Liability Dollarization and Exchange Rate Pass-through

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joint with Junhyong Kim (Korea Development Institute)

Motivation: Strong Dollar & Spillover to Emerging Markets

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- The negative balance sheet effect of $ debt on **domestic inflation** is neglected in the literature.

Research Question

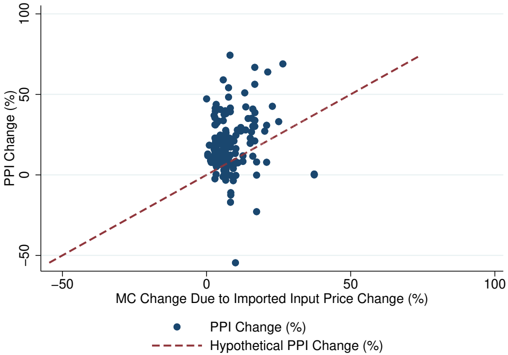
1. How do firms' pricing decisions vary with different levels of FC debt?

2. How significant is this balance sheet effect of FC debt
in explaining the exchange rate pass-through to domestic producer inflation?

Motivation: Domestic PPI Across Manufacturing Sectors in Korea

- From 1996-98, Realized PPI changes vs. $\underbrace{\text{PPI changes implied via the imported input channel}}_{\text{Imported Input Share} \times \Delta \text{Imported Input Price}}$

assuming (i) Cobb-Douglas production function with CRTS, and (ii) a complete pass-through



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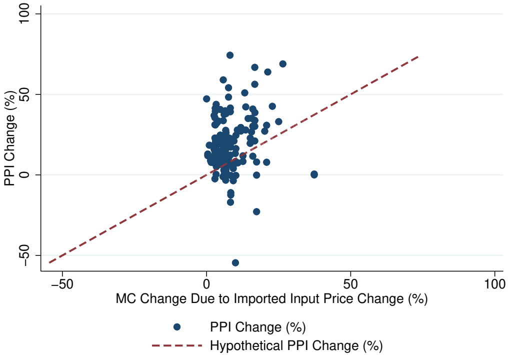
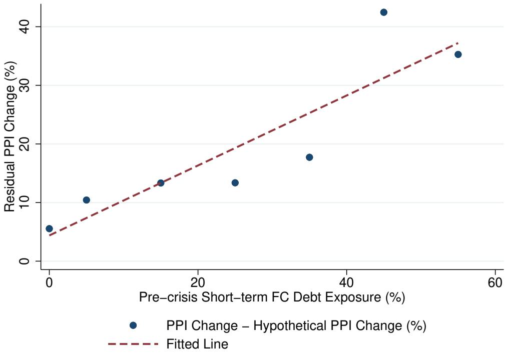


- The imported input channel is in fall short of generating the level of PPI changes upon a large depreciation. Cross-country

Motivation: Positive Correlation Between FC Debt Exposure and Residual PPI Changes

- Residual PPI changes (Realized PPI changes - Implied PPI Changes via Imported Input Channel) and Pre-crisis Short-term FC debt exposure



- Relatively neglected balance sheet channel may account for the much pronounced increase in domestic producer prices.

Literature Review

Exchange Rate Pass-Through to Prices

Exchange rate pass-through to domestic prices

Goldberg, Campa (2010), Amiti, Itskhoki, Konings (2019)

⇒ **Exploring the neglected balance sheet channel in the exchange rate pass-through**

Contractionary Effects of Foreign Currency Debt

- Empirical and theoretical investigation of negative balance sheet effects on firm performance

  Krugman (1999), Céspedes, Chang, Velasco (2004), Kim, Tesar, Zhang (2015), Kohn, Leibovici, Szkup (2018)

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Financial Frictions and Firms' Pricing Decisions

- Closed Economy Setting

  Gilchrist et al. (2017), Christiano et al. (2015), Del Negro et al. (2015), Kim (2021)

⇒ **Open economy setting in the sudden stop episodes with dollar debt and a large depreciation**

Overview

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(3) The estimated model performs well in explaining price dynamics during the crisis:

(i) 35% of the mean effect of the short-term foreign currency debt on the price changes across industries

(ii) 52% of the variation in price changes across industries during the crisis.

(4) Preliminary: We decompose the price changes via the imported input channel and those via the balance sheet effect.

Empirical Analysis

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Firm-level balance sheet data: KISVALUE Dataset

1. currency composition & maturity of their debt:
   foreign currency vs. domestic currency, short-term vs. long-term
2. not only large but small and medium-sized firms:
   $\approx$ 3,000 firms in manufacturing sector (as of 1998)
3. a rich set of firm-level variables to control for potential endogenity bias:
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Domestic Produce Price Index (PPI) for 149 industries in manufacturing sector (4-digit).

⋆ We exploit **a large devaluation** in Korea in 1997 & different **FC debt exposure** across industries to identify the balance sheet effect on the exchange rate pass-through to domestic output prices.

▸ Won per $

Summary Statistics

	1993	1994	1995	1996	1997	1998
Number of firms	1392	1631	2174	2792	2959	3446
Fraction of firms with FC debt (%)	56.3	53.3	45.7	43.0	40.8	34.5
Fraction of firms with FC short-term debt (%)	49.3	44.7	37.1	34.9	32.0	28.0
Mean FC short-term debt ratio (%)	4.6	3.8	3.5	3.5	3.6	3.2
Mean FC short-term debt ratio given positive holding (%)	9.4	8.6	9.3	10.0	11.0	11.4
Mean FC long-term debt ratio (%)	7.1	6.6	5.7	5.9	7.3	5.8
Mean FC long-term debt ratio given positive holding (%)	13.7	13.4	13.6	15.4	20.1	18.9
Mean FC share of short-term debt (%) given positive holding	16.8	14.5	14.5	15.9	18.1	19.3
Mean FC share of long-term debt (%) given positive holding	34.4	35.8	35.1	38.9	46.6	44.5

Note: Short-term debt is the amount of debt due within one year.

Industry-level Investigation

$$\Delta p_{i,96-98} = \beta_0 + \beta_1 \text{ ST FC}_{i,96} + \beta_2 \text{LT FC}_{i,96} + \beta_3 \text{X}_{i,96} + \epsilon_i$$

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- ST FC_i : weighted average of firms' short-term foreign currency debt to total debt in industry i.
- LT FC_i : weighted average of firms' long-term foreign currency debt to total debt in industry i.
- X_i includes:
  - Import channel: imported intermediate input share, weighted imported input price change
  - Other industry-level pass-through determinants: degree of the product differentiation (Rauch classification), degree of price stickiness
  - Weighted average of other firm-level variables: log of real assets, leverage ratio, domestic short-term debt ratio, export/sales ratio.

Empirics: Industry-Level Analysis

- Industries with high foreign currency exposure increase their prices more during the crisis.

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	(1)	(2)	(3)	(4)	(5)
ST FC	0.481***	0.437**	0.365**	0.478***	0.377**
	(0.176)	(0.191)	(0.164)	(0.178)	(0.183)
LT FC	0.061	0.121	0.107	0.075	0.133
	(0.185)	(0.180)	(0.175)	(0.185)	(0.176)
Rauch dummy		-0.068**			-0.046*
		(0.026)			(0.027)
Imported input share			0.195***		0.137*
			(0.066)		(0.074)
Degree of price stickiness				0.001	-0.000
				(0.002)	(0.002)
R^2	0.190	0.237	0.238	0.192	0.256
N. of cases	157	149	157	157	149

$X_{i,96}$: the level of product differentiation; imported intermediate input share; price stickiness; and the weighted average values of firm-level characteristics – size, export to sales ratio, domestic currency short-term debt ratio and leverage ratio.

Pre-crisis · Imported Input Channel · Firm Exit

Firm-level Investigation: Model Mechanism

$$\Delta y_{j,96-98} = \beta_0 + \beta_1 \text{ ST FC}_{j,96} + \beta_2 \text{LT FC}_{j,96} + \beta_3 \text{Size}_{j,96} + \beta_4 \text{ ST FD}_{j,96} \cdot \text{Size}_{j,96} + \beta_5 \text{ LT FD}_{j,96} \cdot \text{Size}_{j,96} + \beta_6 \text{X}_{j,96} + \epsilon_i$$

- Δy_j: changes in log of firm j's y variables in 1996-98.
- y includes (1) sales, (2) net worth and (3) estimated mark-ups.

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- Size_j: log of real assets of firm j

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- $Size_j$: log of real assets of firm j
- X includes: leverage ratio, domestic short-term debt ratio, export/sales ratio and industry FE.

mark-up estimation

Empirics: Firm-Level Analysis

- Firms with high foreign currency debt exposure have lower mark-up growth during the crisis.

$$\Delta y_{j,96-98} = \beta_0 + \beta_1 \text{ ST FC}_{j,96} + \beta_2 \text{LT FC}_{j,96} + \beta_3 \text{Size}_{j,96}$$
$$+ \beta_4 \text{ ST FC}_{j,96} \cdot \text{Size}_{j,96} + \beta_5 \text{ LT FC}_{j,96} \cdot \text{Size}_{j,96} + \beta_6 X_{j,96} + \epsilon_i$$

Dep.var: Δy_{96-98}	Sales growth	Net worth growth	Markup growth
ST FC	-7.749***	-5.679**	-0.914***
	(1.547)	(2.333)	(0.302)
LT FC	-1.777	-2.010	0.497
	(1.911)	(1.858)	(0.396)
Size	-0.153***	-0.046	0.000
	(0.031)	(0.037)	(0.008)
Size * ST FC	0.321***	0.205**	0.034***
	(0.061)	(0.090)	(0.012)
Size * LT FC	0.094	0.085	-0.020
	(0.076)	(0.076)	(0.016)
N. of cases	2237	2237	2237
R^2	0.212	0.086	0.069

$X_{j,96}$: size (measured by log of total assets), export to sales ratio, domestic currency short-term debt ratio, leverage ratio, and broad industry fixed effects. Other Variables

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- **Kimball aggregator** to examine variable mark-ups / strategic complementarity.
- Firms face two types of **financial** frictions.
- We assume that the economy is in the stationary equilibrium before **one-time unexpected** real exchange rate depreciation.
- We analyze the **transition dynamics** of industry price for each of 149 industries

Kimball-CES Structure

- Each industry I faces an exogenous CES demand, where the demand for industry I's composite goods is given by:

$$Y_I = \frac{P_I}{\bar{P}}^{-\nu} \bar{Y}$$

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- Each industry I is populated by a continuum of entrepreneurs indexed by $j(I)$.
- **Intermediate goods,** y_j, are produced by entrepreneurs j, aggregated into industry I's composite goods by the Kimball (1995) aggregation.
- Following Gopinath and Itskhoki (2010), we assume functional forms and the demand for an intermediate good produced by an entrepreneur j is:

$$y_j = \left(1 - \epsilon \ln(\frac{p_j}{P_I})\right)^{\sigma/\epsilon} Y_I, \quad p_j = \exp\left(\frac{1}{\epsilon}\left(1 - (\frac{y_j}{Y_I})^{\epsilon/\sigma}\right)\right) P_I$$

Entrepreneurs: Production

- In the beginning of each period, entrepreneur j learns this period's productivity z_{jt}
- z_{jt} is an idiosyncratic productivity that follows AR(1) process:

$$ln(z') = (1 - \rho_z)\mu_z + \rho_z \ln(z) + \omega_z, \text{ where } \quad \omega \sim N(0, \sigma_\epsilon)$$

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- Produces differentiated goods with domestic inputs n, foreign inputs x and capital k:

$$y = zk^{\alpha} x^{\kappa} n^{1-\alpha-\kappa}$$

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- ξ is the real exchange rate, the price of foreign final goods in units of domestic final goods
  - **expect** $\xi_t = 1$ **for all** t

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- Saves in liquid assets to pay a certain faction $(\frac{1}{\theta_a})$ of production costs before profits are realized:

$$wn + \xi x \leq \theta_a a$$

where a is non-interest-bearing asset chosen from previous period.

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- Note that the UIP holds so the prices of debt denominated in domestic and foreign final goods are the same as they expect the exchange rate to stay constant: price is $\frac{1}{1+r}$

$$1 + r_D = (1 + r_F)\,\mathbb{E}\,\frac{\xi'}{\xi} = (1 + r_F) \equiv (1 + r)$$

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- Face financial constraints:

$$\frac{d'}{1+r} \leq \theta_k k'$$

- The stationary equilibrium **doesn't depend on λ but it depends on κ.**

$$v(k,d,a,z;\lambda,\kappa,\xi) = \max_{c\geq 0, d',k',a',n,p} \frac{c^{1-\gamma}}{1-\gamma} + \beta E_{z'}[v(k',d',a',z';\lambda,\kappa,\xi')]$$

$$s.t. \quad c + k' - (1-\delta)k + \Phi(k,k') + a' + d\Big((1-\lambda) + \lambda \underbrace{\frac{\xi}{\xi_{-1}}}_{=1}\Big) = \underbrace{py - wn - \xi x}_{\pi(k,z)} + a + \frac{d'}{1+r}$$

$$\frac{1}{1+r}d' \leq \theta_k k' \quad \{\eta_1\}, \quad wn + \xi x \leq \theta_a a \quad \{\eta_2\},$$

where

$$(i)\ y = \left(1 - \epsilon \ln(\frac{p}{P_I})\right)^{\sigma/\epsilon} P_I^{-\nu}$$

$$(ii)\ y = zk^{\alpha}x^{\kappa}n^{1-\alpha-\kappa}, \quad (iii)\ \Phi(k,k') = \frac{\phi}{2}\left(\frac{k'-(1-\delta)k}{k}\right)^2 k$$

Transition: MIT Shock

- Each industry with its specific firm-level distribution of λ and the imported input share κ has different stationary equilibrium and different transition dynamics upon **one time unexpected depreciation** of the real exchange rate.
  - period 0 : stationary equilibrium (SS)
  - period 1 : unexpected depreciation of real exchange rate (MIT shock)

    $\Rightarrow k'$ and a' change

    $\cdots$
  - period ∞: new stationary equilibrium (SS)
- We investigate the transition dynamics when ξ goes up from 1 to 2.1 in the first period and stays there afterwards for each of 149 industries

Model Mechanism

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- Firm j's optimal pricing decision is

$$p_{j,t} = \mu_{j,t} mc_{j,t} \underbrace{(1 + \eta_{2,j,t})}_{\uparrow \text{ tighter working capital constraints}}$$

- Balance sheet deterioration has an effect on price by

(i) Investment adjustment

Balance sheet deterioration $\Rightarrow$ $\downarrow$ Investment$(k_{j,t+1})$ $\Rightarrow$ $\downarrow$ productivity $\Rightarrow$ $\uparrow$ $mc_{j,t+1}$

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Balance sheet deterioration $\Rightarrow \downarrow$ Investment$(k_{j,t+1})$ $\Rightarrow \downarrow$ productivity $\Rightarrow \uparrow mc_{j,t+1}$

(ii) Working-capital channel

Balance sheet deterioration $\Rightarrow \downarrow$ Cash$(a_{j,t+1})$ $\Rightarrow \uparrow \eta_{2,j,t+1}$

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- Balance sheet deterioration has an effect on price by

(i) Investment adjustment

Balance sheet deterioration $\Rightarrow$ $\downarrow$ Investment$(k_{j,t+1})$ $\Rightarrow$ $\downarrow$ productivity $\Rightarrow$ $\uparrow$ $mc_{j,t+1}$

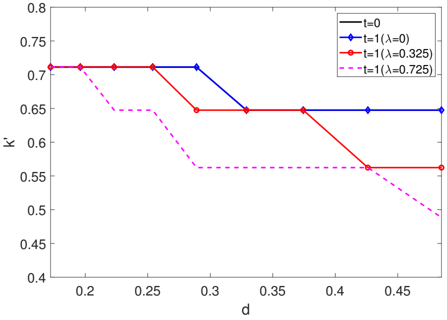
(ii) Working-capital channel

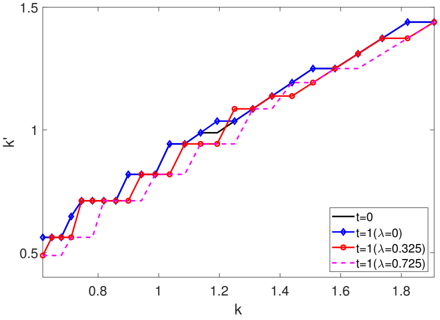
Balance sheet deterioration $\Rightarrow$ $\downarrow$ Cash$(a_{j,t+1})$ $\Rightarrow$ $\uparrow$ $\eta_{2,j,t+1}$

- **Strategic Complementarity** allows additional channel via the adjustment of $\mu_{j,t+1}$

Policy Function of k': (i) Investment adjustment

- With high enough debt d, the borrowing constraint starts binding, lowering investment k'
- With lower k, next-period capital $k' \downarrow$
- With higher FC debt λ, investment $k' \downarrow$

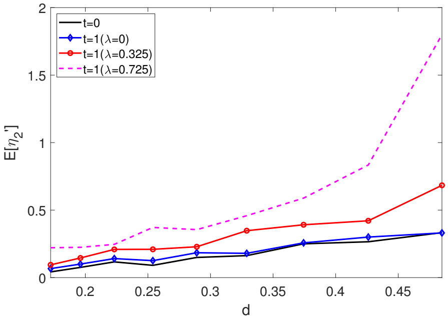


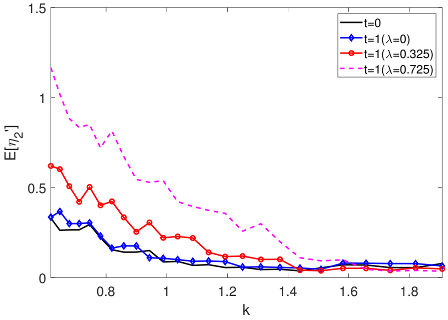


Policy Function of η_2: (ii) Working-capital channel

$$\beta r E_{z'|z}[(c')^{-\gamma}] + \underbrace{\eta_1}_{\text{more binding collateral constraints} \uparrow} = \beta \theta_a E_{z'|z}[\eta_2']$$

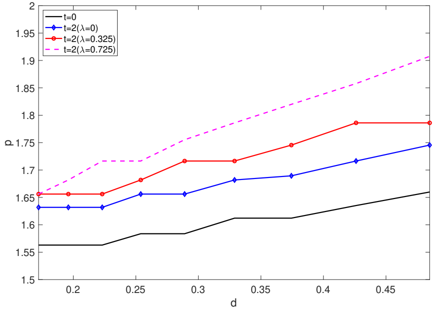
- The working capital constraints are more binding $\eta_2 \uparrow$ with lower k, higher d and higher λ

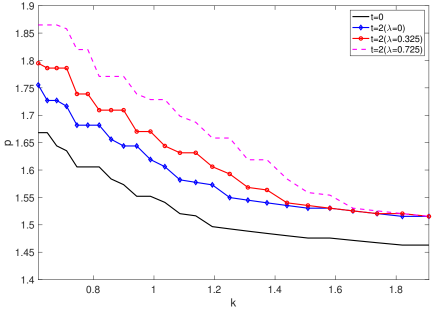




▸ Policy Functions: a'

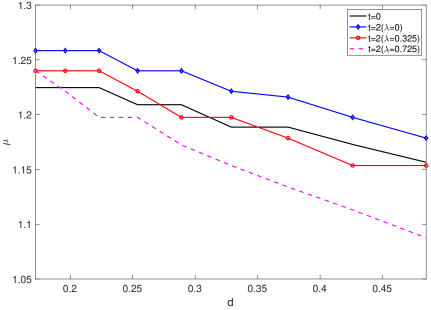
- Firms charge higher $p \uparrow$ with lower k, higher d and higher λ.
- Strategic complementarity pushing up the policy function even with zero FC debt λ.

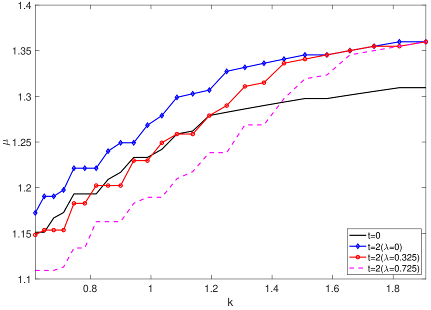




Policy Function of μ''

- Firms lower their markups $\mu \downarrow$ with lower k, higher d and higher λ upon $\uparrow$ effective MC
  - Relatively better off firms with higher k and lower d increase their markups $\mu \uparrow$.
- Strategic complementarity pushing up the policy function even with zero FC debt λ.





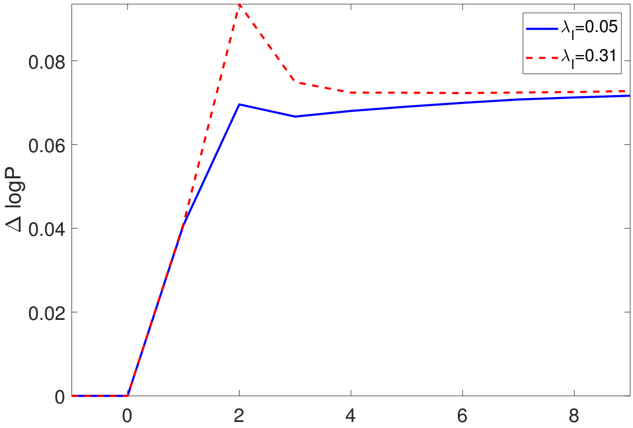
Quantitative Analysis

Calibrated Parameters

Predetermined			
Parameter	**Value**	**Description**	**Data Source**
γ	2.0	Relative risk aversion	Standard
δ	0.1	Depreciation rate of physical capital	Standard
ν	2.0	Elasticity of substitution across sectors	Standard
σ	5.0	Elasticity of substitution within a sector	Gopinath and Itskhoki (2010)
ϵ	4.0	Super elasticity of demand	Gopinath and Itskhoki (2010)
ϕ	0.9569	Physical capital adjustment cost	Gilchrist and Sim (2007)
r	0.08	Interest rate	Bank of Korea
ρ_z	0.9	AR coefficient of z	Estimated
σ_z	0.07	STD of z	Estimated
λ_m	$\in [0, 0.975]$	Distribution of FC debt share	KIS data
π_m^I	$\in [0, 1]$	Distribution of FC debt share	KIS data
κ_I	$\in [0, 1]$	Industry-level imported input share	Korea Input-Output table in 1995
Calibrated			
Parameter	**Value**	**Description**	**Targeted Moments**
β	0.9211	Time discount factor	Mean of Leverage Ratio (0.595)
θ_k	0.7193	Fraction of capital as a collateral	Std of Leverage Ratio (0.21)
θ_a	1.3525	Fraction of working capital	Mean of Cash to Sales ratio (0.412)

Industry-Level Analysis

- Industry Price Dynamics Upon Unexpected Large Depreciation at Period 1
- Industries with imported input share = 0.18



Model: Industry-Level Analysis

- Marginal Effect of FC Short-term Debt Ratio on Price Changes in Crisis (Data vs. Model)

Residual PPI: Model

$$\Delta p_{I,0-2} = \beta_0 + \beta_1 \text{ ST FC}_{I,0} + \beta_2 \text{ Imported Input Share}_I + \epsilon_I$$

	Data	Model
ST FC	0.389	0.1368
	(0.185)	
Imported Input Share	0.372	0.5082
	(0.180)	
R^2	0.259	0.9972
N	149	149

- The model can explain around half of the variation in price changes across industries.

	Data	Model
Std of $\Delta p_{I,0-2}$	0.1188	0.0623

Firm-level Regression: Price Changes

$$\Delta p_j = \beta_0 + \beta_1 \text{ST FC}_j + \beta_2 \text{Imported Input Share}_I + \beta_3 \Delta P_I + \beta_4 1_{\text{Unconstrained},j} + \beta_5 \text{ST FC}_j \times 1_{\text{Unconstrained},j} + \epsilon_j$$

$$\Delta p_j = \beta_0 + \beta_1 \text{ST FC}_j + \beta_2 \text{Imported Input Share}_I + \beta_3 \Delta P_I + \beta_4 \log(k_j) + \beta_5 \text{ST FC}_j \times \log(k_j) + \epsilon_j$$

Firm-level Regression: Price Changes

$$\Delta p_j = \beta_0 + \beta_1 \text{ST FC}_j + \beta_2 \text{Imported Input Share}_I + \beta_3 \Delta P_I + \beta_4 1_{\text{Unconstrained},j} + \beta_5 \text{ST FC}_j \times 1_{\text{Unconstrained},j} + \epsilon_j$$

$$\Delta p_j = \beta_0 + \beta_1 \text{ST FC}_j + \beta_2 \text{Imported Input Share}_I + \beta_3 \Delta P_I + \beta_4 \log(k_j) + \beta_5 \text{ST FC}_j \times \log(k_j) + \epsilon_j$$

	Price Changes		
ST FC_j	0.0496	0.0701	0.0247
$\text{Imported Input Share}_I$	0.1671	0.1283	0.2480
ΔP_I	0.6674	0.7438	0.5723
$1_{\text{Unconstrained},j} \times \text{ST FC}_j$		-0.0518	
$log(k_j) \times \text{ST FC}_j$			-0.0330

Price: log(a+k)

Firm-level Regression: Markup Changes

$$\Delta\mu_j = \beta_0 + \beta_1 \text{ST FC}_j + \beta_2 \text{Imported Input Share}_I + \beta_3 \Delta P_I + \beta_4 1_{\text{Unconstrained},j} + \beta_5 \text{ST FC}_j \times 1_{\text{Unconstrained},j} + \epsilon_j$$

$$\Delta\mu_j = \beta_0 + \beta_1 \text{ST FC}_j + \beta_2 \text{Imported Input Share}_I + \beta_3 \Delta P_I + \beta_4 \log(k_j) + \beta_5 \text{ST FC}_j \times \log(k_j) + \epsilon_j$$

Firm-level Regression: Markup Changes

$$\Delta\mu_j = \beta_0 + \beta_1 \text{ST FC}_j + \beta_2 \text{Imported Input Share}_I + \beta_3 \Delta P_I + \beta_4 1_{\text{Unconstrained},j} + \beta_5 \text{ST FC}_j \times 1_{\text{Unconstrained},j} + \epsilon_j$$

$$\Delta\mu_j = \beta_0 + \beta_1 \text{ST FC}_j + \beta_2 \text{Imported Input Share}_I + \beta_3 \Delta P_I + \beta_4 \log(k_j) + \beta_5 \text{ST FC}_j \times \log(k_j) + \epsilon_j$$

	Markup Changes		
ST FC_j	-0.0490	-0.0696	-0.0239
Imported Input $Share_I$	-0.1673	-0.1273	-0.2469
ΔP_I	0.3365	0.2576	0.4301
$1_{\text{Unconstrained},j} \times$ ST FC_j		0.0519	
$log(k_j) \times$ ST FC_j			0.0333

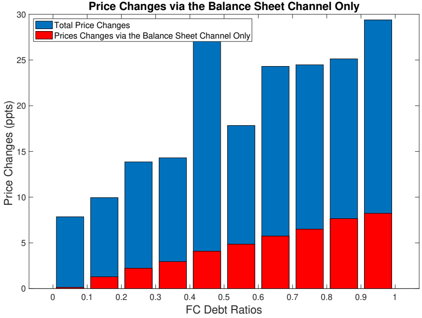
▸ Markup: log(a+k)

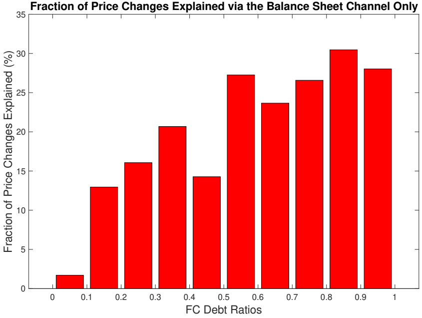
Quantitative Size of the Balance Sheet Channel

$$\Delta p_j = \beta_0 + \beta_1 \text{ST FC}_j + \beta_2 \text{Imported Input Share}_I + \epsilon_j$$

$$\Delta \hat{p}_{j,\text{Balance Sheet Channel Only}} = \hat{\beta}_1 \text{ST FC}_j$$

- Across FC debt share deciles, the balance sheet channel explains a substantial share of the simulated firm-level price changes.





▸ Direct Effect

Conclusion

- We find empirically that industries with higher foreign currency debt increased their prices more during the crisis.
- The estimated quantitative model can generate around 35 % of the mean effect of the foreign currency debt ratio on the price changes and 52 % of the variation in price changes across industries.
- With the firm-level model simulated data, we decompose the **two distinct channels of exchange rate pass-through** – **balance sheet channel** **and imported input channel** and show that both are significant contributors to the firm-level price dynamics during the crisis.
- Our empirical analysis and our quantitative analysis reveal that it is important, albeit overlooked, to incorporate the balance sheet effect when analyzing how the exchange rate affects domestic prices, especially for *emerging economies with dollarized liability*.

Thank you! :)

Motivation: Cross-Country

- Realized PPI change vs. Imported input implied PPI change

	Crisis Year	Δ Import Price Index	Imported Input Share (%)	Δ MC Due to Import Price Changes Implied PPI Changes via Imported Input*	Δ PPI (%)
Brazil	1999	49.52	6.0	2.97	28.51
Mexico	1994	97.60	13.2	12.91	38.60
Korea	1997	40.37	14.6	5.89	16.46
Thailand	1997	18.31	22.0	4.04	16.43
Argentina	2002	99.28	6.1	6.07	97.87

The country sample is identical to Burstein, Eichenbaum and Rebelo (2005).

The imported input share is $\frac{\text{imported input}}{(\text{total input} + \text{value added})}$

We assume a complete exchange rate pass-through.

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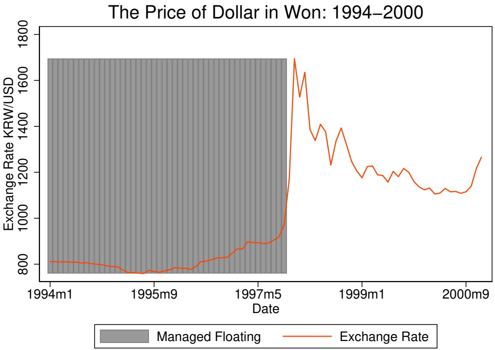
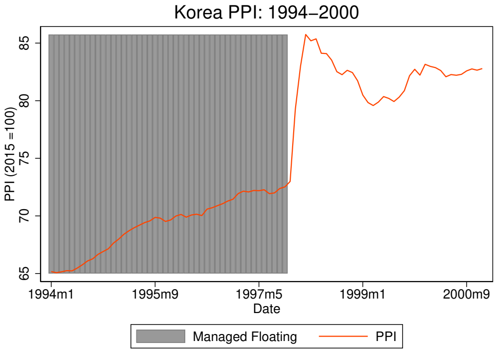
Depreciation of Korean Won After Floating





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Industry Price Dynamics and Short-term FC Debt Ratio (Pre-crisis Period)

$$\Delta p_{i,93-95} = \beta_0 + \beta_1 \text{ ST FC}_{i,93} + \beta_2 \text{LT FC}_{i,93} + \beta_3 X_{i,93} + \epsilon_i$$

	(1)	(2)	(3)	(4)	(5)
ST FC	0.147	0.115	0.098	0.157	0.121
	(0.144)	(0.132)	(0.145)	(0.135)	(0.134)
LT FC	0.151	0.191	0.154	0.136	0.158
	(0.215)	(0.205)	(0.210)	(0.202)	(0.192)
Rauch dummy		-0.073			-0.069
		(0.038)			(0.041)
Imported input share			0.129		0.050
			(0.075)		(0.082)
Degree of price stickiness				-0.001	-0.002
				(0.001)	(0.001)
R^2	0.056	0.097	0.078	0.057	0.106
N	151	144	151	151	144

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Balance Sheet Channel Independent of Imported Input Channel

	(1)	(2)	(3)
ST FC	0.437	0.377	0.389
	(0.191)	(0.183)	(0.185)
LT FC	0.122	0.133	0.125
	(0.181)	(0.176)	(0.175)
Imported input share		0.137	
		(0.074)	
Imported input price change			0.372
			(0.180)
R^2	0.237	0.256	0.259
N	149	149	149

Back

Controlling the Effect of Firm Exits

	(1)	(2)	(3)
ST FC	0.481	0.452	0.370
	(0.176)	(0.180)	(0.186)
LT FC	0.061	0.059	0.131
	(0.185)	(0.187)	(0.177)
Log change of number of firms		0.151	0.075
		(0.121)	(0.123)
Rauch dummy			-0.045
			(0.027)
Imported input share			0.131
			(0.074)
Degree of price stickiness			-0.000
			(0.002)
R^2	0.190	0.197	0.258
N. of cases	157	157	149

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Mark-up Measure: De Locker and Warzynski (2011)

- Assume that producer j is a cost minimizer:

$$\min \quad C_{jt} = \sum_{v=1}^{n} \underbrace{p_{jt}^{v} x_{jt}^{v}}_{\text{variable input costs}} + \underbrace{r_{jt} k_{jt}}_{\text{cost of capital}} + \lambda_{jt}(Q_{jt} - \underbrace{F(x_{jt}^{1}, \dots, x_{jt}^{n}, k_{jt})}_{\text{production function}})$$

- FOC w.r.t a variable input x_{jt}^{v} :

$$\underbrace{\frac{\partial F(.)}{\partial x_{jt}^{i}} \frac{x_{jt}^{v}}{Q_{jt}}}_{\text{output elasticity:}\theta_{jt}^{v}} = \frac{1}{\lambda_{jt}} \frac{p_{jt}^{v} x_{jt}^{v}}{q_{jt}} \quad \text{where} \quad \lambda_{jt} = \frac{\partial C_{jt}}{\partial Q_{jt}}$$

- Hence, mark-up is:

$$\mu_{jt} = \frac{P_{jt}}{\lambda_{jt}} = \theta_{jt}^{v} \times \frac{P_{jt} Q_{jt}}{p_{jt}^{v} x_{jt}^{v}}$$

- Change in mark-up, assuming the output elasticity is constant over time:

$$\Delta log \mu_{jt} = \Delta log \frac{P_{jt} Q_{jt}}{p_{jt}^{v} x_{jt}^{v}}$$

back

Empirics: Firm-Level Analysis

- Firms with high foreign currency debt exposure have lower investment growth, lower labor productivity growth and lower employment growth during the crisis.

Dep.var: Δy_{96-98}	Capital growth	Labor productivity growth	Employment growth*
ST FC	-6.127*	-3.538*	-5.000***
	(3.192)	(2.022)	(1.426)
LT FC	-3.401	-1.502	-5.849***
	(2.346)	(1.777)	(1.478)
Size	-0.089*	-0.073**	-0.125***
	(0.046)	(0.034)	(0.035)
Size * ST FC	0.250**	0.150*	0.202***
	(0.123)	(0.078)	(0.056)
Size * LT FC	0.145	0.075	0.246***
	(0.095)	(0.071)	(0.060)
R^2	0.044	0.122	0.136
N	1828	2142	1568

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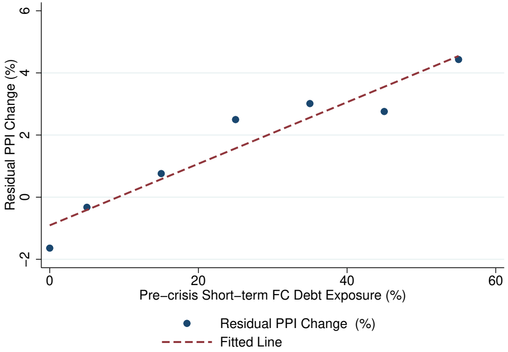
Model: Industry-Level Analysis



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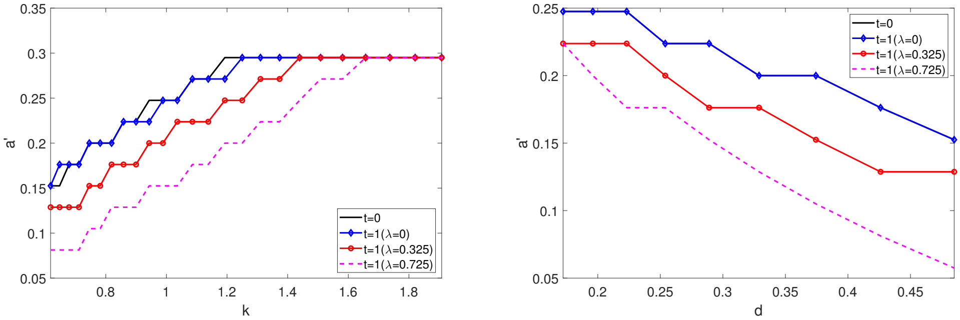
Policy Function: (ii) Working-capital channel



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Firm-level Regression: Price Changes

$$\Delta p_j = \beta_0 + \beta_1 \text{ST FC}_j + \beta_2 \text{Imported Input Share}_I + \beta_3 \Delta P_I + \beta_4 \log(k_j) + \beta_5 \text{ST FC}_j \times \log(k_j + a_j) + \epsilon_j$$

	Price Changes
ST FC_j	0.0359
$\text{Imported Input Share}_j$	0.2399
ΔP_I	0.5831
$log(k_j + a_j) \times \text{ST FC}_j$	-0.0315

back

Firm-level Regression: Markup Changes

$$\Delta\mu_j = \beta_0 + \beta_1 \text{ST FC}_j + \beta_2 \text{Imported Input Share}_I + \beta_3 \Delta P_I + \beta_4 \log(k_j) + \beta_5 \text{ST FC}_j \times \log(k_j + a_j) + \epsilon_j$$

	Markup Changes
ST FC_j	-0.0354
Imported Input Share_j	-0.2388
ΔP_I	0.4193
$log(k_j + a_j) \times \text{ST FC}_j$	0.0314

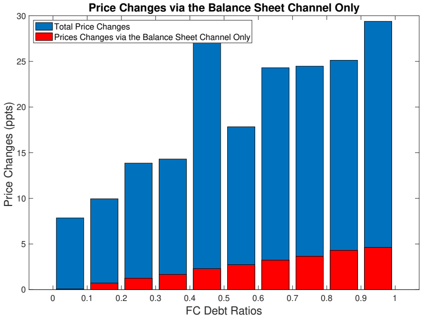
back

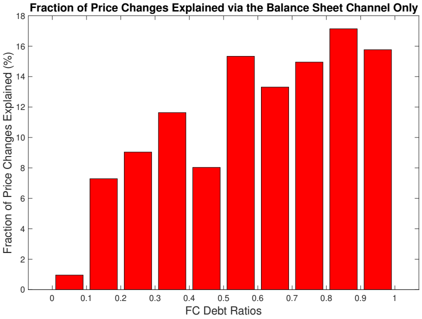
Quantitative Size of the Direct Balance Sheet Channel

$$\Delta p_j = \beta_0 + \beta_1 \text{ST FC}_j + \beta_2 \text{Imported Input Share}_I + \Delta P_I + \epsilon_j$$

$$\Delta \hat{p}_{j,\text{Balance Sheet Channel Only}} = \hat{\beta}_1 \text{ST FC}_j$$

- Across FC debt share deciles, the balance sheet channel explains a substantial share of the simulated firm-level price changes.





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