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by Dennis Wesselbaum

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Kiel Institute for the World Economy, Düsternbrooker Weg 120, 24105 Kiel, Germany

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E-mail:
dennis.wesselbaum@ifw-kiel.de

The Intensive Margin Puzzle and Labor Market Adjustment Costs*

Dennis Wesselbaum†

Kiel Institute for the World Economy and EABCN

May 25, 2011

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This paper documents a puzzling fact, namely that there is a significant negative relation between employment protection legislation and the usage of the intensive margin of labor market adjustments. We then make use of a Real Business Cycle model and introduce search and matching frictions as well as adjustment costs along the extensive and the intensive labor market margins. We show that the model is able to replicate the observed pattern, if we assume low firing costs and relatively large hours adjustment costs. Furthermore, the model requires those values to replicate the U.S. business cycle statistics.

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†Kiel Institute for the World Economy, Hindenburgufer 66, 24114 Kiel, Germany. Tel: +49-431-8814-233. Email: dennis.wesselbaum@ifw-kiel.de.

1 Introduction

The seminal contribution from Hansen (1985) establishes the so called indivisibility of labor. In his model, all fluctuations in hours worked are caused by variations in the number of employed, i.e. the extensive margin. This approach contradicts the previous viewpoint that assumes that indivduals are free to adjust continously the number of hours worked, as for instance in Kydland and Prescott (1982). Hansen (1985) justifies this change in paradigm by using a variance decomposition that shows that 55 % of the variance in total hours can be explained by changes in the number of employed and only 20 % are xplained by changes in the number of hours worked (while the missing percents are due to the covariance term).

In a more recent study (Merkl and Wesselbaum (2011)), we provide evidence that the extensive labor adjustment margin is significantly more important than the intensive margin. This holds for a comparsion of the labor markets in the United States and Germany. More precisely, we find that at least 80 % of the variation in total hours in both countries can be explained by changes along the extensive margin. This result is to some extend surprising as we choosed two countries with very different labor markets. The very flexible U.S. labor market and the more rigid German one. One might expect that due to stronger restrictions along the extensive margin German firms would prefer to adjust along the intensive margin, however, this finding is to some extend rejected. The reason might be that there are also restrictions for the adjustment of hours worked such as legal restrictions, overtime pay, or union agreements.

In this paper, we provide further evidence that the extensive margin is the predominantly used adjustment margin using a cross-country sample containing nine countries. First, we show that the extensive margin is the predominantly used margin for adjustment on the labor market which confirms our earlier finding. Second, we find that in our sample there is a significant negative relation between employment protection legislation (EPL, for short) and the intensive margin. This finding is to some extend surprising, as one would expect that countries with higher hiring and firing costs - the basic driving forces of the EPL - should have a smaller adjustments along the extensive margin.

We continue by providing a model that can explain this stylized fact. For this purpose, we take a standard Real Business Cycle (RBC, for short) model and introduce search and matching frictions in order to generate equilibrium unemployment. The search and matching model is the usual approach to model unemployment in modern macroeconomic research. Furthermore, we add hours and hours adjustment costs to this framework, so to give firms the option to adjust in the number of hours worked. Finally, we add firing costs to this model, because we need a parameter that captures changes in EPL.

Our model allows us to draw several conclusions. First, the model with hours adjustment costs leads hours to increase after a favorable technology shock, as it is the baseline result in the RBC literature. However, a non-regulated intensive margin leads hours to decline after a favorable technology shock. Therefore, the model adds to the discussion originated by Galí (1999). Galí shows that hours fall after a positive technology shock, implying that the RBC model is not able to explain this finding which would contradict the RBC paradigm that technology shocks are the main driving force of business cycles. In our specifications, this result is explained by the existence of labor market imperfections and hours adjustment costs. Second, we show that the size of hours adjustment costs has substantial effects on the volatility of the economy. Third, the model is able to replicate the empirical findings discussed above, but requires a quite high value of hours adjustment costs and a low value of firing costs.

The paper proceeds as follows. In the next section, we perform a cross-country analysis for the importance of the extensive versus the intensive margin over the business cycle. Section 3 derives the model while section 4 discusses our findings. Section 5 briefly concludes.

2 Empirical Analysis

For our empirical analysis we use a data set containing nine countries.[1] Time series for employment and hours per worker are obtained from the Eurostat database with two exceptions. First, time series for Germany are obtained from the *German Federal Statistical Office*. Second, time series for the United States are obtained from the *Bureau of Labor Statistics*. All time series are seasonally adjusted and are on a quarterly basis, covering the period from 1998:Q1 to 2010:Q1. Time series are written in logarithmic scale and are detrended using a Hodrick-Prescott filter with $\lambda = 10^5$. Then, we decompose total hours, T, into two parts, hours per worker, H , and number of workers, N ($T = HN$). By log-linearization, we obtain

$$\hat{t} = \hat{h} + \hat{n}. \tag{1}$$

This linear decomposition makes it possible to quantitatively assess the aggregate hours variability in terms of the separate contributions of the two margins. The variance of the total hours can be

[1] Those nine countries are Czech Republic, Finland, Germany, Greece, Italy, Portugal, Slovak Republic, Spain, and the United States.

written as

$$
\begin{aligned}
var(\hat{t}) &= var(\hat{h}) + var(\hat{n}) + 2cov(\hat{h}, \hat{n}), && (2)\\
&= cov(\hat{t}, \hat{h}) + cov(\hat{t}, \hat{n}), && (3)
\end{aligned}
$$

since the covariance term gives the variability explained by variations in the respective margin, both directly and through its correlations. While Hansen (1985) calculates the variation of hours per workers and employment divided by total hours, we follow Fujita and Ramey (2009) and make use of the covariance terms in equation (3). Thus, the proportion of the intensive margin of total variation is given by

$$
\vartheta^{INT} = \frac{cov(\hat{t}, \hat{h})}{var(\hat{t})}. \qquad (4)
$$

Analogously, the proportion of the extensive margin of total variation is given by

$$
\vartheta^{EXT} = \frac{cov(\hat{t}, \hat{n})}{var(\hat{t})}. \qquad (5)
$$

Our results are presented in Figure 1 and Table 1.

Table 1: Extensive vs. Intensive Margin.

Country	Extensive	Intensive
Czech Republic	0.35	0.65
Finland	0.76	0.24
Germany	0.66	0.34
Greece	0.67	0.33
Italy	0.63	0.37
Portugal	0.90	0.10
Slovak Republic	0.31	0.69
Spain	0.88	0.12
USA	0.79	0.21

We find that seven out of nine countries show a larger proportional extensive margin of total variation. The only two exceptions are Czech Republic and Slovak Republic. In contrast to our earlier findings presented in Merkl and Wesselbaum (2011), we now find a stronger intensive margin, which is due to the fact that we use a data set that covers the recent recession. Therefore, e.g. the short-time program in Germany let to a larger adjustment along the intensive margin. However, the extensive margin is still much more important as the intensive margin. Furthermore, a linear regression gives a statistically significant relation between the strictness of EPL and the importance

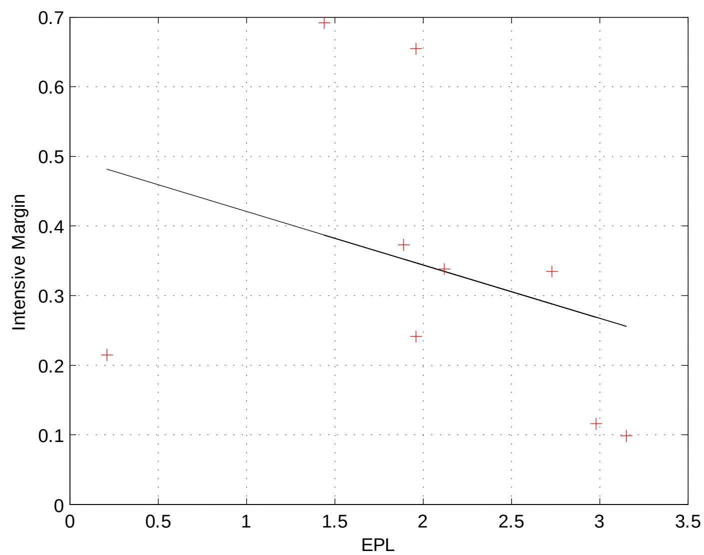

Figure 1: Intensive margin regressed on EPL. Linear regression: $R^2 = 0.10$, quadratic regression: $R^2 = 0.58$.

of the extensive margin, intensive margin respectively. In addition, we find evidence for large non-linear effects in the data set.

3 Model Derivation

The description of our model economy proceeds in three steps. First, we define the economy's preferences and technology and we then present the model's assumed market structure. Finally, we conclude with the definition of an equilibrium.

3.1 Preferences and Technology

We now present a general equilibrium model with flexible prices, labor market frictions and two labor adjustment margins. Our economy inhibits two different agents; households and firms. The labor market is imperfect due to the assumption of search and matching frictions following Mortensen and Pissarides (1994). Firms can adjust either along the extensive margin, i.e. changing the number of employees, or along the intensive margin, i.e. changing the number of hours worked. Both margins are characterized by adjustment costs.

3.1.1 Households

We assume that our economy is populated by a continuum of infinitively-lived identical households. Households equally share income and risk among all family members as in Merz (1995). The households preferences are given by the following utility function

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \int_0^1 N_t \frac{H_t^{1+\vartheta}}{1+\vartheta} di \right], \tag{6}$$

where $\beta \in (0, 1)$ is the discount factor, C_t is consumption represented by the standard Dixit-Stiglitz CES aggregate of differentiated goods. The number of household members employed is denoted by N_t and H_t denotes the corresponding number of hours. The intertemporal elasticity of substitution is given by $\sigma > 0$ and $\vartheta > 0$ denotes the Frisch labor supply elasticity.

3.1.2 Firms

Our economy is populated by a continuum of identical firms. They use labor services to produce differentiated goods according to the production function

$$Y_t = Z_t H_t N_t \int_{\tilde{a}_t} a \frac{f(a)}{1 - F(\tilde{a}_t)} da \equiv Z_t H_t N_t P(\tilde{a}_t), \tag{7}$$

where Z_t is a Hicks-neutral aggregate technology shock following a first-order autoregressive process

$$\ln Z_t = \rho_Z \ln Z_{t-1} + e_{Z,t}, \tag{8}$$

where $0 < \rho_Z < 1$ is the autocorrelation term and its innovation is i.i.d. over time and normally distributed

$$e_{Z,t} \sim N(0, \sigma_Z).$$

Labor services are driven by the number of employes, N_t, the worker's idiosyncratic productivity, a_t, and hours worked, H_t. The idiosyncratic productivity is drawn in advance of the production process in every period from a time-invariant distribution with c.d.f. $F(a)$ and positive support $f(a)$. Its mean is given by μ_{LN} and the variance is determined by σ_{LN}. Furthermore, $\tilde{a}_t$ is an endogenously determined cut-off point below which separation takes place.

3.2 Market Structure

While the good market is perfectly competitive, the labor market is imperfect due to the assumption of search and matching frictions. Trade in the labor market is uncoordinated, costly and time-consuming. Search takes place on a discrete and closed market. Workers can be either employed or unemployed, such that there is no out of labor force option. Similarly, each firm has one job that is either filled, or vacant. If the job is filled, it is subject to the probability of being either exogenously destructed, $\rho^x > 0$, or being endogenously destructed, $\rho_t^n = F(\tilde{a}_t)$. Then, total separations are given by

$$\rho_t = \rho^x + (1 - \rho^x)F(\tilde{a}_t). \tag{9}$$

In addition, firms create jobs at the rate $M(U_t, V_t)$ at the non-state-contingent cost of $c > 0$ units of output per vacancy, where M is the homogeneous-of-degree-one-matching-function,

$$M(u_t, v_t) = mU_t^{\mu}V_t^{1-\mu}, \tag{10}$$

where $m > 0$ gives the match efficiency, $\mu > 0$ is the elasticity of the matching function with respect to unemployment and V_t is the vacancy rate. The vacancy-to-unemployment ratio, $\theta_t = V_t/U_t$, reflects labor market tightness. Then, the vacancy filling probability is $q(\theta_t) = M(U_t, V_t)/V_t$. Combining entry and exit definitions yields the evolution of employment

$$N_t = (1 - \rho_t)(N_{t-1} + M_{t-1}). \tag{11}$$

Similarly, the evolution of aggregate unemployment can be written as

$$U_t = 1 - N_t. \tag{12}$$

Finally, households own all shares in the firm and receive any of their profits as dividends each quarter.

3.3 Optimization and Equilibrium

Optimization of all agents defines the equilibrium. We start with the households utility maximization problem and continue with the firms profit maximization problem. Then, we solve the bargaining problem between firm and worker and determine the optimal combination of wage and hours. We conclude with a definition of the equilibrium.

3.3.1 Households

We assume that the economy begins with all households having identical financial wealth and consumption histories. This assumption assures that together with the optimal use of the available contingent claims markets, this homogeneity will continue. Moreover, this allows us to only consider the consumption and savings decisions of a representative household. The representative household faces the following budget constraint

$$C_t + T_t = W_tN_tH_t + bu_t + \Pi_t, \tag{13}$$

where benefits b are financed by lump-sum taxes, T_t. Dividends are denoted by Π_t and W_t is the hourly real wage. Then, the household maximizes (6) subject to (13), which gives the standard first order condition

$$C_t^{-\sigma} = \lambda_t, \tag{14}$$

where λ_t is the multiplier on the budget constraint.

As in Lubik (2009), in this model environment, we do not obtain a first-order condition for labor supply, as the labor market outcome is determined by the search process.

3.3.2 Firms

The representative firm in our economy solves its profit maximization problem by choosing the optimal path for $\{N_t, V_t\}_{t=0}^{\infty}$ by maximizing

$$E_t \sum_{t=0}^{\infty} \beta^t \lambda_t \left[Y_t - W_t H_t N_t - cV_t - G(\tilde{a}_t) - \frac{\alpha}{2} \left(\frac{H_t}{H} \right)^2 N_t \right], \tag{15}$$

subject to the evolution of employment (11) and the production function (7). The first term in parenthesis gives real revenue depleted by total wage costs, vacancy posting costs, total firing costs, and hours adjustment costs. $G(\tilde{a}_t)$ gives the total amount of firing costs, which is the integral over those workers idiosyncratic productivities falling below the threshold. For a worker with the idiosyncratic producitivity a_{it}, the firm has to pay

$$g(a_t) = ka_{it}, \tag{16}$$

as purely wasted firing costs. Here, $k > 0$ denotes the share of idiosyncratic productivity paid as a firing tax. We choose this specification for the lay-off function because we want to reproduce the findings from Dolado et al. (2005), namely that employment protection varies within a country. Reasons for those differences within a country amongst others are educational level, firm size, skill and tenure. Those factors are idiosyncratic and hence we need a variable that captures those idiosyncratic characteristics. For this reason, we relate lay-off costs directly to the workers productivity, as the wage will also depend on macroeconomic variables.[2]

To incorporate hours adjustment costs into our model, we assume that the firm has to pay a cost if hours deviate from its steady state value (which is calibrated to be eight hours per day). Furthermore, we assume that the adjustment costs are quadratic in the deviation, such that larger deviations are associated with larger costs.

[2] Here, we assume that lay-off costs are linear in idiosyncratic productivity. This assumption is supported by the finding from Abowd and Kramarz (2003) showing that in France separation costs are mildly concave in the number of exits.

Finally, the first-order conditions are

$$\begin{aligned}\partial N_t : \tau_t &= \frac{Y_t}{N_t} - W_t H_t + (1-\rho_t) E_t \beta_{t+1} \tau_{t+1} - \frac{\alpha}{2}\left(\frac{H_t}{H}\right)^2, &(17)\\ \partial V_t : c &= (1-\rho_t) q(\theta_t) E_t \beta_{t+1} \tau_{t+1}, &(18)\end{aligned}$$

$\beta_{t+1} = \beta \frac{\lambda_{t+1}}{\lambda_t}$ is the stochastic discount factor and τ_t is the multiplier on the evolution of employment. Using these two equations yields the job creation condition

$$\frac{c}{q(\theta_t)} = (1-\rho_t) E_t \beta_{t+1} \left[\frac{Y_{t+1}}{N_{t+1}} - W_{t+1} H_{t+1} - \frac{\alpha}{2}\left(\frac{H_{t+1}}{H}\right)^2 + \frac{c}{q(\theta_{t+1})}\right].$$

The left-hand side of this equation gives the hiring costs which equal the benefits of creating a new job. The latter depends on the marginal product of labor depleted by the wage and increased by saved hiring costs in the next period in case of non-separation.

3.3.3 Wage and Hours Bargaining

If a firm and a worker have matched, the job shares an economic rent which is splitted in individual Nash bargaining by maximizing the Nash product

$$W_t = \underset{\{W_t\}}{\arg\max} \left[\left(\mathcal{S}_t^H\right)^{\eta} \left(\mathcal{S}_t^F + k a_t\right)^{1-\eta}\right], \tag{19}$$

where $\mathcal{S}_t^H$ is the household's surplus, $\mathcal{S}_t^F$ is the firm's surplus and $\eta \in (0,1)$ is the worker's relative bargaining power. $\mathcal{S}_t^H$, in terms of a Bellmann equation, is given by - in terms of the consumption good -

$$\mathcal{S}_t^H = W_t H_t - b - \frac{1}{\lambda_t} \frac{H_t^{1+\vartheta}}{1+\vartheta} + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \left((1-\rho_{t+1}) - \theta_{t+1} q(\theta_{t+1})\right) \mathcal{S}_{t+1}^H. \tag{20}$$

The surplus is the gap between the income and the outside option depleted by the disutility of working and increased by the future conditional value of working.

Similarly, firm's surplus, $\mathcal{S}_t^F$, is

$$\mathcal{S}_t^F = \mathcal{A}_t H_t \tilde{a}_t - W_t H_t - \frac{\alpha}{2}\left(\frac{H_t}{H}\right)^2 + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \left[(1-\rho_{t+1}) \mathcal{S}_{t+1}^F - \rho_{t+1} k \tilde{a}_t\right]. \tag{21}$$

The firm's surplus is driven by the output generated by the worker reduced by her wage and the hours adjustment costs. In case of non-separation, the worker will yield a surplus in the next period, but if she is laid-off, the firm has to pay a firing cost.

It can be shown that the individual real wage satisfies the optimality condition

$$\mathcal{S}_t^H = \frac{\eta}{1-\eta} \left(\mathcal{S}_t^F + k a_t\right). \tag{22}$$

To obtain an explicit expression for the individual real wage, we substitute the surplus expressions into the Nash bargaining solution, eq. (22). Inserting these value functions into the Nash bargaining solution yields the hourly real wage

$$W_t = \frac{(1-\eta)\left(b + \frac{1}{\lambda_t}\frac{H_t^{1+\vartheta}}{1+\vartheta}\right) + \eta A_t H_t \tilde{a}_t - \frac{\alpha}{2}\eta\left(\frac{H_t}{H}\right)^2 + \eta c\theta_t - \left(\beta E_t \frac{\lambda_{t+1}}{\lambda_t}\eta\rho_{t+1} - \eta\right) k\tilde{a}_t}{H_t}.$$

Simultaneously, hours are set by maximizing the joint surplus, $\mathcal{S}_t = \mathcal{S}_t^H + \mathcal{S}_t^F$, implying that

$$\frac{\partial \mathcal{S}_t}{\partial H_t} : W_t - \frac{1}{\lambda_t} H_t^{\vartheta} + A_t \tilde{a}_t - \eta\alpha \frac{H_t}{H^2} - w_t = 0, \tag{23}$$

has to hold. Simplifying,

$$H_t^{\vartheta} + \eta\alpha \frac{\lambda_t H_t}{H^2} = \lambda_t A_t \tilde{a}_t. \tag{24}$$

Finally, the cut-off point can be found by letting

$$\mathcal{S}_t^F < -k\tilde{a}_t, \tag{25}$$

which gives

$$\tilde{a}_t = \frac{(1-\eta)\left[b + \frac{1}{\lambda_t}\frac{H_t^{1+\vartheta}}{1+\vartheta}\right] + \eta c\theta_t - \frac{\alpha}{2}\eta\left(\frac{H_t}{H}\right)^2 - \frac{c}{q(\theta_t)}}{(1-\eta)A_t H_t + \left[1 - \eta - (1-\eta)\beta E_t \frac{\lambda_{t+1}}{\lambda_t}\rho_{t+1}\right] k}. \tag{26}$$

Here, we find that the introduction of lay-off costs shifts the cut-off point to the left, compared with the laissez-faire economy. Therefore, the firm is more reluctant to separate from a worker.

3.3.4 Equilibrium

The resource constraint of our economy is given by

$$Y_t = C_t + cV_t + G(\tilde{a}_t) + \frac{\alpha}{2}\left(\frac{H_t}{H}\right)^2 N_t. \tag{27}$$

Then, for the given stochastic process $\{Z_t\}_{t=0}^{\infty}$, a determined equilibrium is a state-contingent sequence of $\{C_t, M_t, U_t, V_t, N_t, \theta_t, Y_t, W_t, H_t, \tilde{a}_t, \rho_t, \lambda_t\}_{t=0}^{\infty}$. Finally, the set of equations forming the equilibrium is linearized around the non-stochastic steady-state.

The calibration of the model is on a quarterly basis for the United States and parameter values are set according to stylized facts and the relevant literature.

Risk aversion, σ, is set to the value 1 and the discount factor, β, is 0.99. The mark-up on real marginal costs is set to 10 % as in Krause and Lubik (2007), which leads ε to be 11. The disutility of work, ϑ, is set to 1.9 based on the estimations from Leeper et al. (2010). Hours in steady state are calibrated to be 1/3. The elasticity of the matching function with respect to unemployment,

μ, is set to 0.5 while the match efficiency, m, is calibrated to be 0.4. Separations in steady state, ρ, are set to 0.15 and the share of exogenous separations, ρ^x, is calibrated to be 0.068. This implies that endogenous separations are given by $\rho^n = \frac{\rho-\rho^x}{1-\rho^x}$. The steady state cut-off point can then be found by computing $\tilde{a} = F^{-1}(\rho^n)$. Parameters characterizing the c.d.f $F(a)$ are taken from Krause and Lubik (2007) and are set to $\mu_{LN} = 0$, and $\sigma_{LN} = 0.12$. The employment rate, n, is 0.95, such that we have an unemployment rate of 5 percent, which corresponds roughly to the long-term unemployment rate in the United States. The job finding rate, q, is taken from den Haan et al (2000) and is set to 0.7. Matches in steady state, M, is given by $M = \frac{\rho}{1-\rho}n$. Then, vacancies can be found by using $v = M/q$. Furthermore, we assume symmetric bargaining and set $\eta = 0.5$. Following the discussion in Brown et al. (2009), we set $k = 0.1$, i.e. 10 % of the worker's productivity is paid as a firing tax. Finally, the shock is autocorrelated with $\rho_A = 0.9$. The hours adjustment cost parameter, α, is subject to a robustness check. We will increase this parameter from the baseline calibration of $\alpha = 0$, so to understand the effects of higher regulation of the intensive margin. Finally, missing parameter values are computed from the steady state.

4 Discussion

In this section, we hit our model economy with a one percent favorable, stationary technology shock. The response of our economy for different calibrations of hours adjustment costs is presented in Figure 2.

The positive technology shock increases total output in our economy such that it converges from above to the old steady state.[3] Firms react to the increased output by decreasing the separation rate, i.e. they protect even less productive workers, as the value of a worker increases. On the other hand, vacancies decrease as the expected profit from posting a vacancy decreases - which is mainly driven by a higher wage bill and lower re-hiring costs. However, as the drop in the separation rate dominates the drop in vacancy posting, unemployment falls therefore breaking the Beveridge curve relationship.

The adjustment process in the labor market is driven by changes in the separation margin. Firms prefer to adjust along this margin, because changes are directly effective as opposed to the hiring margin. Furthermore, workers also negotiate higher wages, as they claim a share of the increased productivity, and a lower individual supply of hours. Overall, total hours decrease, as the drop in individual hours is stronger than the increase in employment. As the shock dies out,

[3] Note, that the persistence in the model is to a large extend driven by the autocorrelated shock. The model itself has only a very weak propagation mechanism.

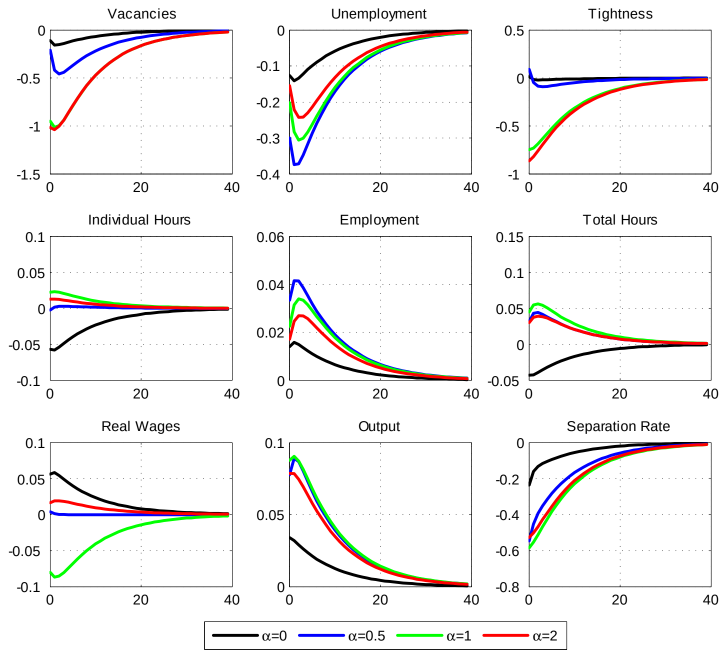

Figure 2: Notes: Impulse responses for different degrees of hours adjustment costs. Horizontal axes measure quarters, vertical axes deviations from steady state.

the model converges back to its old steady state.

Let us now assume that we increase the hours adjustment cost parameter, α. What we have seen so far is that the firm increases the number of workers as to extract the surpluses created by the technology shock. On the flipside, the firm significantly decreases the number of individual hours and hence subsitutes between those two margins, so as to ensure the optimal input factor mix. If we increase hours adjustment costs starting from zero, we infer that firms reduce separations and vacancy posting activities. Firms shifts the adjustment process more towards the extensive margin, as firing costs remain unchanged. Therefore, the substitution effect generated by hours adjustment costs works in favor of adjusting along the extensive margin. Here, firms reduce firing as they know that they can not adjust individual hours freely.

One particularly interesting finding is that hours (individual and total) increase with higher hours adjustment costs. Galí (1999) uses a structural VAR model that is identified by the assumption that long-run changes in labor productivity are only driven by technology shocks.[4] Using this econometric approach, Galí reports that hours fall after a positive technology shock, which

[4] Christiano et al. (2003) show that Galí's findings are not robust to expressing the VAR in levels as opposed to first-differences.

is in contrast to the prediction of the standard RBC model. This finding is often used to justify that the technology driven RBC model is not in line with empirical evidence. However, we offer an alternative explanation to econometric reasons. We find that a RBC model with labor market imperfections and a non-regulated intensive margin can explain the fall in hours after a positive technology shock. With this finding, all econometric reasoning aside, we can justify that the RBC model is in fact in line with the empirical evidence.

Table 3 presents the business cycle statistics for different values of the hours adjustment costs.

Table 2: Business Cycle Statistics for different Firing Costs.

	$std(U)$	$std(V)$	$std(\theta)$	$std(H)$	$std(T)$	$corr(U,V)$	$corr(H,N)$	$corr(H,Y)$
Data U.S.	7.71	9.36	16.76	0.30	1.10	-0.93	0.53	0.72
$k=0$								
$\alpha=0$	5.10	5.69	0.65	2.27	1.71	0.99	-0.99	-1
$\alpha=0.5$	4.84	4.88	0.73	0.04	0.51	0.99	-0.77	-0.80
$\alpha=1$	3.91	12.88	9.02	0.29	0.72	0.99	0.99	0.99
$k=0.1$								
$\alpha=0$	4.55	5.03	0.68	1.83	1.34	0.99	-0.99	-0.99
$\alpha=0.5$	4.27	5.17	1.11	0.04	0.50	0.99	0.82	0.80
$\alpha=1$	3.55	11.41	7.90	0.26	0.65	0.99	0.99	1
$k=0.5$								
$\alpha=0$	3.02	3.44	0.89	0.80	0.47	0.97	-0.99	-0.96
$\alpha=0.5$	3.12	5.56	2.72	0.17	0.52	0.96	0.97	0.98
$\alpha=1$	2.77	7.51	4.75	0.17	0.47	0.99	0.99	0.99

Table 3: Theoretical Moments relative to output. Data values for the U.S. are taken from Krause and Lubik (2010).

We do find that higher firing costs decrease the volatility of key labor market variables. The laissez-faire version of our model (in which both margins are not regulated) creates too less volatility compared with the U.S. labor market data taken from Krause and Lubik (2010). In particular, we observe that the standard deviations of unemployment and vacancies, being 5.10, 5.69 respectively, are not in line with the empirical values of 7.71, 9.36 respectively. Similarly, we find that higher hours adjustment costs decrease the volatility of unemployment but increase the volatility of vacancy posting. This finding is driven by the substitution effect and its implications for the vacancy posting incentive structure. Stronger regulation along the intensive margin force the firm to adjust more strongly along the extensive margin, which increases the volatility over the cycle.

Along this line, we find that the model needs a large value of hours adjustment costs to replicate the patterns of cyclicality observed in U.S. data.

Finally, we can also draw the conclusion that the behavior of volatility is u-shaped in the hours adjustment costs. Furthermore, the fact that a high parameter for hours adjustment costs together with a low firing cost parameter, explains the empirically observed standard deviations fairly well, indicates that regulated adjustment margins are important to replicate labor market dynamics.

Furthermore, the ability of the model to fit the stylized facts of volatility and cyclicality is only one dimension to judge the model's performance. The model is also able to explain our empirical finding that higher employment protection implies more adjustment along the extensive margin, i.e. less usage of the intensive margin. For this purpose, we simulate the model for different values of the firing cost parameter, k, holding all other parameters fixed. We repeat this example for four values of the hours adjustment costs, $\alpha \in [0, 0.5, 1, 2]$. Our results are presented in Table 5.

Table 4: Intensive margin for different firing cost values.

k	0	0.1	0.5	1
$\alpha = 0$	1.32	1.37	1.67	ID
$\alpha = 0.5$	-0.07	0.06	0.32	ID
$\alpha = 1$	0.41	0.40	0.35	0.25
$\alpha = 2$	0.34	0.32	0.23	0.14

Table 5: Notes: Theoretical Moments for ϑ^{INT}. ID = Indeterminacy.

We find that only a value of α larger as 0.5 is able to replicate the finding that higher employment protection goes along with a higher share of the extensive margin of total hours variation. In addition, the model replicates realistic values for the extensive-intensive margin split observed in the data.

We can draw the conclusion that the model needs a relatively large value of hours adjustment costs - larger than 0.5 - to replicate the empirically observed values related to volatility, cyclicality, and the extensive-intensive margin.

5 Final Remarks

This paper presents evidence that the extensive margin is the predominantly used adjustment margin using a cross-country sample containing nine countries. We find that most countries show a stronger usage of the extensive margin over the business cycle, therefore confirming the results from an earlier paper by Merkl and Wesselbaum (2011). More importantly - and more surprisingly - we show that there is a negative relation between employment protection and the usage of the intensive margin over the business cycle. This finding is counterintuitive, as one would expect that countries with a stronger employment protection legislation should have a more important intensive margin, as adjustments along the extensive margin are more costly.

Furthermore, we develop a model that replicates this pattern. We make use of a standard RBC model and introduce search and matching frictions, as well as an intensive margin for labor adjustments. In addition, we add hours adjustment and firing costs to this framework, so to make adjustments along those margins costly for the firm. We obtain several results from our simulations. First, we find that our model requires a high value of hours adjustment costs and a low value of firing costs in order to replicate the observed volatility and cyclicality of the U.S. labor market. However, the model is not able to replicate the Beveridge curve relationship, as the substitution effect between the two margins triggered by the adjustment costs leads vacancies to decrease.

Second, the model adds to the discussion originated by Galí (1999), showing that hours fall after a positive technology shock. Our model explains this fact by the existence of labor market imperfections and hours adjustment costs, that create a substitution effect between the two margins.

Third, we replicate the puzzling observation that countries with a stronger employment protection legislation make less use of the intensive margin. In order to replicate this stylized fact, we need a high value of the hours adjustment costs such that adjustments along the intensive margin are already expensive for the firm. Then, given high hours adjustment costs, the increase in firing costs closes the wedge between the adjustment costs of the two margins and therefore creates incentives for the firm to adjust along the extensive margin. Put differently, higher firing costs work against the substitution effect triggered by higher hours adjustment costs and drives the firm back to its laissez-faire behavior.

Our findings have interesting policy implications. Labor market reforms that aim at increasing the flexibility of the labor market will increase the adjustments along the intensive margin. This has further implications as e.g. income taxes will then have larger disincentive effects due to a larger aggregate labor supply elasticity.

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