# The effects of the single contract and short time work schemes in dual labor markets

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# Motivation

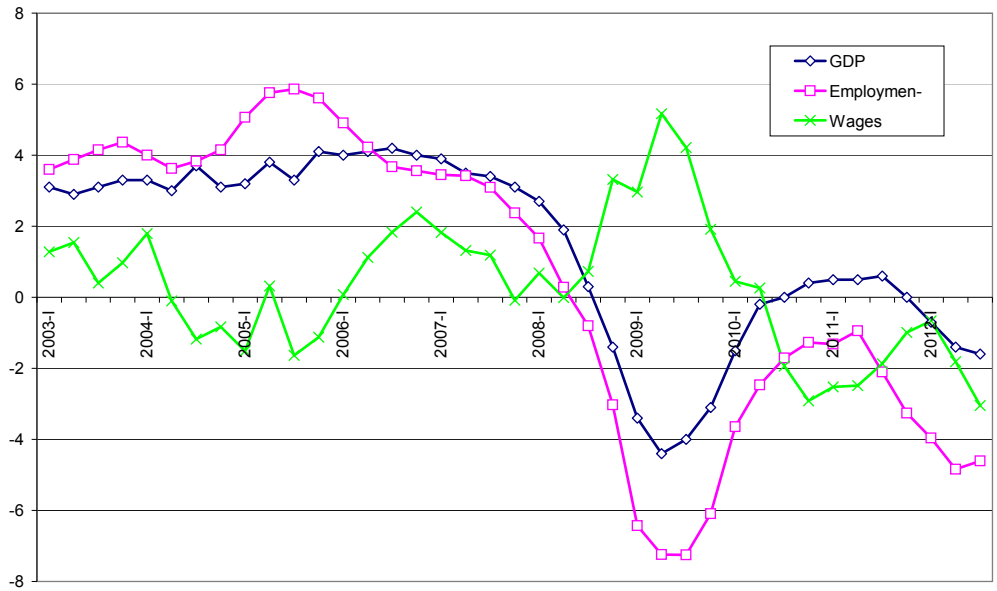
The “Great Recession” has revealed the poor performance of certain labour markets in EU: **Spain is the champion!**

- Institutional features of the Spanish labour market:
  1. **External flexibility**: a large gap in severance costs of permanent (PCs) and temporary contracts (TCs).
  2. **Internal flexibility**: hours and wages difficult to modify.

- These features imply that, during downturns, job destruction is much larger in Spain than in the rest of the EU...

# Motivation

- The adjustment mechanism is based on employment instead of wages...
- The temporary employment rate is $33\%$ ($14\%$ in the EU).



# Motivation

The need to eliminate the duality to prevent its perverse consequences on the Spanish labour market:

- Huge employment volatility: 77% of total job losses during the current crisis were due to TCs (34% in the EU).
- Labor market segmentation is quite persistent: 40% of the workers who have a temporary job at age 20 still have one at the age of 40.
- Low productivity growth: no training, poor match quality and specialization in relatively low-productivity sectors.
- Demographics: bad implications for emancipation, birth rates, sustainability of the pension system.

# Objective

**Steady State**: effects of more external and internal flexibility on **unemployment**, **job destruction** and the **tenure distribution.**

**Transition**: **welfare** effects, the **costs** of the policies and **distributional issues.**

**Policies:**

- Reducing the **severance** costs gap of PCs and TCs.
- Introducing a **single contract.**
- Availability of **short-time** work schemes.

# A JC-JD model of the search and matching type

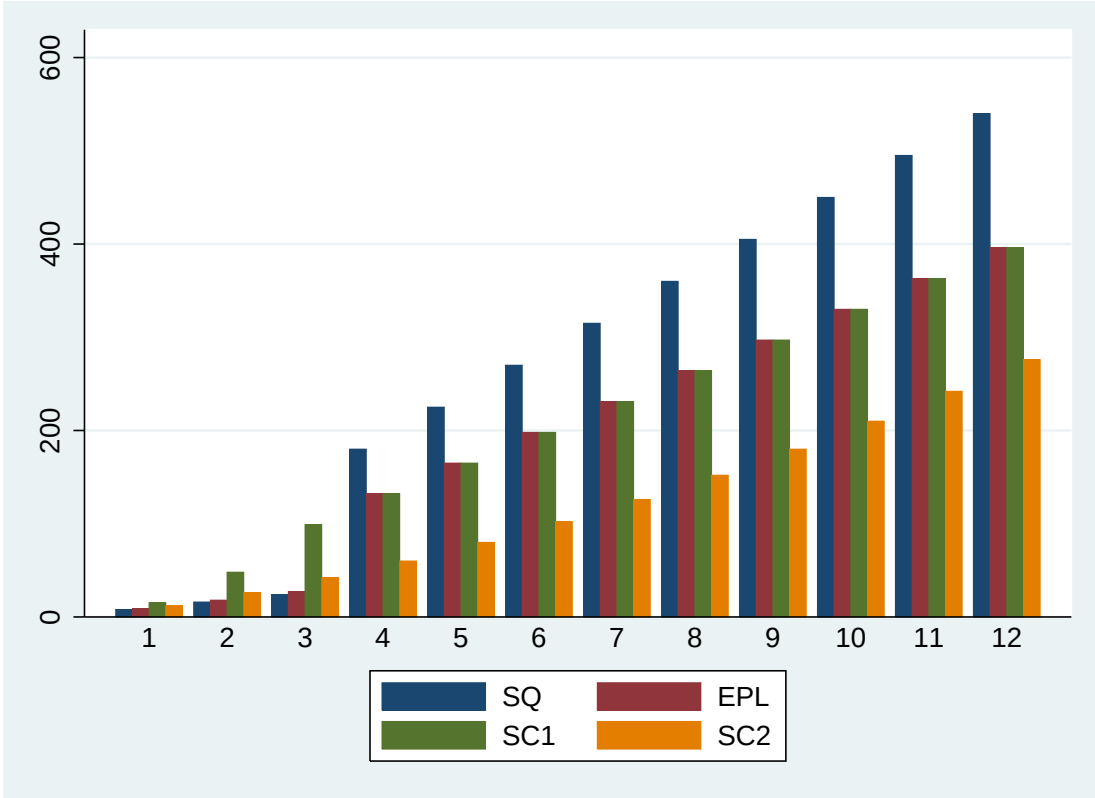
## Standard ingredients:

- Heterogeneity (idiosyncratic shocks)
- Persistency (Markov processes)
- Frictions in the matching process
- Endogenous job destruction

## New ingredients:

- Dual labor market: two types of contracts (PCs and TCs) differing in productivity, in the maximum length of the contract and in the associated severance costs.
- Endogenous job conversion of TCs into PCs.
- Severance costs modelled as a transfer from the firm to the worker, and as a function of wages and seniority.
- Downward wage rigidity (wage set by collective agreements).
- Seniority as a state variable
- Availability of short-time work.

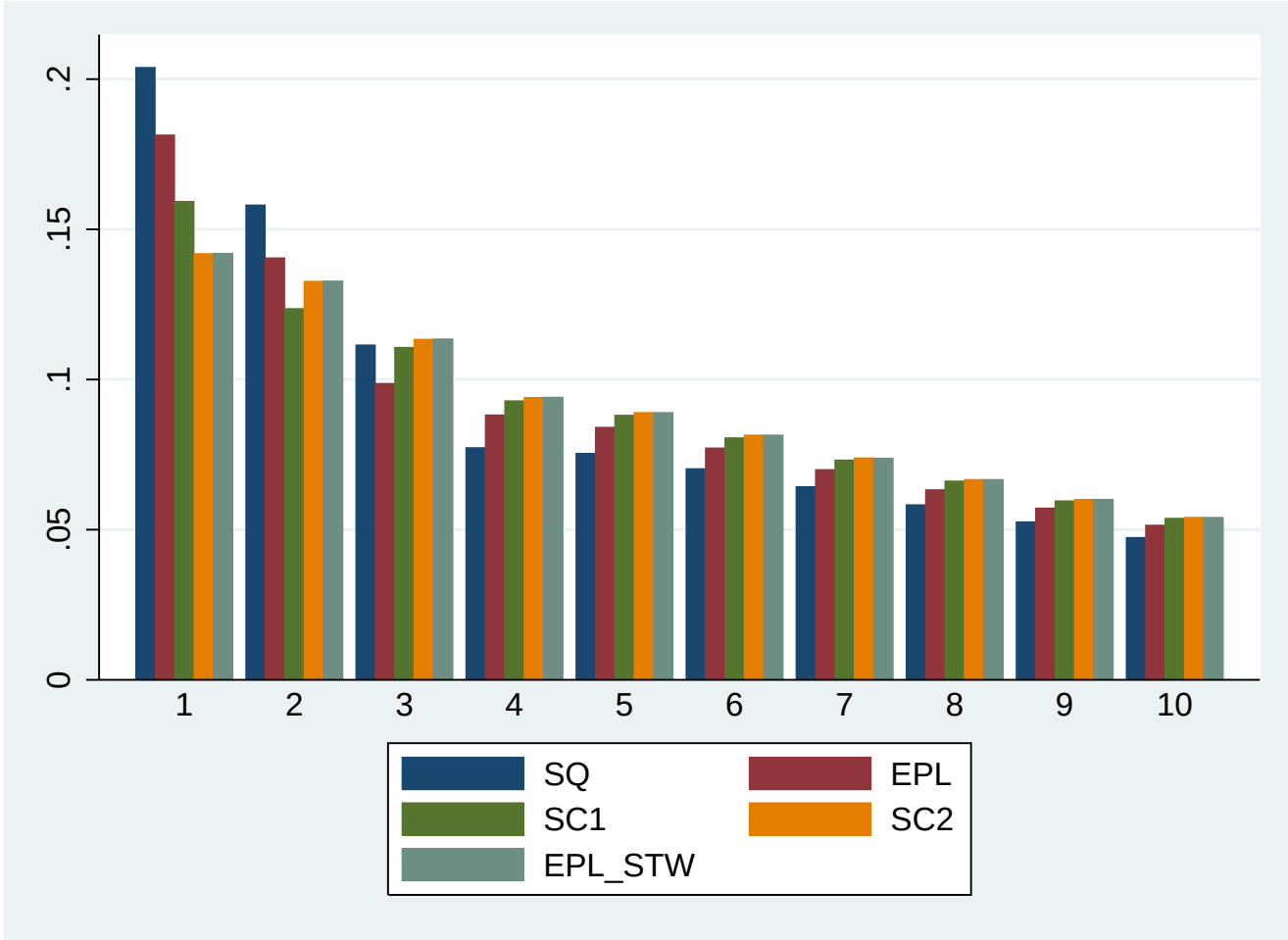
# Comparing severance costs structures



# Steady State Effects

| Statistics | SQ (45-8) days | EPL ch. (33-11) days | EPL ch. + STW No subs. | EPL ch. + STW $33\%$ subs. | EPL ch. + STW Prop. subs. | Base Single contract |
|---|---|---|---|---|---|---|
| $u$ | 17.3 | 15.4 | 15.6 | 12.4 | 11.8 | 13.7 |
| $u_{fte}$ | 17.3 | 15.4 | 16.6 | 13.1 | 14.2 | 13.7 |
| $JD$ | 12.6 | 11.9 | 11.8 | 9.3 | 8.9 | 11.6 |
| $JDt$ | 26.7 | 22.2 | 22.0 | 12.3 | 8.9 | 16.8 |
| $JDp$ | 7.4 | 8.0 | 8.0 | 8.2 | 8.9 | 8.1 |
| $n_{d=1}$ | 20.4 | 18.1 | 18.1 | 14.2 | 13.4 | 16.6 |
| $n_{d>3}$ | 52.7 | 57.9 | 58.1 | 61.2 | 63.5 | 60.6 |

# Tenure Distribution



# The Transition

- We perform the transition from the **SQ** to the **reform scenarios**.
- We compare the resulting labor market careers under the SQ and under the transition for a sample of workers from the MCVL data set that differ in their employment status, type of contract, tenure and productivity.
- In every scenario, workers are subject to the same shocks, but their employment histories will be different because the policy rules are different.
- We compute the **equivalent variation** (EV) and the **fiscal costs** (implied by the SQ and by the reform scenarios) and express them as an income annuity.

| Statistics | EPL change (33-11) days | EPL ch. + STW 33% | EPL ch. + STW prop. | Base SC | SC 12-36 |
|---|---|---|---|---|---|
| Fiscal bal. variation | 291 | -67 | 403 | 590 | 762 |
| Equivalent variation | -105 | -164 | 329 | 15 | 329 |

# Winners and Losers

| EPL vs SQ | All % | All | Perm. % | Perm. | Temp. % | Temp. | U % | U |
|---|---|---|---|---|---|---|---|---|
| ↑ sev.cost | 38.1% | 33.2 | 38.6% | 21.0 | 36.6% | 47.8 | 38.8% | 45.0 |
| ↓ sev.cost | 37.3% | 61.3 | 37.2% | 51.2 | 37.4% | 73.7 | 37.4% | 70.0 |
| ↑ tenure | 28.9% | 2.0 | 24.3% | 2.1 | 30.4% | 2.3 | 38.4 % | 1.7 |
| ↓ tenure | 7.5% | 0.1 | 10.2% | 0.0 | 7.4% | 0.3 | 0.9 % | 1.8 |
| ↑ income | 49.9% | 413 | 48.2% | 360 | 48.8% | 450 | 55.1% | 483 |
| ↓ income | 28.8% | 337 | 29.7% | 249 | 28.7% | 438 | 26.6% | 489 |
| STW vs SQ | All % | All | Perm. % | Perm. | Temp. % | Temp. | U % | U |
| ↑ sev.cost | 29.7% | 72.9 | 26.7% | 49.5 | 31.6% | 98.5 | 34.5% | 86.7 |
| ↓ sev.cost | 47.1% | 53.2 | 48.7% | 43.7 | 47.3% | 65.0 | 42.9% | 62.8 |
| ↑ tenure | 49.3% | 3.0 | 45.6% | 2.9 | 51.5% | 2.9 | 55.7% | 3.1 |
| ↓ tenure | 7.4% | 1.3 | 8.1% | 0.6 | 9.9% | 2.4 | 2.6% | 1.3 |
| ↑ income | 57.7% | 658 | 56.1% | 489 | 61.5% | 932 | 57.0% | 683 |
| ↓ income | 35.3% | 615 | 36.3% | 534 | 31.7% | 697 | 37.5% | 717 |

# Winners and Losers

| Base SC vs SQ | All % | All | Perm. % | Perm. | Temp. % | Temp. | U % | U |
|---|---|---|---|---|---|---|---|---|
| ↑ sev.cost | 37.8% | 79.9 | 37.8 % | 62.3 | 36.7% | 92.9 | 39.3% | 105.8 |
| ↓ sev.cost | 37.4% | 56.5 | 37.8 % | 47.0 | 37.2% | 68.9 | 36.7% | 64.3 |
| ↑ tenure | 44.3% | 3.0 | 38.8% | 2.9 | 48.7% | 3.3 | 52.0% | 2.8 |
| ↓ tenure | 5.4% | 0.2 | 8.4% | 0.0 | 3.5% | 0.6 | 0.8% | 2.0 |
| ↑ income | 46.0% | 499 | 45.9% | 444 | 45.5% | 513 | 46.9% | 615 |
| ↓ income | 39.6% | 613 | 38.9% | 562 | 39.5% | 636 | 41.1% | 700 |
| SC1236 vs SQ | All % | All | Perm. % | Perm. | Temp. % | Temp. | U % | U |
| ↑ sev.cost | 30.4% | 40.9 | 28.8% | 28.5 | 30.1% | 55.7 | 34.8% | 4.9 |
| ↓ sev.cost | 45.0% | 85.9 | 46.6% | 64.3 | 43.6% | 98.8 | 42.8% | 126.2 |
| ↑ tenure | 53.0% | 3.4 | 49.4% | 3.2 | 54.8% | 3.7 | 59.5% | 3.4 |
| ↓ tenure | 3.7% | 0.3 | 5.6% | 0.1 | 2.7% | 0.9 | 0.5% | 2.2 |
| ↑ income | 33.6% | 432 | 33.2% | 393 | 34.8% | 438 | 33.1% | 516 |
| ↓ income | 52.0% | 914 | 51.7% | 803 | 50.2% | 944 | 54.8% | 1134 |

# Concluding Remarks

- The sole reduction in **EPL** decreases both, the unemployment rate and the temporary job destruction, and smoothes the tenure distribution.
- Adding **STW** decrease the unemployment and the JDt substantially, and smoothes much more the tenure distribution, but only if payroll taxes are subsidized.
- The effects of the **SC** depends on how it is designed.
- The **transition** analysis shows that all the reform scenarios are Pareto improving. In those where welfare decreases, a lump sum subsidy could be used to compensate for the welfare loss.
- **Policy implication**: the SC seems to be the best option to reduce the duality without significantly harming the budget, while STW should be better used as a strategy to prevent a drastic increase in the unemployment rate when economies are hit by temporary negative shocks.

# The Transition

| Statistics | SQ | EPL change | EPL change + Short-time No subsidy | EPL change + Short-time $33\%$ subsidy | EPL change + Short-time Prop. subsidy |
|---|---|---|---|---|---|
| Income | 17793 | 17898 | 17786 | 17957 | 17465 |
| Average Wage | 16143 | 16427 | 16188 | 16038 | 15897 |
| Severance Cost | 784 | 717 | 717 | 724 | 747 |
| State $Cost_b$ | 866 | 754 | 799 | 627 | 560 |
| State $Cost_{w-sub}$ | 0 | 0 | 82 | 567 | 261 |
| State $Cost_{ss-cc}$ | 762 | 679 | 709 | 657 | 612 |
| State Total Cost | 1628 | 1434 | 1590 | 1852 | 1434 |
| Firm $Cost_{ss-cc}$ | 3487 | 3577 | 3547 | 3606 | 3651 |
| Firm $Cost_{ss-u}$ | 903 | 911 | 911 | 941 | 948 |
| State Revenue | 4390 | 4487 | 4458 | 4547 | 4599 |
| Fiscal balance | 2763 | 3054 | 2867 | 2695 | 3166 |
| Fiscal bal. var. | – | 291 | 105 | -67 | 403 |
| Equivalent var. | – | -105 | 7 | -164 | 329 |

# SS Effects of the 2012 reform

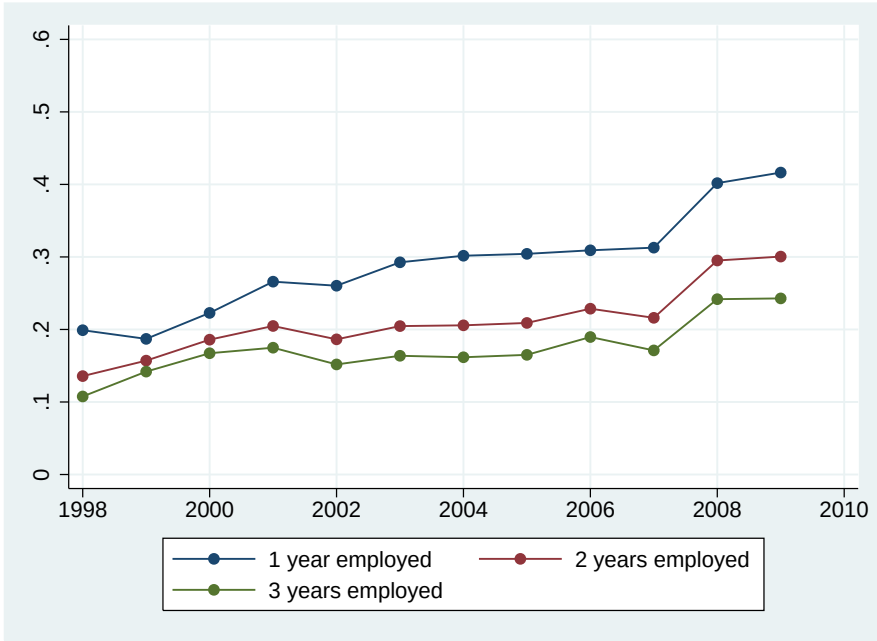
| Statistics | SQ | EPL change: (45-8) days to (33-11) | EPL change + Short-time No subsidy | EPL change + Short-time $33\%$ subsidy | EPL change + Short-time Prop. subsidy |
|---|---|---|---|---|---|
| $u$ | 17.3 | 15.4 | 15.6 | 12.4 | 11.8 |
| $u_{fte}$ | 17.3 | 15.4 | 16.6 | 13.1 | 14.2 |
| $JD$ | 12.6 | 11.9 | 11.8 | 9.3 | 8.9 |
| $JDt$ | 26.7 | 22.2 | 22.0 | 12.3 | 8.9 |
| $JDp$ | 7.4 | 8.0 | 8.0 | 8.2 | 8.9 |
| $JD_{d=2}$ | 22.5 | 22.5 | 22.4 | 6.5 | 6.6 |
| $JD_{d=3}$ | 29.5 | 29.8 | 29.5 | 14.5 | 14.5 |
| $JD_{d=4}$ | 30.6 | 10.6 | 10.7 | 17.1 | 5.2 |
| $n_{d=1}$ | 20.4 | 18.1 | 18.1 | 14.2 | 13.4 |
| $n_{d=2}$ | 15.8 | 14.1 | 14.0 | 13.3 | 12.5 |
| $n_{d=3}$ | 11.2 | 9.9 | 9.9 | 11.4 | 10.7 |
| $n_{d>3}$ | 52.7 | 57.9 | 58.1 | 61.2 | 63.5 |

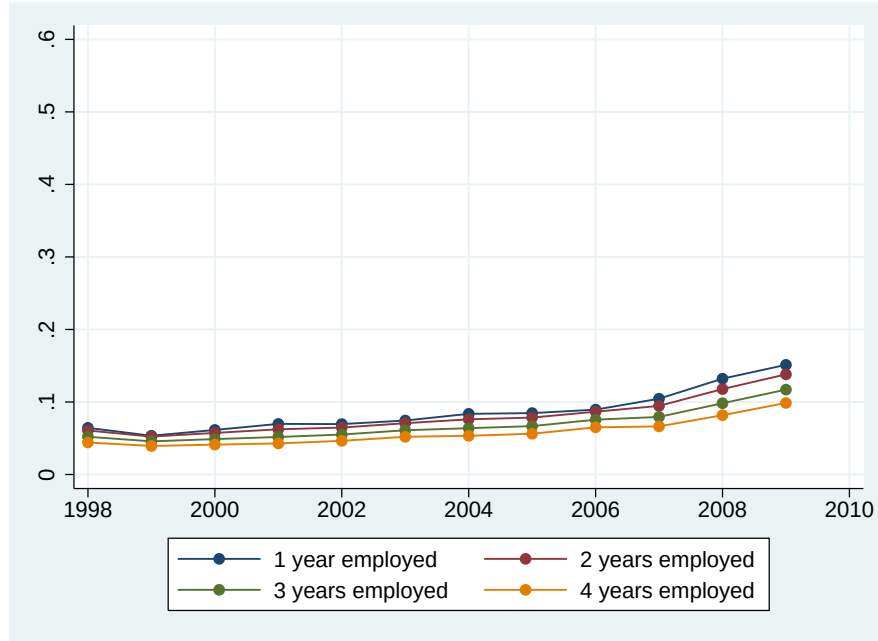
# Calibration

**Data set**: "Muestra continua de vidas laborales" (MCVL): random draw from the Social Security archives.

**Info on**: personal characteristics and all employment and unemployment spells throughout worker's entire labour history.

**Graph**: Exit rates from temporary (left) and permanent (right) employment to unemployment, by employment duration




The exit from a temporary contract is much larger, at any employment duration

# Severance cost functions

Status Quo:

- Legal indemnities in fair dismissals (20 days of wages p.y.o.s. with a maximum of 12 monthly wages)
- Legal indemnities in unfair dismissals (45 days of wages p.y.o.s. with a maximum of 42 monthly wages)
- Procedural wages of around two monthly wages (except when applying the Law 45/2002: 57.6% of cases)
- $14.5\%$ of all firing processes were judged and $74.3\%$ of them were declared unfair.
- The rest of dismissals are: $7\%$ collective dismissals, $20.9\%$ agreed at UM (we assume all apply 45 days).

- In the status quo $s^p = 44.1\frac{w}{365}(d-1) + 23.2\frac{w}{365}$ and $s^t = 8\frac{w}{365}(d-1)$.
- In the 2012 Reform $s^p = 33\frac{w}{365}(d-1)$ and $s^t = 11\frac{w}{365}(d-1)$.

# Social security function

In TCs:

- Status Quo: $\xi^{tc}(w_{ft}^{tc}, w_{pt}^{tc}) = (\xi_{cc} + \xi_u) w_{ft}^{tc}$
- Short-time but no payroll subsidy: $\xi^{tc}(w_{ft}^{tc}, w_{pt}^{tc}) = (\xi_{cc} + \xi_u) w_{ft}^{tc}$
- Short-time and a $33\%$ payroll subsidy: $\xi^{tc}(w_{ft}^{tc}, w_{pt}^{tc}) = (0.67 * \xi_{cc} + \xi_u) w_{ft}^{tc}$
- Short-time and a proportional payroll subsidy: $\xi^{tc}(w_{ft}^{tc}, w_{pt}^{tc}) = \xi_{cc} w_{pt}^{tc} + \xi_u w_{ft}^{tc}$

In PCs:

- Status Quo: $\xi^{tc}(w_{ft}^{tc}, w_{pt}^{tc}) = (\xi_{cc} + \xi_u) w_{ft}^{pc}$
- Short-time but no payroll subsidy: $\xi^{tc}(w_{ft}^{tc}, w_{pt}^{tc}) = (\xi_{cc} + \xi_u) w_{ft}^{pc}$
- Short-time and a $33\%$ payroll subsidy: $\xi^{tc}(w_{ft}^{tc}, w_{pt}^{tc}) = (0.67 * \xi_{cc} + \xi_u) w_{ft}^{pc}$
- Short-time and a proportional payroll subsidy: $\xi^{tc}(w_{ft}^{tc}, w_{pt}^{tc}) = \xi_{cc} w_{pt}^{tc} + \xi_u w_{ft}^{pc}$

# Calibration

| | | |
|---|---|---|
| Discount factor | $\beta$ | 0.97 |
| Productivity shock (mean) | $\mu$ | 1 |
| Productivity shock (autocorrelation) | $\rho$ | 0.75 |
| Productivity shock (standar deviation) | $\sigma$ | 0.11 |
| Productivity gap | $\gamma$ | 0.135 |
| Unemployment benefit | $b$ | 0.2 |
| Minimum wage | $w_{min}$ | 0.72 |
| Bargaining power | $\pi$ | 0.33 |
| Matching elasticity | $\eta$ | 0.51 |
| Vacancy cost | $c_v$ | 0.26 |
| Training cost | $\tau$ | 0.6 |
| Experience effect on productivity | $\lambda$ | 0.0065 |
| Mismatch degree | A | 0.64 |

# Calibration results

| Statistics | Spanish Data | Status Quo |
|---|---|---|
| $JDp$ | 8.1 | 7.4 |
| $JDt$ | 26.6 | 26.7 |
| $u_{dur}$ | 11.1 | 12.3 |

# Status Quo

**Statistics of interest**

| Statistics | Data | Status Quo |
|---|---|---|
| $u$ | 14.6 | 17.3 |
| $JD$ | 11.5 | 12.6 |
| $n_{d=1}$ | 25.8 | 20.4 |
| $n_{d=2}$ | 15.7 | 15.8 |
| $n_{d=3}$ | 11.4 | 11.2 |
| $n_{d=4}$ | 8.6 | 7.7 |
| $n_{d=5}$ | 6.8 | 7.5 |
| $\bar{d}_{d\leq 6}$ | 1.94 | 1.96 |
| $\bar{d}_{d\leq 10}$ | 3.05 | 3.83 |

# The model

## Population

- Workers: employed or unemployed.
- Firms-Jobs: occupied or vacant.

## State Space

$S = \{\{0,1\} \times \mathcal{E} \times D\}$, where

$$\mathcal{E} = \{\epsilon_1, ..., \epsilon_n\}$$

$$D = \{d_1, ..., d_N\}$$

## Preferences

- Identical and linear in consumption.
- Work is offered inelastically.

# The model

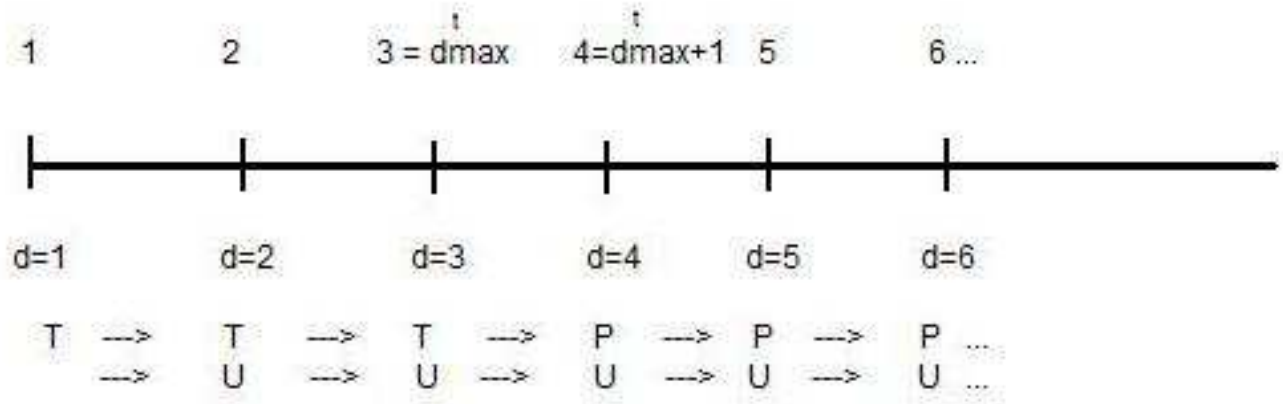
## Production Technology

- Each firm produces one unit of product whose price is $y(\epsilon_t)$ where
  - $\{\epsilon_t\}$ is Markov chain, $\epsilon' \in \mathcal{E} = \{1, 2, ..., n_\epsilon\}$, $\Gamma(\epsilon'|\epsilon) = Pr\{\epsilon_{t+1}|\epsilon_t\}$
  - Entry level $\epsilon_e$

## Matching Technology

- $c_v$ : cost of posting a vacancy.
- Every job is created as a temporary job.
- $m = m(u_t, v_t)$ matching function.
- Transition rates:
  - $q(\nu) = \frac{m(v,u)}{v} = m\left(1, \frac{u}{v}\right)$
  - $\alpha(\nu) = \frac{m(v,u)}{u} = m\left(\frac{v}{u}, 1\right)$
  - Job conversion at the end of the TC's maximum length.

# The model: timing




1. Firm's idiosyncratic shocks are revealed.
2. Firms and workers renegociate wages.
3. Firm decides whether to continue producing or to terminate the match.
4. After that, production starts.
5. Finally, search decisions are made.

# The model: value functions

Vacancy and Job creation

Every job is created as a temporary job according to the following equation

$$J^0 = c_v + \beta q(\theta) J^{tc}(\epsilon_e, 1) + \beta(1 - q(\theta)) J^0$$

On the other hand, job conversion leads to permanent job creation. Job conversion will take place for sufficiently high productivity realisations at the end of the TC's maximum length.

# The model: value functions

Problem of a firm with an existing temporary job

$$
\begin{aligned}
J^{tc}(\epsilon,d) \quad = \quad & max\{y(\epsilon)(1-\gamma)h_{ft} - w^{tc}_{ft}(\epsilon,d) - \xi^{tc}(w^{tc}_{ft},w^{tc}_{pt}) + \beta\sum_{\epsilon\prime}\Gamma(\epsilon\prime|\epsilon)J^{tc}(\epsilon\prime,d\prime),\\
& y(\epsilon)(1-\gamma)h_{pt} - w^{tc}_{pt}(\epsilon,d) - \xi^{tc}(w^{tc}_{ft},w^{tc}_{pt}) + \beta\sum_{\epsilon\prime}\Gamma(\epsilon\prime|\epsilon)J^{tc}(\epsilon\prime,d\prime),\\
& -s^{tc}(\epsilon,d-1) - c_v + \beta(q(\theta)J^{tc}(\epsilon_e,1) + (1-q(\theta))V)\}
\end{aligned}
$$

$$
g^{tc}(\epsilon,d) = \begin{cases} h_{ft} & \text{if the fulltime match continues} \\ h_{pt} & \text{if the match continues at a reduced number of hours} \\ 0 & \text{if the worker is fired} \end{cases}
$$

# The model: value functions

Problem of a firm with an expired TC (prospective PC)

$$J^{ppc}(\epsilon,d) = max\{y(\epsilon)(1-\tau)h_{ft} - w^{ppc}_{ft}(\epsilon,d) - \xi^{pc}(w^{ppc}_{ft},w^{ppc}_{pt}) + \beta\sum_{\epsilon\prime}\Gamma(\epsilon\prime|\epsilon)J^{pc}(\epsilon\prime,d\prime),$$

$$y(\epsilon)(1-\tau)h_t - w^{ppc}_{pt}(\epsilon,d) - \xi^{pc}(w^{ppc}_{ft},w^{ppc}_{pt}) + \beta\sum_{\epsilon\prime}\Gamma(\epsilon\prime|\epsilon)J^{pc}(\epsilon\prime,d\prime),$$

$$-s^{tc}(\epsilon,d-1) - c_v + \beta(q(\theta)J^{tc}(\epsilon_e,1) + (1-q(\theta))V)\}$$

$$g^{ppc}(\epsilon,d) = \begin{cases} h_{ft} & \text{if the firm promotes the worker to a fulltime job} \\ h_{pt} & \text{if the firm promotes the worker to a partime job} \\ 0 & \text{if the worker is fired} \end{cases}$$

# The model: value functions

Problem of a firm with an existing permanent job

$$
\begin{aligned}
J^{pc}(\epsilon,d) \quad = \quad & max\{y(\epsilon)\Lambda(d)h_{ft} - w^{pc}_{ft}(\epsilon,d) - \xi^{pc}(w^{pc}_{ft},w^{pc}_{pt}) + \beta\sum_{\epsilon\prime}\Gamma(\epsilon\prime|\epsilon)J^{pc}(\epsilon\prime,d\prime),\\
& y(\epsilon)\Lambda(d)h_{pt} - w^{pc}_{pt}(\epsilon,d) - \xi^{pc}(w^{pc}_{ft},w^{pc}_{pt}) + \beta\sum_{\epsilon\prime}\Gamma(\epsilon\prime|\epsilon)J^{pc}(\epsilon\prime,d\prime),\\
& -s^{pc}(\epsilon,d-1) - c_v + \beta(q(\theta)J^{tc}(\epsilon_e,1) + (1-q(\theta))V)\}
\end{aligned}
$$

$$
g^{pc}(\epsilon,d) = \begin{cases} h_{ft} & \text{if the fulltime match continues} \\ h_{pt} & \text{if the match continues at a reduced number of hours} \\ 0 & \text{if the worker is fired} \end{cases}
$$

# The model: value functions

Problem of a worker in a PC and a PPC

$$
\begin{aligned}
W^{tc}(\epsilon, d) \quad = \quad & \tilde{\Phi}(g^{tc} = h_{ft})[w^{tc}_{ft}(\epsilon, d) + \beta \sum_{\epsilon\prime} \Gamma(\epsilon\prime|\epsilon) W^{tc}(\epsilon\prime, d\prime)] + \\
& \tilde{\Phi}(g^{tc} = h_{pt})[w^{tc}_{pt}(\epsilon, d)(1+\omega) + \beta \sum_{\epsilon\prime} \Gamma(\epsilon\prime|\epsilon) W^{tc}(\epsilon\prime, d\prime)] + \\
& \tilde{\Phi}(g^{tc} = 0)[U + s^{tc}(\epsilon, d-1)]
\end{aligned}
$$

$$
\begin{aligned}
W^{ppc}(\epsilon, d) \quad = \quad & \tilde{\Phi}(g^{ppc} = h_{ft})[w^{ppc}_{ft}(\epsilon, d) + \beta \sum_{\epsilon\prime} \Gamma(\epsilon\prime|\epsilon) W^{pc}(\epsilon\prime, d\prime)] + \\
& \tilde{\Phi}(g^{ppc} = h_{pt})[w^{ppc}_{pt}(\epsilon, d)(1+\omega) + \beta \sum_{\epsilon\prime} \Gamma(\epsilon\prime|\epsilon) W^{pc}(\epsilon\prime, d\prime)] + \\
& \tilde{\Phi}(g^{ppc} = 0)[U + s^{tc}(\epsilon, d-1)]
\end{aligned}
$$

# The model: value functions

Problem of a worker in a TC

$$
\begin{aligned}
W^{pc}(\epsilon, d) \quad = \quad & \tilde{\Phi}(g^{pc} = h_{ft})[w^{pc}_{ft}(\epsilon, d) + \beta \sum_{\epsilon\prime} \Gamma(\epsilon\prime|\epsilon) W^{pc}(\epsilon\prime, d\prime)] + \\
& \tilde{\Phi}(g^{pc} = h_{pt})[w^{pc}_{pt}(\epsilon, d)(1+\omega) + \beta \sum_{\epsilon\prime} \Gamma(\epsilon\prime|\epsilon) W^{pc}(\epsilon\prime, d\prime)] + \\
& \tilde{\Phi}(g^{pc} = 0)[U + s^{pc}(\epsilon, d-1)]
\end{aligned}
$$

Problem of an unemployed worker

$$V^0 = b + \beta\alpha(\theta)V^t(\epsilon_e, 1) + \beta(1-\alpha(\theta))V^0$$

Law of motion for unemployment

$$U_t = U_{t-1} + \sum_{i=1}^{N^{pc}_{t-1}} (1 - g^{pc}_i(\epsilon, d)) + \sum_{i=1}^{N^{ppc}_{t-1}} (1 - g^{ppc}_i(\epsilon, d)) + \sum_{i=1}^{N^{tc}_{t-1}} (1 - g^{tc}_i(\epsilon, d)) - \alpha(\nu)U_{t-1}$$

# The model: wage determination

Bargaining surplus (e.g. in a permanent job)

$$S^{pc}(\epsilon, d) = [J^{pc}(\epsilon, d) - (J^0 - s^{pc}(\epsilon, d-1))] + [V^{pc}(\epsilon, d) - (V^0 + s^{pc}(\epsilon, d-1))]$$

Wages maximize:

$$[J^{pc}(\epsilon, d) - (J^0 - s^{pc}(\epsilon, d-1))]^{1-\pi}[V^{pc}(\epsilon, d) - (V^0 + s^{pc}(\epsilon, d-1))]^{\pi}$$

The first order conditions are:

$$(1-\pi)S^{pc}(\epsilon, d) = J^{pc}(\epsilon, d) + s^{pc}(\epsilon, d-1)$$

$$\pi S^{pc}(\epsilon, d) = V^{pc}(\epsilon, d) - (V^0 + s^{pc}(\epsilon, d-1))$$

# The model: wage determination

In equilibrium:

$$w^{pc}(\epsilon,d) = max\{w_{min} \quad , \quad \pi y(\epsilon)\Lambda(d) + (1-\pi)V^0 + s^{pc}(\epsilon,d-1) + \pi\beta\sum_{\epsilon\prime}\Gamma(\epsilon\prime|\epsilon)J^{pc}(\epsilon\prime,d\prime) - \beta(1-\pi)\sum_{\epsilon\prime}\Gamma(\epsilon\prime|\epsilon)V^{pc}(\epsilon\prime,d\prime)\}$$

$$w^{ppc}(\epsilon,d) = max\{w_{min} \quad , \quad \pi y(\epsilon)(1-\tau) + (1-\pi)V^0 + s^{t}(\epsilon,d-1) + \pi\beta\sum_{\epsilon\prime}\Gamma(\epsilon\prime|\epsilon)J^{p}(\epsilon\prime,d\prime) - \beta(1-\pi)\sum_{\epsilon\prime}\Gamma(\epsilon\prime|\epsilon)V^{p}(\epsilon\prime,d\prime)\}$$

$$w^{tc}(\epsilon,d) = max\{w_{min} \quad , \quad \pi y(\epsilon)(1-\gamma) + (1-\pi)V^0 + s^{t}(\epsilon,d-1) + \pi\beta\sum_{\epsilon\prime}\Gamma(\epsilon\prime|\epsilon)J^{t}(\epsilon\prime,d\prime) - \beta(1-\pi)\sum_{\epsilon\prime}\Gamma(\epsilon\prime|\epsilon)V^{t}(\epsilon\prime,d\prime)\}$$

# Equilibrium

A recursive equilibrium is a list of value functions $J^{pc}(\epsilon, d)$, $J^{ppc}(\epsilon, d)$, $J^{tc}(\epsilon, d)$, $V^{pc}(\epsilon, d)$, $V^{ppc}(\epsilon, d)$, $V^{tc}(\epsilon, d)$, $J^0$, $V^0$, transition rates $q(\nu)$, $\alpha(\nu)$, wages $w^{pc}(\epsilon, d)$, $w^{ppc}(\epsilon, d)$ and $w^{tc}(\epsilon, d)$, and decision rules $g^{pc}(\epsilon, d)$, $g^{ppc}(\epsilon, d)$, $g^{tc}(\epsilon, d)$ such that

1. **Optimality**: Given functions $q(\theta)$, $\alpha(\theta)$, $w^{pc}(\epsilon, d)$, $w^{ppc}(\epsilon, d)$ and $w^{tc}(\epsilon, d)$ the value functions $J^{pc}(\epsilon, d)$, $J^{ppc}(\epsilon, d)$, $J^{tc}(\epsilon, d)$, $V^{pc}(\epsilon, d)$, $V^{ppc}(\epsilon, d)$ and $V^{tc}(\epsilon, d)$ satisfy the Bellman equations.
2. **Free entry:** $J^0 = 0$, implying $c_v = \beta q(\theta) J^t(\epsilon_e, 1)$.
3. **Wage bargaining:** Equilibrium conditions from maximising the surplusin PCs, PPCs and TCs. For instance, in PCs:

$$(1 - \pi) S^{pc}(\epsilon, d) = J^{pc}(\epsilon, d) + s^{pc}(\epsilon, d - 1)$$
$$\pi S^{pc}(\epsilon, d) = V^{pc}(\epsilon, d) - (V^0 + s^{pc}(\epsilon, d - 1))$$

   In PPCs and TCs similar conditions hold.