Narrow Framing and Risk Management*

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

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

100 MXN loss
**FX hedging: an example**

**Operations**
- Enter import contract for 100 USD worth of goods
- Pay 2100 MXN vs. expected 2000 MXN
- MXN depreciates: $S_{t+1}^{exp} = 20$, $S_{t+1} = 21$
- Pay **2100** MXN vs. expected **2000** MXN

**100 MXN loss**

**Risk Management**
- Buy forward contract at rate of 20 MXN/USD
- Buy 100 USD for **2000** MXN vs. current value **2100** MXN

**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

**Risk Management**

- Buy forward contract at rate of 20 MXN/USD
- Buy 100 USD for **2000** MXN vs. current value **1900** MXN

100 MXN **gain**

100 MXN **loss**
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.
- **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
Roadmap

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

- Derivative transactions in Mexico
  - 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
    - 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.
- Net importers (exporters) are naturally short (long) USD.
  - High correlation (∼0.9) between MXN/USD, MXN/EUR, and MXN/JPY exchange rates.

### Currency of invoicing of Mexican customs transactions, 2018

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

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

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

![Graph showing probability of taking a new position in the next 90 days after a gain or a loss in quarterly cuts of the data](image_url)

**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

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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
     \[ NW_{i,t} = NW_{i,0} + \left( S_t - F_{0,t} \right) N_{i,t} + \left( P^{MXN} - S_t Q^{USD} \right) NM_{i,t} \]
Can each story explain our empirical facts?

<table>
<thead>
<tr>
<th>Fact</th>
<th>Narrow Framing</th>
<th>Net Worth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: mixed hedging use</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2: loss  (\implies) new forward less likely</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3: kinked function</td>
<td>✓</td>
<td>X</td>
</tr>
</tbody>
</table>
### Estimated effect from regression kink design (RKD)

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>95% C.I.</th>
<th>Sample</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.0424</td>
<td>[-0.0845, -0.0004]</td>
<td>No outs.</td>
<td>4,785</td>
</tr>
<tr>
<td>-0.0163</td>
<td>[-0.0303, -0.0023]</td>
<td>Full</td>
<td>79,244</td>
</tr>
</tbody>
</table>

*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.
Roadmap

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4. Intensive margin
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
### Summary statistics

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

Back
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.

![Graph showing the probability of taking a new position after a gain or a loss over time.]

Probability of taking a new position after an expiration by time allowed after expiration to take a new position.
The effects of narrow-framing are reduced when MXN/USD volatility is high

- Less regret?
- More leeway for risk manager?

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

*Note: Confidence intervals are constructed using heteroskedastic-robust nearest neighbor s.e. clustered at the firm level.*
### Effect of narrow framing on risk management

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

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

\[
Y_{i,t} = y(NW_{i,t}(V_{i,t}), L(V_{i,t}), NM_{i,t+1})
\]

where

\[
NW_{i,t} = NW_{i,0} + \left\{ V_{i,t} N_{i,t} \right\} + \left\{ P^{MXN} - S_t Q^{USD} \right\} NM_{i,t}
\]

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

► 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.
Identification through a regression kink design

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

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

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

\[
\lim_{V_{i,t} \to 0^+} \frac{dY_{i,t}}{dV_{i,t}} = \xi N_{i,t} + \tau \times \lim_{V_{i,t} \to 0^+} \frac{dL}{dV_{i,t}}
\]
Identification through a regression kink design

By taking the difference we obtain our effect of interest:

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

\( \tau \) is the difference in slope around the kink of \( y \) at \( V_{i,t} = 0 \).
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.
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