)
UC		-0.0007		-0.1764		-0.1087
		(0.0010)		(0.1496)		(0.1605)
ALMP		-0.0340		0.0028		0.0110
		(0.0631)		(0.0643)		(0.0653)
R-square	0.41	0.59	0.23	0.32	0.22	0.31
observations	16	15	120	105	120	91

Estimated equations are $\sigma_{w,i}/\sigma_{u,i} = \alpha + \mathbf{x}_i'\beta + \varepsilon_i$ for level equations and $(\sigma_{w,i}/\sigma_{u,i})/(\sigma_{w,j}/\sigma_{u,j}) = \alpha + \mathbf{x}_{i,j}'\beta + \varepsilon_{i,j}$ for ratio equations, where i and j indicate country names. $\mathbf{x}_i$ is the vector of labor market institution variables in country i and $\mathbf{x}_{i,j}$ is the vector of ratios of labor market institution variables between country i and j. ε_i and $\varepsilon_{i,j}$ are possibly heteroskedastic random disturbances. * and ** on the estimates indicate 10% and 5% statistical significance. Figures in parentheses indicate robust standard errors that are based on Huber-White-sandwich estimator.

Table 2: Regression results

3 The model

This section presents a RBC-style model with search and matching frictions in the labor market. There are four types of agents in the model: households, intermediate good firms, retailers and the government. Labor search takes place between households and intermediate good firms. I divide firm sectors into the retail sector and the intermediate good sector only to incorporate price stickiness in section 6.

3.1 households

Assume that a household contains a continuum of workers residing on the unit interval. As we will see later, each worker is either employed or unemployed as a result of labor search. However, workers can insure their consumption by being members of a household which pools and equally distributes its members' income. The maximization problem of households is then written as:

$$\max E_t \sum_{s=t}^{\infty} \beta^{s-t} u\left(c_s - \varsigma c_{s-1}\right), \tag{1}$$

$$s.t. \quad c_t + B_{t+1} = z_t + R_t B_t - T_t, \tag{2}$$

$$z_t = n_t \bar{\omega}_t + u_t b.$$

where c_t is the consumption bundle of retail goods, B_t is the stock of nominal bonds, z_t is real income, and T_t is a lump-sum tax with R_t denoting the real interest rate.[10] The real income, z, consists of wage income, $\bar{\omega}_t$, contributed by employed workers, denoted by n_t, and the unemployment benefit,[11] b, received by unemployed workers, u_t. $u()$ is the period utility function that takes the argument of the current period consumption and the consumption one period ago. $\varsigma > 0$ means there is habit formation in consumption. I assume that the exact form of the period utility is:

$$u\left(c_t - \varsigma c_{t-1}\right) = \log\left(c_t - \varsigma c_{t-1}\right). \tag{3}$$

Because workers can insure risks regarding employment uncertainty, we can adopt a rep-

[10]In section 6 where I introduce nominal variables, the budget constraint is modified as $P_t c_t + B_{t+1} = P_t z_t + r_t B_t - T_t$ where P_t is the nominal price of the consumption goods and r_t now stands for the nominal interest rate.

[11]In search and matching models, b is typically interpreted as the sum of unemployment benefits, other transfers to unemployed workers, household production and leisure. In this paper, I follow the same interpretation and set b such that it is larger than the replacement rates observed in the data. And I also assume that b is transferred from a government that runs a balanced budget. Whether we assume that the "unemployment benefit" constitutes a government transfer or takes the form of leisure is not crucial.

resentative agent setting. Note that workers' job search and wage bargaining determine their income stream that is given to households. The first order conditions of households' problem can then be written:

$$\begin{aligned} E_t\left(\Lambda_{t+s,t}\right) &= \beta^s E_t\left(\lambda_{t+s}/\lambda_t\right), \\ \lambda_t &= \frac{1}{c_t-\varsigma c_{t-1}} - \beta\varsigma E_t\left(\frac{1}{c_{t+1}-kc_t}\right). \end{aligned} \tag{4}$$

where λ_t is the Lagrange multiplier on the budget constraint and $E_t\left(\Lambda_{t+s,t}\right)$ is the stochastic discount factor that governs the consumption-saving decision of households.

3.2 the labor market and intermediate good firms

The labor market is characterized by search and matching frictions *à la* Mortensen and Pissarides (1994). In this market, intermediate good firms, simply firms hereafter, search the labor force while workers search for jobs. An implicit assumption is that several forms of matching frictions prevent firms and workers from forming matches: some firms fail to fill vacancies; at the same time, some workers fail to find jobs. I assume that the number of matches can be described by the aggregate matching function below:

$$m_t = \chi u_{t-1}^{\alpha} v_t^{1-\alpha}. \tag{5}$$

where u_{t-1} is the pool of unemployment at the end of time $t-1$, which is equivalent to workers searching for jobs at the beginning of time t, and v_t stands for vacancies posted by firms. χ measures the efficiency of matching, and $0 \leq \alpha \leq 1$.

By defining the labor market tightness as $\theta_t \equiv v_t/u_{t-1}$, we can formulate the probability that a vacancy is filled with a worker, $q(\theta_t)$, and the probability that a job-seeking worker is matched with a firm, $s(\theta_t)$, as follows:

$$q(\theta_t) = \frac{m_t}{v_t} = \chi\theta_t^{-\alpha}, \quad (6)$$

$$s(\theta_t) = \frac{m_t}{u_{t-1}} = \chi\theta_t^{1-\alpha}. \quad (7)$$

The timing of job separations is two-fold. First, employed workers leave their jobs exogenously with probability ρ.[12] The firms whose job posts are still filled, then, fire workers if matches are unproductive.[13] The basis of firing is the idiosyncratic productivity of workers, a. In each period, workers draw their own productivity from a time-invariant continuous distribution with support $[0, \infty)$. I detail the firing mechanism below, but the result is that firms fire workers whose productivity falls below a certain threshold, $\bar{a}$. Let the $c.d.f$ of the distribution be $F(a)$. Then the law of motion of employed workers is written as:

$$n_t = (1 - F(\bar{a}_t)) \left[(1 - \rho) n_{t-1} + q_t v_t \right]. \quad (8)$$

I normalize the number of workers to one. Thus unemployment at any given time is $u_t = 1 - n_t$.

The production of firm i is described by the level of technology times the labor input. Workers, if they are hired, supply one unit of labor inelastically. Thus the output of firm i is a multiple of aggregate productivity, A, and the worker's idiosyncratic productivity:[14]

$$y_{i,t} = A_t a_{i,t}. \quad (9)$$

In recruiting workers, firms pay a cost, γ_v, per vacancy posting. They also have to pay a

[12] I assume that search and matching takes place before exogenously separated workers reenter the labor market. Therefore, workers who voluntarily quit their jobs become unemployed for at least one period.

[13] At this point, new matches are already formed. Thus workers in new but unproductive matches are also "fired". This assumption is made purely for analytical convenience.

[14] I describe the employment contract as if a firm is able to hire only a worker. However, assuming that a firm can hire more than one worker yields the same result because the firm's profit function can be written, eventually, as a linear function of the workers.

firing cost, γ_f, for dismissing a worker. These costs are denominated in units of the consumption good and they represent pure losses of production resources. Firm i pays a real wage, $\omega_t(a_{i,t})$, to a worker with productivity $a_{i,t}$ if the worker is retained for production. Finally I assume that the intermediate good sector is competitive and that firms sell their goods to retailers at the price $p_{m,t}$.[15]

I can now define the value of posting an additional vacancy, V_t, and the value of keeping a worker with productivity $a_{i,t}$ for the firms, $J_t(a_{i,t})$, as follows:

$$
\begin{aligned}
V_t &= -\gamma_v - \gamma_f q(\theta_t) F(\bar{a}_t) + q(\theta_t)\bar{J}_t, && (10)\\
J_t(a_{i,t}) &= p_{m,t} A_t a_{i,t} - \omega_t(a_{i,t}) + E_t\left[\Lambda_{t+1,t}\left\{(1-\rho)\left(\bar{J}_{t+1} - \gamma_f F(\bar{a}_{t+1})\right)\right\}\right], && (11)\\
\bar{J}_t &\equiv \int_{\bar{a}_t}^{\infty} J_t(a)\,dF(a).
\end{aligned}
$$

The cost of an additional vacancy consists of the vacancy posting cost and the expected firing cost that enter with negative signs in (10). The latter arises if firms successfully find workers but they are unproductive, i.e. $a_{i,t} < \bar{a}_t$. The benefit is the expected value of keeping a productive worker. This value, (11), is the sum of the period profit, which constitutes sales minus wage payments, and the expected value of retaining the worker less the expected firing cost next period.

Assuming free entry into vacancy postings, firms post vacancies until V_t falls to zero. This generates the following vacancy posting condition:

$$\gamma_v + \gamma_f q(\theta_t) F(\bar{a}_t) = q_t \bar{J}_t. \tag{12}$$

Once a worker and a firm form a match, firing occurs if the surplus from keeping the worker falls short of the value of releasing the worker and keeping the job vacant ($E_t(V_{t+1}) - \gamma_f$ with

[15] To make this assumption valid, I assume that all firms set prices before observing the productivity of their employees. The equilibrium price, therefore, guarantees that firms' expected profit is zero.

$E_t(V_{t+1}) = 0$ in equilibrium). This determines the following job destruction condition:

$$J(\bar{a}_t) + \gamma_f = 0. \tag{13}$$

Equation (13) implies a positive relationship between the cutoff productivity, $\bar{a}_t$, and the firing cost γ_f under moderate firing probability. As the firing cost increases, the benefit of releasing the matched worker and keeping the position vacant declines. Then keeping even relatively unproductive workers makes sense for firms.[16]

Similar to the value of workers for firms, we can define the value of employment and unemployment for workers, $W_t(a_{i,t})$ and U_t, as follows:

$$W_t(a_{i,t}) = \omega_t(a_{i,t}) + E_t\left[\Lambda_{t+1,t}\left\{(1-\rho)\bar{W}_{t+1} + ((1-\rho)F(\bar{a}_{t+1}) + \rho)\, U_{t+1}\right\}\right], \tag{14}$$

$$U_t = b + E_t\left[\Lambda_{t+1,t}\left\{s(\theta_{t+1})\bar{W}_{t+1} + (1 - s(\theta_{t+1}) + s(\theta_{t+1})F(\bar{a}_{t+1}))\, U_{t+1}\right\}\right], \tag{15}$$

$$\bar{W}_t \equiv \int_{\bar{a}_{t+1}}^{\infty} W_t(a)dF(a).$$

The present value of employment is the period utility plus the expected future gains. That of unemployment takes the same form. The period utility of employment and unemployment are wage income and unemployment benefit respectively. In calculating the expected future gains, workers take into account the transition probability of moving between the employment and the unemployment state. The surplus from employment is defined as $W_t(a_{i,t}) - U_t$. Workers negotiate with firms over real wages to maximize this surplus.

As in typical search and matching friction models, I assume that the results of wage bargaining take the form of the Nash bargaining solution. In this setup, a firm and a matched worker share the joint surplus from the match. The relative size of their shares depends on the

[16] If $F(\bar{a})$ takes a high enough value, then the reduction in the value of keeping workers, $J_t(a_{i,t})$, accompanying an increase in γ_f may be large enough for firms to prefer to fire even productive workers. However, with a reasonable firing probability consistent with the U.S. data, this channel is insignificant.

bargaining power of workers denoted by η, where $\eta \in [0, 1]$. Formally, the bargaining problem is formulated as:

$$\arg \max_{\omega_t(a_{i,t})} \left(J_t(a_{i,t}) + \gamma_f\right)^{1-\eta} \left(W_t(a_{i,t}) - U_t\right)^{\eta}. \tag{16}$$

The resulting real wage conditional on idiosyncratic productivity $a_{i,t}$ is:

$$\omega_t(a_{i,t}) = \eta \left[p_{m,t} A_t a_{i,t} + \gamma_v E_t \left(\Lambda_{t+1,t}\theta_{t+1}\right) + \gamma_f \left\{1 - E_t \left(\Lambda_{t+1,t} \left(1 - \rho - s(\theta_{t+1})\right)\right)\right\}\right] + (1 - \eta)\, b. \tag{17}$$

The terms in the square bracket after η constitute the real wage demanded by the worker, while b is firms' ideal wage offer if they had full bargaining power.

Finally, we can define the average productivity and the average real wage of employed workers as follows:

$$E(a_{i,t}|a_{i,t} \geq \bar{a}) \equiv H_t = (1 - F(\bar{a}_t))^{-1} \int_{\bar{a}_t}^{\infty} a dF(a), \tag{18}$$

$$E(\omega_t(a_{i,t})|a_{i,t} \geq \bar{a}) \equiv \bar{\omega}_t = (1 - F(\bar{a}_t))^{-1} \int_{\bar{a}_t}^{\infty} \omega_t(a) dF(a). \tag{19}$$

3.3 equilibrium

There is a continuum of monopolistically competitive retailers on the unit interval. Each retailer purchases the intermediate good at the price $p_{m,t}$ and transforms it into a differentiated retail goods in a one-to-one relation. The price of the retail good j, $p_{j,t}$, is set given the demand schedule $y_{j,t} = (p_{j,t}/P_t)^{-\varepsilon} Y_t$ where Y_t is the aggregate output and ε is the price elasticity of demand. According to this setup, the price of the intermediate good is determined as follows:

$$p_{m,t} = \frac{\varepsilon - 1}{\varepsilon}. \tag{20}$$

This relationship is modified when I introduce price stickiness in section 6.

In this economy, the government levies a lump-sum tax, T, on households so as to finance the payment of unemployment benefits. I assume that the government runs balanced budget:

$$T_t = (1 - n_t)b. \tag{21}$$

The aggregate output is given by the CES aggregator of retail goods less resource losses incurred as a result of search and matching frictions:

$$Y_t = \left(\int_0^1 y_{j,t}^{\frac{\varepsilon-1}{\varepsilon}} dj\right)^{\frac{\varepsilon}{\varepsilon-1}} - \gamma_v v_t - \gamma_f F(\bar{a}_t)\left[(1-\rho)\, n_{t-1} + q_t v_t\right]. \tag{22}$$

Because retailers transform the intermediate good into retail goods in a one-to-one relation, we can rewrite the aggregate output as:[17]

$$Y_t = A_t H_t n_t - \gamma_v v_t - \gamma_f F(\bar{a}_t)\left[(1-\rho)\, n_{t-1} + q_t v_t\right]. \tag{23}$$

The aggregate output is solely consumed by households:

$$Y_t = c_t. \tag{24}$$

Finally, aggregate productivity evolves according to the following stochastic process:

$$\begin{aligned} \log(A_t) &= \rho_A \log(A_{t-1}) + \varepsilon_{A,t}, \\ \varepsilon_{A,t} &\sim N(0, \sigma_A). \end{aligned} \tag{25}$$

[17] This is true up to the first order approximation of Y_t. For details, see chapter 3 of Gali (2009).

4 Results

This section presents the simulation results from the model and examines whether they are consistent with the empirical findings reported in section 2.

4.1 calibration

The calibration strategy in this paper is as follows: first, as a benchmark, I calibrate the model's parameters using U.S. data, on which the existing literature provides a rich store of information; then I shift the firing cost and the replacement rate, $b/\bar{\omega}$, one at a time to examine the effects of labor market institutions on the cyclical behavior of the model's labor market. Although other sources may also be expected to affect the cyclical behavior of labor markets, the current paper does not attempt to identify all sources of labor market fluctuations. Rather I would like to assess the relevance of the labor market institution variables to labor market cyclicalities in a search and matching framework.

The benchmark parameters in the labor market are in line with Krause and Lubik (2007). The time frequency is quarterly. I choose the steady state total separation rate, $\rho + (1-\rho)F(\bar{a})$ to be 0.10. I set the exogenous separation rate $\rho = 0.068$, which consequently implies $F(\bar{a}) = 0.034$. As assumed in most of the existing literature, a is log-normally distributed with mean μ_a and standard deviation σ_a. μ_a is normalized to zero and σ_a is set to 0.15.[18] To be consistent with the job-filling rate targeted in Krause and Lubik (2007) and the job-finding rate reported in Shimer (2005), I target $q(\theta) = 0.70$ and $s(\theta) = 0.76$ respectively.[19] There is still a wide range of possible values for $(\chi, \alpha, \gamma_f, \gamma_v, \eta)$ that would satisfy the targets above. Among them I fix $\alpha = 0.4$ and $\eta = 0.5$ and select a low γ_f to be consistent with the fact that the employment protection index in the U.S. is the lowest among OECD members. I set $\gamma_f = 0.018$, implying that

[18] Krause and Lubik (2007) sets $\sigma_a = 0.12$ while Thomas (2006) sets it to be 0.10.

[19] Shimer (2005) reports the average monthly job-finding rate to be about 0.45 between 1951-2003. This translates into a quarterly job-finding rate of 0.77.

	Description	Values		Description	Values
ρ	Exogenous separation	0.068	γ_f	Firing cost	0.018
$F(\bar{a})$	Endogenous separation	0.034	γ_v	Vacancy posting cost	0.068
$q(\theta)$	Job-filling rate	0.70	$b/\bar{\omega}$	Replacement rate	0.89
$s(\theta)$	Job-finding rate	0.76	β	Discount rate	0.99
μ_a	The mean of $F()$	0	ς	Habit formation	0
σ_a	The SD of $F()$	0.15	ε	Elasticity of demand	11
χ	Matching efficiency	0.73	ρ_A	Productivity inertia	0.92
α	Matching elasticity	0.4	σ_A	The SD of productivity shocks	0.0034
η	Worker's bargaining power	0.5			

Table 3: Benchmark parameter values

firing a worker costs about two percent of firm's income. As shown in Table 2, the remaining labor market parameters take the values $\gamma_v = 0.068$ and $\chi = 0.73$. Finally, I set the replacement rate equal to 0.89. This is much higher than the actual replacement rate in the U.S.[20] However, the existing literature provides rationales for choosing a high replacement rate. Some authors consider b to be a composite of various forms of non-working benefits such as severance transfers and the value of leisure. In addition, Hagedorn and Manovskii (2008) recommend a high replacement rate so as to obtain the moderate elasticity of real wages and the large elasticity of vacancies with respect to productivity shocks that are observed in the U.S.

The discount rate of households, β, is set to 0.99. I choose the habit parameter $\varsigma = 0$ as the baseline case. In section 6, I shift this parameter together with price stickiness to assess the quantitative importance of non-labor market parameters to labor market cyclicalities. Finally, I set the parameters related to productivity evolution to match the output volatility of the U.S. I choose the persistence in productivity, ρ_A, to be 0.92. The implied standard deviation of the productivity shock, σ_A, is then 0.0023.

[20]Technically, lower replacement rates, such as 0.5 or even 0.8, are not consistent with the required condition, $s(\theta) \leq 1$

	Baseline	High firing cost	Low replacement rate	High FC and high RR
		$\gamma_f = 0.09$	$b/\bar{\omega} = 0.84$	$\gamma_f = 0.072, b/\bar{\omega} = 0.92$
$\sigma_{\bar{\omega}}/\sigma_u$	0.092	0.128	0.163	0.088
		(39%)	(76%)	(-5%)
σ_{jc}/σ_{jd}	1.26	7.28	1.59	2.36
		(477%)	(26%)	(87%)

Figures in parentheses represent the percentage change of each measure from the baseline.

Table 4: Cyclical properties of the labor market

4.2 the effects of changes in labor market institutions

Table 4 presents the effects of changes in the labor market institution variables on the cyclical behavior of the labor market. While I present $\sigma_{\bar{\omega}}/\sigma_u$ generated by the model to compare with the data, I also show the job creations/job destructions standard deviation ratio (σ_{jc}/σ_{jd}) to highlight the drivers of job flows. Column two displays these two cyclicality measures under the baseline calibration. Columns three and four display those under the 'high firing cost' and the 'low replacement rate' scenarios. The high firing cost scenario quintuples the firing cost parameter and the low replacement rate scenario lowers the replacement rate by five percent points relative to the baseline. Larger changes to the target parameters are not admissible because either $q(\theta)$ or $s(\theta)$ exceeds one. In this sense, these two scenarios represent extreme cases within the admissible range of parameter values. The figures given in the last column are for the scenario when both the firing cost and the replacement rate are raised. This scenario most closely resembles the situation in Western European countries. Note that other parameters remain constant throughout.

The main finding is the model's results are consistent with the empirical result reported in Table 2: real wage volatility increases relative to unemployment volatility when the firing cost rises or the replacement rate declines in the model as well as in the data. In both cases of the model simulation, the economic impacts are sizable: 39% and 76% increases in $\sigma_{\bar{\omega}}/\sigma_u$

respectively.

The simulation result predicts that the total effect of changes in the labor market institutions is ambiguous when the firing cost and the replacement rate co-move positively. In column five, it can be seen that $\sigma_{\bar{\omega}}/\sigma_u$ in the economy with a high firing cost and a high replacement rate is similar to that of the baseline economy where both indicators are low. Again this result is in line with the data. Recall that the data exhibited positive correlation between firing costs and replacement rates in general. Together with the empirical result reported in Table 2, the implication is that one force offsets the other, making the net effect ambiguous. For example, the UK (firing cost and replacement rate both low) and Sweden (both variables high) have about the same real wages/unemployment standard deviation ratio: they are 0.107 in the UK and 0.095 in Sweden.

One shortcoming of my model is that the variation of σ_w/σ_u that my model can generate is not large enough to fully account for the actual variation. In the data, this is as low as 0.05 in the U.S. and as high as 0.3 in Italy - a significantly wider range than can be generated by the model. Recall, however, that labor market institutions could not explain all the variation in the data. What my model is mostly successful in replicating, therefore, is the empirical relation between labor market institutions and labor market cyclicalities, measured as σ_w/σ_u. Exploring additional sources to fully account for the cyclical behavior of labor markets remains an interesting issue for further research both theoretically and empirically.

It is worthwhile to note that other aspects of the labor market are affected differently depending on the nature of changes in labor market institutions (see the impact on σ_{jc}/σ_{jd}): there is a tendency that firms exploit the job creation margin to adjust their work forces when the firing cost rises. This is not the case when the replacement rate is lowered. As will be apparent in the next section, there are several channels that can affect the real wages/unemployment standard deviation ratio depending on the nature of changes in labor market institutions.

5 The background of the results

This section analyzes the mechanisms underlying the simulation results. The following points are important for understanding these mechanisms. First is the range of available labor market variables that firms are able to adjust flexibly. As will be clarified below, the form of obstacles in the labor market determines which specific channels firms prefer to employ to encounter shocks. These incentives affect the cyclical behavior of the labor market. Second, we need to consider the steady state values of the labor market variables. As emphasized in Thomas and Zanetti (2009), shifts in the steady state due to changes in labor market institutions have quantitative impacts on the impulse responses of endogenous variables.

5.1 the case of the firing cost

Figure 3 displays the impulse responses of labor market variables to a positive productivity shock for different degrees of the firing cost. The bottom center panel exhibits that a rise in the firing cost mitigates the decline in unemployment while the bottom right panel shows that the response of the real wage is almost invariant to the degree of the firing cost. We can conclude that, in a RBC setting, the response of $\sigma_{\bar{\omega}}/\sigma_u$ to changes in the firing cost is driven mainly by the change in unemployment volatility.[21]

The fluctuation of unemployment is best understood by examining the gross job flows in search and matching models. As the top center panel indicates, raising the firing cost impedes the responsiveness of the job destruction channel. Yet firms do not lose all channels to adjust labor quantity: they can still alter the rate of job creation. Firms therefore exploit the vacancy posting channel more vigorously. However, raising the number of vacancy postings has a negative congestion externality effect: when all firms increase vacancy postings simultaneously, surging labor market tightness causes the job-filling probability to plunge. Competitive firms

[21] In the New-Keynesian setting presented in section 6, I find that the real wage becomes more volatile.

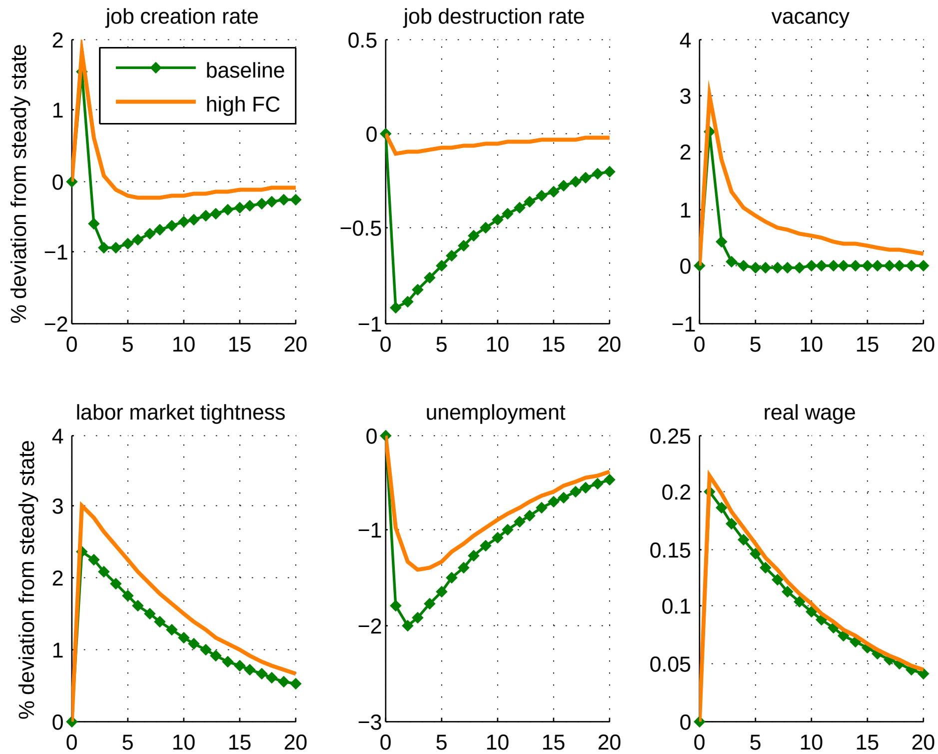

Figure 3: Labor market responses to a productivity shock for alternative firing costs

cannot internalize this effect. This is contrary to the case of the job destruction channel, in which one firm's decision does not affect the ease with which other firms can destroy jobs. As a consequence, the extra jobs created under the high firing cost are not sufficient to compensate for the lost flexibility to reduce the job destruction rate, resulting in a more muted response in unemployment than the baseline case.[22]

We can see the validity of the above argument by substituting the unemployment identity

[22]This mechanism is different from that employed in Abbritti and Weber (2010) which also deal with unemployment rigidities in the context of employment protection legislation. The difference arises from the way they calibrate their model: Abbritti and Weber shift multiple labor parameters simultaneously to impede both the job creation and job destruction channels. Moreover, they do not introduce firing costs explicitly in their model. The advantages of the method of this paper are that clarity regarding control parameters is guaranteed and firing costs are explicitly considered.

equation, $u_t = 1 - n_t$, into (8) and log-linearizing the resulting equation around the steady state:

$$\hat{u}_t = (1-\rho)(1-F(\bar{a}))\,\hat{u}_{t-1} - \tfrac{1-u}{u}\left[1-(1-\rho)(1-F(\bar{a}))\right]\left(\hat{v}_t - \mu\hat{\theta}_t\right) + \tfrac{1-u}{u}\tfrac{f(\bar{a})\bar{a}}{1-F(\bar{a})}\widehat{\bar{a}}_t. \quad (26)$$

In this formula, variables without time subscripts, such as u, denote steady state values while variables with hat, such as $\hat{u}_t$, denote log deviations from steady state. The second term on the right hand side denotes the outflow of workers from the pool of those unemployed. The outflow increases as v_t rises but this is counteracted by the simultaneous increase in θ_t.

A theoretically interesting, but quantitatively minor in the RBC setting, effect emerges in the fluctuation of the real wage: the response of the real wage in the high firing cost scenario is slightly more than in the baseline case. There is a firm theoretical background for this. When we log-linearize the real wage equation (17), we obtain the following:

$$\widehat{\bar{\omega}}_t = \frac{\eta}{\bar{\omega}}\left[\begin{array}{c} \frac{\varepsilon-1}{\varepsilon}AH\left(\hat{A}_t + \hat{H}_t\right) + \left(\gamma_v\beta\theta - \gamma_f\beta(1-\rho-\chi\theta^{1-\mu})\right)\hat{\Lambda}_{t+1,t} \\ +\left(\gamma_v\beta\theta + \gamma_f\beta\chi\theta^{1-\mu}(1-\mu)\right)\hat{\theta}_{t+1} \end{array}\right]. \quad (27)$$

We can see that the labor market tightness tomorrow, $\hat{\theta}_{t+1}$, is positively correlated with today's real wage. Therefore the slightly larger response of the real wage in the high firing cost scenario is consistent with increased labor market tightness exhibited in the bottom left panel of Figure 3.[23]

The labor market tightness enters into the real wage equations because it represents the opportunity cost of replacing current workers. Releasing current workers is costly because firms have to pay additional vacancy costs tomorrow to refill jobs. When the opportunity cost of releasing current workers is larger, firms are more willing to offer higher wages in exchange for the rights to keep workers. Its effective cost is measured in terms of the next period's labor market tightness, $\hat{\theta}_{t+1}$.

[23] The differences in the responses of $\hat{H}_t$ and $\hat{\Lambda}_{t+1,t}$ are negligibly small.

Though theoretically stimulating, the quantitative effect of this channel is small. This is because $\hat{\theta}_{t+1}$ is multiplied by the steady state labor market tightness, θ, which takes a smaller value in the high firing cost scenario. As firing becomes more costly, firms attempt to reduce their workforces so as to save on average the firing costs. This reduces the steady state labor market tightness and mitigates the impact of changes in the labor market tightness on the real wage.

5.2 the case of the replacement rate

Figure 4 displays the impulse responses of labor market variables to a positive productivity shock for different replacement rates. A striking feature of the responses is that all of the labor quantity variables exhibit smaller fluctuations in absolute terms when the replacement rate is lowered. This reduces the unemployment volatility relative to the baseline case.

I highlight the mechanism behind this phenomenon by following the argument of Hagedorn and Manovskii (2008). They claim that firms have more incentive to post vacancies in response to a change in productivity the more sensitive their profits are to that change. They further demonstrate that firms' profits are more responsive in percentage terms when the steady state profit is smaller and when real wages absorb a smaller part of the change in productivity. What happens in the low replacement rate scenario is exactly the opposite. The steady state profit is larger in this case because firms pay less wages.[24] Meanwhile, the real wage absorbs at least as large a portion of the increase in productivity as in the baseline case.[25] As a result, the firm has

[24]Remember the real wage is a linear function of the respective claim of the worker and the firm, where the firm's claim equals to unemployment benefit. Hence a reduction in unemployment benefit implies a reduction in the real wage.

[25]I saw a slightly larger response in the real wage in the low replacement rate scenario. This is so despite the smaller response seen in the labor market tightness. To restore the link between the labor market tightness response and the real wage response, we must focus on the increase in steady state labor market tightness in the low replacement rate scenario. This inflates the effect of given percentage changes in the labor market tightness on the real wage. In this calibration, this steady state effect dominates resulting in the slightly larger response in the real wage.

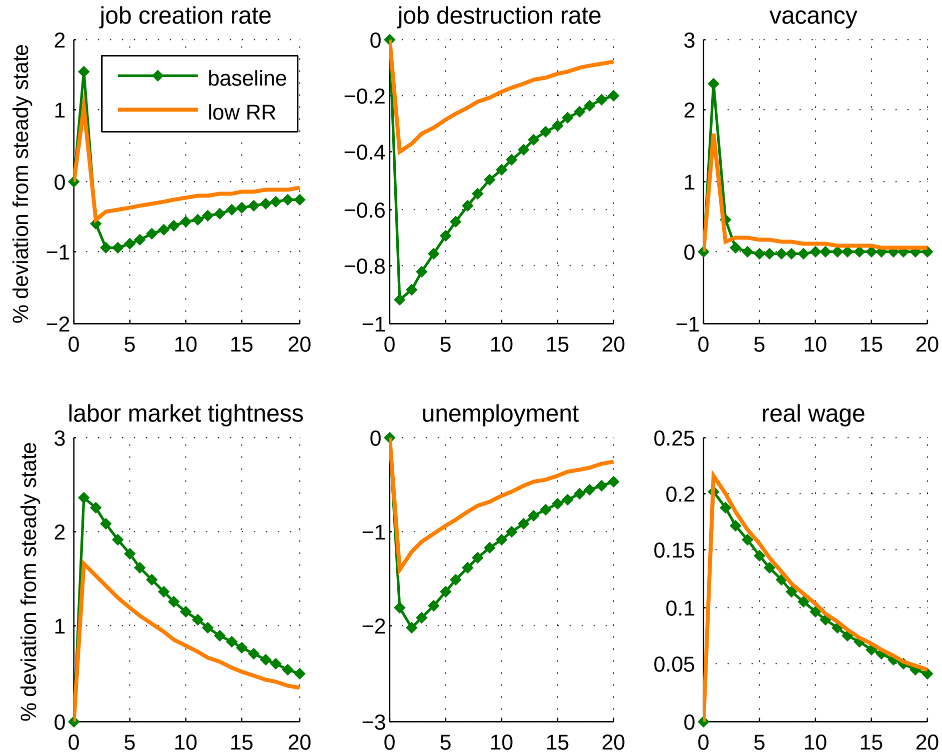

Figure 4: Labor market responses to a productivity shock for alternative replacement rates

less incentive to change vacancy postings in response to a productivity shock. This argument should also hold true for the firing incentive because hiring and firing are alternative means to adjust labor quantity.

6 Sensitivity analyses: introducing nominal rigidities

I now turn to check the robustness of the simulation results obtained in section 4. My particular interest is whether the results are robust to changes in the modeling of non-labor markets. Robustness would suggest that the labor market institutions focused on are independent elements that affect the cyclicality of labor markets. Otherwise, we must explore interaction mechanisms between the labor and non-labor markets. To this end, I introduce two additional features into the RBC-styled model: price stickiness and habit formation, both of which are commonly observed in modern macroeconomic models.

6.1 retailers, the central bank and the New-Keynesian Phillips curve

I begin by briefly describing the modifications to the model. I already introduced habit formation in section 3. I just need to recalibrate the model. As for price stickiness, I introduce a constant price resetting probability in the retail sector, as in Calvo (1983).[26] In each period, each retailer obtains the opportunity to reset her/his price with constant probability, κ. The demand schedule is the same as described in section 3. After solving the dynamic profit maximization problem of retailers and then aggregating, we obtain the usual New-Keynesian Phillips Curve:

$$\pi_t = \frac{(1-\beta\kappa)(1-\kappa)}{k}\hat{p}_{m,t} + \beta E_t(\pi_{t+1}), \tag{28}$$

where π is the inflation rate of the consumption goods.

Because the intermediate good is a whole input for retail goods production, the real marginal cost, which drives inflation in the New-Keynesian theory, is equal to the price of the intermediate good. By combining (11) and (12), we can link the real marginal cost to the labor market condition as follows:

$$p_{m,t} = \frac{1}{A_t H_t}\left[\bar{\omega}_t + \gamma_v\left\{\frac{1}{q(\theta_t)(1-F(\bar{a}_t))} - \frac{\beta(1-\rho)}{E_t(q(\theta_{t+1}))}\right\} + \gamma_f\frac{F(\bar{a}_t)}{1-F(\bar{a}_t)}\right]. \tag{29}$$

With a Walrasian labor market, the formula shrinks to $p_{m,t} = \frac{\bar{\omega}_t}{A_t H_t}$ with $\bar{\omega}_t$ equalized to the marginal product of labor. However, the presence of search and matching frictions introduces two additional components to the real marginal cost equation. The first is costs associated with

[26]Introducing price stickiness in the retail sector while assuming the presence of search and matching frictions in the intermediate good sector is a convenient way to avoid complications in the aggregation of firms' behavior. Trigari (2009) adopts the same strategy.

vacancy postings. To hire an additional worker, firms have to post $\frac{1}{q(\theta_t)(1-F(\bar{a}_t))}$ vacancies on average. However, if they succeed in hiring, then they can make a saving of $\frac{\beta(1-\rho)}{E_t(q(\theta_{t+1}))}$ on their vacancy posting costs tomorrow. The net cost is passed through to retail prices. The second extra component is the expected firing cost that attends the hiring of an additional worker. This cost is realized when firms dismiss matched but unproductive workers. Note further that the real wage, $\bar{\omega}$, is no longer the marginal product of labor as is evident from (17). These forces together potentially change the inflation dynamics.

To close the model, I introduce a central bank that controls the short term nominal interest rate, r, as a tool of monetary policy. In the log-linearized form, the policy rule is described as a type of Taylor-rule reaction function augmented with interest rate smoothing:

$$\hat{r}_t = (1-\rho_m)\,\hat{r}_{t-1} + \rho_m\left(\varphi_\pi \pi_t + \varphi_y \hat{Y}_t\right) + \varepsilon_{m,t}. \tag{30}$$

$(1-\rho_m)$ measures the degree of interest rate smoothing. φ_π and φ_y measure degrees of responsiveness to inflation and aggregate output, respectively. Finally, there is a random policy shock, $\varepsilon_{m,t}$, which is normally distributed $N(0,\sigma_m)$.

6.2 results

Before checking the performance of this New-Keynesian-style model, I briefly describe the setting of the parameters. To begin with, I introduce only price stickiness (the left side of Table 5), where the chance of resetting prices is set to 0.2. This is in line with most of the New-Keynesian literature. I set the interest rate inertia, $1-\rho_m$, to be 0.85 and the responsiveness to output and inflation, φ_y and φ_π, to be 0.1 and 2.0 respectively.[27] I also recalibrate the standard deviations of the productivity shock and the monetary shock to match the output volatility ob-

[27]Recent studies that estimate DSGE models with search and matching frictions find similar magnitudes for Taylor rule coefficients in the U.S. See, for example, Gertler, Sala and Trigari (2008).

	sticky price, $\kappa = 0.2$			sticky price + habit formation, $\kappa = 0.2$ $\varsigma = 0.55$		
	Baseline	$\gamma_f = 0.09$	$b/\bar{\omega} = 0.84$	Baseline	$\gamma_f = 0.09$	$b/\bar{\omega} = 0.84$
$\sigma_{\bar{\omega}}/\sigma_u$	0.083	0.115	0.126	0.089	0.121	0.139
		(35%)	(53%)		(37%)	(57%)
σ_{jc}/σ_{jd}	1.79	15.4	2.81	1.55	13.46	2.53
		(756%)	(56%)		(767%)	(63%)
σ_π/σ_y	0.149	0.150	0.183	0.167	0.169	0.207
		(1%)	(22%)		(1%)	(24%)

Table 5: Cyclical properties of the labor market and inflation under alternative parameters

served in the U.S. This leads to $\sigma_A = 0.0032$ and $\sigma_m = 0.0010$. Finally, on the right side of Table 5, I introduce habit formation, $\varsigma = 0.55$, on top of price stickiness. The value is taken from Trigari (2009) in which she synthesizes the search and matching frictions in labor markets with the New-Keynesian framework. Other parameters remain constant.

I find that the findings in section 4 are robust to changes in the non-labor market parameters: the baseline values in both the price stickiness only and price stickiness plus habit formation cases are almost invariant from those in the baseline case of the RBC-styled model (See the column two of Table 4). Moreover, shifts in labor market institution variables within each of the alternative models exert similar impacts on $\sigma_{\bar{\omega}}/\sigma_u$. This implies that the firing cost and the replacement rate are likely to be independent factors that affect the cyclical behavior of labor markets.

The effect of labor market institutions on the inflation-output trade-off, represented by σ_π/σ_y, is more muted than that on the labor market. Raising the firing cost has no impact on the inflation-output trade-off. The effect of the change in the replacement rate is somewhat more marked. However, the overall impact is smaller than that on $\sigma_{\bar{\omega}}/\sigma_u$.

By this result, we can conclude that the labor market institutions that I consider in this paper have only a limited impacts on the inflation dynamics. This is consistent with recent theoretical studies, such as Thomas and Zanetti (2009). The result of this paper is also consistent with recent empirical studies, such as Ravenna and Walsh (2008) and Krause, Lopez-Salido and Rubik (2008), in which they find that search and matching frictions are too stylized to fully account for inflation dynamics.

7 Conclusion

This paper has examined whether the relevance of labor market institutions in search and matching models is consistent with evidence on business cycle properties from cross-country data. I first find that the strictness of employment protection and the replacement income of unemployed workers are variables empirically influential on labor market cyclicalities. I then confirm that the predictions of modern macroeconomic models with search and matching frictions in labor markets are consistent with this empirical regularity. I also find that the theoretical predictions are robust to some orthodox changes in the modeling of non-labor market structures. From these findings, I conclude that search and matching frictions in labor markets have certain validity to explain the cyclical behavior of labor markets across countries. Yet the framework is not powerful enough to fully account for all the observed differences in labor market cyclicalities quantitatively. Thus we need to explore further sources of fluctuations in order to strengthen the usefulness of models with search and matching frictions in labor markets. My analysis suggests that exploring other labor market structures would be a promising avenue for future research to better explain labor market fluctuations.

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