Currency Hedging: Managing Cash-Flow Exposure

Laura Alfaro

(Harvard & CEPR & NBER)

Mauricio Calani

(Central Bank of Chile)

Liliana Varela

(LSE & CEPR)

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Disclaimer: The opinions and assessments expressed in this presentation do not necessarily reflect those of the Central Bank of Chile or its Board Members.

Background

- Use of foreign currency is prevalent → currency mismatches
 - Trade, capital markets, funding for banks and non-financial firms (original sin); fear of floating → systemic risk

(Eichengreen and Hausmann, 1999; Calvo and Reinhart, 2002; Céspedes et al., 2004; Goldberg and Tille, 2009; Rey, 2013; Bruno and Shin, 2015; Gopinath, 2015; Itzetzi et al., 2019; Gopinath and Itskhoki, 2021)

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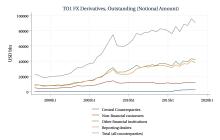
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- FX-derivative markets are among the largest and fastest-growing financial markets in the world
 - Globally: daily turnover in FX market: 70% in FX-derivatives vs 30% spot
 - EMEs: non-existent two decades ago, but last 15 years have seen impressive growth in size and scope (\$1.6T daily in April 2019, vs. < \$0.5T in spot; growth rates 60% in 2016-2019; BIS,2019)

Growth FX derivatives market

A. By Counterparty



B. By Instrument



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 - Data limitation: firms' FX <u>exposure</u> and <u>derivatives</u> use to assess FX financial risk management.

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 - Data limitation: firms' FX <u>exposure</u> and <u>derivatives</u> use to assess FX financial risk management.
- ightarrow (i) Analysis firms' foreign currency financial risk management
 - (ii) Census transaction-level data on all foreign currency exposure & <u>FX derivatives</u>

Currency Hedging: Main Questions

- Do firms exploit natural hedging? (match FC payables ↔ FC receivables/ currency choice)
 - Literature: extreme assumption—firms fully operationally hedged

- Do firms hedge their FX currency exposure with FX derivatives?

- Literature: extreme & opposite assumption—firms fully hedged; "Theoretical finance literature has focused on analyzing why hedging can make sense while imposing the assumption that firms should fully hedge" Froot et al. (1993)

Which transactions firms use FX derivatives for?

 Literature: limited assumption—hedge FC debt only → Ignores trade and trade financing exposure (pricing/operational hedged)

How are FX contracts priced (across/within firms)?

 Literature: limited by data—How does the FX derivative market price firm's hedging needs?

- Does FX hedging add value to the firm?

- Literature: ignored the role of FX hedging—How do financial conditions affect firms' FX hedging policies and outcomes?

Currency Hedging: Approach

- Unique/novel dataset with detailed firm/transaction-level data (2005-2018) for Chile (non-dollarized/ FC pricing):
 - Foreign currency (FX) derivatives (all daily transaction, detailed contract information, 1997-)
 - 2. Foreign and local currency debt (montly, census, bonds, loands, FDI, 2003-)
 - Custom's international trade (operation, currency of invoice, census); trade credit
 - 4. Employment/sales;
 - Tax IDs (create firms/corporations)

Comprehensive: firms' joint decision on FC exposure (trade, financing) and FX hedging

- Exploit Market Supply Shock—Policy reform to pension funds regulation
 - Effects of FX Hedging on Firms' Outcomes
 - Propensity score matching exercise

Currency Hedging: Rationale and Implications

- Firms are exposed to a variety of risks: market, commercial, political, etc.
 - Risk management options: operational (payments, receivable, location, pricing, etc.); self-insurance and buffers (accumulating foreign currency assets or liabilities); financial products (derivatives). (Servaes et al. 2009; Lewis, 2018)
- Focus: exchange rate transaction risk, which is contractual, clearly defined and can potentially be managed using financial derivatives.

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- Friction-less neoclassical framework: hedging adds no value to the firm
 - Market imperfections financial frictions, transaction costs, and convex tax schedules— volatility can be costly, conveying a role to hedging by firms.

(Froot et al. 1993; Rampini and Viswanathan, 2010; Rampini et al, 2014)

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- Comprehensive granular information: Transaction-level Derivative data + Broad Firm Coverage + Foreign Currency Exposure (Trade and Debt)
 - Precisely measure firms' transaction exposure and their hedging behaviour.
 - New facts regarding firm's use and effects of FX derivatives.

Currency Hedging: Main Findings

- 1. Natural (operational) hedging of currency risk is **quantitatively limited** even for large firms that use foreign currency
 - Timing of cash-flows.
- 2. Firms actively use FX derivatives to partially hedge short-term financing, principally from **trade** and debt
- 3. Firms hedge larger amounts of their gross exposure
- 4. FX derivatives are priced heterogeneously
 - FX premium is higher for smaller firms and for **longer** maturity contracts
- 5. FX hedging adds value to the firm (higher export, import, employment)
 - A supply shock to FX market translates into lower liquidity, reduces intensive & extensive margins, raises FX premium; affects firms operations even under DC pricing

Currency Hedging: Main Findings (Cont.)

- Firms using FX derivatives are larger—firms in trade and foreign currency borrowing: foreign currency exposure (Bernard et al, 2007; Melitz, 2003, Helpman et al. 2004, Alfaro and Chen, 2018, Salōmao and Varela, 2020; Gaubert and Itskhoki, 2022)
 - Firms engaging in international trade are not naturally hedged
 - Firms use financial derivatives to partially hedge larger amount and gross transactions
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- Different timing operational and financial milestones—signing of a contract, production, sale, and delivery of a product or service and payments
 - Timing and uncertainty of day-to-day operation key to understanding exposure
 - Longer deliveries and transportation times in international transactions (In trade: Antras and Foley, 2015)

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 - Longer deliveries and transportation times in international transactions (In trade: Antras and Foley, 2015)
- Timing misalignment between FC payables and receivables and their interaction with domestic currency obligations → use financial hedges
 - Firms vulnerable to currency fluctuations associated with working capital obligations
 → hedging adds value to the firm
 - Non-dollarized economies: firms turn FC exposure into LC

Literature: International Economics and Finance

 International Economics: vast literature focusing on currency mismatches and vulnerabilities but few papers consider firm's use of financial foreign currency hedging (theoretically, empirically: managed EXR periods; lack of data); or assumed operational hedging / no role FX hedging (Itzetzi, Reinhart and Rogoff 2021; Gopinath and Itskhoki, 2021)

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- Finance: focused on documenting a firm's use of currency derivatives; exploit listed/MNCs firms' net positions or surveys (departure from neoclassical no derivatives benchmark)
 - Operational hedging (geographic dispersion): not substitute for FX hedging Geczy et al. 1997; Allayannis et al. (2001): US MNC financial statements

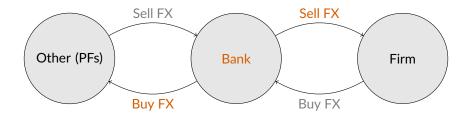
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- FX derivative market: dominated by OTC activities + banks (intermediaries) in the matching of buyers and sellers (Duffi et al. 2005; Hau et al., 2021; Bodnar et al. 2011)
 - Financial constraints and risk management: FXD adds value even when using foreign currency pricing (Froot et al. 1993) and limit their use (Rampini and Viswanathan 2010)

Background + Data

Chile's FX Derivatives Market: Over-The-Counter

- Options and futures are usually transacted on the Stock Exchange.
- Forwards and Swaps are transacted outside the Stock Exchange in the over-the-counter (OTC) market (sticky bank-client Relationships)



FX Derivatives: Transaction Level—Snapshot

A. By market

			All market			Real-sector					
	Obs.	Share	Notional Median	Maturity Median	Non- delivery	Obs.	Share	Notional Median	Maturity Median	Non- delivery	
Туре	(#)	(%)	(\$ 000)	(days)	(%)	(#)	(%)	(\$ 000)	(days)	(%)	
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)	
Forwards	1,518,688	80.4	5,630	71.1	83.5	639,736	88.3	1,308	90.5	65.1	
Futures	2,211	0.1	1,684	43.3	96.8	356	0.0	1,728	85.6	82.6	
Call options	24,974	1.3	1,436	159.2	91.6	21,414	3.0	716	164.4	91.2	
Put options	15,677	0.8	1,936	167.6	93.0	13,224	1.8	852	175.1	93.6	
Swaps	502	0.0	7,887	1,382.4	74.3	234	0.0	6537	1,690.6	56.8	
FX swaps	271,427	14.4	1,2723	77.2	90.6	15,650	2.2	3,901	77.7	37.0	
CC Swaps	55,474	2.9	6,505	1051.4	31.4	33,799	4.7	1,566	684.8	5.5	
Total	1,888,953	100.0	6,584.8	103.0	83.2	724,413	100.0	1,352.6	122.2	63.0	

Merge of Detailed Administrative Data, Chile (2005-18)

- 1. FX-derivatives: Daily, census, transaction-level (1997-); > 7 days
- 2. Foreign Debt: Foreign debt: monthly, census, firm-instrument level (bonds, loans, FDI) (2003–)
- 3. Local debt: Bank credit registry (incl. delinquency and line of credit)
- 4. Customs: Monthly, census, operation (incl. trade credit & currency)
- 5. Firm data: Yearly, census, firm-level (sales, sector, age and workers)
- 6. Tax ID: Merge create firms/corporations
- Chile: 2 decades of quality data, flexible ER, no capital controls, stable macro (no domestic fueled crises)
- The Market: OTC, active FX derivatives market (BIS, 2019)

► FX-Snapshot

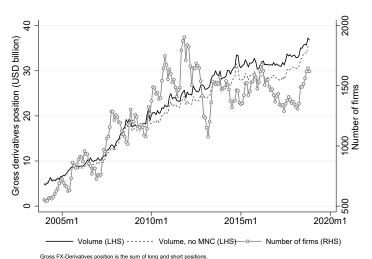
FX Derivatives: Non-Financial Firms-Snapshot

- Total contracts close to 1.9 million; 725K: with one non-financial firm counter-party; forwards (88%), Non deliv. (limits default risk; BIS, 2019)

		Non-Fi	nancial Firms:	purchases		Non-Financial Firms: sales						
	Obs.	Share	Notional Median	Maturity Median	Non- delivery	Obs.	Share	Notional Median	Maturity Median	Non- delivery		
Туре	(#)	(%)	(\$ 000)	(days)	(%)	(#)	(%)	(\$ 000)	(days)	(%)		
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)		
Forwards	452,145	89.4	1,324.2	80.9	57.5	187,591	85.8	1,270.8	113.6	83.6		
Futures	299	0.1	1935.5	92.2	90.3	57	0.0	645.0	50.9	42.1		
Call options	6,470	1.3	617.7	145.4	93.8	14,944	6.8	758.8	172.6	90.1		
Put options	7,086	1.4	736.7	153.4	92.5	6,138	2.8	985.1	200.2	94.9		
Swaps	141	0.0	7670.8	1839.6	61.7	93	0.0	4,819.1	1,464.8	49.5		
FX swaps	11,810	2.3	4024.3	74.4	26.6	3,840	1.8	3,524.6	88.1	69.0		
CC Swaps	27,725	5.5	1120.0	635.9	2.7	6,074	2.8	3,605.2	907.6	18.0		
Total	505,676	100.0	1,360.9	113.5	54.7	218,737	100.0	1,333.5	142.2	82.3		

FX Derivatives Market: Non-Financial Firm Counterparty

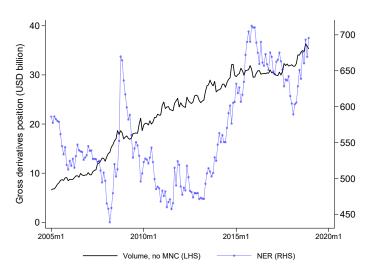
Fig: Number of firms and gross FX Derivatives positions



Volume and number of firms consider only those in the non-financial corporate sector

Non-Financial Firms FX Derivatives Market and EXR

Fig: Non-Financial Firms FX Derivative Position and Exchange rate (peso to US dollars)



FX Financial Risk Management: Selected Firms

ightarrow Firms using FX derivatives are an order of magnitude larger than the mean firm X, M, FC debt

		200	6	2016					
	(1) (2) Yes No		(3) Log-difference	(4) Yes	(5) No	(6) Log-difference			
Panel A. All firms									
Employment (workers)	374.87	112.53	1.61***	452.64	106.96	1.84***			
Sales (M\$)	17.22	5.28	1.33***	20.85	5.63	1.50***			
Panel B. Trading firms									
Employment (workers)	281.00	67.13	1.83***	339.63	98.36	0.65***			
Sales (M\$)	11.61	3.23	1.16***	13.37	4.57	0.86***			
Panel C. Firms in internat	ional trade								
Employment (workers)	396.05	114.57	1.61***	480.93	108.53	1.84***			
Sales (M\$)	18.48	5.38	1.33***	22.72	5.82	1.50***			
Exports (M\$)	7.75	1.65	0.32***	2.08	1.38	0.18***			
Imports (M\$)	4.94	0.47	0.65***	4.25	0.37	0.76***			
Exports TC (M\$)	7.66	1.60	0.31***	1.99	1.29	0.17***			
Imports TC(M\$)	4.80	0.44	0.63***	3.85	0.31	0.71***			
Panel D. Firms in debt ma	ırket								
Employment (workers)	833.11	197.28	2.72***	1167.60	341.66	2.65***			
Sales (M\$)	27.34	6.30	2.04***	36.47	14.14	1.72***			
Foreign Debt (M\$)	105.94	15.08	1.98***	549.24	101.39	2.54***			

 Echoes literature differences between domestic and firms in international activity: trade, MNCs, foreign borrowing (Melitz 2003; Helpman 2004; Alfaro & Chen 2018; Salomao & Varela 2022.

Samples: 2005-2018

- Non-financial firms cleaned by tax ids (\approx 105,000)
- Exclude < 7 days (excl. 1.4% of sample)
- Dollar hedging (> 85% of sample; robustness all currencies)
- Domestic firms (90% domestic firms); robustness with MNCs
- Without and with copper (244 firms, 4,561 contracts)
- Subsets of only X, only M, trade (X & M), only debt, debt & trade
- Without and with swaps

Operational Hedging

Firms' Exposure to Currency Risk—Are Firms Naturally Hedged?

- Many firms have operational/ financial exposure to foreign currency (FC)
- If FC cash flows in opposing directions → Firms could naturally hedge
 - Natural hedge: operational hedging matching payables and receivables time t, associated to pricing (different from alternatives, self-insuring/borrowing)
- What is the correlation between receivable and payables in FC due the same period?

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- What is the correlation between receivable and payables in FC due the same period?
- Consider all cash flows maturing in t for firm firm i, month m, industry j

$$X_{i,m}^{CF} = \alpha_0 + \alpha_1 (M_{i,m}^{CF} + FCD_{i,m}^{CF}) + \eta_i + \eta_{j,y} + \varepsilon_{i,m}$$

- $X_{i,m}^{CF}$, Cash-flow-maturing-in-t from export trade credit (log)
- $M_{i.m}^{CF}$, Cash-flow-maturing-in-t from import trade credit (log)
- FCD_{i,m}, Foreign currency debt (log); flows/maturities
- Firm FE; industry × year FE; errors clustered at the firm-level

 $\rightarrow \alpha = 1$, naturally hedged

Firms' use of natural hedging is limited: Flows maturing in the same period

Dependent variable: (log) Exports trade credit at maturity, X^{CF}										
M ^{CF}	(1) 0.027** (0.007)	(2) 0.023*** (0.005)	(3)	(4)	(5)	(6)	(7)			
M ^{CF} +FCD ^{CF}	,,,,,,	, ,	0.015*** (0.003)							
$M^{CF} \times 1$ (Trade Only)				0.017* (0.008)	0.022** (0.007)	0.019*** (0.005)	0.05*** (0.012)			
$M^{CF} \times 1$ (Trade and FX)				0.027** (0.009)	0.034*** (0.007)	0.029*** (0.006)	0.063*** (0.012)			
$M^{CF} \times 1$ (Trade and FCD)				0.052** (0.019)	0.058** (0.020)	0.039*** (0.011)	0.079*** (0.018)			
$M^{CF} \times 1$ (Trade and FX and FCD)				0.033* (0.013)	0.032* (0.015)	0.041*** (0.012)	0.073*** (0.020)			
Observations	1,613,353	1,599,768	1,599,768	1,618,731	1,613,353	1,599,768	195,275			
R^2	0.85	0.83	0.83	0.85	0.77	0.83	0.88			
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Include MNC	-	-	-	Yes	-	-	-			
Include Mining	Yes	-	-	Yes	Yes	-	-			
X > 0 and $M > 0$	-	-	-	-	-	-	Yes			

Note: All variables in logs, clustered s.e. at firm level in parentheses

- Several Robustness: different t (quarterly, yearly), measurement
- ightarrow Little support for hypothesis of natural hedging **quantitatively** high

Firms' Natural Hedging is Limited: **Timing** and Amount of Flows

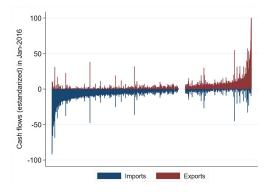
Different maturities and timing of flows

	Mean St. Dev. Min p10 Median p90 Max							Num. Obs.
Imports trade credit	91	58	1	30	88	180	540	1,435,762
Exports trade credit	137	94	1	21	115	267	540	433,350
Foreign currency debt	1375	1291	30	90	1099	2880	10830	10,103

- Trade credit for export is 50% longer than for imports
- FC debt has 10 times longer maturity than exports
- Financial/operational milestones: sign contract, pay contract, produce contract, deliver, receive,
 - → Different timing: difficult to match the cash flows ("naturally hedge")

Firms' Natural Hedging is Limited: Timing and Amount of Flows

- → Firms do not match their cash in and out.
 - Each bar is a firm, trade flows normalized to 100 within the firm, only firms with X > 0 or M > 0 (January 2016).

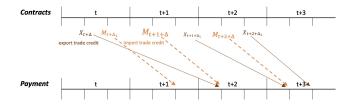


ightarrow Different **timing & amount** makes it difficult to be operationally hedged, even if invoicing/borrowing in USD.

Firms' Natural Hedging is Limited: Timing and Amount of Flows

→ Timing/Maturity and Amount Matters

- Trade credit for export & imports might be due in different dates, even within month.
- The amounts of each transaction might also be different (larger letters for larger amounts).



Uncertainty about exchange rate and future cash flows

Net Transaction Exposure, January 2016

-200

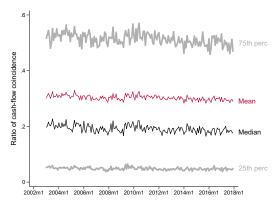
 \rightarrow Net cash flow exposure from trade (trade credit + upfront payment) of firm i in month m.

$$NCF_{im} = \left(X_{im}^{U} + \sum_{t=0}^{m-1} X_{im}^{TC}\right) - \left(M_{im}^{U} + \sum_{t=0}^{m-1} M_{im}^{TC}\right)$$

$$(X_{im} \ge 0, M_{im} \ge 0 \text{ (excluded } X_{im} = M_{im} = 0), X_{im} \& M_{im} > 0)$$

200

Coincidence of Cash Flows



Note. – All series show moments of within-period distributions of the coincidence measure. Thick gray lines show the 25th and 75th percentiles, solid black line depicts the median, and the dashed black line the mean across observations within a month.

 Alternative ways to manage FC risk: operational hedge; self-insuring; external finance; financial instruments

FX Financial Risk Management

Do Firms Engage in FX Financial Risk Management?

- 8%-10% of firms (w/ trade or FC debt, \approx 7300 firms) engage in FX financial risk management
- They account for 30-40%+ trade and their average imports are 10 times higher, and exports 4 times than average firms without FXD. (30% of employment and 40%+ of value added)
- Most of trade is financed 80%
- Extended use FX derivatives:
 - At the aggregate level: forwards/trade credit 90%
 - At the firm level: forwards/trade credit close to 50% (hedging partial)
- Firms sign about 4 contracts per month (2005-18)

	Imports	Export	FC Debt
Trade Credit/Trade (aggregate)	0.78	0.82	
Forward/ Trade Credit (aggregate)	0.94	0.93	
Forward/ Trade Credit (median, across firms w/ trade credit & fwd)	0.50	0.45	
FX long (CC Swap)/FC Debt (aggregate)			0.14
FX long (CC Swap)/FC Debt (median, across firms w/debt & CCSwap)			0.65

Largest firms actively use FX derivatives to hedge currency risk.

- Contract level analysis: which operations do firms hedge? \rightarrow not straightforward
- Match an FX contract i with an import/export j using: firm ID, maturity date and (coarsened) amount lacus et al. (2012). Compare matched vs. unmatched exposures
- Regression at the transaction c level, for firm-i in month-m

$$A_{c,i,m} = \alpha_1 \mathbf{1}(Hedged)_c + \eta_i + \eta_m + \epsilon_{c,i,m}$$

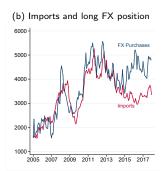
- Contract level analysis: which operations do firms hedge? \rightarrow not straightforward
- Match an FX contract i with an import/export j using: firm ID, maturity date and (coarsened) amount lacus et al. (2012). Compare matched vs. unmatched exposures
- Regression at the transaction c level, for firm-i in month-m

$$A_{c,i,m} = \alpha_1 \mathbf{1}(Hedged)_c + \eta_i + \eta_m + \epsilon_{c,i,m}$$

	A. Exp	orts trade c	redit (logs)	B. Imports trade credit (logs)			
	2006	2016	2005-2018	2006	2016	2005-2018	
1(Hedged)	(1)	(2)	(3)	(4)	(5)	(6)	
	0.765***	0.516***	0.630***	0.561***	0.545***	0.591***	
	(0.123)	(0.144)	(0.110)	(0.065)	(0.103)	(0.047)	
Observations R^2 Firm FE Month FE	14,948	6,576	213,364	15,146	8,224	196,104	
	0.40	0.37	0.32	0.36	0.35	0.31	
	Yes	Yes	Yes	Yes	Yes	Yes	
	-	-	Yes	-	-	Yes	

 A large portion of firms that both import and export, hedge imports and exports separately





Notes: Sample used in this figure excludes firms which have foreign currency debt, to avoid biasing upwards the estimation of the use of FX derivatives. Correlations between series are 0.73 for exports, and 0.84 for imports. This sample also excludes multinational corporations, and mining related companies. Results without exclusion of such firms make the results stronger.

Firms' use of FX derivatives: Extensive and Intensive margins

	Extensiv	e Margin		Intensiv	e Margin	
			Sa	les	Purc	hases
	(1)	(2)	(5)	(6)	(3)	(4)
X ^{TC}	0.020***	0.019***	0.047***	0.033***	0.001	
	(0.004)	(0.004)	(0.008)	(0.009)	(0.007)	
M ^{TC}	0.054***	0.057***	0.012*		0.155***	0.146***
	(0.005)	(0.005)	(0.007)		(0.015)	(0.015)
FCD	-0.015***	-0.007	-0.015	-0.012	-0.005	-0.001
	(0.005)	(0.005)	(0.013)	(0.011)	(0.013)	(0.011)
$X^{TC} \times M^{TC}$		-0.007**				
		(0.003)				
$X^{TC} \times FCD$		-0.000				
		(0.002)				
M^{TC} x FCD		-0.006**				
		(0.003)				
M^{TC} exp./ X^{TC} imp.				0.027***		0.001
				(0.010)		(0.008)
M^{TC} non-exp./ X^{TC} non-imp.				0.006		-0.003
				(800.0)		(0.006)
Observations	2,264,326	2,296,913	2,264,326	2,296,913	2,264,326	2,296,913
R^2	0.53	0.53	0.54	0.53	0.65	0.65
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Includes MNC	-	Yes	-	Yes	-	Yes

All variables in logs, Robustness; complexity, lagged delinquent debt, cash coincidence.

▶ Debt Robustness

FX Derivatives Contracts—Priced Differently

$$FXP_{c,i,b,d} = \beta_1 A_{c,i,b,d} + \frac{\beta_2}{\beta_2} N_{c,i,b,d} + \beta_3 D_{c,i,b,d} + \beta_4 \mathbf{X}_{i,y} + \eta_i + \eta_{b,m} + \eta_m + \varepsilon_{c,i,b,d}$$

	FX Pu	rchases	FX S	FX Sales	
	(1)	(2)	(3)	(4)	
Maturity (N _{c,i,b,d})	0.425**	0.425**	-2.117***	-2.120***	
	(0.197)	(0.197)	(0.384)	(0.384)	
Size (sales) ($\mathbf{X}_{i,v}$)	-0.157*	-0.156*	0.075	0.076	
~	(0.086)	(0.087)	(0.132)	(0.132)	
Notional amount $(A_{c,i,b,d})$		0.014		-0.046	
		(0.052)		(0.067)	
Delivery instrument $(D_{c,i,b,d})$		0.158		-0.330	
		(0.198)		(0.336)	
Observations	343,621	343,621	133,424	133,424	
R Squared	0.18	0.18	0.22	0.22	
Firm FE	Yes	Yes	Yes	Yes	
Month FE	Yes	Yes	Yes	Yes	
Bank-Month FE	Yes	Yes	Yes	Yes	

Notes: Notional amount: amount hedged (logs) in a given contract. Maturity: days from signing of the contract to its maturity ($N_{t,f,b,i}$). Robustness: complexity, lagged delinquent debt. S.E. clustered at the firm level. FXP in percentage points.

- Firms in international trade are prone to cash-flow currency mismatches
- Benchmark Modigliani-Miller (MM): Hedging adds no value to the firm
 - Firms do use FX derivatives: arguably motivated by market imperfections that deviate from neoclassical assumptions
 - \rightarrow External financing is costly

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- 1. Timing/maturity of cash flows matters
 - → Limit natural hedging and consistent with hedging of gross positions
 - Firms with higher coincidence: less FX derivatives ▶ □ □
 - Higher EXR volatility: more FX derivatives → EXR

Additional Robustness Exchange Rate Expectations and Volatility

	A. Extensi	ve margin	B. Int. Margi	n: Sales (log)	C. Int. Margin:	Purchases (log
Baseline variables						
	(1)	(2)	(3)	(4)	(5)	(6)
X ^{τc}	0.020***	0.020***	0.047***	0.047***	0.001	0.001
	(0.004)	(0.004)	(0.008)	(0.008)	(0.007)	(0.007)
M ^{TC}	0.054***	0.054***	0.012*	0.012*	0.155***	0.155***
	(0.005)	(0.005)	(0.007)	(0.007)	(0.015)	(0.015)
FCD	-0.015***	-0.015***	-0.015	-0.015	-0.005	-0.005
	(0.005)	(0.005)	(0.013)	(0.013)	(0.013)	(0.013)
Volatility						
Expectation disp.12m (%), survey	0.051***	0.051***	0.031***	0.016***	0.017**	0.028***
	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)
Past and expected depreciation						
E[12m depr], survey median	-0.010	-0.011	-0.183***	-0.112***	0.110***	0.058***
	(800.0)	(0.007)	(0.009)	(0.007)	(0.008)	(800.0)
Depr trend past 12m		-0.001		0.005***		-0.004***
		(0.001)		(0.000)		(0.000)
Observations	2264326	2264326	2264326	2264326	2264326	2264326
R Squared	0.53	0.53	0.54	0.54	0.65	0.65
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Includes MNC	No	No	No	No	No	No
Includes mining	No	No	No	No	No	No

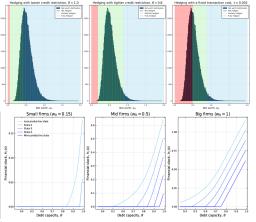
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 - → Maturity premium that is heterogeneous across firms
- 2. But hedging is partial, selection of larger firms, for larger amounts
 - ightarrow Financial frictions also limit the use of FXD (Rampini and Viswanathan 2010)
 - ▶ Frictions

- Firms in international trade are prone to cash-flow currency mismatches
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 - Firms with higher coincidence: less FX derivatives ▶ □ □
 - Higher EXR volatility: more FX derivatives
 - \rightarrow Maturity premium that is heterogeneous across firms (Fact 4)
- 2. But hedging is partial, selection of larger firms, for larger amounts
 - → Financial frictions also limit the use of FXD
 - → Suggests fixed-costs, transaction-level (OTC) FC Simulations

Capital Market Imperfections: Collateral Constraints and Transaction Costs (AC, 2022)

Hedging, Firm Size, Collateral, Transaction Costs



Buy asset $h_1(s)$ to hedge status s at t=1. For this you must pay τ_0 in all states.

▶ Go back

Taking Stock: Value of Hedging when Pricing in Foreign Currency

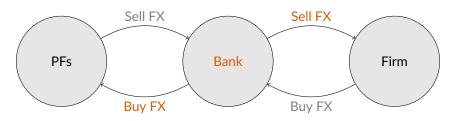
- Does hedging add value to the firm even when pricing in foreign currency?
 - 1. Regulatory change to pension funds lowering the supply of FXD to firms.
 - 2. Propensity score matching and coarsened exact matching.

FX Financial Hedging and Real

Outcomes

Supply Shock FX Derivatives Market

- Pensions Funds and regulation: LIMIT on the share of un-hedged portfolio invested abroad
- In 2012 limits were adjusted
- Announced May 2012, approved June 2012, enforced Dec 2012.
- How did the supply shock get to firms? → Banks





Supply Shock FX Derivatives Market

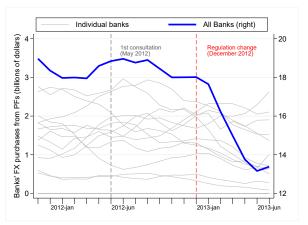


Fig: Banks' purchases of FX derivatives from Pension Funds

Supply Shock FX Derivative Market

- 1. Average Effects of Supply Shocks
- 2. Evolution of the Supply Shock: From Banks to Firms (OTC Market)
 - Supply of FX derivatives to firms
 - Price of FX derivatives: forward premium
 - Additional check: from AFPs to Banks
- 3. Effect of firms' hedging decisions at the intensive and extensive margins, and real/financial effects

Supply Shock FX Derivatives Market: Average Effect

$$FX_{i,\tau}^{\mathsf{Long}} = \beta_1 Post_{\tau} + \eta_i + \varepsilon_{i,\tau},$$

Purchases of FX derivatives before and after change in regulation

	Outstand	ling (log)	Annual Grov	vth (%)
1(Post)	(1) -0.245**** (0.060)	(2) -0.248*** (0.062)	(3) -0.550*** (0.099)	(4) -0.545*** (0.103)
Observations R^2 Firm FE Includes Mining and MNC	660 0.930 Yes Yes	658 0.920 Yes	616 0.48 Yes Yes	614 0.48 Yes

Notes: $FX_{i,\tau}^{\text{Long}} = \log \text{ of the average outstanding FX position by firm } i \text{ in period } \tau; Post_{\tau} = 1 \text{ Dec 2011-May 2012; Dec 2012-May 2013; Firm FE; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = \log \text{ of the average outstanding FX position by firm } i \text{ in period } \tau; Post_{\tau} = 1 \text{ Dec 2011-May 2012; Dec 2012-May 2013; Firm FE; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = \log \text{ of the average outstanding FX position by firm } i \text{ in period } \tau; Post_{\tau} = 1 \text{ Dec 2011-May 2012; Dec 2012-May 2013; Firm FE; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = \log \text{ of the average outstanding FX position by firm } i \text{ in period } \tau; Post_{\tau} = 1 \text{ Dec 2011-May 2012; Dec 2012-May 2013; Firm FE; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = \log \text{ of the average outstanding FX position by firm } i \text{ in period } \tau; Post_{\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; Dec 2012-May 2013; Firm FE; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; Dec 2012-May 2013; Firm FE; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; Dec 2012-May 2013; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; } i \text{ Notes: } FX_{i,\tau}^{\text{Long}} = 1 \text{ Dec 2011-May 2012; } i \text{ Notes: } FX_{i,\tau}^{\text{$

Supply Shock FX Derivatives Market: Firms' FX Hedging and Forward Premium

 Aggregate effects are important: 60% reduction of purchases of FX derivatives and 0.7pp increase in the forward premium (6 month window)

Table: Weighted average estimated supply shock

	FX-derivatives purchase (Growth Rate)	Forward Premium (pp.)
All firms	(1) -0.572***	(2) 0.705*
Firms in international trade	(0.063) -0.549***	(0.357) 0.775***
Timis in international trade	(0.060)	(0.179)

Supply Shock FX Derivatives Market: Firm Effects

- Firms—with multibanking—decreased their imports and size (employment, leverage)
 - Single-banked reduced by more
 - Consistent with hedging adding value to firms who use it
- Exporters lowered their sales of FX derivatives, deepening the initial shock

	FX sales (1)	Imports (2)	Exports (3)	Employment (4)						
	Window of N=6 months									
1(Post)	-0.664**	-0.141**	-0.204	-0.029**						
	(0.324)	(0.061)	(0.154)	(0.013)						
Obs.	101	424	189	419						
R^2	0.075	0.16	0.14	0.0024						

FX Hedging and Real Outcomes

 Propensity Score Matching (Rosembaum and Rubin, 1983) and Coarsened Exact Matching (lacus et al, 2021)

$$\beta = E\left(\left.Y_{1}\right| \textit{FXD hedging} = 1, X\right) - E\left(\left.Y_{0}\right| \textit{FXD hedging} = 0, X\right) - \left[E\left(\left.Y_{0}\right| \textit{FXD hedging} = 1, X\right) - E\left(\left.Y_{0}\right| \textit{FXD hedging} = 0, X\right)\right]$$

Table: Real Effects: Matching

Panel A: CEM				Panel B: PSM					
	Sales (1)	Imports (2)	Exports (3)	Total trade (4)	Sales (1)	Imports (2)	Exports (3)	Total trade (4)	
ATET (2010-14)	0.083***	0.108***	0.012	0.115***	0.144*** (0.026)	0.103**	0.184***	0.179***	
Observations	17964	16159	2542	17419	55568	47413	14562	53578	
ATET (2011-15)	0.129***	0.186***	0.068	0.222*** (0.031)	0.100***	0.221***	0.182** (0.086)	0.271***	
Observations	17947	16539	2468	17595	58741	50200	15053	56599	
ATET (2011-17)	0.127***	0.166***	0.069	0.190***	0.144*** (0.026)	0.103**	0.184***	0.179***	
Observations	21245	19819	2872	20821	55568	47413	14562	53578	

Notes: Variables: Match: the number of workers, industry, available line of credit, and outstanding accounts payable and receivable (pre-treatment period).

ightarrow Further evidence on real outcomes using an exogenous Supply Shock

Conclusions

 \rightarrow Under dominant currency pricing, is FX financial risk management still relevant? Yes!

1. Exposure

- Operational hedging is limited due to different timing & amount of cash flows

2. Use

- Largest firms actively engage in FX financial risk management
 - \rightarrow 90% Forward/ Trade Credit by firms accounting for 40%+ VA
- Firms hedge short-term financing for larger amounts, and gross exposure

3. Real outcomes

- FX derivatives add value: firms get bigger and trade more
- Market thickness/liquidity: key for mitigating risks
- → FX financial risk management as a tool to complement operation hedging in a world of dominant currencies

Currency Hedging: Managing Cash-Flow Exposure

Laura Alfaro (Harvard & CEPR & NBER)

Mauricio Calani (Central Bank of Chile) Liliana Varela (LSE & CEPR)

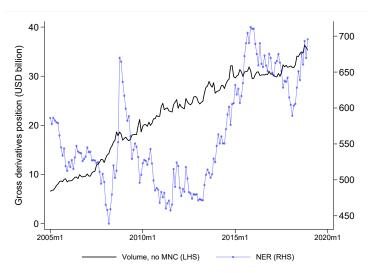
November 2022

Disclaimer: The opinions and assessments expressed in this presentation do not necessarily reflect those of the Central Bank of Chile or its Board Members.

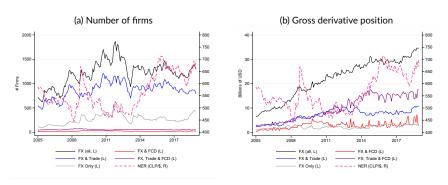
Appendix

FX derivatives market—Chile

Fig: FX Derivative Position and Exchange rate (peso to US dollars)



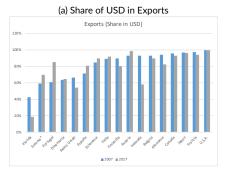
Use of FX derivatives by type of firm

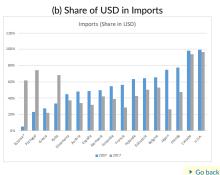


Notes: Categories of firms are mutually exclusive, except for the "(all)" category which includes all the others.



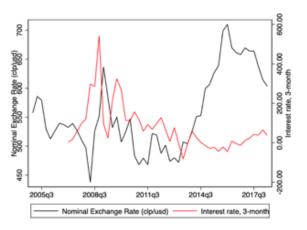
Currency of Trade





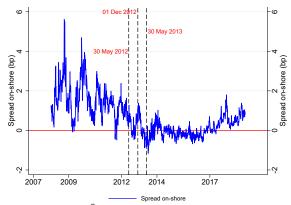
Exchange Rate and Interest Rate

Exchange Rate (CHP/USD) and Interest Rate (3 Months)





Covered Interest Rate Parity



- $(1+i^*_{t,n}+x_{t,n})=(1+i_{t,n})*\frac{S_t}{F_{t+n}}$, where $i^*_{t,t+n}$ and $i_{t,t+n}$, n-year risk-free interest rates quoted at date t in U.S. dollars and Chilean pesos; S_t the spot exchange rate, and $F_{t,t+n}$ the n-year outright forward exchange rate signed in t; x_t , n the measure of CIP deviation.



Intensive margin: robustness debt

	(1)	(2)	(3)	(4)
_M TC	0.143*** (0.013)	0.135*** (0.016)	0.143*** (0.016)	0.135***
FCD	0.001 (0.013)	(0.010)	0.035* (0.022)	(0.010)
X ^{TC} by exp	0.012 (0.010)	0.013 (0.016)	0.002 (0.009)	0.016 (0.014)
X ^{TC} by imp.	0.006 (0.006)	0.026* (0.016)	0.002 (0.067)	0.030** (0.015)
FCD, up to 6 months		0.029 (0.019)		0.033* (0.018)
FCD, 7 to 1 year		0.044* (0.023)		0.041** (0.020)
FCD, 1 years +		0.002 (0.006)		0.003 (0.006)
Observations	2520309	22857366	2121848	2306632
R^2	0.65	0.65	0.69	0.69
Firm FE	Yes	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes	Yes
Includes MNC	Yes	Yes	Yes	Yes
Includes Mining	Yes	Yes	Yes	Yes
Includes Swaps	-	-	Yes	Yes

Notes: Standard errors clustered at the firm level reported in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01



Additional Robustness Coincidence, Complexity

	Extensive Margin		Intensive	Margin:	Intensive	Margin:
	Extensiv	e iviargin	Purchas	ses (log)	Sales (log)	
	(1)	(2)	(3)	(4)	(5)	(6)
X ^{TC}	0.014***	0.018***	-0.003	-0.002	0.030***	0.043***
	(0.004)	(0.004)	(0.007)	(0.007)	(0.009)	(0.008)
M ^{TC}	0.049***	0.052***	0.144***	0.154***	0.015*	0.010
	(0.005)	(0.005)	(0.015)	(0.015)	(0.008)	(0.007)
Foreign Currency Debt	-0.012***	-0.015***	-0.001	-0.005	-0.012	-0.015
	(0.004)	(0.005)	(0.011)	(0.013)	(0.011)	(0.013)
Managerial constraints						
Coincidence	-0.008**	-0.009***	-0.014***	-0.016***	0.005+	0.003
	(0.003)	(0.003)	(0.005)	(0.005)	(0.003)	(0.004)
# Import countries	0.008***	0.009***	0.005**	0.006**	0.008***	0.008***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
# Export countries	0.005**	0.004**	0.007**	0.006*	0.009***	0.009***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)
Observations	2296913	2264326	2296913	2264326	2296913	2264326
R Squared	0.53	0.53	0.65	0.65	0.53	0.54
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Includes MNC	No	Yes	No	Yes	No	Yes
Includes mining	No	Yes	No	Yes	No	Yes

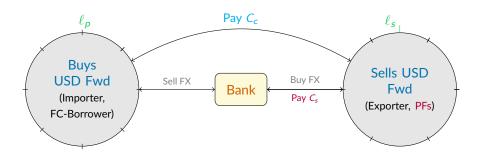


Financial Constraints

	FX=1 (Firm F	X derivatives)	Sales FX o	derivatives	Purchases F	X derivatives
	(1)	(2)	(3)	(4)	(5)	(6)
		Panel A. Financ	cial Constraints	5		
X ^{TC}	0.020***	0.019***	0.047***	0.046***	0.000	0.000
	(0.004)	(0.004)	(0.008)	(0.008)	(0.007)	(0.007)
M^{TC}	0.054***	0.054***	0.012*	0.012*	0.155***	0.155***
	(0.005)	(0.005)	(0.007)	(0.007)	(0.015)	(0.015)
FCD	-0.015***	-0.016***	-0.015	-0.015	-0.005	-0.005
	(0.005)	(0.005)	(0.013)	(0.013)	(0.013)	(0.013)
Delinquency	-0.024***	-0.022***	-0.008**	-0.008**	-0.016***	-0.015**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Credit line		0.011***		0.005**		0.007***
		(0.002)		(0.002)		(0.002)
Observations	2,264,326	2,264,326	2,264,326	2,264,326	2,264,326	2,264,326
R^2	0.53	0.53	0.54	0.54	0.65	0.65
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-industry FE	Yes	Yes	Yes	Yes	Yes	Yes



Sketch of Model-Market Thickness

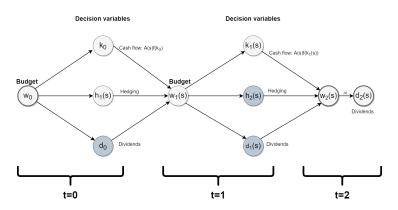


- Pension funds exit the market temporarily
- Bank evaluates selling FX derivative ℓ_p , but cannot find a seller of opposite position ℓ_s
- Bank does not sell ℓ_s
- Firms who normally sell USD forward, know they cannot later buy, so they too stop selling \rightarrow pay coordination cost C_c , market is even thinner.

Model: Dynamic Problem-Rampini Viswanathan (2010)

$$\begin{split} V_t(w(s^t), s^t) &= \max_{d(s^t), k(s^t), w(s^{t+1}), h(s^{t+1})} d(s^t) + \beta \mathbb{E}[V_{t+1}(w(s^{t+1}), s^{t+1}) | s^t] \\ \text{subject to} \\ w(s^t) &\geq d(s^t) + \wp k(s^t) + R^{-1} \mathbb{E}[h_{t+1} | s^t] \\ w(s^{t+1}) &\leq A(s^{t+1}) f_t(k(s^t)) + q(s^{t+1}) k(s^t) (1-\theta) + h(s^{t+1}) \\ w(s^{t+1}) &> 0 \\ h(s^{t+1}) &\equiv \theta q_{t+1}(s) k(s^t) - Rb(s^{t+1}) \geq 0 \end{split} \tag{Positive Net Worth)}$$

Time Line

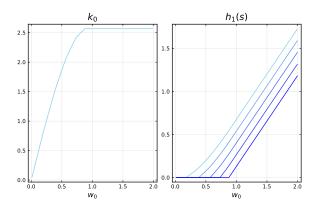


*Darker circles, set to zero (assumed in model)

Time Line

- At t=0, the firm decides how much to invest in capital and how much debt capacity to maintain for risk management.
 - If the firm is small, the capital is very productive, thus the firm does not hold any financial slack.
 - Due to the diminishing return to capital, at some point it is more profitable to maintain debt capacity (to cover bad states of nature) instead of investing it in additional capital.
- At t=1, due to the productivity assumption $A_2 = 1.5$, the productivity of capital is so high (exogenously, not due to k_0), that the firm will invest all of it in capital and nothing to maintain financial slack. In this way $h_2(s) = 0$ in all states.
- Therefore, the model uncertainty resolves to t=0. Then the problem at t=1 is trivial, since everything is invested in capital.

Results: RV(2010)

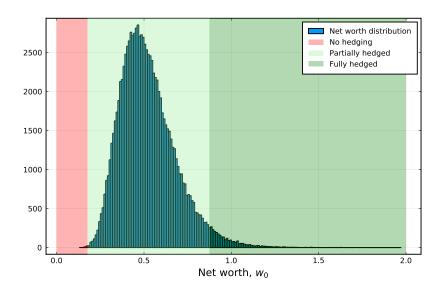


*Darker lines are more productive states according to $A_1(s)$. Left: Shows capital investment. Right: Shows how many resources have been moved to each state. For example, the low-productivity light blue line indicates how many resources were reallocated to that particular state.

Calibration

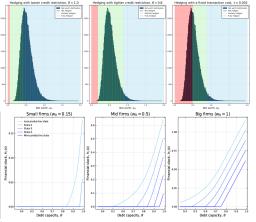
Parameter	Value	Name
$[w_0^{min}, w_0^{max}]$	[1e-2, 3]	Initial net worth
N _w	800	Net worth grid points
N_s	5	Number of states
$\pi_{s.s'}$	$1/N_s$	Transition probability
$q_1 = q_2$	1	Price of state contigent claim
β	0.95	Preferences
α	0.33	Technology
θ	0.8	Collateralization rate
R	$1/\beta$	Expected return
$A_1(s)$	s/10	Productivity $t = 1$
A_2	1.5	Productivity $t = 2$
f(k)	k^{α}	Technology

Results: RV (2010) Model



Capital Market Imperfections: Collateral Constraints and Transaction Costs (AC, 2022)

Hedging, Firm Size, Collateral, Transaction Costs



Buy asset $h_1(s)$ to hedge status s at t=1. For this you must pay τ_0 in all states.

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