Nominal and Real Wage Rigidities.
In Theory and in Europe

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Motivation

Nominal and real wage rigidities are key elements of macroeconomic models.

Definition (Blanchard, 2006): "Real wage rigidity" (RWR) captures the speed at which real wages adjust to changes in warranted real wages (i.e. $\omega_t = w_t - p_t = m_t^R$).

Importance:
- RWR plays a crucial role in the transmission mechanism and for the explanation of business cycle fluctuations (e.g. "Shimer puzzle").
- It breaks the "divine coincidence" (Blanchard and Galí, 2007) and thus reestablishes more realistic trade-offs for monetary policy.

Evidence: Abbritti and Weber (2008), 13 countries, 1990–1999, $\bar{\omega}$(qoq) RWR: 0.64, SD: 0.12, ranging from 0.43 (NLD) to 0.81 (IRL).
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Various reasons are offered for the existence of RWR:
• Unemployment benefits and wages react differently to changes in productivity growth (Blanchard and Katz, 1999)
• Social norms (Hall, 2005) and sequential (real) wage bargaining (Hall and Milgrom, 2008)
• Short-cut assumption (Blanchard and Galí, 2007):
  \[ \omega_t = \gamma \omega_{t-1} \quad \text{where} \quad \gamma \text{measures RWR.} \]

(In the literature \( \gamma \) is mostly chosen between 0.5 and 0.8.)

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The paper deals with a number of issues:

- Derive an explicit measure of RWR in a standard DSGE model with two nominal rigidities
- Discuss the impact of different modelling assumptions (e.g. Calvo vs. Taylor wage contracts, clustering of new wage agreements, indexation)
- Use information on cross-country differences in price and wage stickiness (cf. WDN survey) to calculate implied estimates of RWR
- Compare the size and cross-country variation of these model-based estimates with existing evidence:
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The dynamic equilibrium is determined by 5 equations (the notation follows Galí, 2008, chap. 6):

1. **NKPC (Prices):**
   \[ \pi_p(t) = \beta E_t \pi_p(t+1) + \kappa \tilde{y}_t + \lambda \tilde{\omega}_t \]  

2. **NKPC (Wages):**
   \[ \pi_w(t) = \beta E_t \pi_w(t+1) + \kappa \tilde{y}_t - \lambda \tilde{\omega}_t \]  

3. **IS-Curve:**
   \[ \tilde{y}_t = -\frac{1}{\sigma}(i_t - E_t \pi_p(t+1) - r_n) + E_t \tilde{y}_{t+1} \]  

4. **Monetary Policy Rule:**
   \[ i_t = \rho + \phi \pi_p(t+1) + \phi \pi_w(t+1) + \phi \tilde{y}_t + \nu_t \]  

5. **Definition of Real Wage:**
   \[ \tilde{\omega}_t = \tilde{\omega}_t - 1 + \pi_w(t) - \pi_p(t) - \Delta \omega_n(t) \]
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   \[ \tilde{\omega}_t = \tilde{\omega}_{t-1} + \pi_t^w - \pi_t^p - \Delta \omega_n^t, \]

where \( \tilde{y}_t \equiv y_t - y_n^t \) is the output gap and \( \tilde{\omega}_t \equiv \omega_t - \omega_n^t \) the real wage gap. Technology and interest rate shocks:

\[ a_t = \rho_a a_{t-1} + \varepsilon^a_t, \quad \nu_t = \rho \nu \nu_{t-1} + \varepsilon^\nu_t \]
Real wage rigidity in the EHL model
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Define real wage inflation: \( \pi^\omega_t \equiv \pi^w_t - \pi^p_t \), subtract (1) from (2):

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→ 2nd-order difference equation in $\omega_t$ that can be solved as:

$$\omega_t = \delta \omega_{t-1} + \delta (\kappa_w - \kappa_p) \sum_{s=0}^{\infty} (\beta \delta)^s E_t \tilde{y}_{t+s} + \delta (\lambda_w + \lambda_p) \sum_{s=0}^{\infty} (\beta \delta)^s E_t \omega^n_{t+s},$$

where:

$$\delta = 1 - \sqrt{1 - 4 \beta \tilde{\lambda}^2 \beta},$$

and $\tilde{\lambda} \equiv \frac{1}{1 + \beta + \lambda_w + \lambda_p}$.

With exogeneous output ($\tilde{y}_t = 0, \forall t$), real wages are flexible if either prices or wages are flexible ($\delta = 0$ if $\lambda_w \rightarrow \infty$ [$\theta_p = 0$] or $\lambda_p \rightarrow \infty$ [$\theta_w = 0$]).
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Real wage rigidity in the complete model
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- No closed form solution for RWR in the complete EHL model. The solutions have the form:

\[ \omega_t = \delta^* \omega_{t-1} + \psi_4 a_t + \psi_5 \tilde{y}_t + \psi_6, \]
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- The coefficient \(\delta^*\) is the measure of real wage rigidity in the EHL model
  - It is a useful summary measure that can be used to discuss the effect of different modelling assumptions and to make international comparisons
  - It is similar to \(\gamma\) in the short-cut formulation:
    \[
    \omega_t = \gamma \omega_{t-1} + (1 - \gamma) mrs_t
    \]
RWR and the impact of $\theta_p$ and $\theta_w$
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Basic time unit: one semester (instead of one quarter) $\rightarrow$
$\theta_p = 1/3$ (3 quarters), $\theta_w = 1/2$ (4 quarters)
Results 1 to 3

• Result 1: Nominal price and nominal wage rigidity give rise to RWR. Flexible prices ($\theta_p = 0$) or flexible wages ($\theta_w = 0$) imply zero real wage rigidity ($\delta^* = 0$).

• Result 2: RWR is primarily determined by $\theta_p$ and $\theta_w$. It is rather insensitive to the other structural parameters.

• Result 3: The solution can be written in the form of a traditional Phillips curve:

$$\pi_p t = \delta^* \pi_p t - 1 + f(\tilde{y}_t, \tilde{y}_t - 1, a_t, a_t - 1).$$

Similar to the "triangle" model (cf. Gordon, 1998). The degree of inflation persistence is the same as the degree of RWR.
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Calvo wage contracts are not in line with the evidence

There are 4 problems (cf. WDN):

• Most wage contracts have a fixed and predetermined length (no constant hazard rate of wage changes).
• Contract lengths are heterogeneous. Most are set for one year (60%) but some also for shorter periods (12%).
• There is wage indexation (15%).
• Contracting is clustered in certain months (30% in January).

These features can be better captured by a model with Taylor wage contracts.
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These features can be better captured by a model with **Taylor wage contracts**.
The EHL model with Taylor wage contracts

Assumptions:

- A share $\tau$ of wages is flexible while a share $(1 - \tau)$ is fixed for two semesters.
- Fixed wages in sector $A$ ($B$) are set in periods $t = 0, 2, \ldots$ ($t = 1, 3, \ldots$).
- The size of sector $A$ ($B$) is given by $s_A$ ($s_B = 1 - s_A$).
- A share $\gamma_w$ of fixed contracts are indexed to inflation.
- Prices are still set according to Calvo contracts.
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$$w_t^i = \frac{1}{1 + \varepsilon_w \varphi} \sum_{k=0}^{1} \frac{\beta^k}{1 + \beta} E_{t+k} \left\{ (1 + \varepsilon_w \varphi) w_{t+k} - \tilde{w}_{t+k} + \tilde{y}_{t+k} (\sigma + \frac{\varphi}{1 - \alpha}) \right\}$$
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 w_t &= (1 - \tau) \left( s^i w_t^i + s^{-i} \left( w_{t-1}^{i-1} + \gamma_w \pi_t \right) \right) + \tau \left( \omega_t^n + \left( \sigma + \frac{\varphi}{1 - \alpha} \right) \tilde{y}_t \right)
\end{align*}
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  - Even for symmetric sector sizes there is no a formulation where \( \bar{\omega}_t \) depends just on \( \bar{\omega}_{t-1}, a_t \) and \( \tilde{y}_t \).
  - For asymmetric sector sizes the (period-on-period) RWR differs between the two subperiods and depends on the sector that sets the new wage.
**RWR in the model with Taylor contracts**

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  - Even for **symmetric** sector sizes there is no a formulation where $\bar{\omega}_t$ depends just on $\bar{\omega}_{t-1}$, $a_t$ and $\tilde{y}_t$.
  - For **asymmetric** sector sizes the (period-on-period) RWR differs between the two subperiods and depends on the sector that sets the new wage.

- One can focus, however, on a **year-on-year measure** $\tilde{\delta}$ that is the same for both sectors. Annual RWR $\tilde{\delta}$ in the model with Taylor contracts corresponds to $(\delta^*)^2$ in the model with Calvo contracts.
RWR in the model with Calvo and Taylor wage contracts
(for $s_a = 1/2$, $\tau = 0$ and $\gamma_w = 0$)

Result 4: Taylor wage contracts imply a considerably lower degree of RWR than Calvo wage contracts.
RWR in the model with Calvo and Taylor wage contracts
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- **Result 4**: Taylor wage contracts imply a considerably lower degree of RWR than Calvo wage contracts.
Taylor wage contracts — asymmetric sector sizes
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- **Result 5**: Asymmetric sector sizes lower RWR.
Taylor wage contracts — fixed and flexible wages

Result 6: Higher shares of flexible wages lower RWR.
Taylor wage contracts — partial indexation

**Result 7**: Wage indexation increases RWR.
Evidence on price and wage stickiness

<table>
<thead>
<tr>
<th></th>
<th>Duration (in months)</th>
<th>Sector Size</th>
<th>Flexibility</th>
<th>Indexation</th>
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<tbody>
<tr>
<td>Prices Wages</td>
<td>A</td>
<td>τ</td>
<td>γ</td>
<td>w</td>
</tr>
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<td><strong>Austria (AUT)</strong></td>
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<td>13.9</td>
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<td>14.6</td>
<td>0.34</td>
<td>0.12</td>
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<td><strong>Estonia (EST)</strong></td>
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<td>12.7</td>
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<tr>
<td><strong>Hungary (HUN)</strong></td>
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<td>13.8</td>
<td>0.27</td>
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<td><strong>Lithuania (LTU)</strong></td>
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<td>11.4</td>
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<td><strong>Poland (POL)</strong></td>
<td>9.5</td>
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<td><strong>Slovenia (SVN)</strong></td>
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Price and wage stickiness is rather similar across countries. There is some clustering, indexation and flexibility.
Evidence on price and wage stickiness

Source: WDN survey (cf. Druant et al., 2009)

Price and wage stickiness is rather similar across countries. There is some clustering, indexation and flexibility.
Implied RWR in Europe
RWR in Europe under various assumptions
Summary of the results

• Average RWR: For Calvo contracts the average annual RWR is 0.35 (qoq ≈ 0.77). For (symmetric) Taylor contracts it is 0.17 (qoq ≈ 0.64). These values are broadly in line with empirical estimates (RWR (qoq): 0.64).

• Cross-country variation of RWR: For Calvo contracts RWR is mostly between 0.26 and 0.37 (SD: 0.04), for Taylor contracts between 0.13 and 0.21 (SD: 0.03). This variation is much smaller than in empirical data (SD: 0.13).

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Conclusions 1

• A standard New Keynesian model with sticky prices and sticky wages gives rise to RWR.
• The nominal rigidities are the main determinants behind the RWR. Flexible prices and/or wages are associated with zero RWR.
• The available information on price and wage stickiness implies a sizable degree of RWR that is broadly in line with (average) empirical evidence (for Calvo contracts). Calvo: 0.77, Taylor: 0.64, Data: 0.64.
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Conclusions 2
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- Wage-setting differs along other dimensions: indexation, heterogeneous contract lengths, clustering. Taking these factors into account increases the cross-country variation of RWR.
- Possible missing factors: wage norms (e.g. the role of wage leadership), price indexation (?), wage-price-links.
- Structure of the economy: Countries differ in terms of other (labor market and financial) institutions. These might interact with nominal rigidities to cause different degrees of aggregate RWR.
Clustering of wage contracts

• The measures of clustering $s_A$ are derived from the information about new wage agreements (average of $\%$ Jan-Jun, $\%$ Feb-Jul, $\%$ Aug-Jan, $\%$ Jun-Nov).

• Asymmetry is between $s_A = 0.19$ and $s_A = 0.47$. 