Job Creation and Investment in Imperfect Capital and Labor Markets

http://www.eco.uc3m.es/~srendon

Sílvio Rendon

May 2003

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 reinforce labor market imperfections to produce a low job creation?

- Capital Market imperfections
  - in Spain: Alonso-Borrego and Bentolila (1994), Estrada and Vallés (1995)
- Labor Market imperfections
  - in Spain: Bentolila and Saint-Paul (1992), Bover, Arellano and Bentolila (1997), Alonso-Borrego and Aguirregabiria (1998),
- 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 –> 1380 remain in the sample.

Of 94192 obs. –> 12336 remain in the sample.

Excluded firms:

- non-manufacture;
- that change activity;
- that merge or split.
- public;
- that have less than five observations

Remain: 27704 observations of 3005 firms.

Also excluded: Firms with:

- value of production ≤ 0;
- value of net purchases ≤ 0;
- net material assets (IMN) ≤ 0;
- gross capital formation ≤ 0;
- total alien resources - providers ≤ 0.
- gross value added ≤ 0;
- value of own resources ≤ 0;
- cumulative downpayment ≤ 0;
- IMN grows more than three times its value;

Descriptive Statistics

Variable		All Mean	All St. Dev.
Observations		12336	
Capital	K	881.86	4259.61
Permanent Labor	H	185.62	866.52
Temporary Labor	L	20.36	57.65
Debt	B	445.27	2428.87
Ratios			
B/K		0.505	0.649
K/N		4.281	5.200
B/N		2.162	3.013
L/N		0.099	0.160
Growth (in %)			
$g^K = \Delta K/K$		18.93	14.40
$g^N = \Delta N/N$		-0.57	12.53
$\Delta H/H$		-1.36	12.03
$\Delta L/L$		3.45	67.68

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

Year	Obs.	Freq.	Cumulative
1983	495	4.01	4.01
1984	609	4.94	8.95
1985	745	6.04	14.99
1986	939	7.61	22.60
1987	1048	8.50	31.10
1988	1062	8.61	39.70
1989	1060	8.59	48.30
1990	1024	8.30	56.60
1991	966	7.83	64.43
1992	956	7.75	72.18
1993	925	7.50	79.68
1994	873	7.08	86.75
1995	859	6.96	93.72
1996	775	6.28	100.00
Total	12336	100.00	

Balance of the Panel

Obs. by firm	Obs.	%	Cum.	Firms	%	Cum.
5	1140	9.24	9.24	228	16.52	16.52
6	1170	9.48	18.73	195	14.13	30.65
7	819	6.64	25.36	117	8.48	39.13
8	1088	8.82	34.18	136	9.86	48.99
9	1089	8.83	43.01	121	8.77	57.75
10	1230	9.97	52.98	123	8.91	66.67
11	1397	11.32	64.31	127	9.20	75.87
12	1140	9.24	73.55	95	6.88	82.75
13	897	7.27	80.82	69	5.00	87.75
14	2366	19.18	100.00	169	12.25	100.00
Total	12336	100.00		1380	100.00	

Flexible (temporary) workers over the labor force (%) by year and firm's size

Year	Workers per firm					
	$[0, 50]$	$(50, 100]$	$(100, 500]$	$(500, 1000]$	$1000+$	Total
1983	4.67	7.12	5.14	4.20	1.76	3.39
1984	6.19	5.71	5.91	4.62	2.20	3.95
1985	7.23	8.13	6.81	9.26	0.98	4.55
1986	8.51	9.17	9.11	9.80	2.09	6.39
1987	11.46	10.70	10.92	9.31	4.13	7.86
1988	12.22	15.83	13.91	15.29	5.01	10.35
1989	16.32	15.42	16.31	15.82	8.38	12.63
1990	16.07	19.58	17.10	13.46	7.58	12.78
1991	17.59	21.12	17.88	16.83	5.47	12.49
1992	19.31	23.71	18.60	17.64	7.10	13.97
1993	20.61	21.24	16.93	13.23	5.58	11.92
1994	21.46	21.62	17.43	15.25	5.25	11.92
1995	22.21	22.33	19.68	15.50	5.08	12.41
1996	21.51	23.14	19.79	18.69	4.42	12.35
Total	15.71	16.43	13.74	13.06	4.71	9.88

Debt-Capital ratio by year and firm's size

Year	Workers per firm					
	$[0,50]$	$(50,100]$	$(100,500]$	$(500,1000]$	$1000+$	Total
1983	.3765	.5579	.5199	.6093	.6940	.6264
1984	.5335	.8327	.5652	.6994	.8411	.7387
1985	.5246	1.0306	.6280	.7029	.7610	.7161
1986	.6243	.9394	.5176	.6263	.6280	.6083
1987	.5722	.7466	.5278	.5843	.5899	.5759
1988	.6219	.8073	.4918	.5764	.3738	.4658
1989	.5585	.7538	.5334	.4636	.2644	.4167
1990	.5152	.6149	.5273	.6644	.3548	.4695
1991	.5900	.6352	.5418	.5053	.3718	.4679
1992	.5654	.7276	.5812	.5632	.3280	.4661
1993	.6059	.6853	.5627	.5605	.4119	.4960
1994	.5535	.6866	.5131	.4723	.2969	.4078
1995	.5948	.6911	.4287	.4659	.3231	.4019
1996	.6012	.6034	.3479	.3148	.3277	.3625
Total	.5682	.7218	.5209	.5412	.4600	.5049

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.

$$\begin{aligned} D &= \theta K^{\alpha}\left(H^{\gamma}+\lambda L^{\gamma}\right)^{\frac{\beta}{\gamma}} - I - w_H H - c(H_{-1}, H) \\ &\quad - w_L L - (1+r)B + B', \end{aligned}$$

Capital accumulation:

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

Labor adjusment cost:

$$\begin{aligned} c(H_{-1}, H) &= C \max\left[\left(H_t - (1-\delta_h)\, H_{t-1}\right), 0\right] \\ &\quad - F \min\left[\left(H_t - (1-\delta_h)\, H_{t-1}\right), 0\right] \end{aligned}$$

Constraints: Nonnegative dividends:

$$D \geq 0. \tag{1}$$

Nonnegative debt:

$$B' \geq 0. \tag{2}$$

Endogenous interest rate:

$$G\left(r'\right) = \left(1 - \pi\right)\left(1 + r'\right)B' - \left(1 + \rho\right)B' = 0$$

Bellman Eq.

$$V\left(K, H_{-1}, \left(1 + r\right)B, \theta\right) =$$

$$\max_{K', H, L, B'} \Big\{ \theta K^{\alpha}\left(H^{\gamma} + \lambda L^{\gamma}\right)^{\frac{\beta}{\gamma}} + (1 - \delta)K - K'$$

$$- w_H H - c(H_{-1}, H) - w_L L - (1 + r)B + B'$$

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

subject to (1), and (2).

Exit:

Threshold shock:

$$\underline{\theta} = \{\theta \,|V\,(K, (1 + r)\,B, H_{-1}, \theta) = 0\}$$

Exit rule

$$\text{if } \theta' \;\geq\; \underline{\theta}', \qquad \text{the firm stays;}$$

$$\text{if } \theta' \;<\; \underline{\theta}' \qquad \text{the firm exits.}$$

Probability of survival $\pi = \Pr(\theta' > \underline{\theta}'|\theta) = 1 - \Phi\,(\kappa')$,

where $\kappa' = \frac{\underline{\theta}' - \gamma\theta - \mu}{\sigma}$

Comparative statics:

$$\underline{\theta}_K \;=\; -\frac{V_K}{V_\theta} < 0; \qquad \underline{\theta}_B = -\frac{V_{(1+r)B}}{V_\theta}\,(1 + r) > 0;$$

$$\underline{\theta}_r \;=\; -\frac{V_{(1+r)B}}{V_\theta} B > 0; \qquad \underline{\theta}_{H_{-1}} = -\frac{V_{H_{-1}}}{V_\theta} \lesseqqgtr 0;$$

Interest rate

Firm-specific interest rate:

$$r'\left(K', H, B', \theta\right) = \left\{ r' \middle| G(r') = 0 \right\}. \qquad (3)$$

Comparative statics:

$$r'_{K'} = \underline{\theta}'_{K'} \Upsilon < 0; \qquad r'_{B'} = \underline{\theta}'_{B'} \Upsilon > 0;$$

$$r'_{H} = \underline{\theta}'_{H} \Upsilon \lesseqqgtr 0;$$

$$\Upsilon = \frac{\lambda(\kappa')(1+r')}{1-\lambda(\kappa')(1+r')\underline{\theta}'_{r'}} \geq 0,$$

$$\lambda(\kappa') = \frac{\frac{1}{\sigma}\phi(\kappa')}{1-\Phi(\kappa')} > 0$$

Optimal policy

Lagrange equation:

$$Z = (1 + y_D) \left[\theta K^{\alpha} \left(H^{\gamma} + \lambda L^{\gamma} \right)^{\frac{\beta}{\gamma}} + (1 - \delta) K - K' \right.$$

$$\left. - w_H H - c(H_{-1}, H) - w_L L - (1 + r) B + B' \right]$$

$$+ \frac{1}{1 + \rho} \int \max \left[V(K', H, (1 + r') B', \theta'), 0 \right] dP \left(\theta' | \theta \right) + y_B B'$$

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.-

$$L(\theta, K, H) = \left\{ L \left| \beta \lambda \theta K^{\alpha} \left(H^{\gamma} + \lambda L^{\gamma} \right)^{\frac{\beta}{\gamma} - 1} L^{\gamma - 1} - w_L = 0 \right. \right\}. \tag{4}$$

Rigid Labor.- The first order condition, $Z_H = 0$, holds only if the firm adjusts H.

The firm adjusts

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

$H\ <\ (1-\delta_h)\,H_{-1}$, if $Z_{HF}=0$ 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

$$x = \theta K^{\alpha} \left(H^{\gamma} + \lambda L^{\gamma}\right)^{\frac{\beta}{\gamma}} + (1-\delta)K \qquad (5)$$

$$-w_H H - c(H_{-1}, H) - w_L L - (1+r)B$$

Three regimes.

	Regime I	Regime II	Regime III
y_D	$y_D > 0$	$y_D > 0$	$y_D = 0$
$y_{B'}$	$y_{B'} = 0$	$y_{B'} > 0$	$y_{B'} > 0$
1.	$D = 0$	$D = 0$	$B' = 0$
2.	$\widetilde{E}V_{K'} = -\widetilde{E}V_{B'}$	$B' = 0$	$\widetilde{E}V_{K'} = 1 + \rho$
3. Adj	$D_H \widetilde{E}V_{B'} = -\widetilde{E}V_H$	$D_H \widetilde{E}V_{K'} = -\widetilde{E}V_H$	$\widetilde{E}V_H = -D_H (1+\rho)$
3. No adj		$H = (1-\delta_h) H_{-1}$	
L		Eq (4)	
H	H^I	H^{II}	$H^{III}(H_{-1}, \theta)$
x		Eq(5)	
x	$x < K^{II}$	$K^{II} \leq x < K^{III}$	$x \geq K^{III}$
K'	K^I	x	$K^{III}(H_{-1}, \theta)$
B'	$K^I - x$	0	0

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

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

$$B' = \max\left(K'(K, H_{-1}, (1+r)B, \theta) - x, 0\right).$$

Solve problem in Two stages:

1. Capital and debt

$$W(x,\theta|H) = \max_{K'} \Big\{ \max(x-K',0) + \frac{1}{1+\rho} E \max\left[V(K',H,(1+r')B',\theta'),0\right] \Big\}$$

and $B^{'} = \max(-x+K',0)$,

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

2. Rigid and flexible labor

$$V(K,H_{-1},(1+r)B,\theta) = \max_{H} W(x,\theta|H).$$

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

Unanticipated change

$$\text{No flexible labor} : t \leq 1984$$

$$\text{Flexible labor} : t > 1984$$

Estimation

Use policy rules in a log-likelihood function

$$\ln \mathcal{L}(\Theta) = \sum_{i=1}^{N} \ln \mathcal{L}_i \left(\left\{ K_{it}^{obs}, B_{it}^{obs} \right\}_{t=2}^{T_i}, \left\{ H_{it}^{obs}, L_{it}^{obs} \right\}_{t=1}^{T_i} | K_{i1}^{obs}, B_{i1}^{obs}, \Theta \right) = \sum_{i=1}^{N} \sum_{t=1}^{T_i} \ln \mathcal{L}_{it}.$$

Problem: There may no exist a shock θ 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:

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

$$\begin{aligned}
\psi_{it} &= \frac{1}{\sigma_K}\phi\left(\frac{K_{t+1}^{obs} - K_{t+1}}{\sigma_K}\right)\frac{1}{\sigma_B}\phi\left(\frac{B_{t+1}^{obs} - B_{t+1}}{\sigma_B}\right) \\
&\quad \frac{1}{\sigma_H}\phi\left(\frac{H_t^{obs} - H_t}{\sigma_H}\right)\frac{1}{\sigma_L}\phi\left(\frac{L_t^{obs} - L_t}{\sigma_L}\right), t \leq T_i \\
\psi_{it} &= \frac{1}{\sigma_H}\phi\left(\frac{H_t^{obs} - H_t}{\sigma_H}\right)\frac{1}{\sigma_L}\phi\left(\frac{L_t^{obs} - L_t}{\sigma_L}\right), t = T_i \\
\widehat{\psi}_{it} &= \max_{H_0,\theta_0,\theta_1} \psi_{it}, t = t_0 \\
\widehat{\psi}_{it} &= \max_{\theta_t} \psi_{it}, t_0 < t \leq T_i \\
\widehat{\psi}_{it} &= \max_{\theta_t} \psi_{it}, t = T_i
\end{aligned}$$

Parameter set:

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

Parameter Estimates

Parameters	
Production function	
α	0.25365394
β	0.50425521
γ	0.65514275
λ	0.18393705
Depreciation	
δ_k	0.15292158
δ_h	0.01191726
Wages	
w_h	2.05674331
w_l	0.68865286
Adjustment Costs	
F	8.93248403
C	0.02795131
Riskless interest rate	
ρ	0.03858822
Stochastic Process	
ϕ	0.89086358
μ	1.32291501
σ	2.62944907
Prediction Errors (*)	
σ_K	103.15163997
σ_B	52.77465823
σ_H	30.98753267
σ_L	31.97329201
Borrowing Constraint (*)	
s	0.00000000
Log-Likelihood	
$-\ln \mathcal{L}$	274863.58983350

(*) Constrained

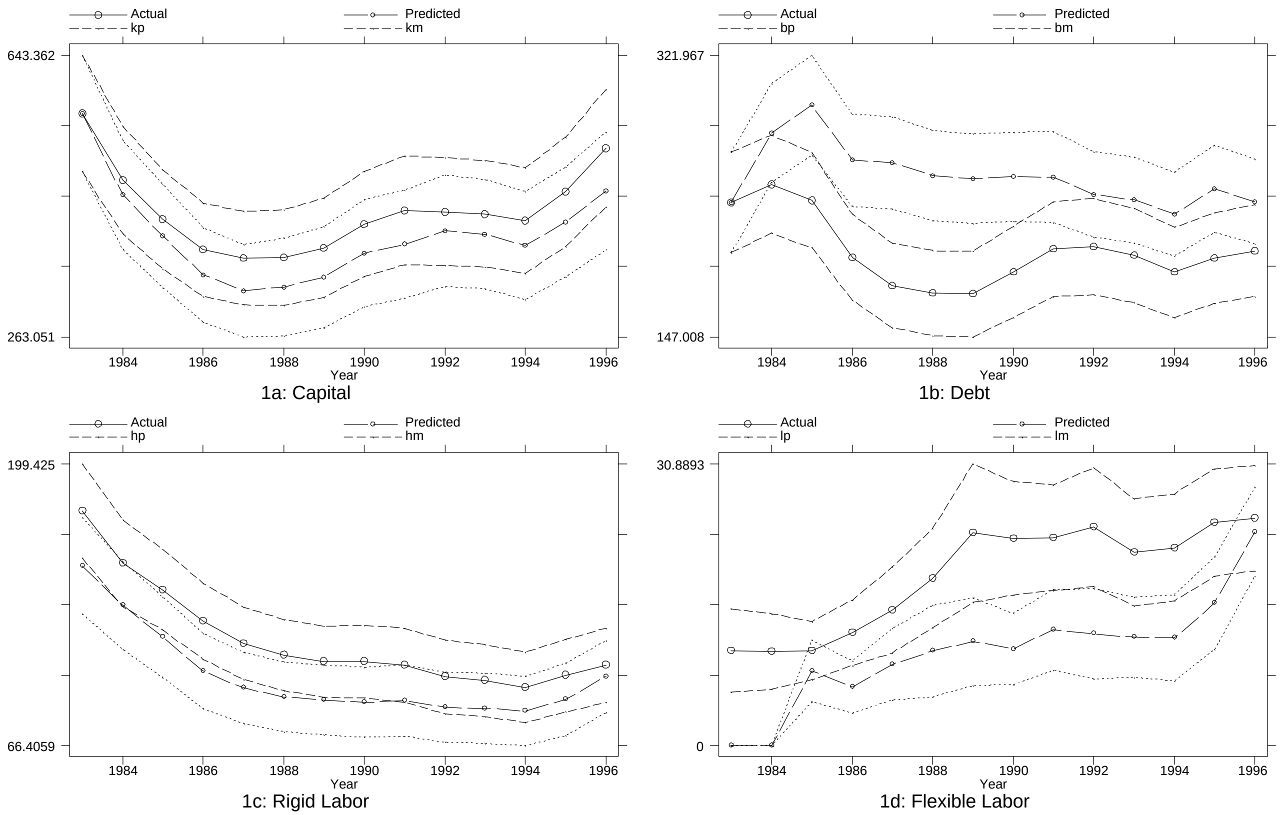
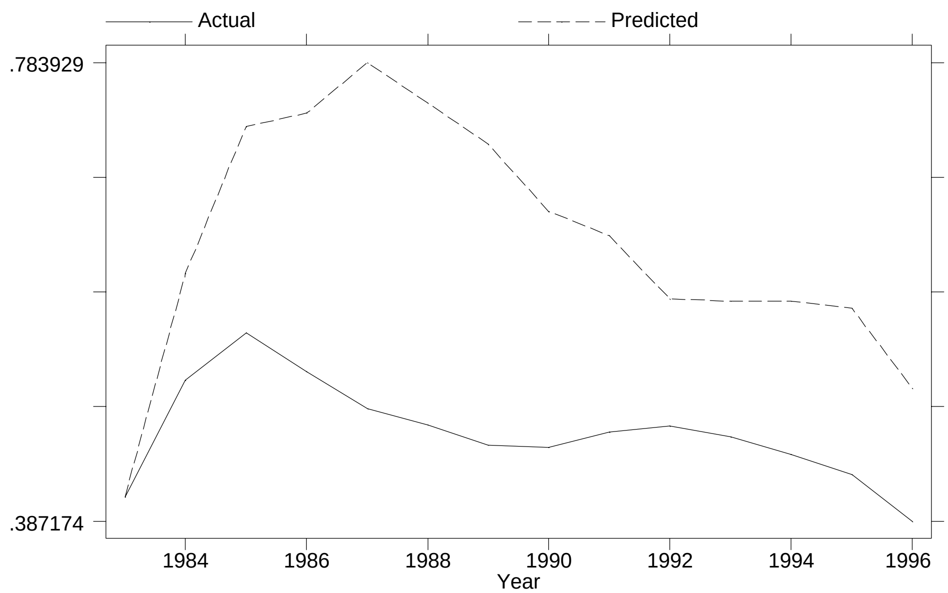
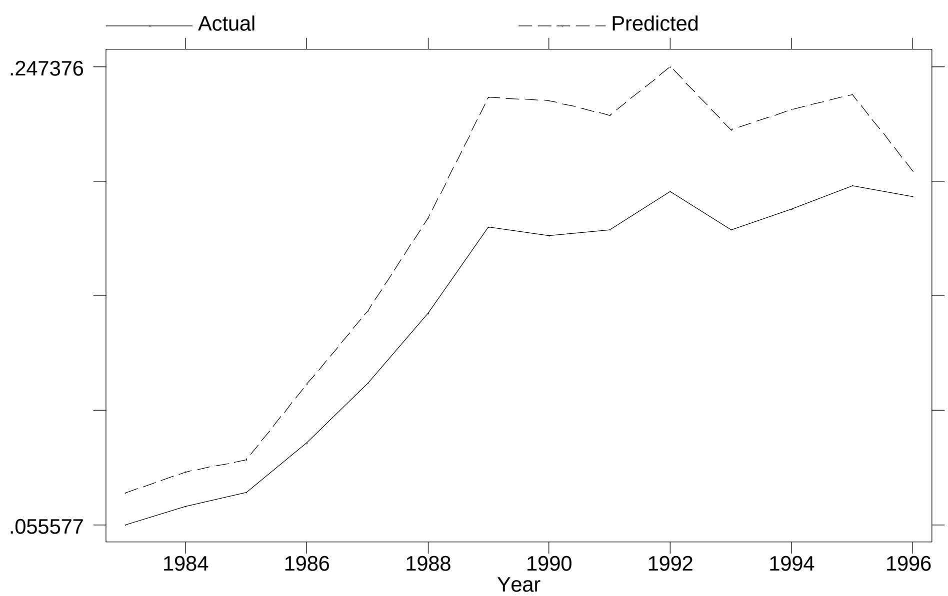


Figure 1: Actual and Predicted Variables



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

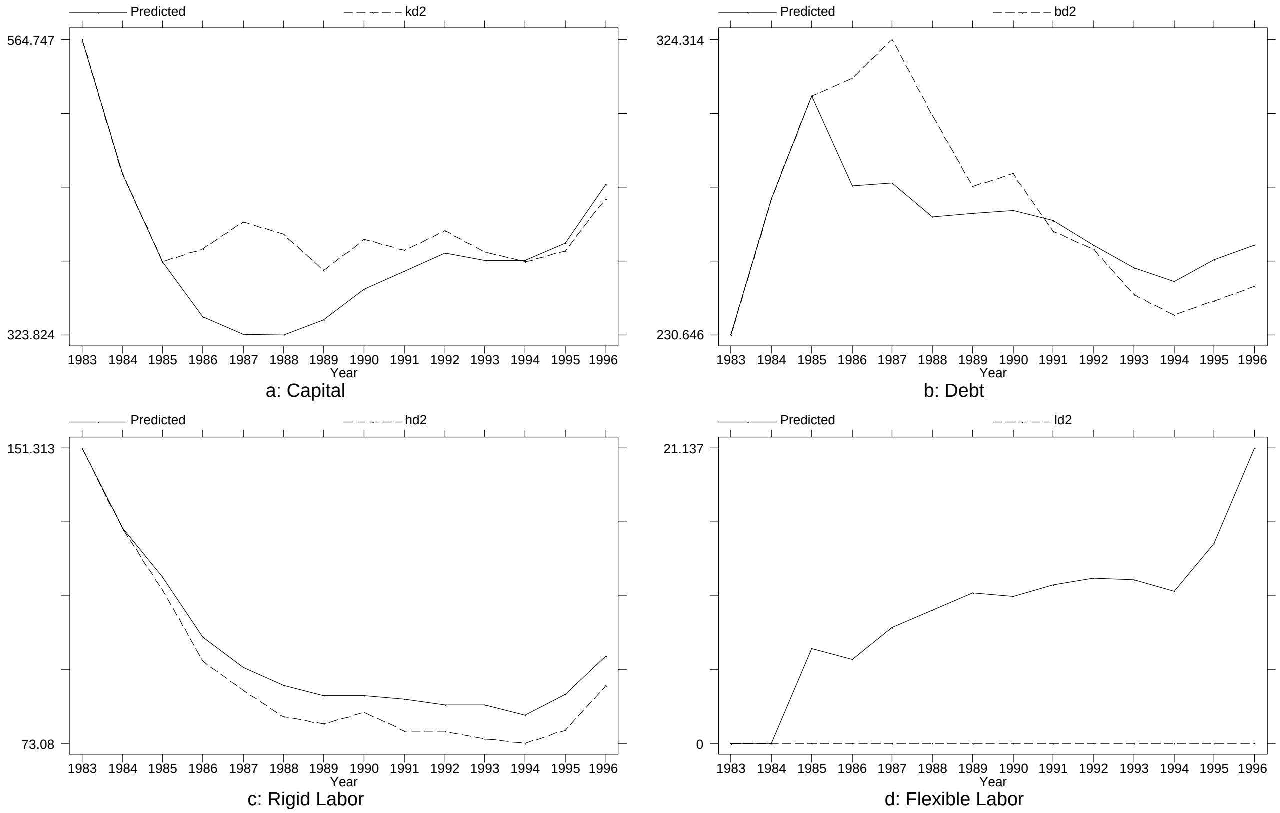


Figure 2: Counterfactual: No Flexible Labor

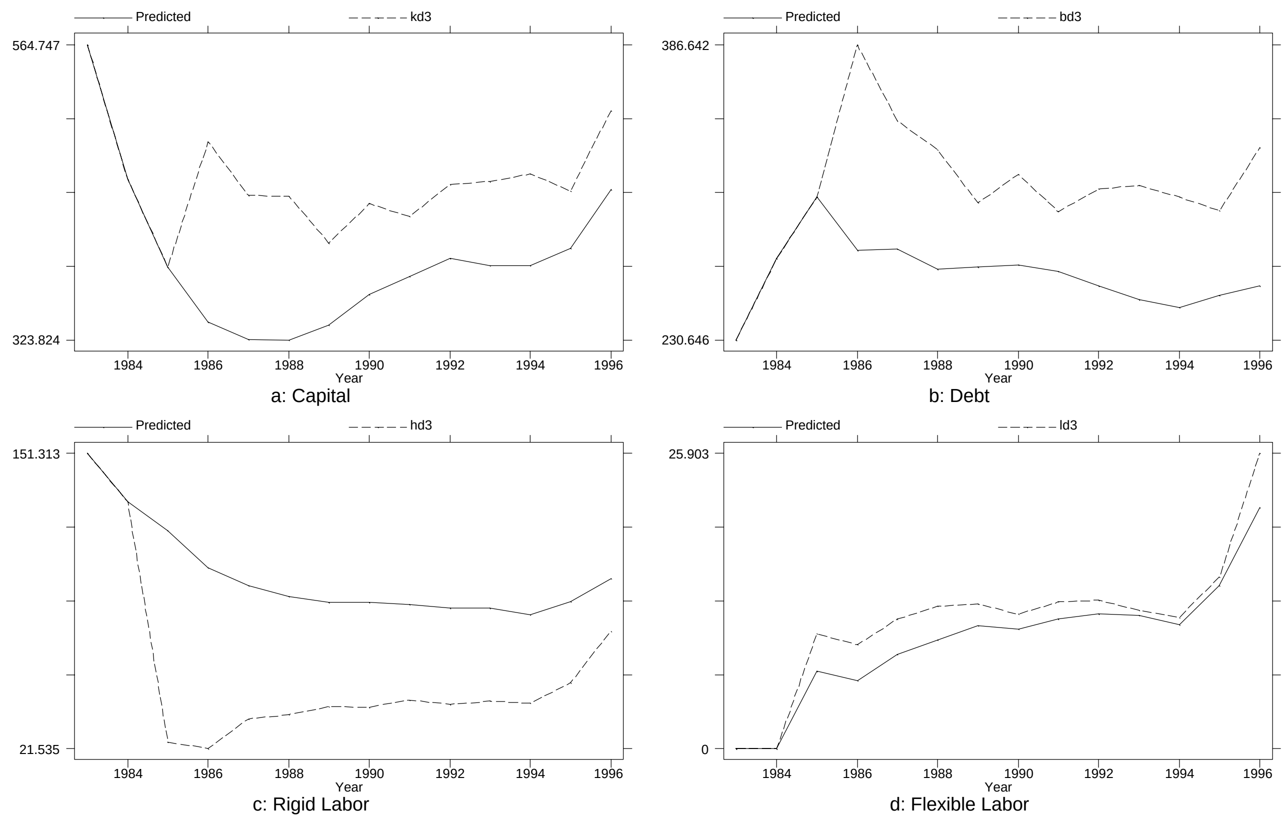


Figure 3: Counterfactual: No Hiring and Firing Costs