Narrow Framing and Risk Management*

Gabriel Levin-Konigsberg**
Amazon

Hillary Stein
Federal Reserve Bank of Boston

Vicente García Averell
London Business School

Calixto López Castañon
Banco de México

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*The views expressed here are solely those of the authors and do not reflect the opinions of the Federal Reserve Bank of Boston, the Federal Reserve System, or Banco de México.
**This work was done prior to Gabriel joining Amazon.

How do non-financial firms make FX hedging decisions?

- Understanding this is critical for predicting how companies will fare in volatile conditions
- While corporate risk management can create value, corporate hedging remains limited
  - One explanation: costly collateral requirement
- We identify an additional channel: firm managers become discouraged if their derivatives positions lose money
  - Even if this coincides with operational gains
  - "Narrow framing"

FX hedging: an example

Operations

Enter import contract for 100 USD worth of goods

MXN **depreciates**: $S^{exp}_{t+1} = 20$, $S_{t+1} = 21$

Pay **2100** MXN vs. expected **2000** MXN

100 MXN **loss**

FX hedging: an example

Operations	Risk Management
Enter import contract for 100 USD worth of goods	Buy forward contract at rate of 20 MXN/USD

MXN **depreciates**: $S_{t+1}^{exp} = 20$, $S_{t+1} = 21$

Operations	Risk Management
Pay **2100** MXN vs. expected **2000** MXN	Buy 100 USD for **2000** MXN vs. current value **2100** MXN
100 MXN **loss**	100 MXN **gain**

FX hedging: an example

Operations

Enter import contract for 100 USD worth of goods

MXN **appreciates**: $S_{t+1}^{exp} = 20,\ S_{t+1} = 19$

Pay **1900** MXN vs. expected **2000** MXN

100 MXN **gain**

Risk Management

Buy forward contract at rate of 20 MXN/USD

Buy 100 USD for **2000** MXN vs. current value **1900** MXN

100 MXN **loss**

This paper

- Considers FX exposure and hedging in Mexico
  - Among the first to use transaction-level data to study derivative use
- Outcome of previous position predicts future hedging:
  - Firms are 19 p.p. less likely to take a new position after incurring losses in their most recently expired position.
- The probability of taking a new position is a **kinked** function of the percent gains (loss) of the most recent expiration:
  - It is flat for gains.
  - It has a positive slope for losses.

Related literature

- **Theoretical determinants corporate risk-management**: Stulz (1984); Smith and Stulz (1985); Froot, Scharfstein, and Stein (1993); Rampini and Viswanathan (2010)
  - Our paper suggests new directions that involve either deviations from rationality or organizational frictions.
- **Empirical determinants of corporate hedging via derivative use**: Nance, Smith, and Smithson (1993); Giambona et al. (2018); Géczy, Minton, and Schrand (1997); Tufano (1996); Rampini, Sufi and Viswanathan (2014)
  - Rely on survey data, mentions of derivative use in public filings, or certain industries that tend to be transparent about hedge ratios.
- **Other facts on currency derivatives use using transaction-level data**: Alfaro, Calani, and Varela (2021), Jung (2021)
- **Behavioral firms and managers**: Stein (1989); Bertrand and Schoar (2003); Malmeinder and Tate (2005); Baker, Pan and Wurgler (2012); Ben-David, Graham and Harvey (2013)
  - We take no stand on whether our phenomenon is caused by a behavioral bias or organizational frictions.

Roadmap

1. Data and exchange rate exposure
2. Three empirical facts
3. Potential mechanisms and RKD
4. Intensive margin

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Data

- Derivative transactions in Mexico Liquidity
  - Includes counterparty ID, type of instrument, transaction details (currency, notional, price, purchase date, maturity date)
  - Sample dates: September 2015 to June 2019
  - Focus on MXN/USD forwards Summary statistics
    - In 2018, non-financial firms purchased a gross notional value of 19.9 bil USD of MXN/USD forwards,
    - 2.4 bil USD of MXN/USD options,
    - and $<$0.16 bil USD of MXN/USD cross-currency swaps.
- Customs data for Mexico
  - Includes the USD value of the transaction, the month and year in which the good cleared customs, HS code, and firm ID
- Mexican credit registry: commercial loans

FX exposure from international trade

- The vast majority of Mexican trade is **invoiced in USD**.
- $\Longrightarrow$ Net importers (exporters) are naturally short (long) USD
  - High correlation ($\sim$0.9) between MXN/USD, MXN/EUR, and MXN/JPY exchange rates.

Currency of invoicing of Mexican customs transactions, 2018

Currency	% of Value	% of Transactions	% of Value (Exports)	% of Value (Imports)
USD	88.60	88.40	93.88	85.08
MXN	5.48	5.60	3.96	6.67
EUR	5.23	5.19	2.02	7.38
JPY	0.32	0.29	0.15	0.44
CAD	0.08	0.18	0.06	0.10
GBP	0.06	0.11	0.03	0.09
CHF	0.06	0.07	0.02	0.09
CNY	0.06	0.06	0.01	0.09

Source: publicly available anonymized transaction-level customs data, published by the Mexican Tax Administration Services

By country

Constructing firm-level operational FX exposure

- Approximate a firm's short operational USD exposure as the sum of the next three months of net imports.
  - Trade contracts have a mean length of 59 days with a standard deviation of 26 days (Klapper, Laeven and Rajan, 2012)
  - The vast majority of forwards are taken out with a maturity of 90 days or less
- Assume that all international trade is invoiced in USD
- Mexican firms hedge their international trade exposure much more than their USD-denominated loan exposure
  - In 2018, only 15% of firms with financial derivatives also had USD-denominated loans, while 78% traded internationally
  - Focus on firms without USD loans

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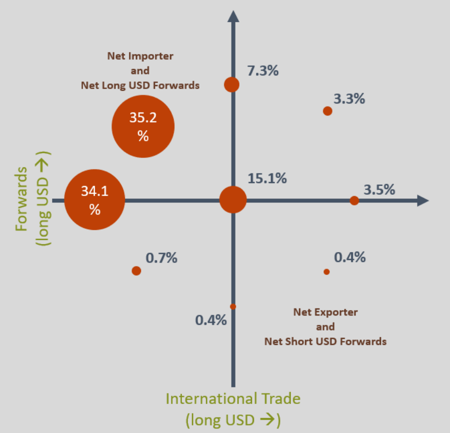
1. Firms with currency exposure and past derivative access often do not hedge

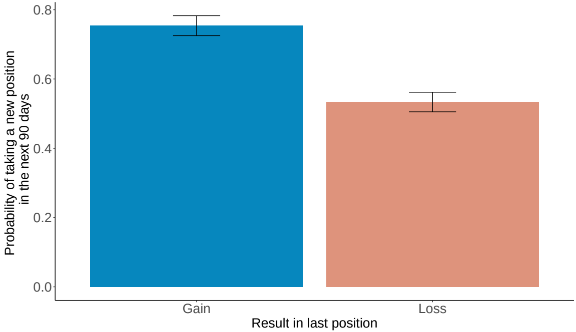
- Only consider observations starting on the first month in which a firm takes a forward position



Proportion of firm-month observations in each of the nine buckets.

2. Firms are less likely to take a new position after experiencing a loss in their most recent expiration

- Firms that incurred derivative losses are $\sim$ 19 p.p. **less likely** to take a new position.

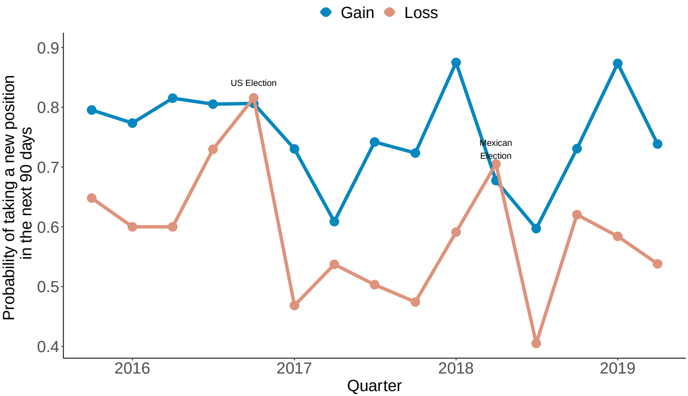


Proportion of net-importing firms that took a new position within the 90 days after an expiration in the USD-MXN forward market, conditional on whether the expiring position yielded gains and losses. Bars show 95% confidence intervals.

Alternative window lengths

This behavior is not driven by a single event

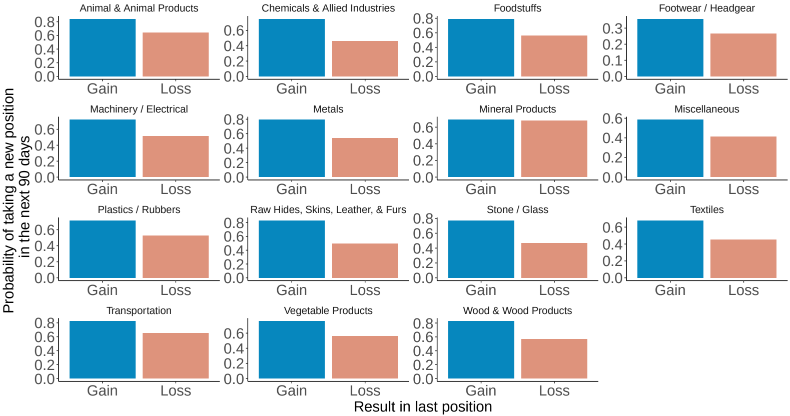
- Split the sample in **quarterly cuts** of the data, and calculate the same statistic **each** quarter.



Probability of taking a new positions in the next 90 days after a gain or a loss in quarterly cuts of the data

This behavior is present regardless of industry

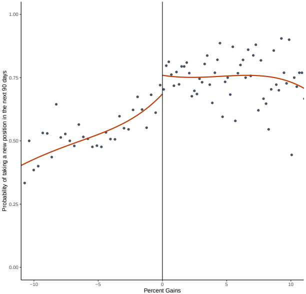
- Split the sample by type of import.



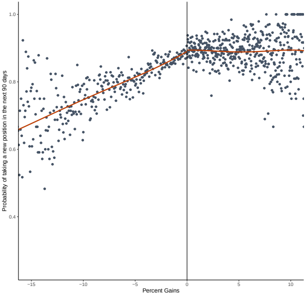
Probability of taking a new positions in the next 90 days
after a gain or a loss by type of imports

3. The likelihood of taking a new position is a kinked function of the percent gain/loss

- The kink is at zero.
- Estimated using a fourth degree global polynomial approach at each side of zero (Calonico, Cattaneo and Titiunik, 2015)



(a) No other outstanding positions



(b) Full sample

Roadmap

Two possible stories

Both deviations from the rational, frictionless setting

1. **Narrow framing.** Firms consider operational gains and financial losses separately and choose to stop hedging.
   - Different causes (triggered by losses): regret, organizational frictions

$$L_{i,t} = \min\{(S_t - F_{0,t})\, N_{i,t}, 0\}$$

2. **Net worth channel.** Firms may refrain from taking out derivatives or reduce their use when they face financial constraints.
   - Firm incurs losses $\implies$ reduction in pledgeable net worth

$$NW_{i,t} = NW_{i,0} + \overbrace{(S_t - F_{0,t})\, N_{i,t}}^{\text{Fin. Result}} + \overbrace{\left(P^{MXN} - S_t Q^{USD}\right) NM_{i,t}}^{\text{Op. Result}}$$

Can each story explain our empirical facts?

Fact	Narrow Framing	Net Worth
1: mixed hedging use	✓	✓
2: loss $\implies$ new forward less likely	✓	✓
3: kinked function	✓	X

Estimated effect from regression kink design (RKD)

Coefficient	95% C.I.	Sample	N
-0.0424	[-0.0845,-0.0004]	No outs.	4,785
-0.0163	[-0.0303,-0.0023]	Full	79,244

Note: Confidence intervals are constructed using heteroskedastic-robust nearest neighbor s.e. clustered at the firm level.

- A 1 p.p. increase in the percent loss of the most recent expiration reduces the probability of taking a new position by 4.24 p.p.
- Ave. percent loss of 5.3% $\implies$ on average, firms become $\sim$22.47 p.p. less likely to take a new position after a loss

Bias-corrected | Split by volatility | RKD in more depth | No manipulation

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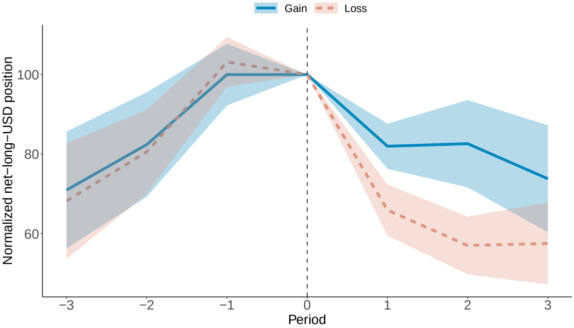
Incurring gains or losses also matters in the intensive margin

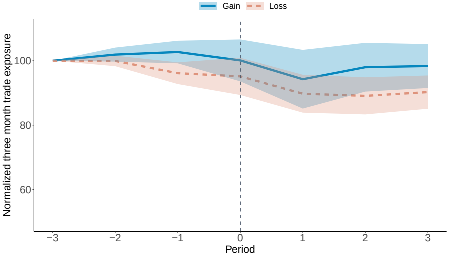
- **Firms that incurred losses** reduce their net forward position by 16.05 p.p. more than those that incurred in gains.



Median forward position of firms after incurring in a gain or a loss, position pre-expiration normalized to 100. 95% confidence intervals with bootstrapped s.e. clustered at firm level.

The effect of gains or losses on operational exposure are limited

- What if firms reduce their **operational exposure**, and hedge ratios stay constant?
- Repeat the same exercise but consider the sum of **next three months of net imports** and normalize $t = -3$ to 100.
- The difference in drop is roughly 4.49 p.p. after the expiration.



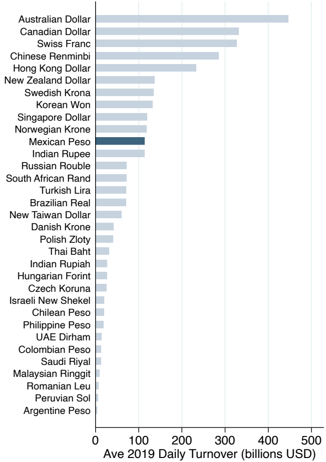
Median exposure of firms after incurring a gain or a loss, exposure three months pre-expiration normalized to 100. 95% confidence intervals with bootstrapped s.e. clustered at firm level.

Conclusion

- We showed that firms act like narrow framers in making their hedging decisions.
  - A new channel explaining the limited use of derivatives among non-financial firms
- Using an RKD, we show that firms are $\sim$20 p.p. less likely to take a new position after incurring losses.
  - Kinked function is consistent with narrow framing but not a net-worth channel.
- Narrow framing also seems to operate on the intensive margin, with firms reducing hedge ratios after losses.

APPENDIX

Liquidity of MXN derivative



Source: BIS Triennial Survey Statistics on Turnover
Not pictured: USD, EUR, JPY, GBP

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Summary statistics

	min	25p	median	75p	max	mean	s.d
Position Size (1000 USD)	1	45	100	296	395, 370	601.5	344.2
Position length (days)	1	25	48	90	744	70.48	70.616
Time to next position (days)	0	2	12	42	1275	42.33	86.72
# of positions by firm	1	4	16	50	4760	64.99	196.379

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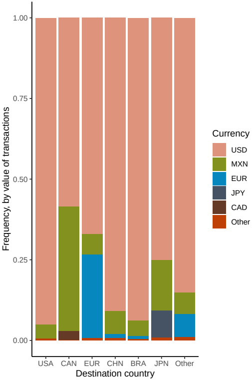
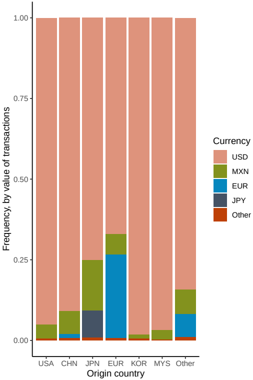
Currency of invoicing of Mexican customs transactions by country, 2018



(c) Exports



(d) Imports

Source: publicly available anonymized transaction-level customs data, published by the Mexican Tax Administration Services

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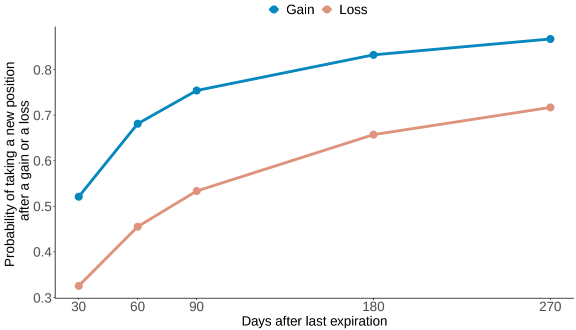
Fact 2 is robust to different window lengths

- Calculate the probability of taking a new position 30, 60, 90, 180, 270 days after the most recent expiration.



Probability of taking a new position after an expiration by time allowed after expiration to take a new position.

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The effects of narrow-framing are reduced when MXN/USD volatility is high

- Less regret?
- More leeway for risk manager?

Coefficient	95% C.I.	Sample	Vol. Period	N
-0.0036	[-0.0858,0.0786]	No outs.	Above median	2,363
-0.0670	[-0.2274,0.0933]	No outs.	Below median	2,422
-0.0062	[-0.0196,0.0071]	Full	Above median	40,086
-0.0205	[-0.0507,0.0096]	Full	Below median	39,158

Note: Confidence intervals are constructed using heteroskedastic-robust nearest neighbor s.e. clustered at the firm level.

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Effect of narrow framing on risk management

Coefficient	95% C.I.	Sample	Vol. Period	N	Type	Bandwidth
-0.0424	[-0.0845,-0.0004]	No outs.	All	4785	Conventional	3.7938
-0.0535	[-0.0955,-0.0115]	No outs.	All	4785	Bias-corrected	7.1187
-0.0036	[-0.0858,0.0786]	No outs.	Above median	2363	Conventional	3.4684
0.0194	[-0.0629,0.1016]	No outs.	Above median	2363	Bias-corrected	6.5814
-0.0670	[-0.2274,0.0933]	No outs.	Below median	2422	Conventional	1.6611
-0.0413	[-0.2016,0.119]	No outs.	Below median	2422	Bias-corrected	3.0439
-0.0163	[-0.0303,-0.0023]	Full	All	79244	Conventional	2.3993
-0.0179	[-0.0319,-0.0039]	Full	All	79244	Bias-corrected	4.8971
-0.0062	[-0.0196,0.0071]	Full	Above median	40086	Conventional	3.6234
-0.0035	[-0.0168,0.0098]	Full	Above median	40086	Bias-corrected	7.5901
-0.0205	[-0.0507,0.0096]	Full	Below median	39158	Conventional	1.5660
-0.0203	[-0.0505,0.0098]	Full	Below median	39158	Bias-corrected	3.1500

Note: Confidence intervals are constructed using heteroskedastic-robust nearest neighbor s.e. clustered at the firm level.

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Empirical strategy: regression kink design

- Both net worth and losses are functions of $V_{i,t} = S_t - F_{0,t}$
- Let $Y_{i,t}$ be the probability that firm i takes a new position at time t

$$Y_{i,t} = y\left(NW_{i,t}(V_{i,t}), L(V_{i,t}), NM_{i,t+1}\right)$$

where

$$NW_{i,t} = NW_{i,0} + \overbrace{V_{i,t}N_{i,t}}^{\text{Fin. Result}} + \overbrace{\left(P^{MXN} - S_t Q^{USD}\right) NM_{i,t}}^{\text{Op. Result}}$$

$$L_{i,t} = \min\{V_{i,t}N_{i,t}, 0\}$$

- If loss is kinked around zero and other variables are not, then any kink around zero in the probability of taking a new position is due to losses.

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Identification through a regression kink design

$$dY_{i,t} = \left(\overbrace{\frac{\partial y}{\partial NW_{i,t}}}^{\xi} \frac{dNW_{i,t}}{dV_{i,t}} + \overbrace{\frac{\partial y}{\partial L}}^{\tau} \frac{dL}{dV_{i,t}} \right) dV_{i,t} + \frac{\partial y}{\partial NM_{i,t+1}} dNM_{i,t+1}$$

- Take the right and left limit of $\frac{dY_{i,t}}{dV_{i,t}}$:

$$\lim_{V_{i,t} \to 0^-} \frac{dY_{i,t}}{dV_{i,t}} = \xi N_{i,t} + \tau \times \overbrace{\lim_{V_{i,t} \to 0^-} \frac{dL}{dV_{i,t}}}^{-N_{i,t}}$$

$$\lim_{V_{i,t} \to 0^+} \frac{dY_{i,t}}{dV_{i,t}} = \xi N_{i,t} + \tau \times \overbrace{\lim_{V_{i,t} \to 0^+} \frac{dL}{dV_{i,t}}}^{0}$$

Back

Identification through a regression kink design

- By taking the difference we obtain our effect of interest:

$$\tau = \left(\lim_{V_{i,t} \to 0^+} \frac{dY_{i,t}}{dV_{i,t}} - \lim_{V_{i,t} \to 0^-} \frac{dY_{i,t}}{dV_{i,t}} \right) \frac{1}{N_{i,t}}$$

- τ is the difference in slope around the kink of y at $V_{i,t} = 0$

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No manipulation in the running variable

- Identification assumption: firms cannot choose to be on the left or right of $V_{i,t} = 0$
  - Firms cannot manipulate the spot rate
- A firm may choose to close a position before its expiration just as it approaches zero from the right.
- Subsample: drop all observations in which a firm has two positions in different directions expiring the same day.

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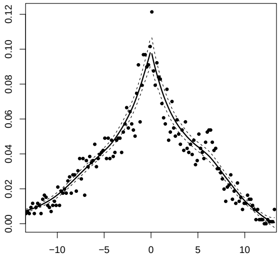
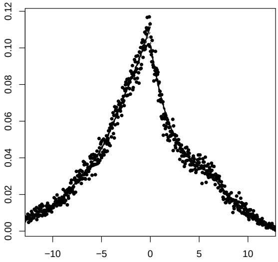
Continuous density $\implies$ no manipulation

Density of percent gains and losses



(e) Observations in which the firm has no other outstanding positions



(f) Full Sample