Firing Costs and Labor Market Fluctuations: A Cross-Country Analysis

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What do we do?: Study aggregate hours in the business cycle

- **Data**: Business cycle volatility of total hours worked widely differ across countries.
- **Theory**: Heterogeneous firm model with extensive and intensive margins of labor and fixed labor adjustment costs (i.e. firing costs).

What do we find?

- Differences in firing costs can account for the cross-country variation of the business cycle volatility of total hours worked.
- Abstracting from the intensive margin has important quantitative implications for the effect of firing costs.
    - With the intensive margin, small firing costs have greater effect on the extensive margin fluctuations.

Agenda

1. Empirical evidence.
2. Model with overtime.
3. Quantitative analysis.
    - Calibration.
    - Results.
    - Extensions.
4. Final remarks.

Stylized facts

Cross-country patterns of labor market fluctuations:

1. Business cycle volatility of total hours worked widely differ across countries.
2. Countries that adjust more via the extensive margin tend to show more volatile total hours worked.

Figure: Volatility of Total Hours Worked vs. Relative volatility Intensive/Extensive Margins

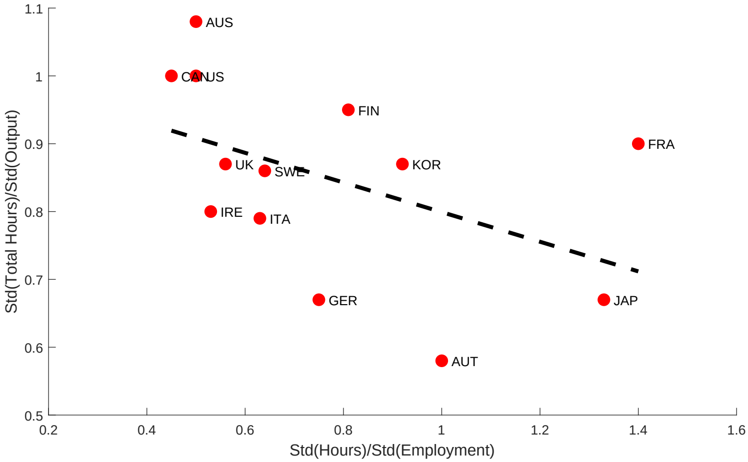
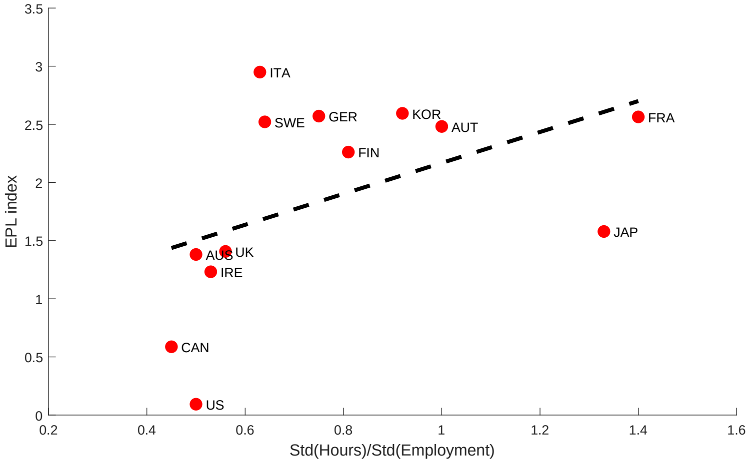


Figure: EPL vs. Relative volatility Intensive/Extensive Margins



Model - Household (1)

- Indivisible labor framework (Hansen and Sargent, 1988).
  - There one family composed by population of individuals (normalized = 1).
  - Individuals choose $\{0, h_1, h_1 + h_2\}$ hours (convexification via lotteries).
  - Family chooses: consumption C, employment levels $N_{1,2}$, next period capital K'.
  - Employment is N_1, from which N_2 works $h_1 + h_2$ and the rest works h_1 hours.
- Preferences:

$$\log C(\mathrm{s}) - \chi \underbrace{(N_1(\mathrm{s}) - N_2(\mathrm{s}))}_{only\ \ h_1\ \ hours} \frac{h_1^{1+\zeta}}{1+\zeta} - \chi \underbrace{N_2(\mathrm{s})}_{h_1+h_2} \frac{(h_1 + h_2)^{1+\zeta}}{1+\zeta}$$

Model - Firms (1)

- Fixed population $j \in [0,1]$.
- Decreasing returns to scale technology:

$$y_{jt} = \underbrace{e^{z_t} e^{\varepsilon_{jt}} k_{jt}^{\alpha} n_{1jt}'^{\nu} h_1}_{First\ stage} + \underbrace{e^{z_t} e^{\varepsilon_{jt}} k_{jt}^{\alpha} n_{2jt}'^{\nu} h_2}_{Second\ stage}, \ \alpha + \nu < 1$$

- Where:
  - Idiosyncratic productivity $\varepsilon_t \in \{\varepsilon_1, ..., \varepsilon_{n_\varepsilon}\} \sim$ i.i.d. Markov.
  - Aggregate productivity $z_{t+1} = \rho_z z_t + \sigma_z \omega_{t+1}^z$, where $\omega_{t+1}^z \sim N(0,1)$.
  - Rented capital k_{jt}, stage-1 employment n_{1jt}', and stage-2 employment n_{2jt}'.
  - Important: $n_{2jt}' \in n_{1jt}' \implies n_{2jt}'$ workers work $h_1 + h_2$ hours.

Model - Firms (2)

- $\hat{v}(\varepsilon, n_1; s)$ is the firm (ε, n_1) value function.
- Firm enters the period with n_1 employment and a fraction $q \in (0,1)$ quits.
- The problem of the firm:

$$\hat{v}(\varepsilon, n_1; s) = \max_{k, n_1', n_2'} \lambda(s) \begin{bmatrix} e^z e^{\varepsilon} k^{\alpha} \left(n_1'^{\nu} h_1 + n_2'^{\nu} h_2\right) - r(s) k - w_1(s) n_1' - w_2(s) n_2' \\ -\tau_h \max\left(0, n_1' - (1-q) n_1\right) \\ -\tau_f \max\left(0, (1-q) n_1 - n_1'\right) \end{bmatrix} + \beta E\left[\hat{v}\left(\varepsilon', n_1'; s'\right) | \varepsilon, n_1; s\right]$$

Model - Firms (3)

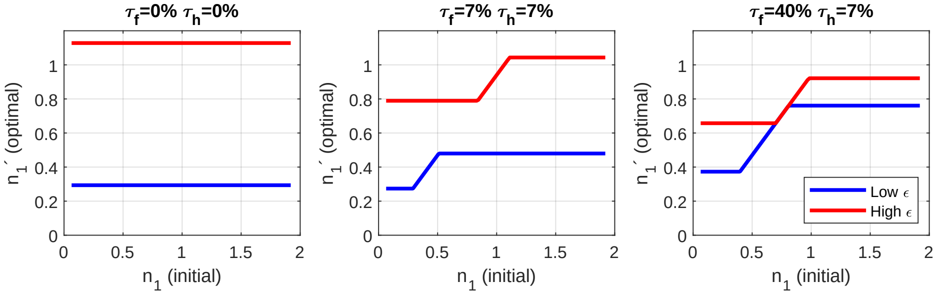
- Problem of the firm:

$$\hat{v}\left(\varepsilon, n_1; s\right) = \max_{k, n_1', n_2'} \lambda\left(s\right) \begin{bmatrix} e^z e^\varepsilon k^\alpha \left({n_1'}^\nu h_1 + n_2'^\nu h_2\right) - r\left(s\right) k - w_1\left(s\right) n_1' - w_2\left(s\right) n_2' \\ -\tau_h \max\left(0, n_1' - \left(1-q\right) n_1\right) \\ -\tau_f \max\left(0, \left(1-q\right) n_1 - n_1'\right) \end{bmatrix}$$
$$+\beta E\left[\hat{v}\left(\varepsilon', n_1'; s'\right) | \varepsilon, n_1; s\right]$$

- Policy function $n_1'\left(\varepsilon, n_1; s\right)$ takes the form of (S,s) band.

Model overtime - Ss bands

Figure: Policy functions $n_1'\left(\varepsilon, n_1; s\right)$



Model - Market clearing and firm size distribution

- Market clearing:

$$\begin{aligned} \int n_1' (\varepsilon, n_1; s) \, d\mu (\varepsilon, n_1) &= N_1 (s) \\ \int n_2' (\varepsilon, n_1; s) \, d\mu (\varepsilon, n_1) &= N_2 (s) \\ \int k (\varepsilon, n_1; s) \, d\mu (\varepsilon, n_1) &= K \\ \int y (\varepsilon, n_1; s) \, d\mu (\varepsilon, n_1) &= C (s) + K' (s) - (1 - \delta) K \end{aligned}$$

- Take a set $\Delta_{n_1'}$, the law of motion of $\mu' (z, \mu)$ is

$$\mu' (z, \mu) \left(\varepsilon' \times \Delta_{n_1'} \right) = \sum_{\varepsilon} \pi (\varepsilon' | \varepsilon) \int \mathbb{I} \left(n_1' (\varepsilon, n_1; s) \in \Delta_{n_1'} \right) d\mu (\varepsilon, n_1)$$

Calibration (1)

- Most parameters take the standard values.

	Parameter	Value	Note
Discount factor	β	0.99	
Depreciation rate	δ	0.025	
Curvature in technology (labor)	ν	0.64	Khan and Thomas (2008)
Curvature in technology (capital)	α	0.256	Khan and Thomas (2008)
Firing costs	τ_f	0.07	Percent of full-time wage Bloom (2009)
Hiring cost	τ_h	0.07	Percent of full-time wage Bloom (2009)
Persistence of aggregate productivity	ρ_z	0.95	
Persistence of idiosyncratic productivity	ρ_ϵ	0.75	Cooper et al. (2015)

Calibration (2)

- These parameters are chosen to match US moments.
- Straight-time and overtime interpretation (Hansen and Sargent, 1988).

	Parameter	Value	Target
Quit rate	q	0.06	6% average quarterly quit rate
Curvature in utility	ζ	0.50	50% overtime wage premium
Scaling in utility	χ	9.55	0.6 employment to population ratio.
Stage-1 hours	h_1	0.46	Full-time hours.
Stage-2 hours	h_2	0.13	Over-time hours.
Volatility of idiosyncratic productivity	σ_ϵ	0.07	5% average job destruction rate.
Volatility of aggregate productivity	σ_z	0.007	1.5% standard deviation of HP GDP.

Steady state effects - overtime

- Substitution of extensive and intensive margins is limited given a permanent changes in firing costs.
- Major impact in terms of job flows.

Table: Steady state effects (overtime)

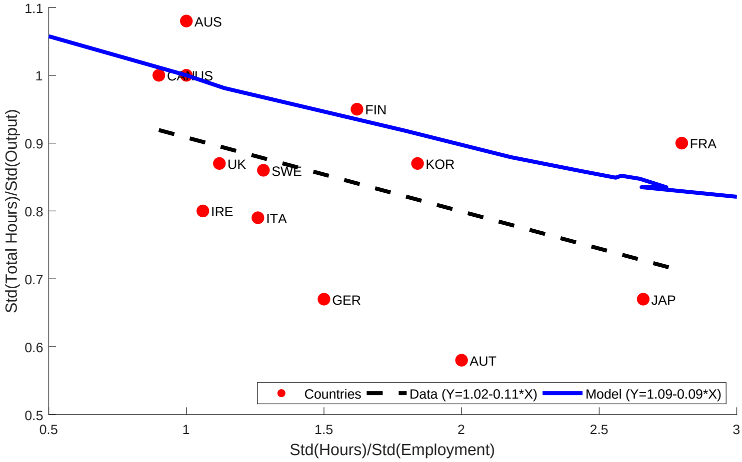
Hiring cost τ_h	$0.0w_1$	$0.07w_1$	$0.07w_1$	$0.07w_1$
Firing cost τ_f	$0.0w_1$	$0.07w_1$	$0.5w_1$	w_1
Output	103.61	100.00	97.04	95.90
Employment	104.99	100.00	95.80	94.15
Hours per worker	99.19	100.00	100.79	101.13
Total hours	104.14	100.00	96.55	95.21
Job destruction rate	11.47	4.92	3.27	2.68

Business cycle effects - overtime

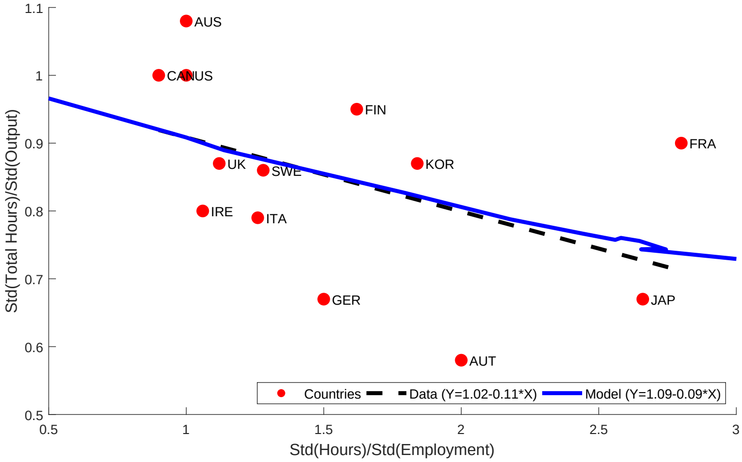
Table: Business Cycle Effects

Hiring cost τ_h	$0.0w_1$	$0.07w_1$	$0.07w_1$	$0.07w_1$
Firing cost τ_f	$0.0w_1$	$0.07w_1$	$0.5w_1$	w_1
A. Standard deviation				
Output	1.62	1.51	1.37	1.37
B. Relative volatility				
Consumption	0.35	0.36	0.37	0.37
Investment	4.07	4.01	3.97	3.98
Employment	0.70	0.63	0.52	0.50
Hours per worker	0.00	0.02	0.04	0.04
Total hours	0.70	0.64	0.55	0.54

Business Cycles



Business Cycles



Business cycle effects - overtime

Table: Intensive vs. extensive margin (overtime)

Hiring cost τ_h	$0.0w_1$	$0.07w_1$	$0.07w_1$	$0.07w_1$
Firing cost τ_f	$0.0w_1$	$0.07w_1$	$0.5w_1$	w_1
Extensive margin only				
Employment	0.71	0.70	0.63	0.59
Extensive and intensive				
Employment	0.70	0.63	0.52	0.50
Hours per worker	0.00	0.02	0.04	0.04
Total hours	0.70	0.64	0.55	0.54

- The intensive margin matters for the labor fluctuations along the business cycle.

Final remarks

- **Data**: We document the following facts:
  - Business cycle volatility of total hours worked widely differ across countries.
  - Countries that adjust more via the extensive margin tend to show more volatile total hours worked.
- **Theory**: Heterogeneous firm model with extensive and intensive margins of labor and fixed firing costs.
- **Results**: Firing costs quantitatively account for the cross-country variation of the business cycle volatility of total hours worked.
  - Substitution between extensive and intensive margins of labor.
- Working progress: adding part-time employment.

Extension - 3 types of labor

- Preferences

$$\frac{C\left(s\right)^{1-\sigma}-1}{1-\sigma}-\chi_f\left(N_f\left(s\right)-N_o\left(s\right)\right)h_f-\chi_o N_o\left(s\right)\left(h_f+h_o\right)-\chi_p N_p\left(s\right)h_p$$

  - Full-time employment includes overtime.
  - Part-time employment is a different type of labor.

- Technology:

$$y=e^z e^\varepsilon k^\alpha\left(n_f^\nu h_f+A_o n_o^\nu h_o+A_p n_p^\nu h_p\right)$$

  - Only n_f faces hiring and firing costs.

Thanks

Calibration - details

- 2% Average monthly quit rate from BLS's JOLTS.
- 50% overtime wage premium, see Hart (2004) - US Fair Labor Standards Act
- $h_1 = 0.46$ straight-time hours is consistent with an average of 40 weekly hours per worker and 3 weekly overtime hours per worker, see Hansen and Sargent (1988).
- $h_2 = 0.13$ over-time hours from Hansen and Sargent (1988).
- 5% average job destruction rate from US Census Bureau BDS.

Model - Family

- Resources:

1. Rents the initial level of capital K at the rate $r(s)$.
2. Supplies labor $N_1(s)$ and $N_2(s)$ at the wage rates $w_1(s)$ and $w_2(s)$.
3. Receives transfers from firms $\int \pi(\varepsilon, n_1; s)\, d\mu(\varepsilon, n_1; s)$ and a lump-sum transfer $T(s)$.

- Uses:

1. Consumes $C(s)$.
2. Invest in new capital $K'(s) - (1-\delta)K$

Model - Family

- From the family problem:

$$N_1(s) \quad : \quad \chi \frac{h_1^{1+\zeta}}{1+\chi} = \lambda(s) w_1(s)$$

$$N_2(s) \quad : \quad \chi \frac{(h_1+h_2)^{1+\zeta}}{1+\zeta} - \chi \frac{h_1^{1+\zeta}}{1+\zeta} = \lambda(s) w_2(s)$$

- Which implies a constant *premium*:

$$\frac{w_2(s)/h_2}{w_1(s)/h_1} = \frac{h_1}{h_2}\left[\left(\frac{h_1+h_2}{h_1}\right)^{1+\zeta} - 1\right] > 1$$

Model overtime - Firms

- Problem of the firm:

$$\hat{v}(\varepsilon, n_1; s) = \max_{k, n_1', n_2'} \lambda(s) \begin{bmatrix} e^z e^\varepsilon k^\alpha \left(n_1'^\nu h_1 + n_2'^\nu h_2\right) - r(s)\, k - w_1(s)\, n_1' - w_2(s)\, n_2' \\ -\tau_h \max\left(0, n_1' - (1-q)\, n_1\right) \\ -\tau_f \max\left(0, (1-q)\, n_1 - n_1'\right) \end{bmatrix} + \beta E\left[\hat{v}\left(\varepsilon', n_1'; s'\right) | \varepsilon, n_1; s\right]$$

- First order conditions of k & n_2' are static.
  - Marginal product = factor price.
  - Marginal products are equalized across firms.

Model overtime - Firms

- Hiring: $n_1' > (1-q)n_1$ FOC is:

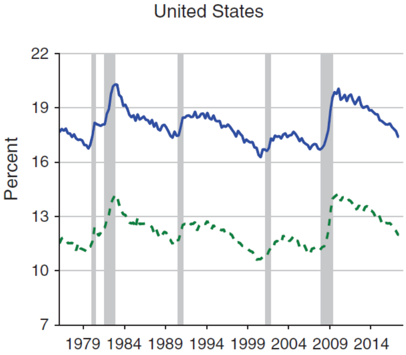
$$\lambda(s)\left[\ \nu \frac{e^z e^\varepsilon k^\alpha n_1'^\nu h_1}{n_1'} - w_1(s) - \tau_h\ \right] + \beta E\left[\frac{\hat{\upsilon}(\varepsilon', n_1'; s')}{\partial n_1'} | \varepsilon, n_1; s\right] = 0$$

- Firing $n_1' < (1-q)n_1$ FOC is:

$$\lambda(s)\left[\ \nu \frac{e^z e^\varepsilon k^\alpha n_1'^\nu h_1}{n_1'} - w_1(s) + \tau_f\ \right] + \beta E\left[\frac{\hat{\upsilon}(\varepsilon', n_1'; s')}{\partial n_1'} | \varepsilon, n_1; s\right] = 0$$

- Inaction : $n_1' = (1-q)n_1$.

Figure: Part-time employment share (35 hours/week or less), Source: Borowczyk-Martins and Lalé (2019). Blue line (working-age population), green dotted line (prime-age population)



Model - Solution method

- The aggregate state is $s \equiv (z, K, \mu)$
- The solution is computed using Boppart et al. (2018) method.
  - Deterministic transition path given a transitory productivity shock $\{z_t\}_{t=0}^T$.
  - Steady state $t = 0 \rightarrow$ steady state $t = T$.
  - Guess a sequence for the interest rate $\{\hat{r}_t\}_{t=0}^T$
    - Family's FOC: $\{\lambda_t, w_{1t}, w_{2t}\}_{t=0}^T$
    - Backward shooting $t = T \rightarrow 0$: $\{k_{jt}, n'_{1jt}, n'_{2jt}, y_{jt}\}_{t=0}^T$ from firms' FOC.
    - Forward shooting $t = 0 \rightarrow T$: $\{K_t, N_{1t}, N_{2t}, Y_t, r_t\}_{t=0}^T$ integrated by $\mu(\epsilon, n_1; s)$.
    - If $\sup |\hat{r}_t - r_t| \leq \epsilon \rightarrow$ convergence, otherwise $\hat{r}_t = (1-\gamma) r_t + \gamma \hat{r}_t$

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