Capital-Reallocation Frictions and Trade Shocks

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ABFER Trade, Growth and Development

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Motivation

- Effects of trade liberalization on domestic production
- Literature focuses on long-run productivity and welfare gains
  - Reallocation of factors, selection
- Pervasive evidence of "frictions" in capital reallocation
- What are short/medium-run effects of import-competition shock on
  - firm dynamics
  - and aggregate productivity?

This Paper

Effects of China import competition on Peru's manufacturing (2000-2015)

- Empirics
  - Stylized facts about capital, productivity, and selection $\rightarrow$ partial investment irreversibility
  - Effects of import competition on capital reallocation
    - measured "misallocation", investment inaction, exit $\uparrow$
- Quantitative Model
  - GE transitional dynamics in response to import-competition shock
  - Irreversibility accounts for intensive and extensive margin evidence
  - Short-run productivity gain $\approx$ half long-run gain
  - However, welfare gains materialize early on

Related Literature

- *Capital "misallocation":*
  Restuccia and Rogerson (2008), Hsieh and Klenow (2009), Asker, Collard-Wexler and De Loecker (2014), Midrigan and Xu (2014), David and Venkateswaran (2018)

- *Investment irreversibility:*
  Ramey and Shapiro (2001), Veracierto (2002), Cooper and Haltiwanger (2006), Eisfeldt and Rampini (2006), Bloom (2009), Lanteri (2018), Tan (2020)

- *Trade and reallocation:*
  Melitz (2003), Buera and Shin (2013), Dix-Carneiro (2014), Artuc, Brambilla and Porto (2017), Medina (2018), Alessandria, Choi and Ruhl (2018), Brooks and Dovis (2020)

Outline

1. Empirical Evidence
   - Key facts about capital, productivity, selection
   - Effects of trade shocks on reallocation
2. Model
3. Quantitative Analysis

Empirics

Data

- *Encuesta Economica Anual*, Peru, annual frequency 2000-2015
  - Approx. 1,500 firms per year. Focus on 6 largest industries: Food, Textiles, Apparel, Printing, Chemical, Machinery
  - Value added, employment, capital stock (and composition) $\rightarrow$ Revenue Productivity (ω), Marginal revenue product of capital (MRPK)
- Firm registry, Peru, annual frequency, 2007-2015.
  - Legal dates of operations.
- UN Comtrade, annual frequency 2000-2015
  - China import penetration in Peru at industry level
  - and in other countries (instruments)

Measurement Framework

Consistent with our structural model.

Production: $y_{jt} = s_{jt} k_{jt}^{\alpha} n_{jt}^{1-\alpha}$

Value added, with CES demand:

$$p_{jt} y_{jt} = B_t^{\frac{1}{\epsilon}} s_{jt}^{\theta} k_{jt}^{\theta\alpha} n_{jt}^{\theta(1-\alpha)} \quad \theta = \frac{\epsilon - 1}{\epsilon}$$

Revenue Productivity: $\omega_{jt} \equiv \frac{p_{jt} y_{jt}}{k_{jt}^{\theta\alpha} n_{jt}^{\theta(1-\alpha)}}$

Marginal Revenue Product of Capital:

$$MRPK_{jt} \equiv \frac{\partial p_{jt} y_{jt}}{\partial k_{jt}} = \theta\alpha \frac{p_{jt} y_{jt}}{k_{jt}}$$

Summary of Empirical Evidence

Key facts about capital, productivity, selection:

1. MRPKs highly dispersed and persistent
2. Low MRPKs more persistent than high MRPKs
3. Probability of exit decreasing in k, conditional on productivity

Effects of trade shock:

- MRPK dispersion $\uparrow$
- Inaction $\uparrow$, little disinvestment (reallocation)
- Exit $\uparrow$, of firms with low ω *and* firms with low k

Fact 2. MRPK Mobility

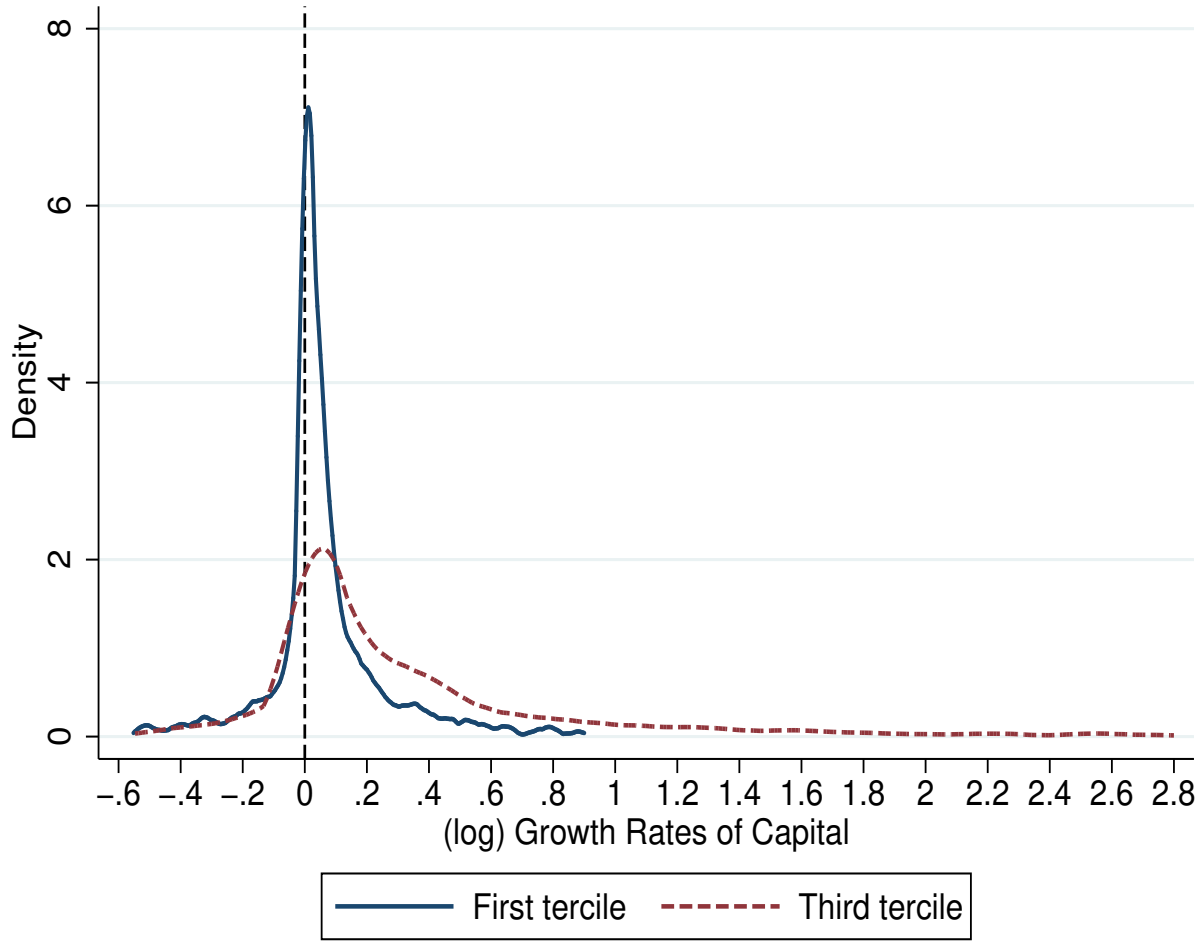
		at $t+1$		
		1	2	3
Tercile at t	1	0.82	0.16	0.02
		(0.01)	(0.01)	(0.00)
	2	0.19	0.69	0.12
		(0.01)	(0.01)	(0.01)
	3	0.03	0.20	0.77
		(0.00)	(0.01)	(0.01)

TABLE: Transition probabilities for terciles of MRPK.

- High persistence of *MRPK*
- Higher persistence of low *MRPK*

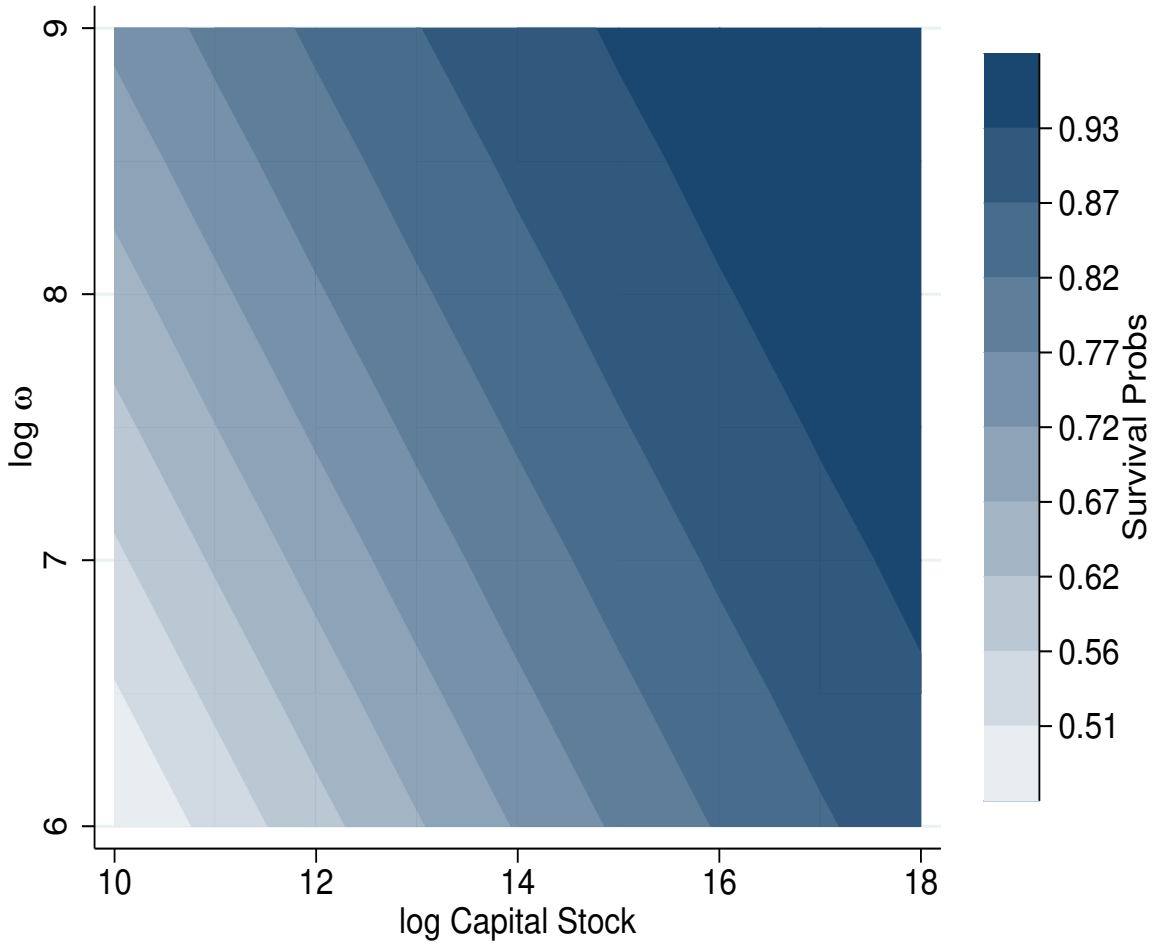
Exit Productivity ω

Fact 2. MRPK Mobility and Investment



Fact 3. Capital Predicts Survival

Conditional on productivity, firms with higher level of capital less likely to exit



Capital Composition and Utilization

1. We use firm-level capital composition: Land, Fixed Installations, Machinery, Computers, Vehicles, among others.
   - To measure firm-level depreciation rates
     - Using US Fixed Assets Table depreciation rates
     - Both Fact 2 and Fact 3 stronger for firms with low depreciation rate
   - To analyze which type of capital drives low-MRPK persistence
     - Fixed Installation and Machinery

2. We measure utilization using
   - Energy
   - Intermediates
   - Asymmetry in MRPK persistence goes away

Trade Shock

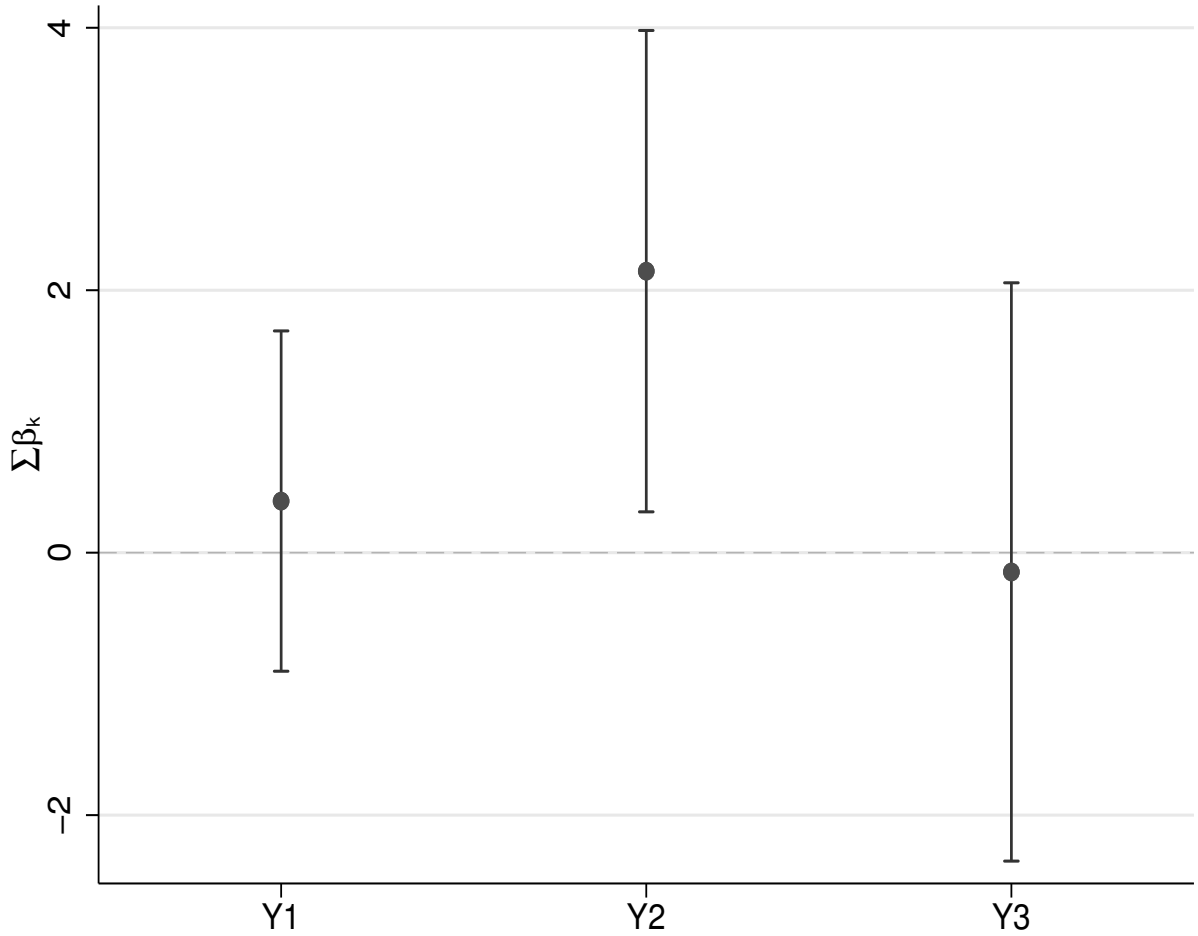
Two alternative measures of import-penetration "shock" - with similar results:

- $ChComp_{nt} = \frac{Imports_{China,nt}}{Imports_{World,nt}}$, where n is 4-digit industry.
- Deviations from 2-digit trend of $ChComp_{nt}$.

Both instrumented using import penetration in border South American countries. Results also robust to other upper-middle income countries not in South America.

Graph 2-digit IV Back

Trade Shock and MRPK Dispersion

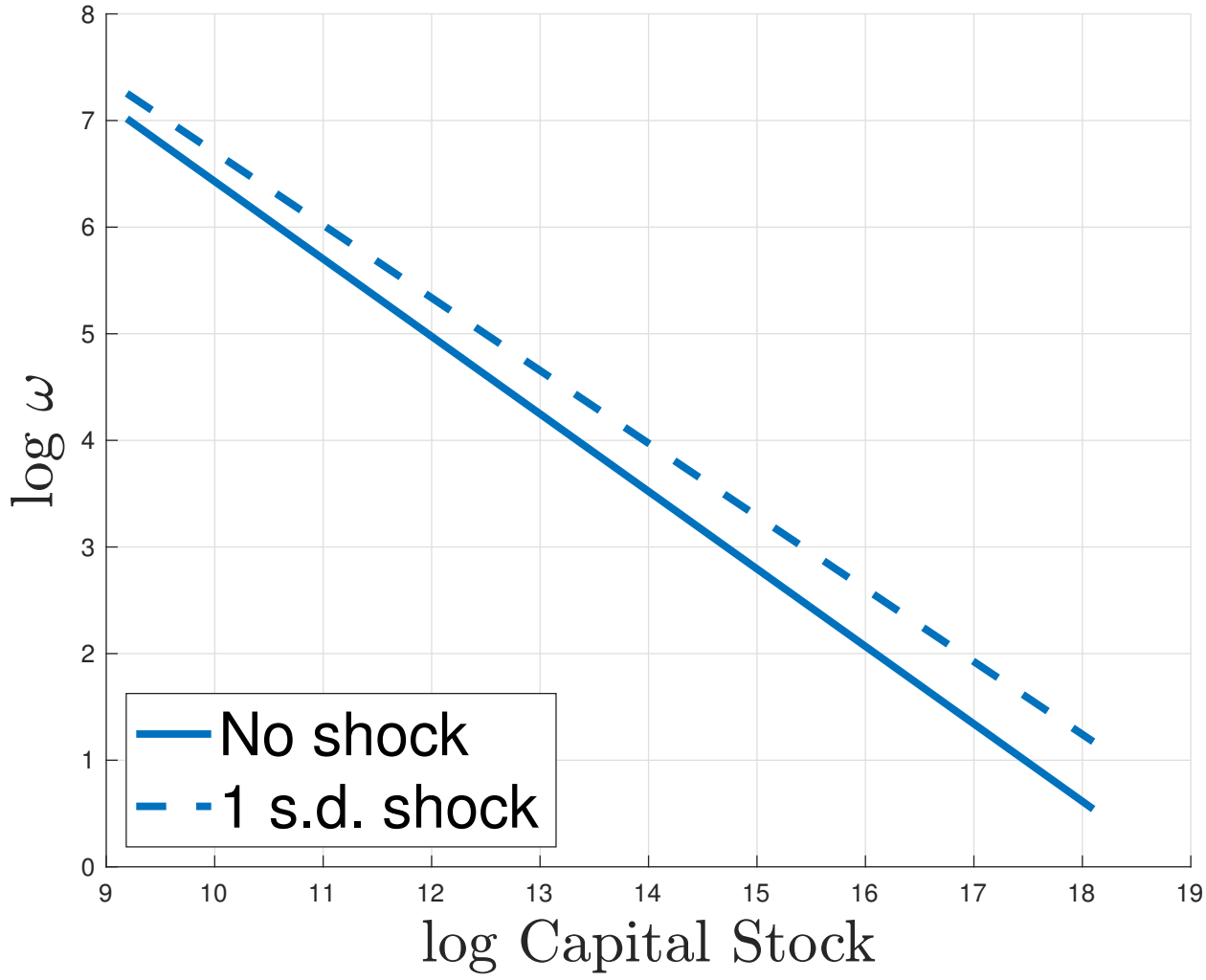


Regression

Trade Shock and Investment

	Inaction	Positive Investment	Negative Investment
ChComp_{nt}	0.456	-0.537	0.081
	(0.092)	(0.107)	(0.065)

Trade Shock and Selection



Def Reg

Model

Key Ingredients

- Representative household
  - $U_0 \equiv \sum_{t=0}^{\infty} \beta^t \left(\log(C_t) - N_t\right)$
  - CES demand structure

$$C_t = \left(\int_0^{M_t} c_{jt}^{\theta} dj + \int_{M_t}^{M_t + M_t^F} c_{jt}^{\theta} dj \right)^{\frac{1}{\theta}}$$

- Heterogeneous manufacturing firms
  - Idiosyncratic productivity shocks, fixed continuation costs, fixed entry costs
  - Endogenous entry and exit
  - Partial investment irreversibility
- Export sector (commodities) produces output using labor

Firms

- Production function

$$y_{jt} = s_{jt} k_{jt}^{\alpha} n_{jt}^{1-\alpha}$$

- Capital accumulation

$$k_{j,t+1} = (1-\delta)\, k_{jt} + i_{jt}$$

with marginal cost of investment

$$Q(i_{jt}) = \begin{cases} Q, & \text{if } i_{jt} \geq 0 \\ q(< Q), & \text{if } i_{jt} < 0 \end{cases}$$

- Continuation cost $f \sim G(f; s)$. If exit, recover scrap value

$$(1-\zeta) q (1-\delta) k$$

Dynamic Program

Static labor choice:

$$\pi(k, s, Z) \equiv \max_{n} P(Z) C(Z)^{\frac{1}{\epsilon}} s^{\theta} k^{\theta\alpha} n^{\theta(1-\alpha)} - n$$

Incumbents: If firm continues,

$$V^{c}(k, s, f, Z) = \max_{i, k'} P(Z)^{-1} \left(\pi(k, s, Z) - f - Q(i) i\right) + \beta \mathbb{E}\left[\frac{C(Z)}{C(Z')} V\left(k', s', f', Z'\right) | s, Z\right]$$

Dynamic Program (cont'd)

If firm exits,

$$V^x(k, s, Z) = P(Z)^{-1}\left(\pi(k, s, Z) + q\left(1-\zeta\right)\left(1-\delta\right)k\right)$$

Value function

$$V(k, s, f, Z) = \max\left\{V^c(k, s, f, Z), V^x(k, s, Z))\right\}$$

Entrants: Constant mass of potential entrants draw entry cost f^e and initial condition s^e

$$P(Z)^{-1}f^e \leq \max_{k'} -P(Z)^{-1}Qk' + \beta\mathbb{E}\left[\frac{C(Z)}{C(Z')}V\left(k', s', f', Z'\right)|s^e, Z\right]$$

Equilibrium

- Household consumption and labor supply
- Firms decision rules for labor demand, investment, entry/exit
- Commodities labor demand and output
- Manufacturing prices

such that

1. Labor market clears
2. Market for each variety clears ($c = y$)
3. Value of exported commodities equals value of imports (capital and manufacturing)

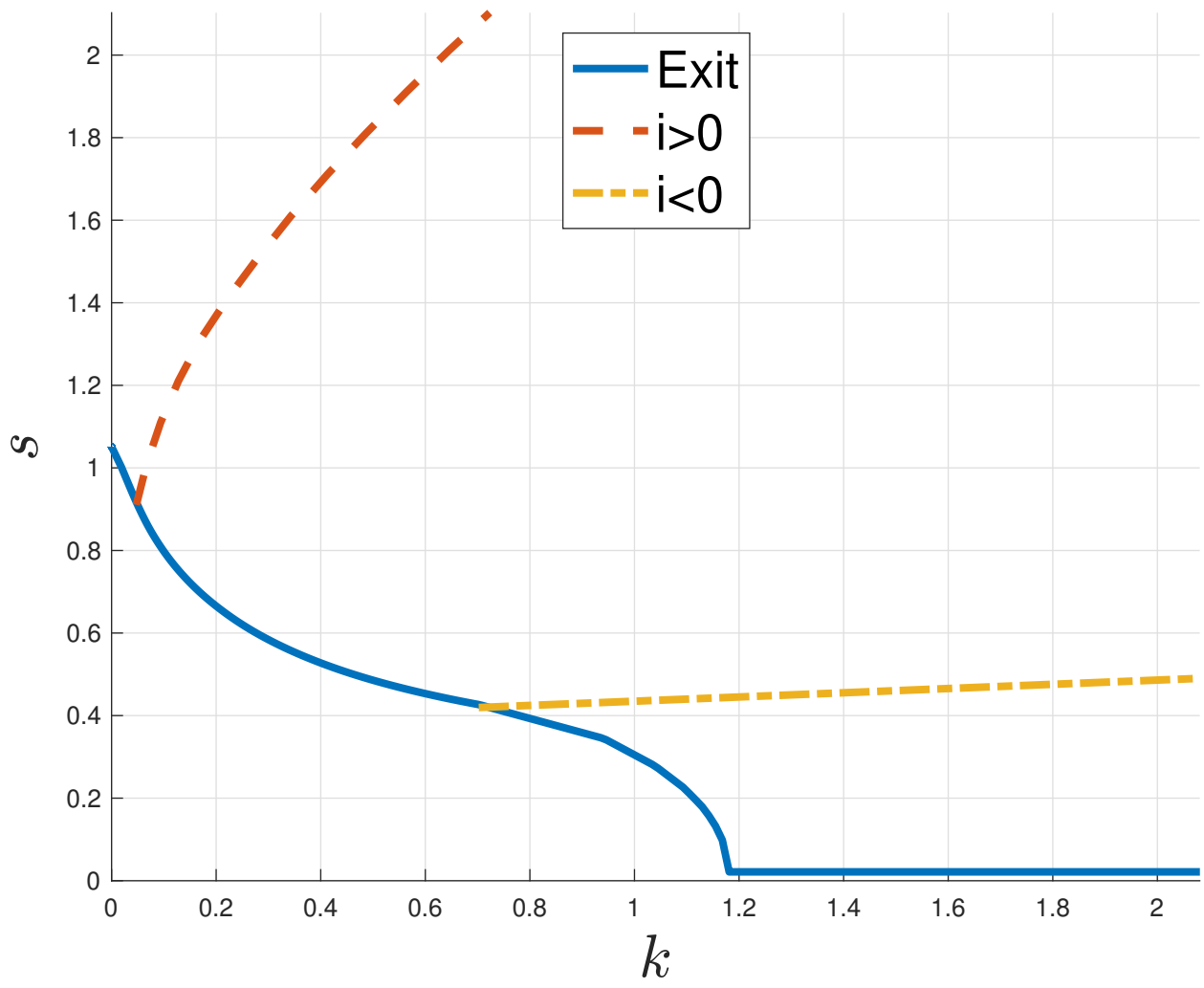
Quantitative Analysis

Calibration

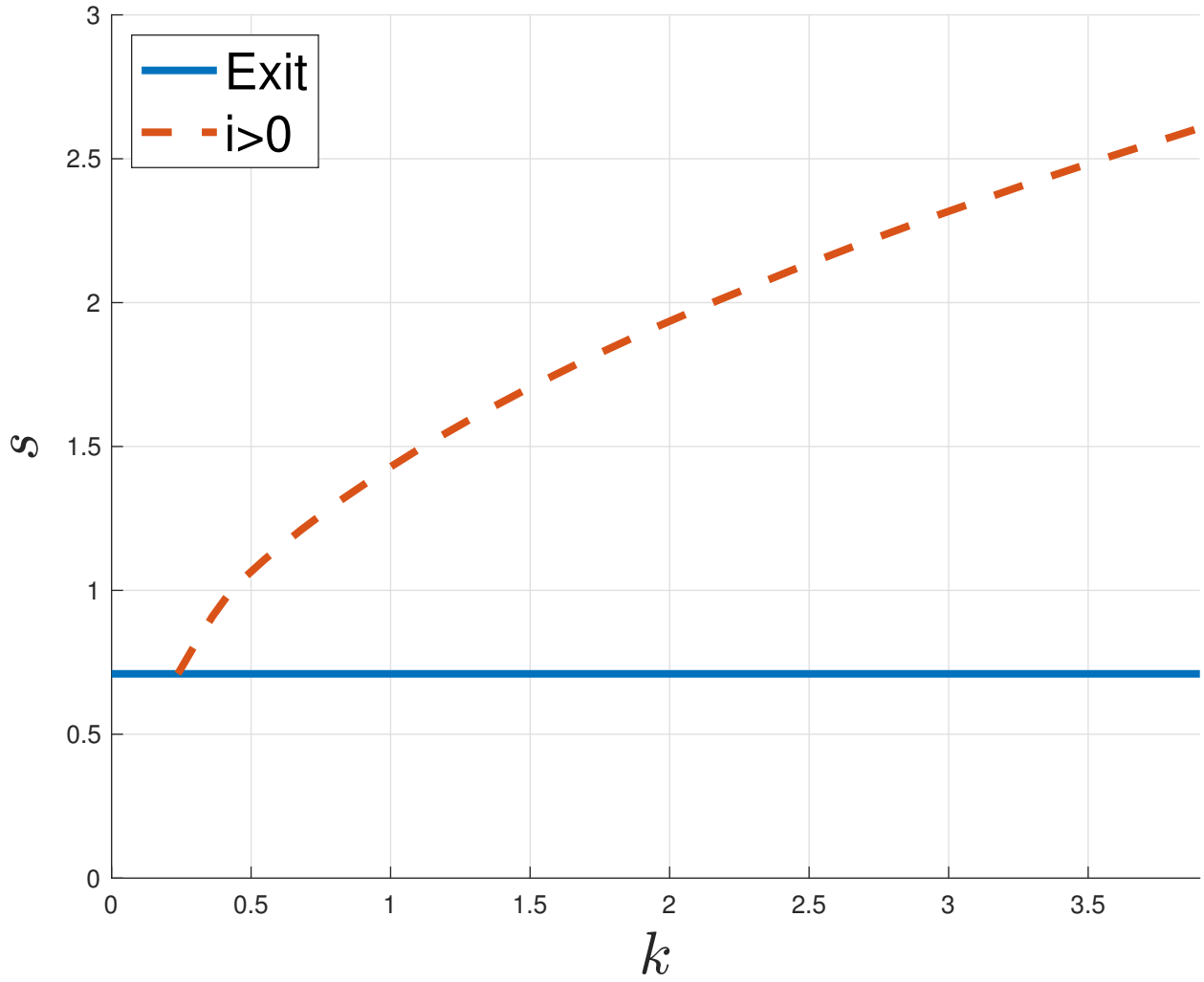
Parameter	Value	Target / Source
β	0.96	Standard (annual frequency)
χ	2.15	Hours worked
ϵ	4	Literature
α	0.396	Capital share
δ	0.105	Depreciation rate
ρ	0.783	Autocorrelation of ω
σ	0.797	Standard deviation of ω
q/Q	0.567	frequency of negative investment
ζ	0.186	Slope of exit thresholds
η_0	0.0744	Exit rate
η_1	4.861	Relative size at exit
η_2	4.864	Relative productivity at exit

Table: Parameter Values.

Thresholds



Thresholds (Frictionless)



MRPK Dispersion and Mobility

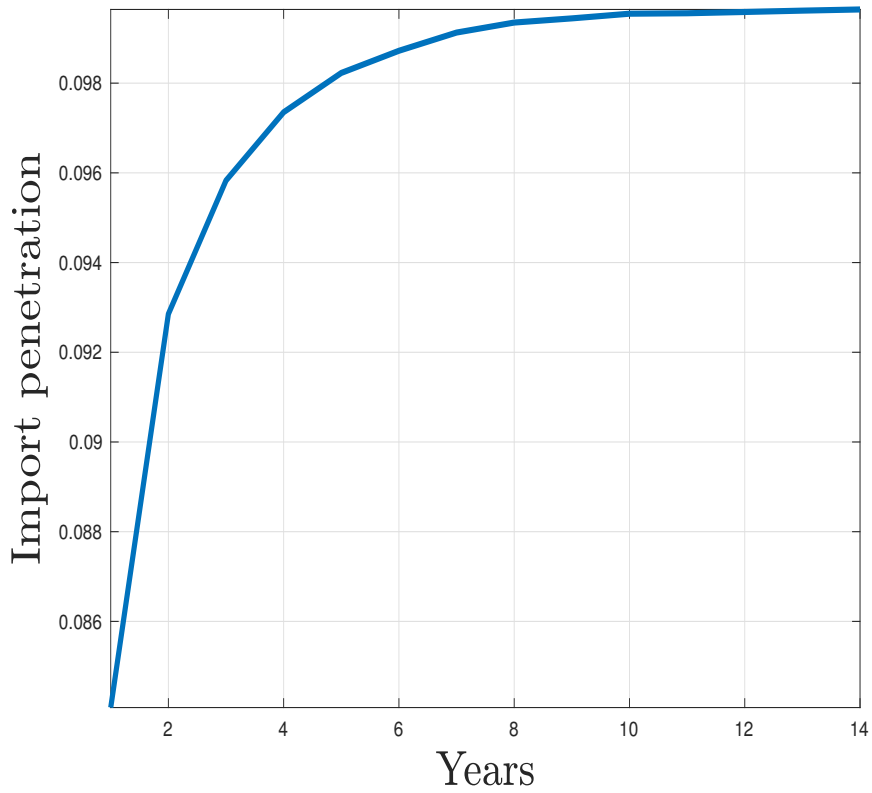
S.D. of log MRPK is 1.47 in the data, 1.29 in the baseline, and 1.09 in the frictionless model

Baseline		at $t+1$		
		1	2	3
Tercile at t	1	0.62	0.28	0.10
	2	0.36	0.38	0.26
	3	0.15	0.35	0.50

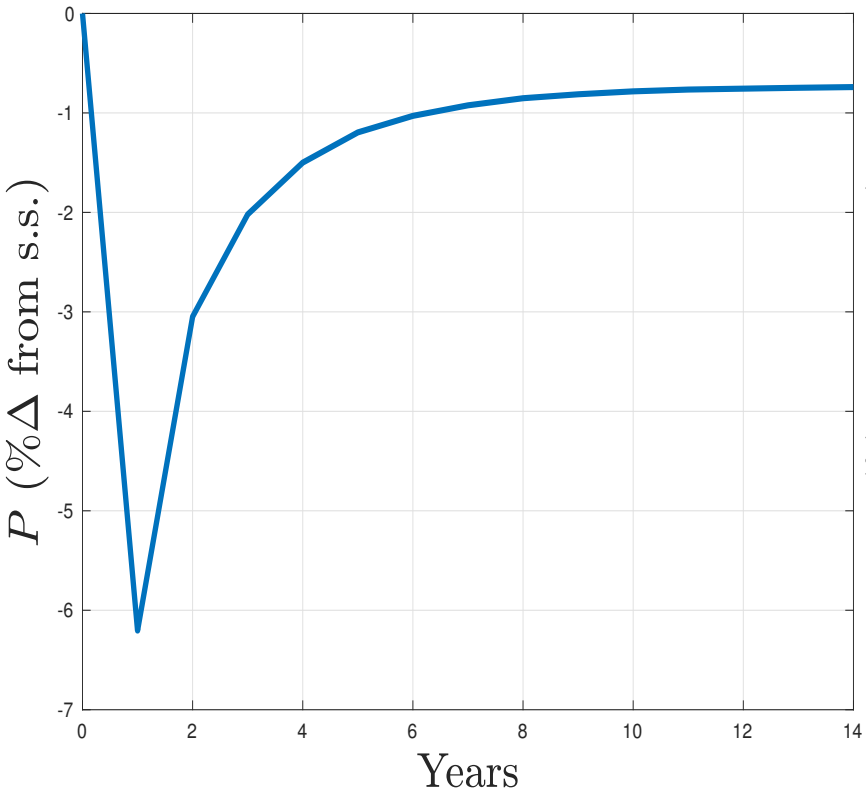
Frictionless		at $t+1$		
		1	2	3
Tercile at t	1	0.33	0.33	0.33
	2	0.33	0.33	0.33
	3	0.33	0.33	0.33

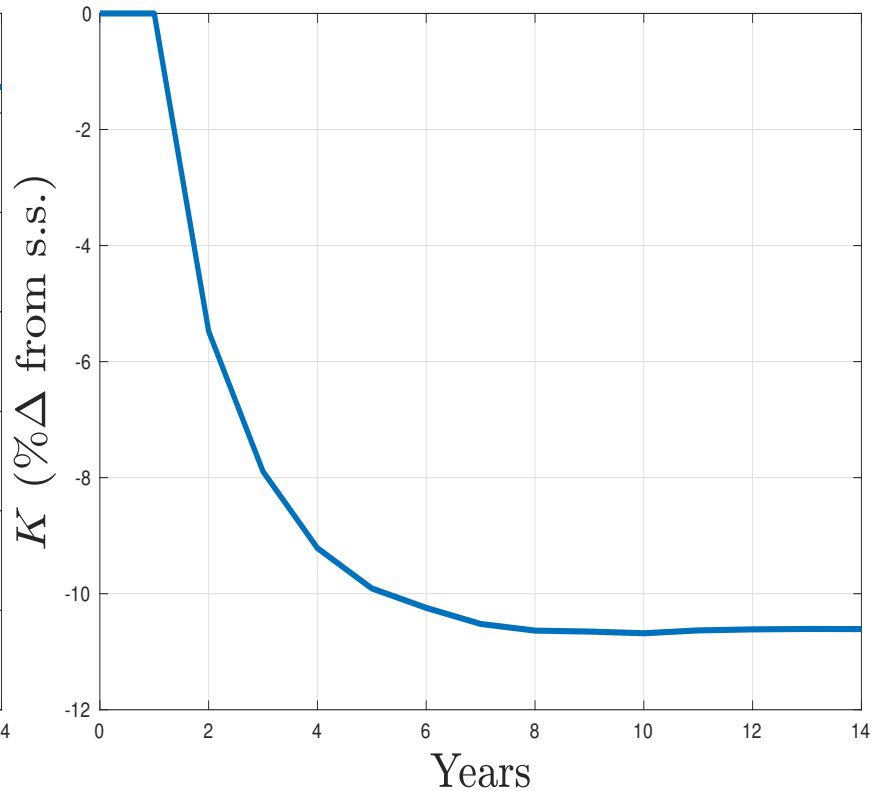
Import Penetration

One-time unexpected, permanent increase in M^f

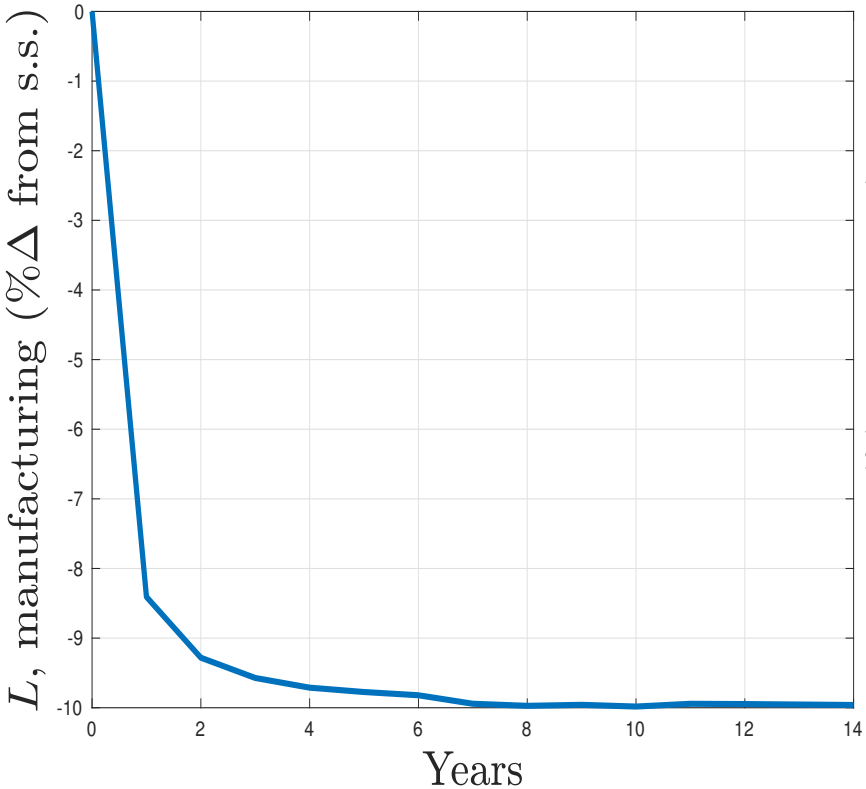


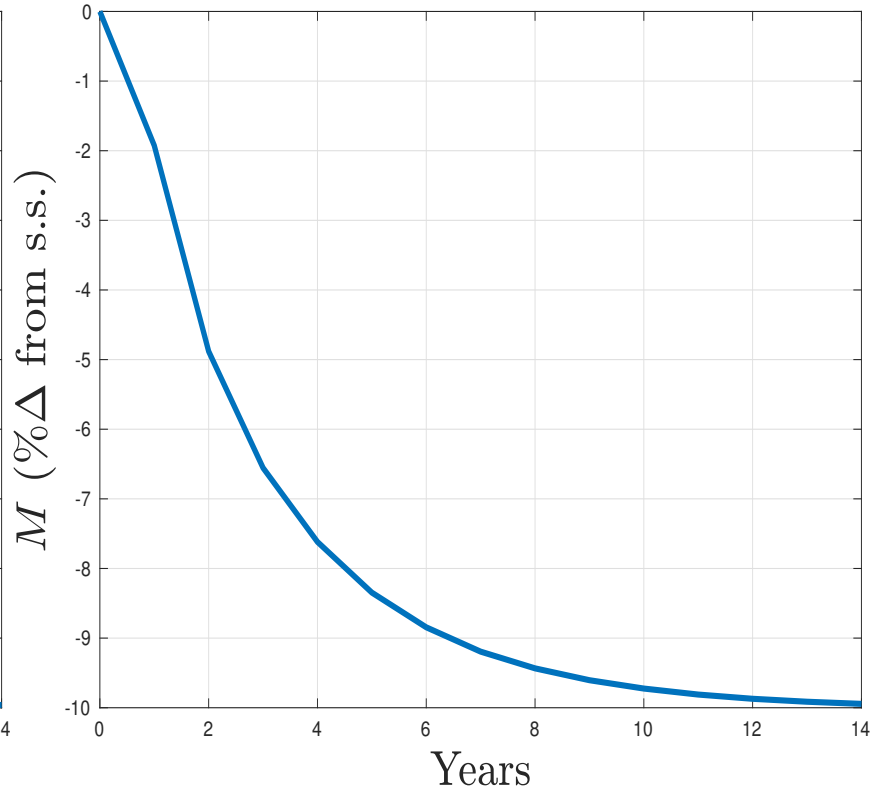
Aggregate Dynamics (P and K)



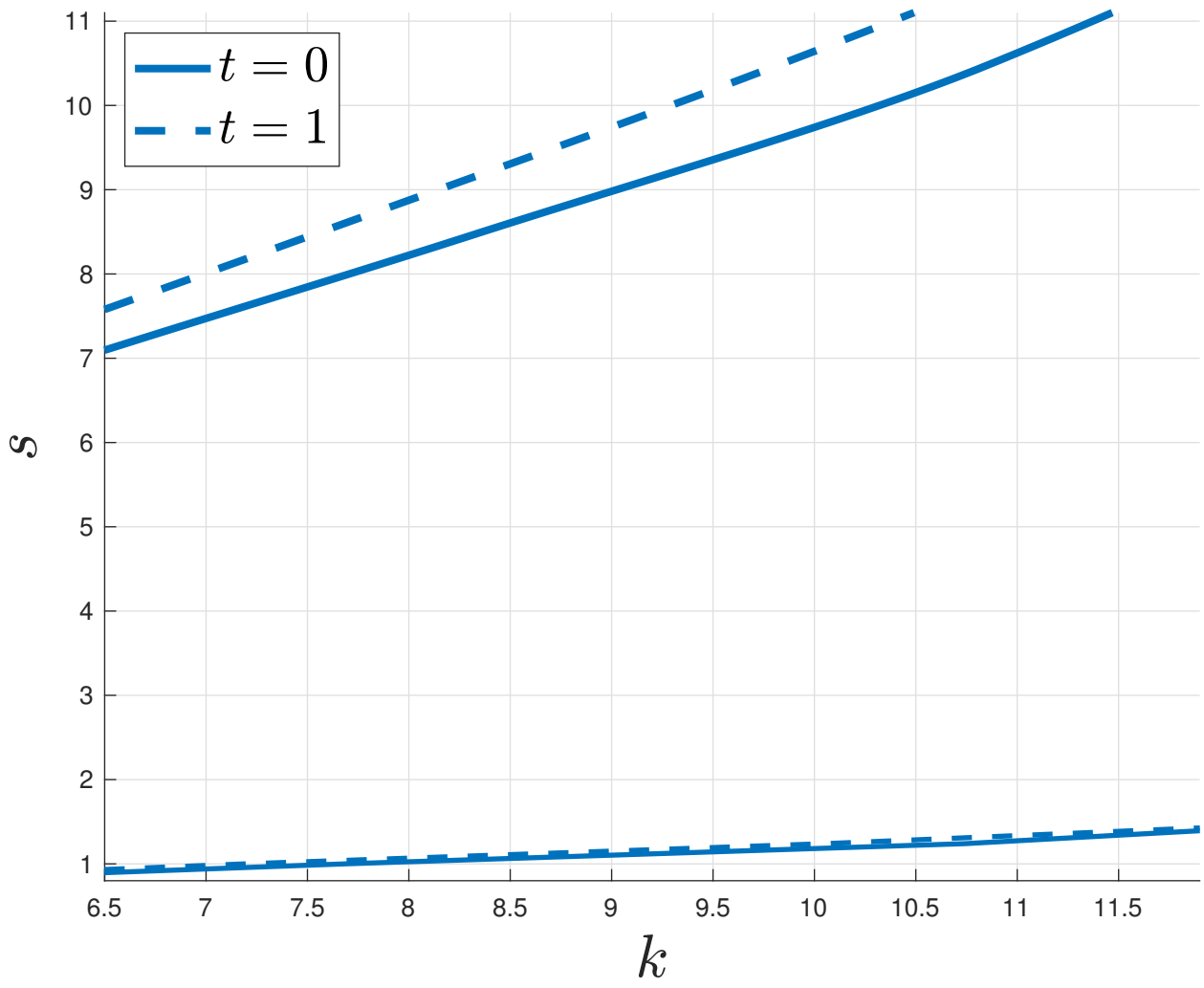


Aggregate Dynamics (N in manuf. and M)

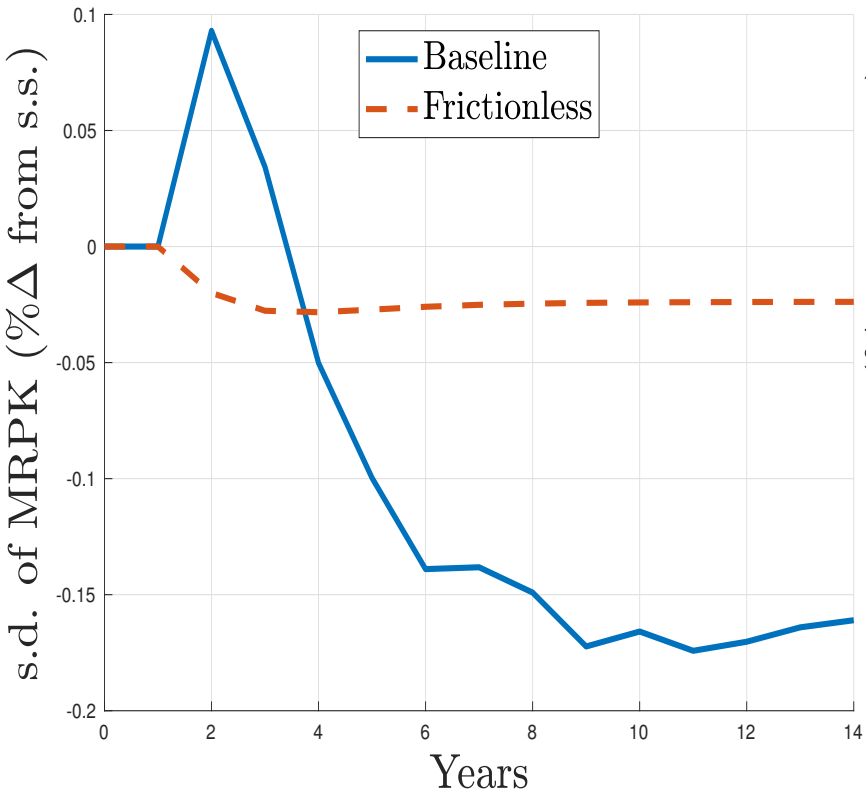


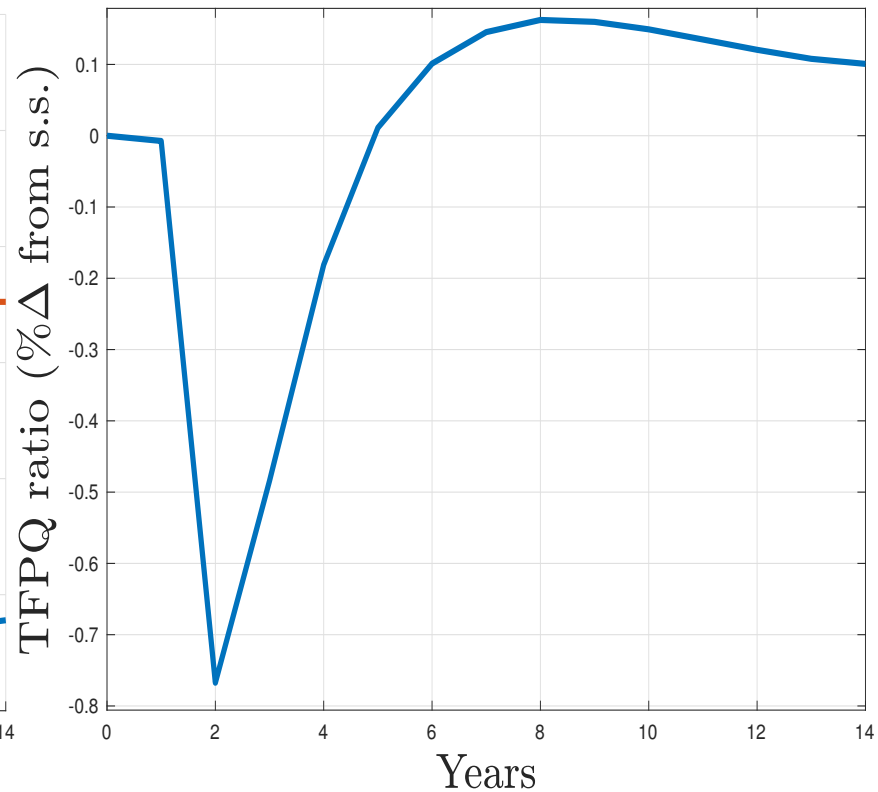


Inaction

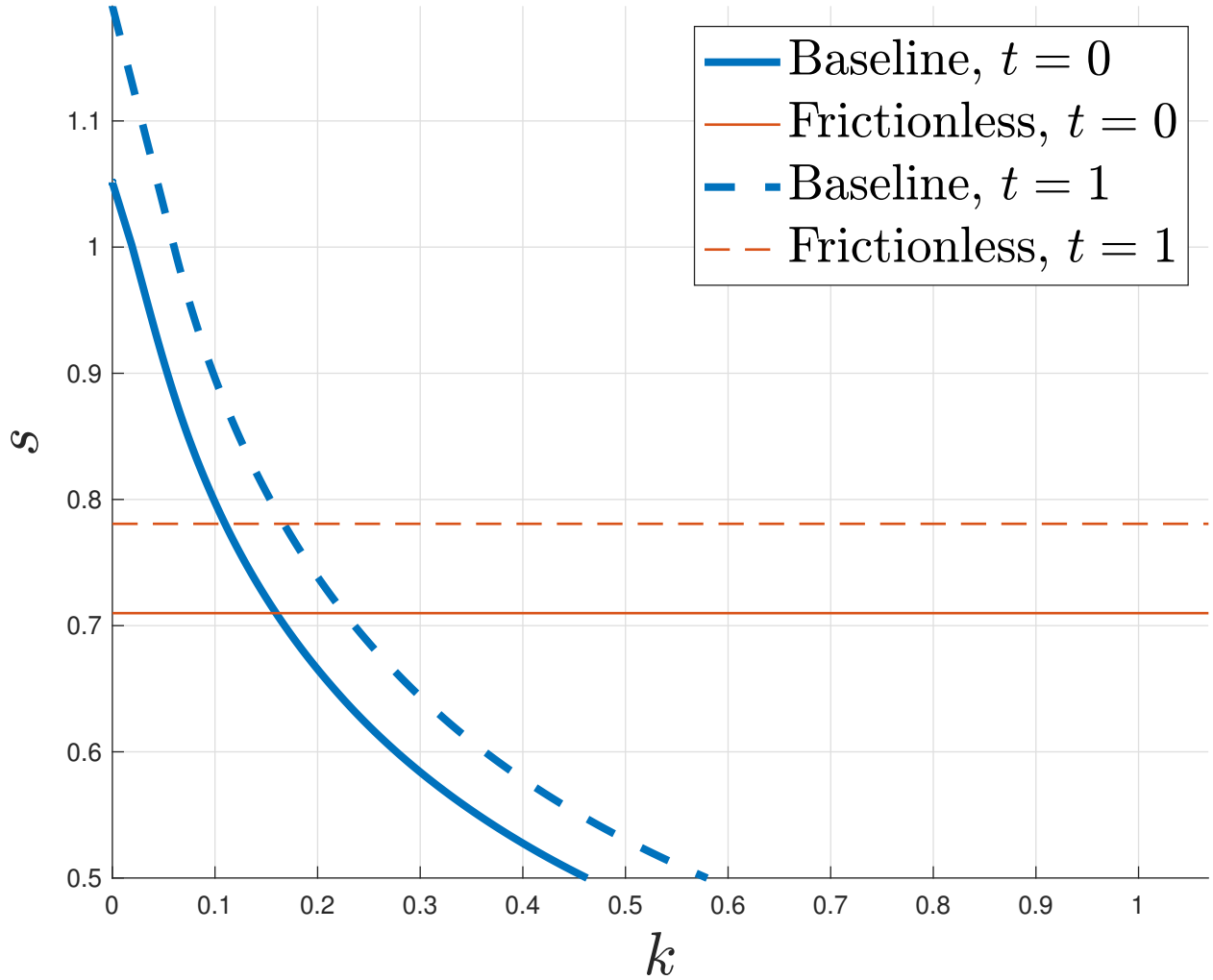


MRPK Dispersion and TFPQ Losses

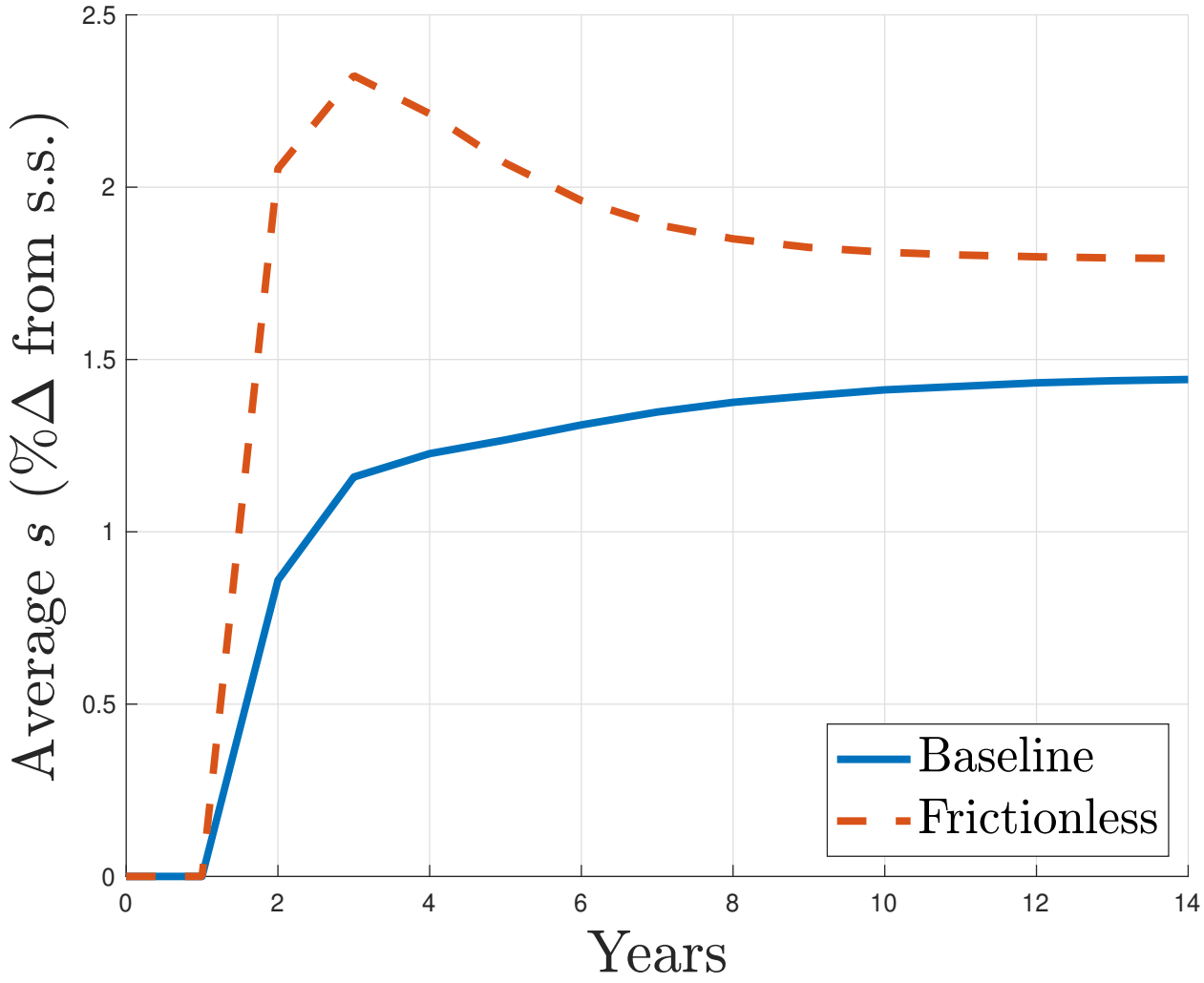




Selection


Baseline, $t = 0$
Frictionless, $t = 0$
Baseline, $t = 1$
Frictionless, $t = 1$
1.1
1
0.9
0.8
0.7
0.6
0.5
s
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
k

Average Firm TFPQ



Extensions and Sensitivity

- Add quadratic capital adjustment cost (and fixed costs)
  - Recalibrate all parameters with additional investment targets
    - Standard deviation of investment
    - "Lumpiness"
  - Estimates of irreversibility (q, ζ) robust
  - Similar effects of trade shock, larger increase in $\sigma(MRPK)$
- Continuation cost f distribution independent of s
  - Worse fit, same results

Conclusions

- Capital reallocation is costly
  - MRPKs dispersed and persistent, especially when low
  - Selection does not depend only on productivity
- To quantify short- and medium-run effects of trade shocks, need to account for capital-reallocation frictions
- Productivity gains from trade come gradually over time
- Welfare gains emerge early in the transition

Extra

Definitions of Revenue Productivity

Notice

$$\omega_{jt} \equiv \frac{p_{jt} y_{jt}}{k_{jt}^{\theta\alpha} n_{jt}^{\theta(1-\alpha)}} = B_t^{\frac{1}{\epsilon}} s_{jt}^{\theta}$$

Different from:

$$TFPR_{jt} \equiv \frac{p_{jt} y_{jt}}{k_{jt}^{\alpha} n_{jt}^{1-\alpha}}$$

which in turn is tightly linked to $MPRK_{jt}$ (e.g., Hsieh and Klenow, 2009)

Back

Fact 3. Capital Matters for Selection

We estimate the probability of survival as a function of k_{jt} and s_{jt}.

$$Survival_{jnt,t+1} = \begin{cases} 1 & \text{if} \quad z^*_{jnt} > 0 \\ 0 & \text{otherwise} \end{cases}$$

and

$$z^*_{jnt} = \alpha + \beta_1 \log \omega_{jnt} + \beta_2 \log K_{jnt} + \gamma_n + \gamma_t + \epsilon_{jnt}$$

Back

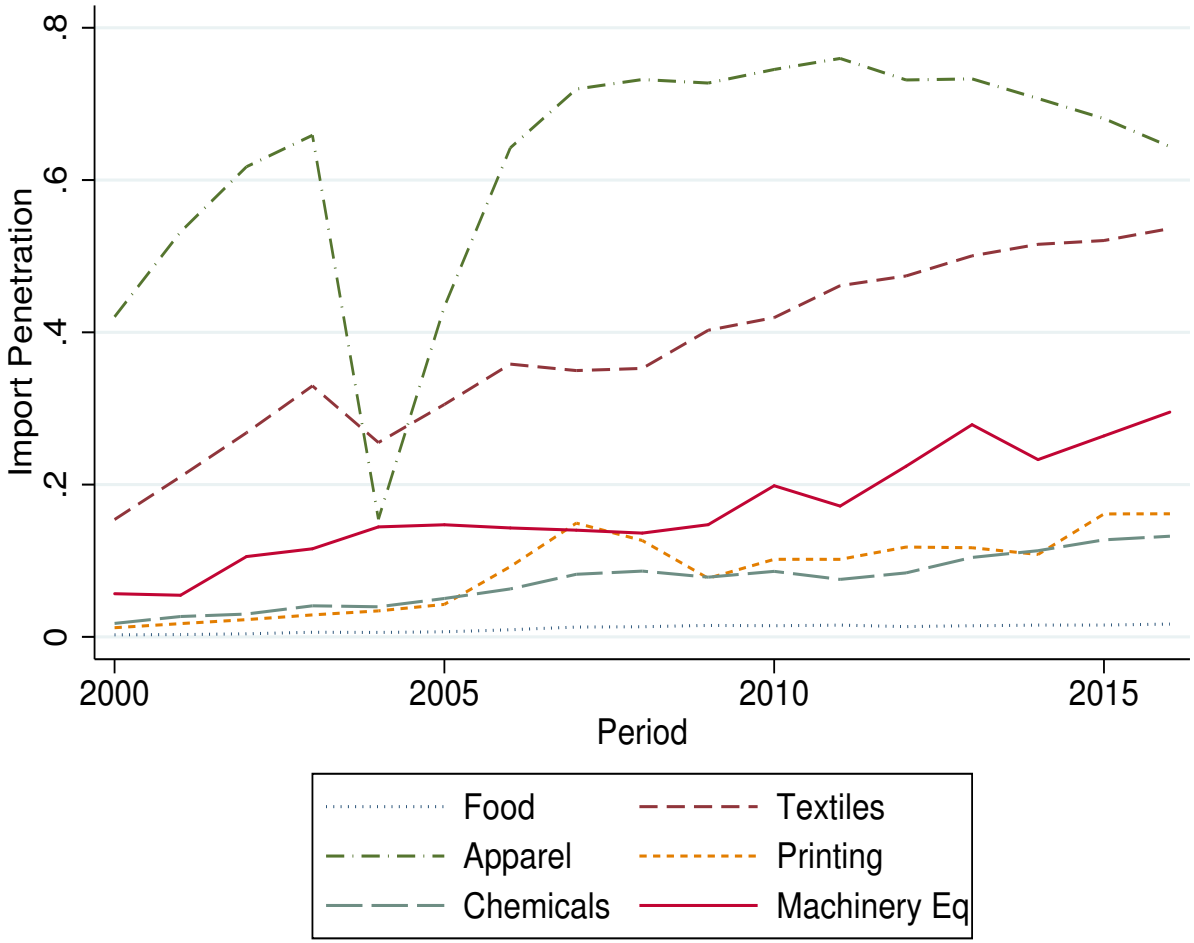
Fact 3. Capital Matters for Selection

	$P(surv_{jnt})$ Full Sample (1)	$P(surv_{jnt})$ Matched Sample (2)	$P(surv_{jnt})$ Matched Sample 2007 and 2011 (3)
log ω_{jnt}	0 .257	0.291	0.302
	(0.017)	(0.041)	(0.054)
log K_{jnt}	0.189	0.121	0.145
	(0.008)	(0.019)	(0.024)
N. Observations	12,401	6,180	2,586

TABLE: Effect on Survival.

Back

Chinese Import Competition



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Trade Shock and Instruments

Objective: instrument $ChComp_{nt}$ and its deviations from trend.

Endogeneity concern: Peru's economic activity attracts both imports from China and affects selection and investment behavior of Peruvian firms.

Solution: Use measures of $ChComp_{nt}$ and its deviations from trend in other South American border countries.

Back

Trade shock and Selection

$$Survival_{jnt,t+1} = \begin{cases} 1 & \text{if} \quad z^*_{jnt} > 0 \\ 0 & \text{otherwise} \end{cases}$$

and

$$z^*_{jnt} = \beta_0 + \beta_1 ChComp_{nt} + \beta_2 \log \omega_{jnt} + \beta_3 ChComp_{nt} * \log \omega_{jnt}$$
$$+ \beta_4 \log K_{jnt} + \beta_5 ChComp_{nt} * \log K_{jnt} + \eta X_{jnt} + \gamma_n + \gamma_t + \epsilon_{jnt}$$

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Trade Shock and Instruments (cont'd)

1. Create the vector $ChComp_{nt}^{other}$ as deviations from each country's industry trends of import penetration. The countries are Ecuador, Colombia, Brazil, Bolivia and Chile.
2. Regress $ChComp_{nt}^{Peru}$ on $ChComp_{nt}^{other}$, X_{jnt}, Y_{jnt}, γ_n and γ_t, where X_{jnt} are exogenous variables in the selection equation and Y_{jnt} are exogenous variables in the main specification, and γ_n and γ_t are the industry and year fixed effects, respectively.
3. Get the predicted value of the first stage regression $\tilde{ChComp}_{nt}^{Peru}$.
4. Use those predicted values as a new measure of import competition shock.

Back

MPRK Transition with Exit State

		at $t+1$			
		1	2	3	exit
Tercile at t	1	0.62	0.12	0.01	0.25
		(0.01)	(0.00)	(0.00)	(0.01)
	2	0.15	0.55	0.10	0.20
		(0.00)	(0.01)	(0.00)	(0.01)
	3	0.02	0.13	0.52	0.33
		(0.00)	(0.00)	(0.01)	(0.01)

TABLE: Transition probabilities of MRPK

Back

Productivity ω Transition

		at $t+1$		
		1	2	3
Tercile at t	1	0.71	0.23	0.06
		(0.01)	(0.01)	(0.00)
	2	0.23	0.60	0.17
		(0.00)	(0.01)	(0.00)
	3	0.04	0.20	0.76
		(0.00)	(0.00)	(0.00)

TABLE: Transition probabilities of ω

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Fact 2. MRPK Conditional Autocorrelation

Another way to see Fact 2 $\rightarrow$

$$\log MRPK_{jnt} = \alpha + \sum_{q \in \{1,2,3\}} \left(\rho_q \log MRPK_{jnt-1} \times \mathcal{I}_{jnt-1,q}\right) + \gamma_n + \gamma_t + \epsilon_{jnt}$$

	MRPK	TFPR
ρ	0.742	0.720
	(0.026)	(0.018)
ρ_{MRPK-1}	0.843	0.513
	(0.017)	(0.026)
ρ_{MRPK-2}	0.641	0.565
	(0.025)	(0.024)
ρ_{MRPK-3}	0.546	0.608
	(0.050)	(0.023)

Back

MPRN "Mobility"

		at $t+1$		
		1	2	3
Tercile at t	1	0.71	0.23	0.06
		(0.01)	(0.01)	(0.01)
	2	0.25	0.59	0.17
		(0.01)	(0.01)	(0.01)
	3	0.07	0.24	0.69
		(0.01)	(0.01)	(0.01)

TABLE: Transition probabilities of MRPN. Standard errors in parenthesis.

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Industry Regressions

$$\Delta y_{jt} = \alpha_j + \sum_{k=[0,5]} \beta_k \Delta Shock_{jt-k} + \epsilon_{jt}$$

where

- Δy_{jt}: Change in outcome variable between period t and $t-1$. This could be defined by 4 digit-industry or 2-digit industry (better and consistent).
- $\Delta Shock_{jt-k}$: Change in *Shock* variable between period $t-k$ and $t-k-1$. This shock is defined at the 4-digit industry level.
- α_j: Fixed effect of industry at 2-digit.

such that the cumulative effect up to year t from $t-k$ is

$$\tilde{\beta}_k = \sum_k \beta_k$$

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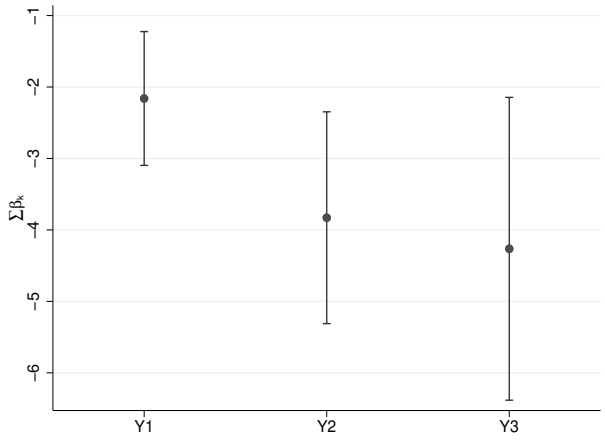
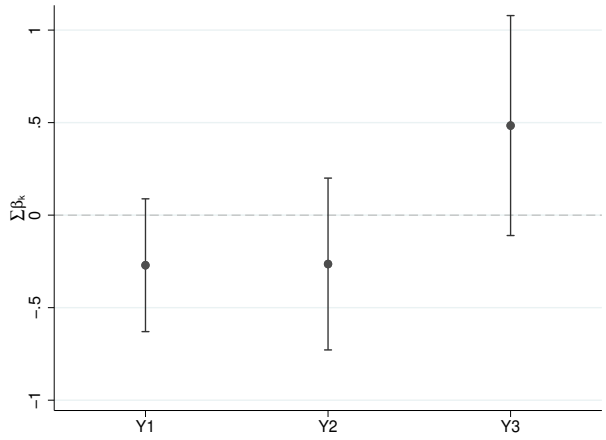
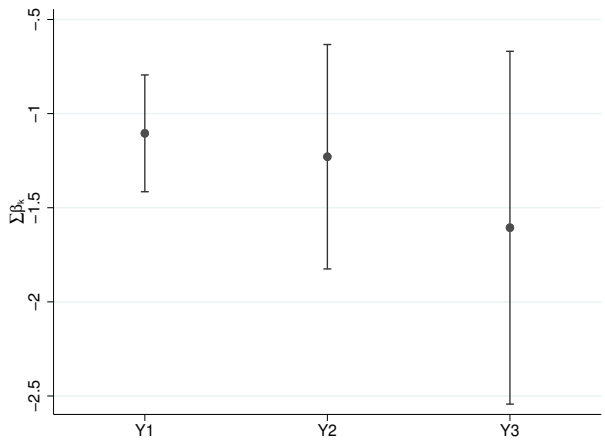
2-digit industries — 3 lags



(a) TFP

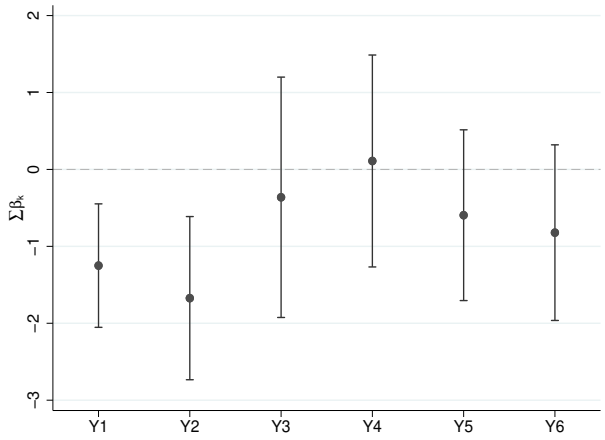


(b) Sd MRPK (big)

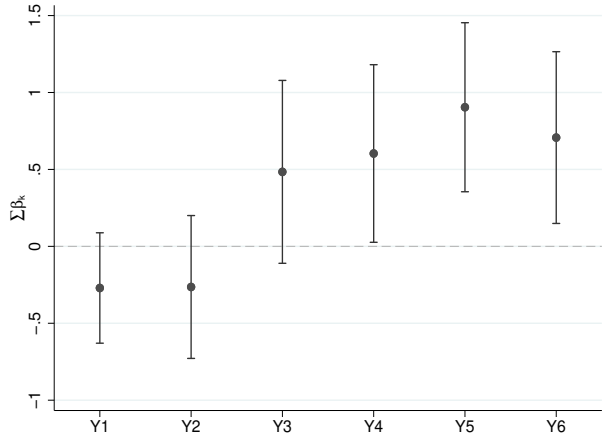


(c) Sd MRPK (all)

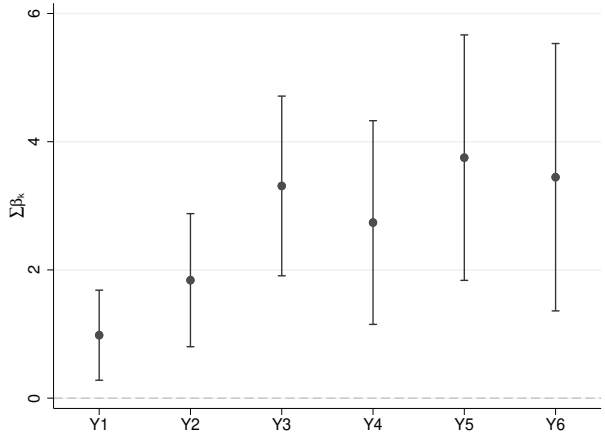
2-digit industries — 6 lags



(d) TFP

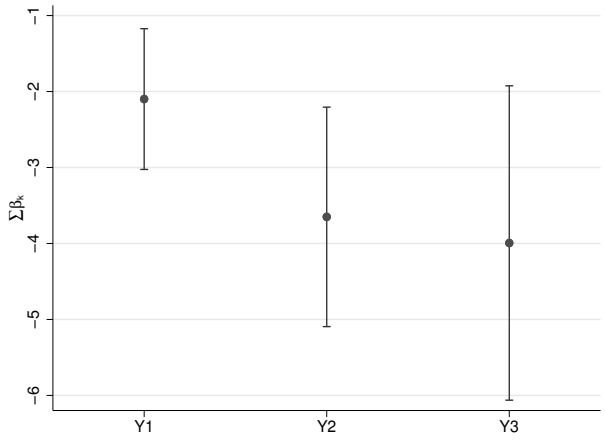


(e) Sd MRPK (big)

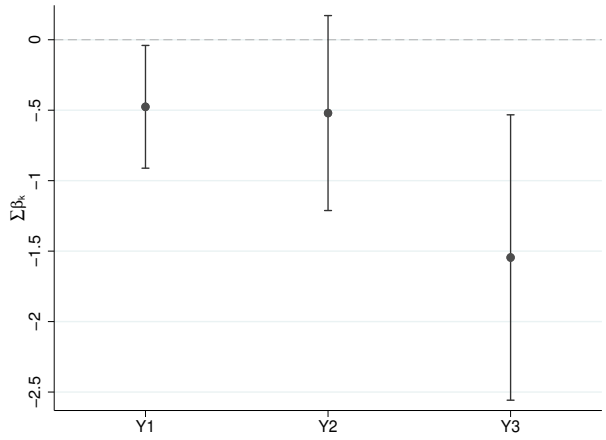


(f) Sd MRPK (all)

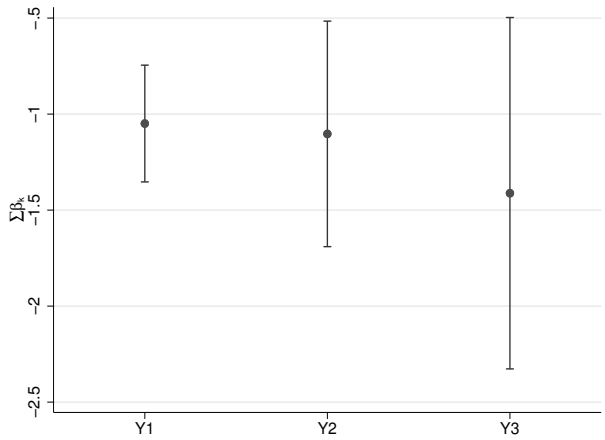
2-digit industries — 3 lags — Import Penetration



(g) TFP

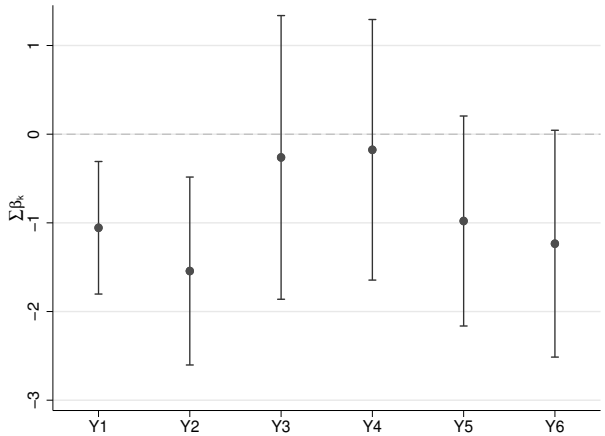


(h) Sd MRPK (big)

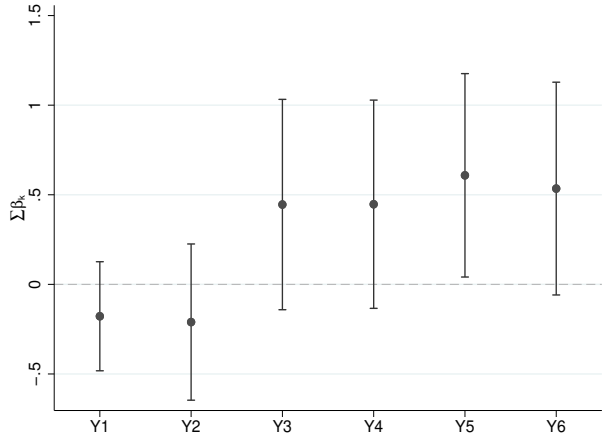


(i) Sd MRPK (all)

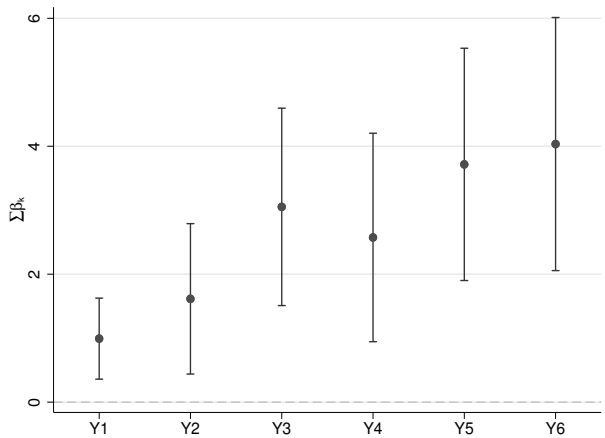
2-digit industries — 6 lags — Import Penetration



(j) TFP



(k) Sd MRPK (big)



(l) Sd MRPK (all)