Job Creation and Investment in Imperfect Capital and Labor Markets

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Issues:

• What is the effect of liquidity constraints faced by firms
  – on job creation?
  – on the choice of the type of contract?

• To what extent capital market imperfections rein-
  force labor market imperfections to produce a low job creation?
• Capital Market imperfections

• Labor Market imperfections

• Structural Estimation of a model in which these issues are analyzed jointly

• Policy simulations
Data

Central de Balances del Banco de España - CBBE.

Of 19473 firms $\rightarrow$ 1380 remain in the sample.

Of 94192 obs. $\rightarrow$ 12336 remain in the sample.

Excluded firms:

- non-manufacture;
- that change activity;
- that merge or split.

Remain: 27704 observations of 3005 firms.

Also excluded: Firms with:

- value of production $\leq 0$;
- value of net purchases $\leq 0$;
- net material assets (IMN) $\leq 0$;
- gross capital formation $\leq 0$;
- total alien resources - providers $\leq 0$.

- gross value added $\leq 0$;
- value of own resources $\leq 0$;
- cumulative downpayment $\leq 0$;
- IMN grows more than three times its value;
Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>All Mean</th>
<th>St. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>12336</td>
<td></td>
</tr>
<tr>
<td>Capital $K$</td>
<td>881.86</td>
<td>4259.61</td>
</tr>
<tr>
<td>Permanent Labor $H$</td>
<td>185.62</td>
<td>866.52</td>
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<tr>
<td>Temporary Labor $L$</td>
<td>20.36</td>
<td>57.65</td>
</tr>
<tr>
<td>Debt $B$</td>
<td>445.27</td>
<td>2428.87</td>
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</table>

Ratios

<table>
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<tr>
<th>Ratio</th>
<th>Mean</th>
<th>St. Dev.</th>
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<tr>
<td>$B/K$</td>
<td>0.505</td>
<td>0.649</td>
</tr>
<tr>
<td>$K/N$</td>
<td>4.281</td>
<td>5.200</td>
</tr>
<tr>
<td>$B/N$</td>
<td>2.162</td>
<td>3.013</td>
</tr>
<tr>
<td>$L/N$</td>
<td>0.099</td>
<td>0.160</td>
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</table>

Growth (in %)

<table>
<thead>
<tr>
<th>Growth Rate</th>
<th>Mean</th>
<th>St. Dev.</th>
</tr>
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<tbody>
<tr>
<td>$g^K = \Delta K/K$</td>
<td>18.93</td>
<td>14.40</td>
</tr>
<tr>
<td>$g^N = \Delta N/N$</td>
<td>-0.57</td>
<td>12.53</td>
</tr>
<tr>
<td>$\Delta H/H$</td>
<td>-1.36</td>
<td>12.03</td>
</tr>
<tr>
<td>$\Delta L/L$</td>
<td>3.45</td>
<td>67.68</td>
</tr>
</tbody>
</table>

Note 1: Total Labor: $N = (H + L)$.

Note 2: With the exception of labor, all data are given in million pesetas of 1987.
### Structure of the Panel

<table>
<thead>
<tr>
<th>Year</th>
<th>Obs.</th>
<th>Freq.</th>
<th>Cumulative</th>
</tr>
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<tbody>
<tr>
<td>1983</td>
<td>495</td>
<td>4.01</td>
<td>4.01</td>
</tr>
<tr>
<td>1984</td>
<td>609</td>
<td>4.94</td>
<td>8.95</td>
</tr>
<tr>
<td>1985</td>
<td>745</td>
<td>6.04</td>
<td>14.99</td>
</tr>
<tr>
<td>1986</td>
<td>939</td>
<td>7.61</td>
<td>22.60</td>
</tr>
<tr>
<td>1987</td>
<td>1048</td>
<td>8.50</td>
<td>31.10</td>
</tr>
<tr>
<td>1988</td>
<td>1062</td>
<td>8.61</td>
<td>39.70</td>
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<tr>
<td>1989</td>
<td>1060</td>
<td>8.59</td>
<td>48.30</td>
</tr>
<tr>
<td>1990</td>
<td>1024</td>
<td>8.30</td>
<td>56.60</td>
</tr>
<tr>
<td>1991</td>
<td>966</td>
<td>7.83</td>
<td>64.43</td>
</tr>
<tr>
<td>1992</td>
<td>956</td>
<td>7.75</td>
<td>72.18</td>
</tr>
<tr>
<td>1993</td>
<td>925</td>
<td>7.50</td>
<td>79.68</td>
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<td>1994</td>
<td>873</td>
<td>7.08</td>
<td>86.75</td>
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<tr>
<td>1995</td>
<td>859</td>
<td>6.96</td>
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<tr>
<td>1996</td>
<td>775</td>
<td>6.28</td>
<td>100.00</td>
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</table>

Total 12336 100.00

### Balance of the Panel

<table>
<thead>
<tr>
<th>Obs. by firm</th>
<th>Obs.</th>
<th>%</th>
<th>Cum.</th>
<th>Firms</th>
<th>%</th>
<th>Cum.</th>
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<td>1140</td>
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<td>9.24</td>
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<td>16.52</td>
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<td>195</td>
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<td>30.65</td>
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<td>7</td>
<td>819</td>
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<td>25.36</td>
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<td>39.13</td>
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<td>8</td>
<td>1088</td>
<td>8.82</td>
<td>34.18</td>
<td>136</td>
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<td>48.99</td>
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<td>1089</td>
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<td>8.77</td>
<td>57.75</td>
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<tr>
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<td>66.67</td>
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<tr>
<td>11</td>
<td>1397</td>
<td>11.32</td>
<td>64.31</td>
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<td>95</td>
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<td>13</td>
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<td>87.75</td>
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<td>14</td>
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<td>100.00</td>
<td>169</td>
<td>12.25</td>
<td>100.00</td>
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</table>

Total 12336 100.00 1380 100.00
Flexible (temporary) workers over the labor force (%) by year and firm’s size

<table>
<thead>
<tr>
<th>Year</th>
<th>[0, 50]</th>
<th>(50, 100]</th>
<th>(100, 500]</th>
<th>(500, 1000]</th>
<th>1000+</th>
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<tr>
<td>1983</td>
<td>4.67</td>
<td>7.12</td>
<td>5.14</td>
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<td>1.76</td>
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<td>1984</td>
<td>6.19</td>
<td>5.71</td>
<td>5.91</td>
<td>4.62</td>
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<tr>
<td>1985</td>
<td>7.23</td>
<td>8.13</td>
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<td>11.46</td>
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<td>10.92</td>
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<td>7.86</td>
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<td>1988</td>
<td>12.22</td>
<td>15.83</td>
<td>13.91</td>
<td>15.29</td>
<td>5.01</td>
<td>10.35</td>
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<td>1989</td>
<td>16.32</td>
<td>15.42</td>
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<td>15.82</td>
<td>8.38</td>
<td>12.63</td>
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<td>1990</td>
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<td>13.46</td>
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<td>17.59</td>
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<td>1992</td>
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<td>23.71</td>
<td>18.60</td>
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<td>13.97</td>
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<td>19.68</td>
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<tr>
<td>Total</td>
<td>15.71</td>
<td>16.43</td>
<td>13.74</td>
<td>13.06</td>
<td>4.71</td>
<td>9.88</td>
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## Debt-Capital ratio by year and firm’s size

<table>
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<tr>
<th>Year</th>
<th>[0, 50]</th>
<th>(50, 100]</th>
<th>(100, 500]</th>
<th>(500, 1000]</th>
<th>1000+</th>
<th>Total</th>
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<tbody>
<tr>
<td>1983</td>
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<td>.5579</td>
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<td>.4078</td>
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<td>.6911</td>
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<td>.3148</td>
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<td>.3625</td>
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<tr>
<td>Total</td>
<td>.5682</td>
<td>.7218</td>
<td>.5209</td>
<td>.5412</td>
<td>.4600</td>
<td>.5049</td>
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</table>
Model

The objective function of the firm is

$$\max_{\{K_t\}_{t=1}^\infty, \{H_t\}_{t=0}^\infty, \{L_t\}_{t=0}^\infty, \{B_t\}_{t=1}^\infty} \sum_{t=0}^\infty \frac{ED_t}{(1 + \rho)^t}$$

Dividends.

$$D = \theta K^\alpha (H^\gamma + \lambda L^\gamma)^{\beta \gamma} - I - w_H H - c(H_{-1}, H)$$

$$-w_L L - (1 + r) B + B',$$

Capital accumulation:

$$K' = (1 - \delta_k) K + I,$$

Labor adjustment cost:

$$c(H_{-1}, H) = C \max [(H_t - (1 - \delta_h) H_{t-1}), 0]$$

$$-F \min [(H_t - (1 - \delta_h) H_{t-1}), 0]$$
Constraints: Nonnegative dividends:

\[ D \geq 0. \] (1)

Nonnegative debt:

\[ B' \geq 0. \] (2)

Endogenous interest rate:

\[ G (r') = (1 - \pi) (1 + r') B' - (1 + \rho) B' = 0 \]

Bellman Eq.

\[ V (K, H_{-1}, (1 + r) B, \theta) = \]

\[
\max_{K', H, L, B'} \left\{ \theta K^\alpha (H^\gamma + \lambda L^\gamma)^{\frac{\beta}{\gamma}} + (1 - \delta) K - K' \\
- w_H H - c(H_{-1}, H) - w_L L - (1 + r) B + B' \\
+ \frac{1}{1 + \rho} E \max [V (K', H, (1 + r') B', \theta'), 0] \right\}
\]

subject to (1), and (2).
Exit:

Threshold shock:

\[ \overline{\theta} = \{ \theta \mid V(K, (1 + r) B, H_{-1}, \theta) = 0 \} \]

Exit rule

\[ \text{if } \theta' \geq \overline{\theta}', \text{ the firm stays; } \]
\[ \text{if } \theta' < \overline{\theta}', \text{ the firm exits.} \]

Probability of survival \[ \pi = \Pr(\theta' > \overline{\theta'}|\theta) = 1 - \Phi(\kappa') \]

where \[ \kappa' = \frac{\theta' - \gamma \theta - \mu}{\sigma} \]

Comparative statics:

\[ \frac{\theta_K}{V_\theta} = -\frac{V_K}{V_\theta} < 0; \quad \frac{\theta_B}{V_\theta} = -\frac{V_{(1+r)B}}{V_\theta} (1 + r) > 0; \]
\[ \frac{\theta_r}{V_\theta} = -\frac{V_{(1+r)B}}{V_\theta} B > 0; \quad \frac{\theta_{H-1}}{V_\theta} = -\frac{V_{H-1}}{V_\theta} \leq 0; \]
Interest rate

Firm-specific interest rate:

\[
\begin{align*}
    r' \left( K', H, B', \theta \right) &= \left\{ r' \mid G\left(r'\right) = 0 \right\}. \quad (3)
\end{align*}
\]

Comparative statics:

\[
\begin{align*}
    r'_{K'} &= \theta'_{K'} \gamma < 0; \\
    r'_{B'} &= \theta'_{B'} \gamma > 0; \\
    r'_{H} &= \theta'_{H} \gamma \geq 0;
\end{align*}
\]

\[
\gamma = \frac{\lambda \left( \kappa' \right) \left( 1 + r' \right)}{1 - \lambda \left( \kappa' \right) \left( 1 + r' \right) \theta'_{r'}} \leq 0, \\
\lambda \left( \kappa' \right) = \frac{\frac{1}{\sigma} \phi \left( \kappa' \right)}{1 - \Phi \left( \kappa' \right)} > 0
\]
Optimal policy

Lagrange equation:

\[
Z = (1 + y_D) \left[ \theta K^\alpha (H^\gamma + \lambda L^\gamma)^{\frac{\beta}{\gamma}} + (1 - \delta)K - K' \right] \\
-w_H H - c(H_{-1}, H) - w_LL - (1 + r)B + B' \\
+ \frac{1}{1 + \rho} \int \max [V(K', H, (1 + r') B', \theta'), 0] \, dP (\theta'|\theta) + y_B B'
\]

First order conditions:

\[Z_{K'} = 0, Z_H = 0, Z_{B'} = 0, Z_L = 0,\]

\[Z_{y_D} = 0, Z_{y_B} = 0\]

Flexible Labor:

\[
L(\theta, K, H) = \left\{ L \left| \beta \lambda \theta K^\alpha (H^\gamma + \lambda L^\gamma)^{\frac{\beta}{\gamma}-1} L^{\gamma-1} - w_L = 0 \right. \right\}.
\]
**Rigid Labor.** - The first order condition, \( Z_H = 0 \), holds only if the firm adjusts \( H \).

The firm adjusts

\[
H > (1 - \delta_h) H_{-1}, \text{ if } Z_{HC} = 0 \text{ and } Z_{HF} > 0, \text{ and }
\]

\[
H < (1 - \delta_h) H_{-1}, \text{ if } Z_{HF} = 0 \text{ and } Z_{HC} < 0;
\]

does not adjust

\[
H = (1 - \delta_h) H_{-1}, \text{ if } Z_{HC} \geq 0 \text{ and } Z_{HF} \leq 0.
\]
**Capital and debt.**- Let

\[ x = \theta K^\alpha (H^\gamma + \lambda L^\gamma)^\beta + (1 - \delta)K \]

\[ -w_HH - c(H_{-1}, H) - w_LL - (1 + r)B \]  

**Three regimes.**

<table>
<thead>
<tr>
<th></th>
<th>Regime I</th>
<th>Regime II</th>
<th>Regime III</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y_D )</td>
<td>( y_D &gt; 0 )</td>
<td>( y_D &gt; 0 )</td>
<td>( y_D = 0 )</td>
</tr>
<tr>
<td>( y_{B'} )</td>
<td>( y_{B'} = 0 )</td>
<td>( y_{B'} &gt; 0 )</td>
<td>( y_{B'} &gt; 0 )</td>
</tr>
<tr>
<td>1. ( D = 0 )</td>
<td>( D = 0 )</td>
<td>( B' = 0 )</td>
<td></td>
</tr>
<tr>
<td>2. ( \tilde{EV}<em>{K'} = -\tilde{EV}</em>{B'} )</td>
<td>( B' = 0 )</td>
<td>( \tilde{EV}_{K'} = 1 + \rho )</td>
<td></td>
</tr>
<tr>
<td>3. Adj ( D_H \tilde{EV}_{B'} = -\tilde{EV}_H )</td>
<td>( D_H \tilde{EV}_{K'} = -\tilde{EV}_H )</td>
<td>( \tilde{EV}_H = -D_H (1 + \rho) )</td>
<td></td>
</tr>
<tr>
<td>3. No adj ( L )</td>
<td>( \text{Eq (4)} )</td>
<td>( H = (1 - \delta_h) H_{-1} )</td>
<td></td>
</tr>
<tr>
<td>( H )</td>
<td>( H^I )</td>
<td>( H^{II} )</td>
<td>( H^{III} (H_{-1}, \theta) )</td>
</tr>
<tr>
<td>( x )</td>
<td>( x &lt; K^{II} )</td>
<td>( K^{II} \leq x &lt; K^{III} )</td>
<td>( x \geq K^{III} )</td>
</tr>
<tr>
<td>( K' )</td>
<td>( K^I )</td>
<td>( x )</td>
<td>( K^{III} (H_{-1}, \theta) )</td>
</tr>
<tr>
<td>( B' )</td>
<td>( K^I - x )</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

\[ K' (K, H_{-1}, (1 + r)B, \theta) = \]

\[
\min \left( \max \left( K^I (K, H_{-1}, (1 + r)B, \theta), x \right), K^{III} (H_{-1}, \theta) \right).
\]

\[ B' = \max \left( K' (K, H_{-1}, (1 + r)B, \theta) - x, 0 \right). \]
Solve problem in Two stages:

1. Capital and debt

\[ W(x, \theta | H) = \max_{K'} \left\{ \max (x - K', 0) \right\} \]

\[ + \frac{1}{1 + \rho} \mathbb{E} \max \left[ V(K', H, (1 + r')B', \theta'), 0 \right] \]

and \( B' = \max (-x + K', 0) \),

Result: \( K'(x, \theta | H), B'(x, \theta | H) \)

2. Rigid and flexible labor

\[ V(K, H_{-1}, (1 + r)B, \theta) = \max_H W(x, \theta | H) \cdot \]

and \( L = L(\theta, K, H) \).

Unanticipated change

No flexible labor : \( t \leq 1984 \)

Flexible labor : \( t > 1984 \)
**Estimation**

Use policy rules in a log-likelihood function

\[
\ln \mathcal{L}(\Theta) = \sum_{i=1}^{N} \ln \mathcal{L}_i \left( \{K_{it}^{obs}, B_{it}^{obs}\}_{t=2}^{T_i}, \{H_{it}^{obs}, L_{it}^{obs}\}_{t=1}^{T_i} | K_i^{obs}, B_i^{obs}, \Theta \right)
\]

\[
= \sum_{i=1}^{N} \sum_{t=1}^{T_i} \ln \mathcal{L}_{it}.
\]

Problem: There may no exist a shock \( \theta \) that produces coincidence between observables and predictions

Solutions:

- Choice-specific shock,
  typically coming from an extreme value dbn (Rust)

- Measurement error (Wolpin)

Here: Prediction error
Likelihood contribution for each period:

$$L_{it} = \hat{\psi}_{it} \frac{1}{\sigma} \phi \left( \frac{\theta_t - \gamma \theta_{t-1} - \mu}{\sigma} \right), \ 1 \leq t \leq T_i$$

$$\psi_{it} = \frac{1}{\sigma_K} \phi \left( \frac{K_{t+1}^{obs} - K_{t+1}}{\sigma_K} \right) \frac{1}{\sigma_B} \phi \left( \frac{B_{t+1}^{obs} - B_{t+1}}{\sigma_B} \right)$$
$$\psi_{it} = \frac{1}{\sigma_H} \phi \left( \frac{H_{t}^{obs} - H_{t}}{\sigma_H} \right) \frac{1}{\sigma_L} \phi \left( \frac{L_{t}^{obs} - L_{t}}{\sigma_L} \right), \ t \leq T_i$$

$$\hat{\psi}_{it} = \max_{H_0, \theta_0, \theta_1} \psi_{it}, \ t = t_0$$

$$\hat{\psi}_{it} = \max_{\theta_t} \psi_{it}, \ t_0 < t \leq T_i$$

$$\hat{\psi}_{it} = \max_{\theta_t} \psi_{it}, \ t = T_i$$

Parameter set:

$$\Theta = \{ \alpha, \beta, \delta, \gamma, \lambda, \rho, w_H, w_L, C, F, \phi, \mu, \sigma, \sigma_K, \sigma_H, \sigma_L, \sigma_B \}$$


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### Production function

- $\alpha$ 0.25365394
- $\beta$ 0.50425521
- $\gamma$ 0.65514275
- $\lambda$ 0.18393705

### Depreciation

- $\delta_k$ 0.15292158
- $\delta_h$ 0.01191726

### Wages

- $w_h$ 2.05674331
- $w_l$ 0.68865286

### Adjustment Costs

- $F$ 8.93248403
- $C$ 0.02795131

### Riskless interest rate

- $\rho$ 0.03858822

### Stochastic Process

- $\phi$ 0.89086358
- $\mu$ 1.32291501
- $\sigma$ 2.62944907

### Prediction Errors (*

- $\sigma_K$ 103.15163997
- $\sigma_B$ 52.77465823
- $\sigma_H$ 30.98753267
- $\sigma_L$ 31.97329201

### Borrowing Constraint (*

- $s$ 0.00000000

### Log-Likelihood

- $-\ln L$ 274863.58983350

(*) Constrained
Figure 1: Actual and Predicted Variables
2a: Debt ratio

Year | Actual | Predicted
--- | --- | ---
1984 | 0.387174 |  
1986 | 0.783929 |  
1988 | 0.387174 |  
1990 | 0.247376 |  
1992 | 0.055777 |  
1994 | 0.055777 |  
1996 | 0.055777 |  

2b: Temporary Labor ratio

Year | Actual | Predicted
--- | --- | ---
1984 | 0.055777 |  
1986 | 0.247376 |  
1988 | 0.055777 |  
1990 | 0.055777 |  
1992 | 0.055777 |  
1994 | 0.055777 |  
1996 | 0.055777 |  

2a: Debt ratio

2b: Temporary Labor ratio
Policy Experiments

The estimation allows to recover a sequence of “true” shocks and “true” observables:

\[
\{\theta_{it}\}_{t=0}^{T}, \{K_{it}\}_{t=1}^{T}, \{B_{it}\}_{t=1}^{T}, \{H_{it}\}_{t=0}^{T}, \{L_{it}\}_{t=1}^{T}
\]

Instead of simulating shocks, one can use the sequence of “true” shocks in performing policy experiments:

1. No flexible labor

2. Full labor market liberalization: C=F=0

3. Full capital market liberalization

   • only rigid labor,

   • rigid and flexible labor.

4. Both liberalizations
Figure 2: Counterfactual: No Flexible Labor
Figure 3: Counterfactual: No Hiring and Firing Costs