Welfare Effects of Capital Controls

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Financial frictions: Macroeconomic implications and policy options for emerging economies

Welfare effects of capital controls

- Since the 2008-2009 global financial crisis, capital controls have regained attention, becoming part of the macroprudential toolkit of policymakers.
- Theoretically, capital controls can be welfare improving by reducing pecuniary externalities that lead to sudden stop episodes.
- But capital controls increase financing costs of firms and affect them differently depending on their size, financial dependence, export status, capital intensity and other characteristics (Alfaro et al. 2017, Andreasen et al. 2020, Forbes 2007).

This paper

- We study the effects of capital controls on misallocation and, consequently, welfare in an economy with financial frictions.
- We build a model with
  - heterogeneity in productivity
  - international trade
  - collateral constraints
- We calibrate it to the Chilean economy in 1990-1991 and study the effects of introducing a capital control as a tax on external borrowing.

Preview of results

- In a simplified version of the model with no financial frictions, there is no misallocation $\Rightarrow$ capital controls distort the allocation of productive factors
- When we introduce a collateral constraint, misallocation arises. Capital controls may overturn it.
- In a richer model, we show numerically that, when capital controls are introduced,
  - misallocation increases for exporters and high productivity firms,
  - misallocation decreases for low productivity ones,
  - welfare losses of introducing capital controls are 2.4% of consumption-equivalent. Welfare losses higher for high-productivity firms,
  - alternative macroprudential policies may have very different welfare losses while reducing credit in the same magnitude.
- We empirically corroborate the main insights obtained from the model using Chilean manufacturing firm data from 1990 to 2007.

MODEL

Model Overview

- General equilibrium model $\rightarrow$ we introduce capital controls as a tax on the interest rate of capital inflows.

- Three types of agents:

  1. **Final good producers**: Purchase intermediate good varieties from domestic and foreign entrepreneurs and aggregate them to produce the final good.

  2. **Heterogeneous entrepreneurs**: Produce differentiated intermediate goods.

  3. **Rest of the world**: Mirrors domestic entrepreneurs and final good producers. Provides financial services to home country.

Final good producers and rest of the world

- Produce final good y_t choosing domestic $y_{h,t}(i)$ and imported varieties $y_{m,t}$ given prices $p_{h,t}(i)$ and $p_{m,t}$, and the following technology:

$$y_t = \left[\int_0^1 y_{h,t}(i)^{\frac{\sigma-1}{\sigma}} di + y_{m,t}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

- Rest of the world demands domestic varieties $y_{f,t}(i)$ at price $p_{f,t}(i)$.

- Demands domestic producers face:

$$y_{h,t}(i) = \left(\frac{p_{h,t}(i)}{p_t} \right)^{-\sigma} y_t$$

$$y_{f,t}(i) = \left(\frac{p_{f,t}(i)}{\bar{p}_t^*} \right)^{-\sigma} \bar{y}_t^*$$

Entrepreneurs (1)

Entrepreneur $i \in (0,1)$

Preferences:

$$\sum_{t=0}^{\infty} [\beta(1-\nu)]^t \frac{c_t^{1-\gamma}}{1-\gamma}$$

Law of motion of capital:

$$k_{t+1} = \frac{1}{1-\nu}[(1-\delta)k_t + x_t]$$

Technology:

$$y_{h,t} + \tau y_{f,t} = z k_t^{\alpha} n_t^{1-\alpha}$$

- ν: exogenous death probability
- z: idiosyncratic productivity draw
- $\tau > 1$: Ad-valorem trade cost,

Entrepreneurs (2)

Trade:

- Sunk entry cost wF to become and exporter.
- Once the entrepreneur pays the entry cost, it remains an exporter until its death.

Collateral constraint:

- They can borrow up to a fraction θ of the value of the capital stock next period:

$$d_{t+1} \leq \theta k_{t+1}$$

Capital Controls

- With no capital controls, entrepreneurs can save or borrow at the international interest rate r.
- With capital controls, the new effective rate for borrowers is:

$$\hat{r} = r + \mu,$$

where μ is the tax equivalent of the capital control. Tax Equivalent

Entrepreneurs' problem

$$V(k,d,e;z) = \max_{c,x,n,d',k',p_h,p_f,y_h,y_f,e\in\{0,1\}} \frac{c^{1-\gamma}}{1-\gamma} + \beta(1-\nu)V(k',d',e';z)$$

s.t.:

$$pc + px + pd + wn + wF\mathbb{I}_{e=0,e'=1} = w + p_h y_h + p_f y_f + pd'\frac{1-\nu}{1+\hat{r}} - T$$

Technology: $y_h + \tau y_f = zk^{\alpha}n^{1-\alpha}$

Law of motion of capital: $k' = \frac{1}{1-\nu}[(1-\delta)k + x]$

Final sector demands: $y_h = \left(\frac{p_h}{p}\right)^{-\sigma} y$, and $y_f = \left(\frac{p_f}{\bar{p}^*}\right)^{-\sigma} \bar{y}^*$

Collateral constraint: $d' \leq \theta k'$

- We solve for a recursive stationary competitive equilibrium. More

No financial distortions

Consider an economy with no collateral constraints ($\theta \to \infty$) and no capital controls ($\mu = 0$). Then,

- In a decentralized equilibrium, all firms equate factor prices to their corresponding marginal revenue products.
- An unconstrained planner that assigns equal Pareto weights to all entrepreneurs equates marginal revenue products of capital and labor across firms.

There is no misallocation.

Financial distortions (1)

Consider an economy with no collateral constraints ($\theta \to \infty$) but with capital controls ($\mu > 0$). Then,

- In a decentralized equilibrium, the marginal revenue product of capital (MRPK) is no longer equalized across firms if some firms start out with a level of capital lower than their optimal scale:

$$MRPK_i \equiv \frac{\partial(p_{h,i}y_{h,i} + p_{f,i}y_{f,i})}{\partial k_i} = \mathbb{I}_{d_i>0}[p(r+\mu+\delta)] + \mathbb{I}_{d_i\leq 0}\left[p(r+\delta) + \frac{p\chi_i}{U_{c,i}}\right] >$$
$$\overline{MRPK} = p(r+\delta) \quad \text{if} \quad k_i < \bar{k}_i.$$

Financial distortions (2)

Consider an economy with collateral constraints ($\theta < \infty$) but no capital controls ($\mu = 0$). Then,

- In a decentralized equilibrium, the marginal revenue product of capital (MRPK) is no longer equalized across firms if some firms start out with a level of capital lower than their optimal scale:

$$MRPK_i \equiv \frac{\partial(p_{h,i}y_{h,i} + p_{f,i}y_{f,i})}{\partial k_i} = p(r+\delta) + \frac{p\eta_i}{U_{c,i}}(1+r-\theta) >$$
$$\overline{MRPK} = p(r+\delta) \quad \text{if} \quad k_i < \bar{k}_i.$$

Misallocation with collateral constraints and CC

There are four channels through which misallocation arises in this case:

1. a binding collateral constraint;
2. the CC μ that increases the cost of financing investment through debt;
3. a binding constraint preventing debt to become positive, once $d_i = 0$ when the firm is subject to the CC;
4. general equilibrium effects that affect aggregate prices $\{p, w\}$, thus altering the optimal scales of firms and, consequently, the stringency of the collateral constraint.

Calibration

Table: Moments

Target Moment	Data (1990-1991) (1)	Model (No C.controls) (2)
Share of exporters	0.18	0.18
Average sales (exporters/non-exporters)	8.55	8.44
Average sales (age 5 / age 1)	1.26	1.39
Aggregate exports / sales	0.21	0.20
Aggregate credit / Value added	0.20	0.20
Aggregate capital stock / wage bill	6.60	6.70

▶ More

Welfare losses

- In order to obtain aggregate measures of welfare losses associated to CCs, we assume a utilitarian social welfare function that assigns equal weight to all entrepreneurs operating in the economy:

$$\int_{\mathcal{S}} \sum_{t=0}^{\infty} (\beta(1-\nu))^t u\left(c_t^{i,NCC}(1+G)\right) \phi(q) dq = \int_{\mathcal{S}} \sum_{t=0}^{\infty} (\beta(1-\nu))^t u\left(c^{i,CC}\right) \phi(q) dq.$$

Results (1)

Table: Dev MRPK from efficient level

	% change	G (%)
All firms	0.11%	−2.39%
Low z	−0.79%	−1.65%
High z	0.38%	−3.52%
Exporters	5.34%	—
Non-exporters	−1.53%	—
Young	0.04%	—
Old	$\simeq$ 0%	—

▶ More

Results (2)

Table: Dev MRPK from efficient level, by level of z

	% change
Exporters, low z	—
Exporters, high z	5.34%
Non-exporters, low z	−0.79%
Non-exporters, high z	−2.73%
Young, low z	−0.83%
Young, high z	0.38%
Old, low z	$\simeq$ 0%
Old, high z	$\simeq$ 0%

Distributional effects

Table: Welfare: Distributional Effects

	$G(\%)$	$G^a(\%)$	$G^d(\%)$
All firms	-2.39%	-2.70%	0.33%
Low z	-1.65%	-1.35%	-0.30%
High z	-3.52%	-3.36%	-0.17%

Other results

- Lump-sum transfers ▸ More
- Counterfactual: interest rate increase ▸ More
- Counterfactual: decrease in θ ▸ More

EMPIRICAL ANALYSIS

Data

- Chilean manufacturing establishments data (ENIA), 1990-2007.
  - All manufacturing firms with more than 10 workers (around 5,000 firms per year, 90,000 observations aprox.).
  - Data on capital stock, investment, workers, sales, exports.
- Standard macroeconomic controls.
- Tax-equivalent of the CC by year (De Gregorio et al, 2000.). more

Summary Statistics

Measure of Misallocation

Follow Bai et al. (2019) and define misallocation as:

$$MIS_{ijt} = \left| MRPK_{itj} - \overline{MRPK_{jt}} \right|$$

where:

$\overline{MRPK_{jt}}$: yearly industry mean of the MRPK.

Econometric model

$$MIS_{ijt} = \omega_0 + \omega_1 CC_{t-1} * RankTFP_{ijt} + \omega_2 CC_{t-1} * Young_{ijt} + \omega_3 CC_{t-1} * Exp_{ijt} + \omega_4 X_{ijt} + + A_i + B_t + \varepsilon_{ijt}$$

- MIS_{ijt}: misallocation measure.
- CC_{t-1}: capital controls lagged one period.
- $RankTFP_{ijt}$: relative ranking of firm's TFP_i at each period t, where industry is defined at the two-digit level.
- $Young_{ijt}$: dummy variable that takes the value of 1 when firms have ten or less years of existence.
- Exp_{ijt}: export status
- X_{ijt}: time varying firm characteristics.
- A_i: firm fixed effects.
- B_t: time dummy variables

Results

Table: Heterogeneous effects of CC on Misallocation: TFP, Age and Export status

VARIABLES	(1) All Firms	(2) All Firms	(3) Firms in 1990	(4) Firms in 1990
CC*Rank_TFP	0.009***	0.009***	0.000***	0.000***
CC*Young	0.080***	0.094***	0.017	0.042
CC*L_Exp	0.087***		0.137***	
CC*F_Exp		0.078***		0.060*
Rank_TFP	-0.024***	-0.024***	-0.001***	-0.001***
Young	-0.123**	-0.134**	-0.042	-0.074
L_Exp	-0.125***		-0.289***	
F_Exp		-0.082		-0.076
TFP	-4.521***	-4.515***	-5.108***	-5.114***
Observations	92,690	92,690	50,403	50,403
R-squared	0.123	0.123	0.105	0.105
Number of id	12,155	12,155	4,521	4,521
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES

Results

Table: Heterogeneous effects of CC on Misallocation: Age and Export status by productivity.

VARIABLES	(1) High prod. Top 50%	(2) Low prod. Bottom 50%	(3) High prod. Top 50%	(4) Low prod. Bottom 50%
CC*Young	0.118***	0.051**	0.143***	0.052**
CC*L_Exp	0.166***	0.032		
CC*F_Exp			0.140***	-0.010
Observations	46,340	46,350	46,340	46,350
R-squared	0.0843	0.160	0.0841	0.159
Number of id	8,002	8,703	8,002	8,703
Controls	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	NO	YES

Results

- Effects of CCs on misallocation are higher
  - the higher the firm's relative productivity is,
  - when firms are young,
  - when firms decide to become exporters.
- Misallocation increases relatively more for exporting-high-productivity firms, while it does not seem to have a significant effect on exporting-low productivity firms.
- When disaggregating by productivity, being young increases misallocation relatively more for high than for low-productivity firms.

Robustness checks

- Interaction of capital intensity with macroeconomic controls More
- P-hacking tests More
- Additional robustness checks: windsorization of TFP and misallocation

Conclusions

- Financial frictions induce misallocation. Capital controls can overturn or exacerbate aggregate misallocation.
- Misallocation increases for firms that are more exposed to the capital control through external borrowing. These are high productivity firms and exporters.
- Misallocation decreases for low productivity firms.
- Welfare losses are higher for high-productivity firms.
- Welfare losses are larger for firms operating in capital intensive sectors.

Table: Summary Statistics: Macroeconomic Indicators 1990-2007

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
CC	18	0.881	1.109	0	2.649
Inflation	18	0.017	0.536	-0.626	1.887
RER_dev	18	-0.009	0.055	-0.082	0.113
Growth	18	0.055	0.028	-0.021	0.120
World Growth	18	3.054	1.000	1.369	4.476
Private Credit/GDP	18	0.613	0.107	0.442	0.743
Libor 12m	18	4.918	1.799	1.364	8.415

back

Table: Effects of CC on Misallocation, Fixed Effects

VARIABLES	(1) All Firms	(2) Exporters	(3) Non-Exporters
CC*KI	-0.027***	-0.041**	-0.035***
	(0.010)	(0.020)	(0.013)
CC*tfp_1990	0.744***	0.495**	0.719***
	(0.116)	(0.242)	(0.139)
Observations	50,403	11,939	38,464
R-squared	0.117	0.131	0.111
Number of id	4,521	1,735	4,412
Firm FE	YES	YES	YES
Time FE	YES	YES	YES

Back

The Chilean *Encaje*

- Policy: Unremunerated Reserve Requirement: 20% (to 30%) of capital inflows had to be deposited at the Central Bank at 0% interest rate for a fixed period of time (6 to 12 months).
  $\Rightarrow$ Analogous to a tax on the interest rate for borrowers (De Gregorio et al., 2000).

- Context: Surge of capital inflows, RER appreciation.

- Aggregate effects: Longer maturity of capital inflows, increased interest rate differential, small effect on RER, not so robust. (De Gregorio, Edwards and Valdes, 2000.; Edwards, 1999)

Back

Main changes in the URR administration

Jun-1991	20% URR introduced for all new credit Holding period (months)=min(max(credit maturity, 3),12) Holding currency=same as creditor Investors can waive the URR by paying a fix fee (Through a repo agreement at discount in favor of the central bank) Repo discount= US$ libor
Jan-1992	20% URR extended to foreign currency deposits with proportional HP
May-1992	Holding period (months)=12 URR increased to 30% for bank credit lines
Aug-1992	URR increased to 30% Repo discount= US$ libor +2.5
Oct-1992	Repo discount= US$ libor +4.0
Jan-1995	Holding currency=US$ only
Sep-1995	Period to liquidate US$ from Secondary ADR tightened
Dec-1995	Foreign borrowing to be used externally is exempt of URR
Oct-1996	FDI committee considers for approval productive projects only
Dec-1996	Foreign borrowing $<$US$ 200,000 (500,000 in a year) exempt of URR
Mar-1997	Foreign borrowing $<$US$ 100,000 (100,000 in a year) exempt of URR
Jun-1998	URR set to 10%
Sep-1998	URR set to zero

Source: De Gregorio et al. (2000).

Back

The evolution of the Chilean encaje

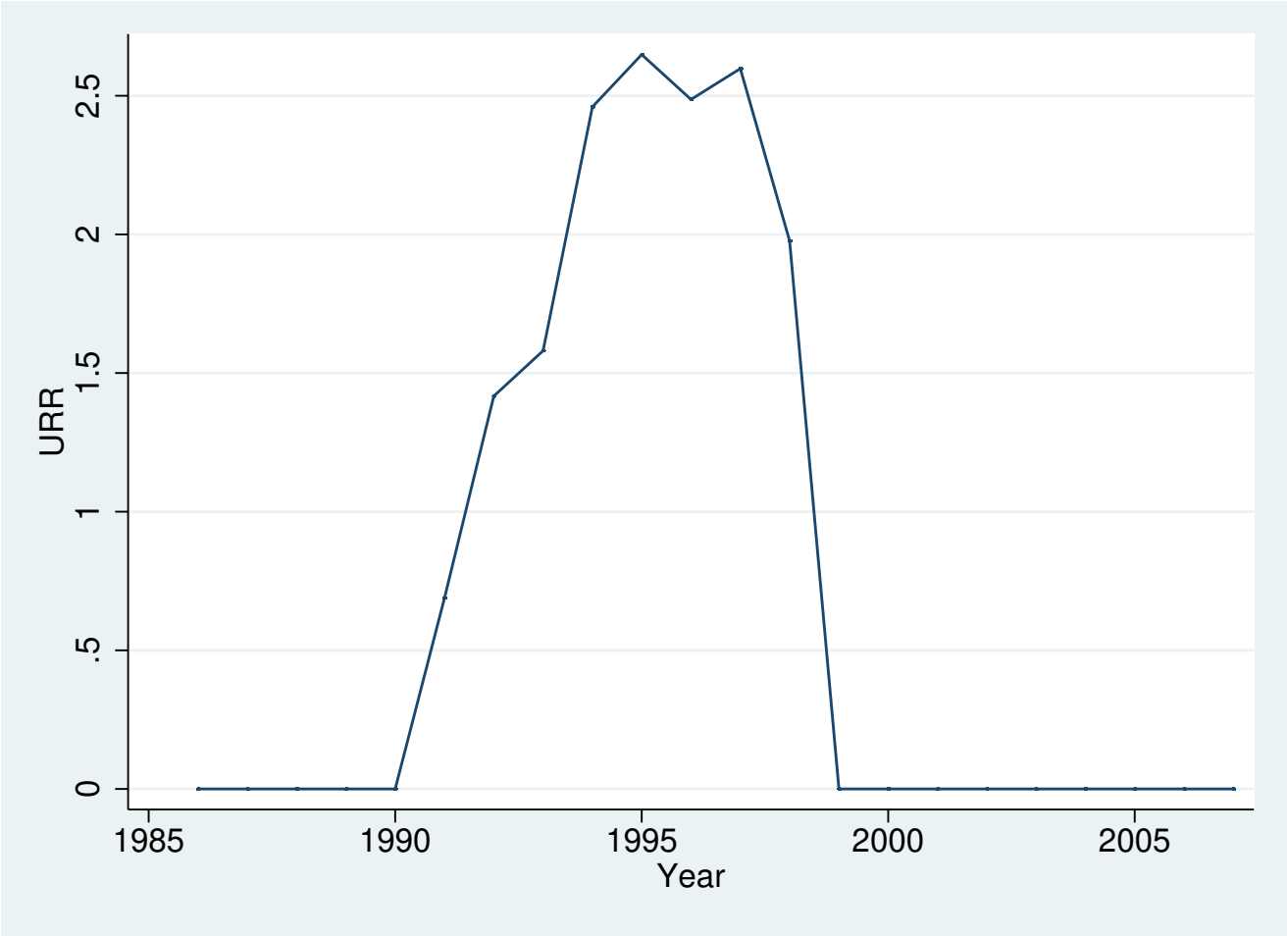


Figure: Tax equivalent

Back

Why Chile?

- Most well-known example of market-based control.
- Economic importance: 1.9% of GDP (Gallego, Hernandez and Schmidt-Hebbel, 2002).
- Firm level data in period of analysis.
- Time period large enough to do SS analysis and to have enough variation for the empirical analysis.

Back

Recursive Equilibrium

For a given value of the interest rate r, a recursive stationary competitive equilibrium of this economy consists of prices (w, p) policy functions and value functions v and g such that:

1. Policy and value functions solve the entrepreneurs' problem.
2. Policy functions solve the final good producers' problem.
3. Labor market clears.
4. The government's budget constraint is satisfied.
5. Markets for domestic varieties and final goods market clear.
6. The measure ϕ of entrepreneurs is stationary.

Back to analysis

Entrepreneurs: Capital Controls

- With no capital controls, entrepreneurs can save or borrow at the international interest rate r.
- When the restriction is in place, the new effective rate for borrowers is:

$$\hat{r} = r + \mu_j,$$

- Tax equivalent of the URR (De Gregorio et al., 2000):

$$\mu_j = r \frac{u}{1-u} \frac{h}{j},$$

with: u = fraction of the credit that has to be deposited in a non-interest-bearing account at the Central Bank; h = holding period; and j = maturity of the credit.

Back

Results: intuition

$$MRPK_{cc} - MRPK_{ncc} = \overbrace{(p_{cc} - p_{ncc})(r+\delta)}^{<0} + \overbrace{p_{cc}\mu\left(1 + \frac{\eta_{cc}}{U_{c,cc}}\right)}^{>0} + \underbrace{\left[\frac{p_{cc}\eta_{cc}}{U_{c,cc}} - \frac{p_{ncc}\eta_{ncc}}{U_{c,ncc}}\right](1+r-\theta)}_{<0}$$

- Low z firms that start out far from their optimal scales $\bar{k}_i$ and have low levels of consumption, η/U_c is large, third term dominates $\rightarrow$ decrease in misallocation
- High z firms that start out far from their optimal scales $\bar{k}_i$ and have high levels of consumption, η/U_c is small, second term dominates $\rightarrow$ increase in misallocation

Back

Sensitivity analysis: lump-sum transfers

Table: Dev MRPK from efficient level, with lump sum transfers

	% change	G (%)
All firms	0.19%	−2.14%
Low z	−0.63%	−1.51%
High z	0.44%	−3.12%
Exporters	4.72%	—
Non-exporters	−1.25%	—
Young	0.13%	—
Old	$\simeq$ 0%	—

Back

Counterfactual analysis: increase in r

Table: Dev MRPK from efficient level, with symmetric R

	% change	G (%)
All firms	7.53%	−2.74%
Low z	6.61%	−2.69%
High z	7.80%	−2.81%
Exporters	19.95%	—
Non-exporters	5.55%	—
Young	7.47%	—
Old	$\simeq 0$%	—

Back

Counterfactual analysis: decrease in θ

Table: Dev MRPK from efficient level, decrease in θ

	% change	G (%)
All firms	4.94%	−0.16%
Low z	6.06%	−0.28%
High z	4.61%	0.04%
Exporters	5.15%	—
Non-exporters	5.75%	—
Young	5.01%	—
Old	$\simeq$ 0%	—

Back

Interaction of capital intensity with macroeconomic controls

Back

Table: Interaction with macroeconomic controls

VARIABLES	(1) Libor	(2) Libor	(3) Inflation	(4) Inflation	(5) Growth	(6) Growth
CC*Rank_TFP	0.009***	0.009***	0.009***	0.009***	0.010***	0.010***
CC*Young	0.083***	0.095***	0.085***	0.095***	0.096***	0.097***
CC*L_Exp	0.081***		0.087***		0.042*	
CC*F_Exp		0.071***		0.078***	0.023	
Young*Libor	0.002	0.002				
L_Exp*Libor	0.016					
Rank_TFP*libor	-0.001***	-0.001***				
F_Exp*Libor		0.036***				
Young*Inflation			-0.003	-0.003		
L_Exp*Inflation			0.004			
Rank_TFP*Inflation			-0.001***	-0.001***		
F_Exp*Inflation				0.008		
Young*Growth					-0.008	-0.002
L_Exp*Growth					0.042***	
Rank_TFP*Growth					-0.001***	-0.001***
F_Exp*Growth						0.057***
Observations	92,690	92,690	92,690	92,690	92,690	92,690
R-squared	0.123	0.123	0.124	0.124	0.123	0.124
Number of id	12,155	12,155	12,155	12,155	12,155	12,155
Controls	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES

Interaction of capital intensity with macroeconomic controls

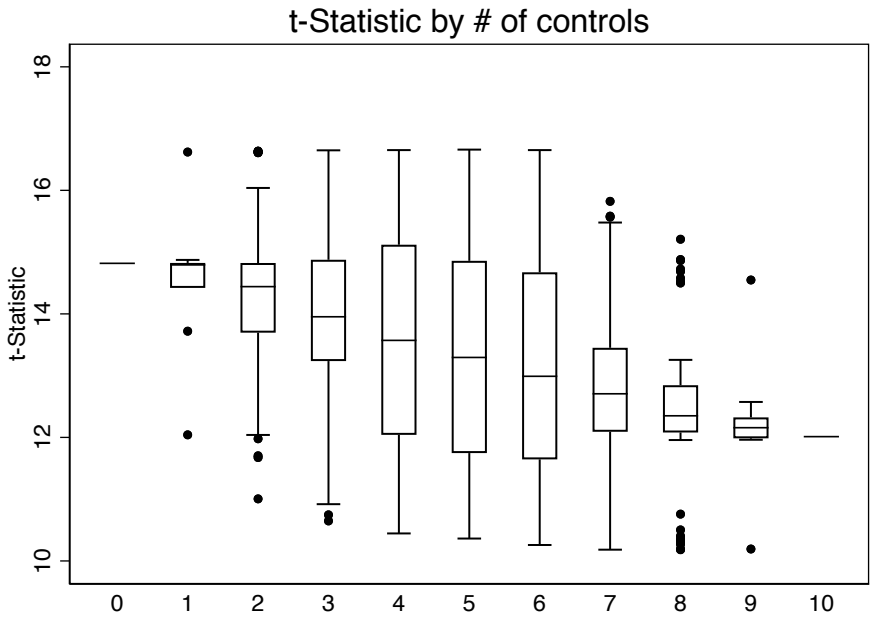
Back

Table: Interaction with macroeconomic controls

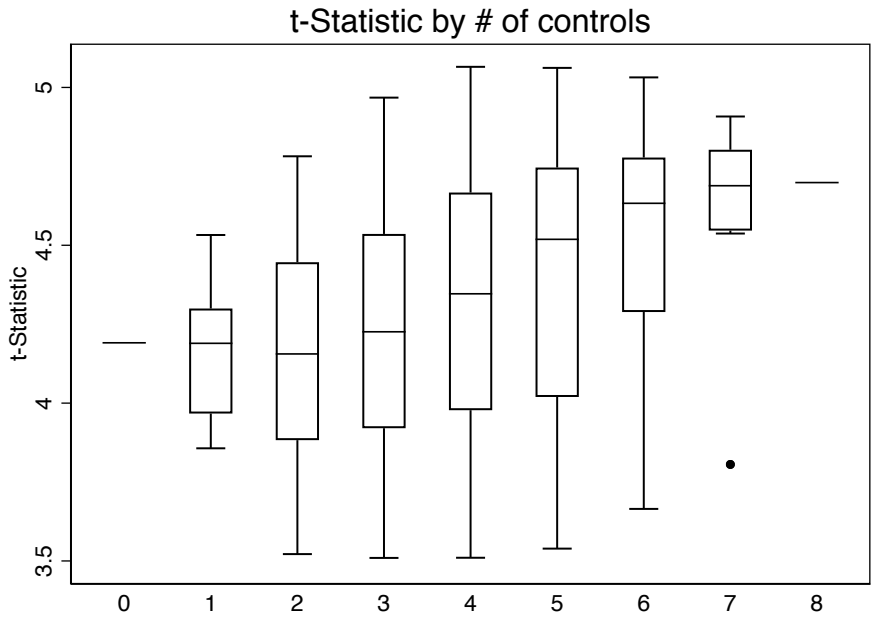
VARIABLES	(7) RER	(8) RER	(9) PrivCreditGDP	(10) PrivCreditGDP	(11) WorldGrowth	(12) WorldGrowth
CC*Rank_TFP	0.005***	0.005***	0.011***	0.011***	0.009***	0.009***
CC*Young	0.081***	0.094***	0.074***	0.094***	0.066***	0.085***
CC*L_Exp	0.084***		0.103***		0.103***	
CC*F_Exp		0.077**		0.081***		0.105***
Young*RER	-0.000	-0.000				
L_Exp*RER	-0.000					
Rank_TFP*RER	-0.001***	-0.001***				
F_Exp*TCR		0.000				
Young*PrivCreditGDP			0.021	-0.006		
L_Exp*PrivCreditGDP			0.417			
Rank_TFP*PrivCreditGDP			0.083***	0.081***		
F_Exp*PrivCreditGDP				0.296		
Young*WorldGrowth					0.005	0.014
L_Exp*WorldGrowth					0.205***	
Rank_TFP*WorldGrowth					0.006***	0.005***
F_Exp*WorldGrowth						0.322***
Observations	92,690	92,690	92,690	92,690	92,690	92,690
R-squared	0.124	0.124	0.124	0.124	0.125	0.125
Number of id	12,155	12,155	12,155	12,155	12,155	12,155
Controls	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES

P-hacking tests

Figure: P-Hacking tests



(a) $CC * Rank\_TFP$

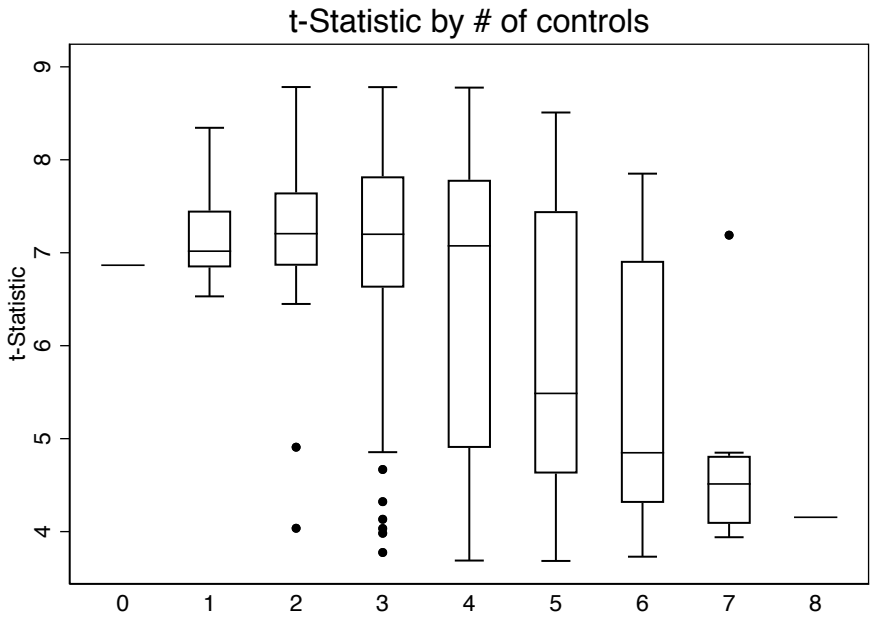


(b) $CC * Young$

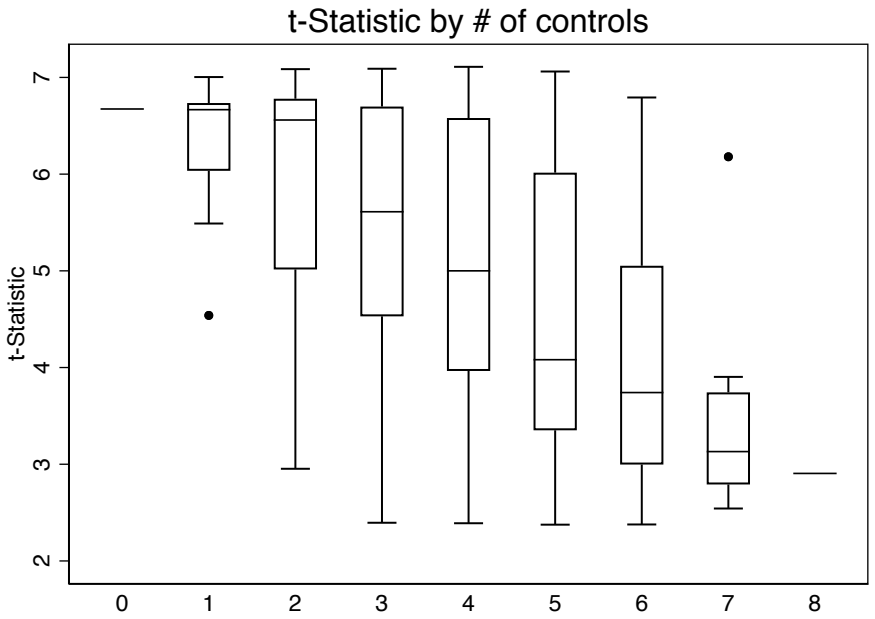
Back

P-hacking tests

Figure: P-Hacking tests



(a) $CC * Lag\_Exp$



(b) $CC * Fwd\_Exp$

Back

Calibration

Table: Parameter Values

Predetermined parameters			Calibrated parameters		
β	Discount factor	0.96	τ	Iceberg trade cost	5.127
γ	Risk aversion	2	σ_z	Productivity dispersion	0.435
σ	Substitution elasticity	4	F	Sunk export entry cost	1.350
δ	Depreciation rate	0.06	θ	Collateral constraint	0.136
r	Interest rate	0.06	$\underline{a}$	Fraction of SS capital as initial net worth	0.252
ν	Death probability	0.08	α	Capital intensity	0.354

Back