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Risk Management and Derivatives Losses

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Abstract:
Even though financial risk management has the ability to generate value, the use of financial derivatives among nonfinancial corporations remains limited. We identify a channel that contributes to this limited use: the decoupling of derivatives losses and operational gains. Specifically, firms ex post consider their operational profits separately from their derivatives profits. We explore this phenomenon among firms in Mexico. We use the universe of US dollar-Mexican peso currency derivatives transactions in Mexico along with customs data to construct a unique data set on operational exchange rate exposure and financial hedging. We find that contrary to a rational and frictionless benchmark, performance in previous derivatives transactions predicts future derivatives use. Using a regression kink design to measure the impact of decoupling on risk management, we find that when losses from previous transactions increase 1 percentage point, firms become 4.24 percentage points less likely to take out a new derivatives position within 90 days. We provide further evidence that is consistent with decoupling and supports rejecting a net worth channel.

JEL Classifications: G32, F31
Keywords: risk management, exchange rates, financial hedging, narrow framing, loss aversion

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Understanding how companies make risk management decisions is critical for predicting how companies will fare in volatile conditions; however, surprisingly little is known about the decisions underlying corporate risk management. Many papers identify motives for firms to engage in risk management (e.g., Froot, Scharfstein and Stein, 1993; Tufano, 1996). Another line of research examines how costly collateral requirements can limit risk management by financially constrained firms (Rampini and Viswanathan, 2010; Rampini, Sufi and Viswanathan, 2014). Regardless, in a rational and frictionless environment,[3] firms make hedging decisions based solely on forward-looking considerations, as these decisions involve moving resources across future states of the world. In this paper, however, we show that the outcomes of previous derivatives positions predict future hedging behavior. Firms decide whether to take a new derivatives position (that is, to continue with their risk management program) contingent on whether their most recent expiring position yielded gains or losses. We argue that this behavior arises because firms ex post treat their financial P&L and operational P&L as separate. This can happen either due to behavioral biases, specifically narrow framing and loss aversion, or due to organizational frictions within the firm.[4] We provide evidence that this phenomenon is not consistent with a costly external financing channel.

Empirical work on hedging has thus far been plagued by two challenges. First, financial derivatives data are limited, as neither firms nor banks have public reporting requirements about individual derivatives trades. Second, even if derivatives data were readily available, understanding and calculating the operational exposure that firms are trying to hedge are not trivial tasks. We overcome these challenges by constructing a unique and novel data set that combines the universe of derivatives transactions in Mexico with international trade transactions and foreign currency borrowing.

The derivatives data are collected by the central bank of Mexico; reporting is a regulatory

[3]In a fully frictionless setting, no hedging would take place. Throughout this paper, we consider a frictionless setting to be one with the standard frictions that would induce hedging à la Froot, Scharfstein and Stein (1993).

[4]In this paper, we allow for both possibilities and leave the task of distinguishing these two channels to future work.

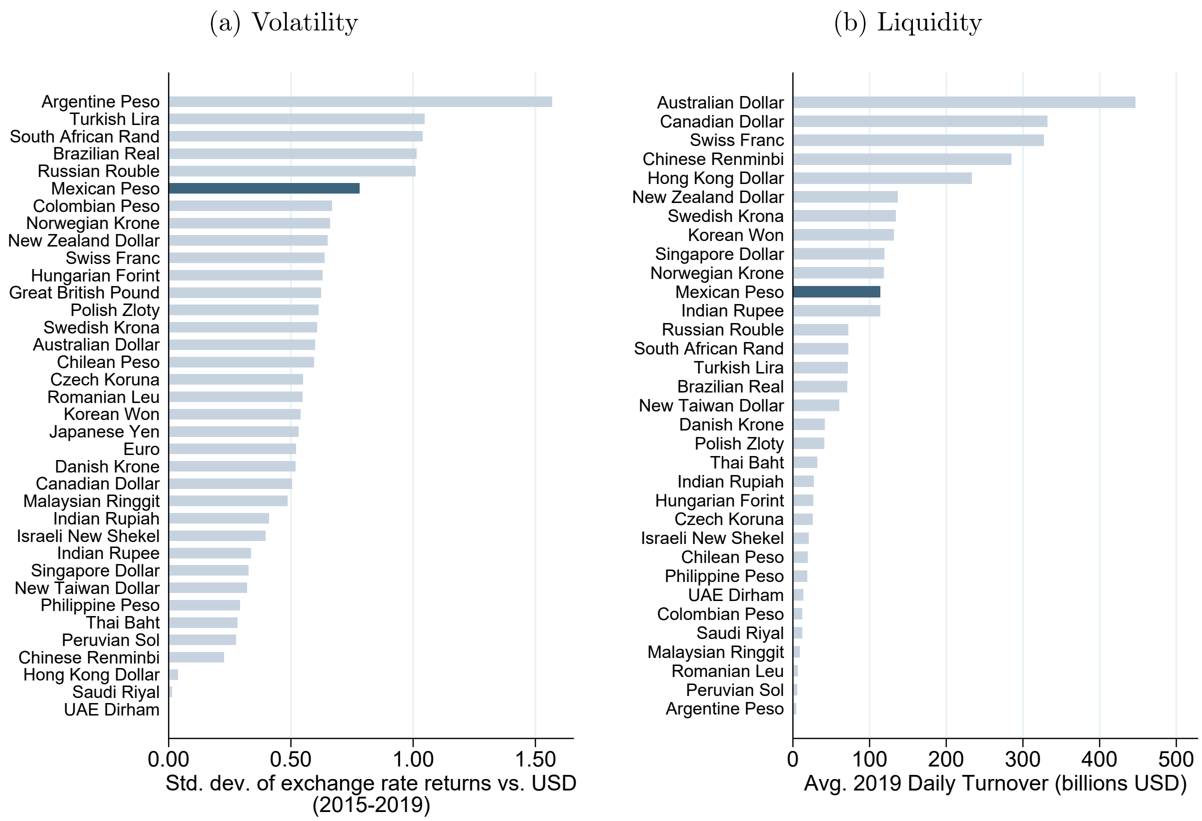
requirement for any bank engaging in derivatives transactions. The data set thus includes any transaction involving a bank that operates in Mexico. Furthermore, we focus on nonfinancial firms' currency derivatives and currency exposure because currency risk for firms in Mexico is broadly relevant and because currency exposure measurement in this setting is relatively straightforward. We match this derivatives data set with the Mexican customs database and the universe of bank loans in Mexico, allowing us to focus on currency derivatives that are taken out as financial hedges for nonfinancial firms. Because the vast majority of Mexican trade is invoiced in international currency, specifically US dollars, net importers are operationally long the Mexican peso (MXN) and short the US dollar (USD), while net exporters are operationally short the Mexican peso and long the US dollar.[5] An appealing feature of studying the MXN-USD exchange rate as our underlying exchange rate of interest is that, like other emerging market currencies, the MXN is more volatile than the currencies of most advanced economies (Figure 1, panel a). However, in contrast to many emerging market currencies, the peso has a high degree of liquidity in its spot market and in traditional derivatives instruments (Figure 1, panel b).

Using these data, we find that net-importing firms that had taken long USD forward positions were 19 percentage points less likely to take a new forward position after their most recent expiration yielded financial losses. We show that this phenomenon is present even when splitting the data according to a firm's most common import and in different time cuts of the data. We conclude that we are not picking up behavior driven by a correlation between past losses and the firm's need to hedge, perhaps due to changes in the currency environment.

Our main finding shows that the probability of taking a new position as a function of the percentage point gain or loss in the most recent expiration is a kinked function. More specifically, when the most recent expiration yields gains, the function is flat; the probability of taking a new position is the same regardless of the magnitude of the gains. However, for

[5] When a firm is "long" the Mexican peso, it profits when the peso appreciates. When it is "short" the Mexican peso, it profits when the peso depreciates.

Figure 1: Volatility and liquidity of different currencies



Notes: Panel (a) provides the volatility of various currencies, calculated as the standard deviation of the daily return of their exchange rate versus the US dollar. Panel (b) provides the liquidity of various currencies across all currency instruments, both spot and derivatives, calculated as the average daily turnover in 2019 on a net-net basis. The four most liquid currencies have been removed from the liquidity graph to improve legibility: the US dollar ($5.8 Tn), the euro ($2.1 Tn), the Japanese yen ($1.1 Tn), and the UK pound ($0.8 Tn).
Source: BIS Triennial Survey Statistics on Turnover.

losses, the function has a positive slope. The larger the losses, the smaller the likelihood of a firm taking a new position. Using a regression kink design, we demonstrate that this kink is statistically significant.

We argue that the decoupling of financial profits and operational profits is the mechanism behind the relevance of derivatives losses and the shape of this risk management policy function. This can be due to either behavioral frictions, specifically the combination of narrow framing (Barberis, Huang and Thaler, 2006) and loss aversion (Kahneman and Tversky, 1979), or organizational frictions. As Barberis, Huang and Thaler (2006) suggest, narrow framing takes place when an agent fails to fully merge their preexisting risk (in our case, the one coming from operational currency exposure from international transactions) with new possible "gambles" (in our case, a new forward position). Combined with loss aversion, narrow framing could explain a differential response to derivatives losses and gains, even if both result in the same overall profit for the firm.

Consider a firm that faces two possible states of the world, one in which it receives a high operational profit due to exchange rate movements (the "good" state) and one in which it receives a low operational profit (the "bad" state). Imagine that the firm enters into a derivatives contract to hedge its exposure. When it fully hedges, no uncertainty remains—the firm's profits are fully insulated from changes in the exchange rate. When the good state of the world is realized, the firm pays its derivatives counterparty. As these financial "losses" materialize, the firm management ex post evaluates the outcome as a bad state of the world. Given this experience, the firm reassesses its previous behavior and adjusts its future risk management practices.[6,7] The firm management is demonstrating loss aversion, but only as it applies to its derivatives P&L. In contrast to Barberis, Huang and Thaler (2006), our story has an important learning component: The management does not consider this state a bad state overall until it experiences a financial loss, even though, by construction, the loss implies currency gains from the firm's operations.

One could also tell a similar story that relies on the presence of organizational frictions. Again, when the firm fully hedges, its profits are insulated from exchange rate changes. However, the operational P&L and the financial P&L might be housed in different divisions

[6] It is worth mentioning the dissimilarity between the phenomenon we observe and the disposition effect studied by Shefrin and Statman (1985) and Odean (1998). Under this effect, investors tend to sell assets that experienced gains and keep those that incurred losses. In this paper, we observe the opposite. Firms don't roll strategies that incurred financial losses. These two phenomena may coexist, as they relate to different types of assets. The disposition effect has been documented in stocks that are infinitely lived, whereas derivatives have a clear expiration date. However, both observations involve the reluctance of investors (or risk managers) to *realize* losses in their positions.

[7] One might draw a parallel between financial derivatives use and other insurance use that allow firms to risk-share across states of the world. However, there are some notable differences: Insurance policies are often longer term and renew automatically, insurance premiums (that is, "losses") are capped, business insurance premiums may be tax deductible in certain jurisdictions, and business insurance policies may be more conventionally accepted and widely used in certain industries.

or under different managers. When the good state of the world is realized, the operational manager reports a profit due to currency movements, while the financial risk manager reports a loss due to financial derivatives use. The punishment that the financial risk manager faces for this loss may not internalize the overall positive value of the strategy for the firm and may disincentivize future derivatives use. Similar to the behavioral story, this organizational story involves a separation of operational and financial P&L and a unique reaction to financial losses.

In addition to this decoupling mechanism, we consider an alternative net worth mechanism. Recent work by Rampini and Viswanathan (2010) stresses that financial constraints restrict the ability of firms to hedge because the counterparty in a derivatives contract requires collateral to be posted. As a firm's net worth decreases, it must choose whether to use its scarce collateral for investment or for risk management. In principle, this mechanism could explain the phenomenon we observe: Financial losses might lead to a decrease in the firm's pledgeable net worth if there is a lag between operational receipts and financial outflows. Financial losses may also prompt a decrease in the firm's actual net worth if the firm initially over-hedged. We argue against this pledgeable net worth channel, citing the fact that firms make their hedging decisions contingent on the most recent expiration, even when that expiration was 270 days ago. At this point, firms' inventories must have at least partially cleared, making the operational gains pledgeable and allowing the firm to take new derivatives positions.

Further, a net worth channel does not explain the kinked risk management function we observe in the data. If we combine backward induction with the outcome of a kinked function, it implies the firm must not be acting optimally. In a Froot, Scharfstein and Stein (1993) setting, firms hedge to preserve their net worth for future investment opportunities. If, however, the kink we observe in the risk management function were caused by a drop in net worth, this would imply that even a small percentage loss (which occurs with high probability) would decrease both the firm's net worth and its ability to make investments, thus rendering hedging suboptimal from a Froot, Scharfstein and Stein (1993) perspective.

Finally, we show that when FX volatility is high, firms no longer make their hedging decisions contingent on the outcome of their most recent derivatives position. From a behavioral perspective, this is consistent with a manager who can rationalize losses and avoid regret during especially volatile times. From an organizational perspective, this is consistent with an incentive structure that in volatile times is more lenient with risk managers.[8] We present a simple model in the appendix that shows how the decoupling phenomenon can be offset by an increased variance of the exchange rate.

This paper contributes to several strands of the literature. Most notably, it furthers the empirical study of the determinants of corporate hedging via derivatives use. Due to data limitations, much of the existing literature has to rely on either survey data (e.g., Nance, Smith Jr. and Smithson, 1993; Giambona et al., 2018) or mentions of derivatives use in annual reports and/or 10-K filings (e.g., Géczy, Minton and Schrand, 1997). A few papers take advantage of the fact that certain industries tend to be very transparent about the fraction of future expenses that have been hedged (e.g., Tufano, 1996; Rampini, Sufi and Viswanathan, 2014); however, these industry-specific studies reduce cross-sectional variation on firms' risk exposure and hedging incentives. In contrast, our study is among the first to examine motives for corporate hedging using transaction-level derivatives data across industries within a country. More recently, Alfaro, Calani and Varela (2023) and Jung (2023) use transaction-level data from Chile and Korea, respectively, to uncover facts on which firms engage in currency hedging and on the consequences of hedging. Our paper, however, delves deeper into the firm-level motives for risk management and the evolving nature of risk management within firms.

Our paper also contributes to the empirical measurement of the value of risk management (e.g., Carter, Rogers and Simkins, 2006; Pérez-González and Yun, 2013). We establish the

[8]Alternatively, it could be the case that only certain firms partake in the derivatives market during these more volatile times, and these firms are less prone to the relevant behavioral biases and organizational frictions. For example, perhaps only more sophisticated firms can afford the higher hedging costs during these more volatile times.

presence of either behavioral biases or organizational frictions in risk management decisions, implying that previous calculations of the value of risk management may be a lower bound for what can be achieved under rational decision making. Similarly, while an established literature studies the theoretical determinants of corporate risk management (e.g., 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.

Finally, our paper builds upon the large literature on behavioral firms and managers (e.g., Stein, 1989; Bertrand and Schoar, 2003; Malmendier and Tate, 2005; Baker, Pan and Wurgler, 2012; Ben-David, Graham and Harvey, 2013). That said, we take no stand on whether the phenomenon we observe is caused by a behavioral bias or organizational frictions.

The rest of this paper is organized as follows: Section 1 describes the data we use and how we construct measures of currency exposure and hedging; Section 2 establishes our empirical findings; Section 3 considers mechanisms that potentially explain these findings; Section 4 describes our identification strategy and results; Section 5 extends our findings to the intensive margin of risk management; and Section 6 concludes.

1 Data and Currency Exposure

In this section, we first describe the data we use to determine a firm's operational exchange rate exposure. We then describe the derivatives data.

1.1 Natural exchange rate exposure from trade in Mexico

When firms engage in international trade, they may have a mismatch between the invoice currencies of their inputs and of their sales. If prices are sticky in the currency of invoicing, the firm's profit will be exposed to currency fluctuations. For example, net importers in

Mexico make the majority of their sales in MXN-denominated prices, and the literature documents the limited nature of exchange rate pass-through in Mexico (Gopinath, 2015). Hence, these firms will have a natural exchange rate exposure if they buy their inputs in a currency other than MXN.

In which currencies do international goods transactions with Mexico tend to occur? To answer this question, we turn to publicly available customs data for Mexico. The data are published by the Mexican Tax Administration Services and contain anonymized transaction-level information about every good clearing Mexican customs. For the year 2018, the data include 9,862,012 transactions, 7,201,296 (73 percent) of which were imports into Mexico. We focus on transactions for which there is currency-of-invoicing data and partner country data (28 percent of import transactions and 32 percent of export transactions in 2018). Using these data, we find that 88.60 percent of trade value is invoiced in USD (Table 1). This is consistent with recent studies establishing the dominance of the USD in international trade (Goldberg and Tille, 2008; Gopinath et al., 2020; Gopinath and Stein, 2021). Overall, 94.23 percent of trade value is invoiced in US dollars, euros (EUR), or Japanese yen (JPY). Only 5.48 percent of trade value is invoiced in Mexican pesos. Figure 2 breaks this down by country for Mexico's top trade partners (with countries sorted in decreasing importance). Regardless of the trading partner, the majority of international trade is invoiced in USD. In particular, 96 percent of trade value with the United States, which accounts for 78 percent of export value from Mexico and 45 percent of import value into Mexico, is invoiced in USD.

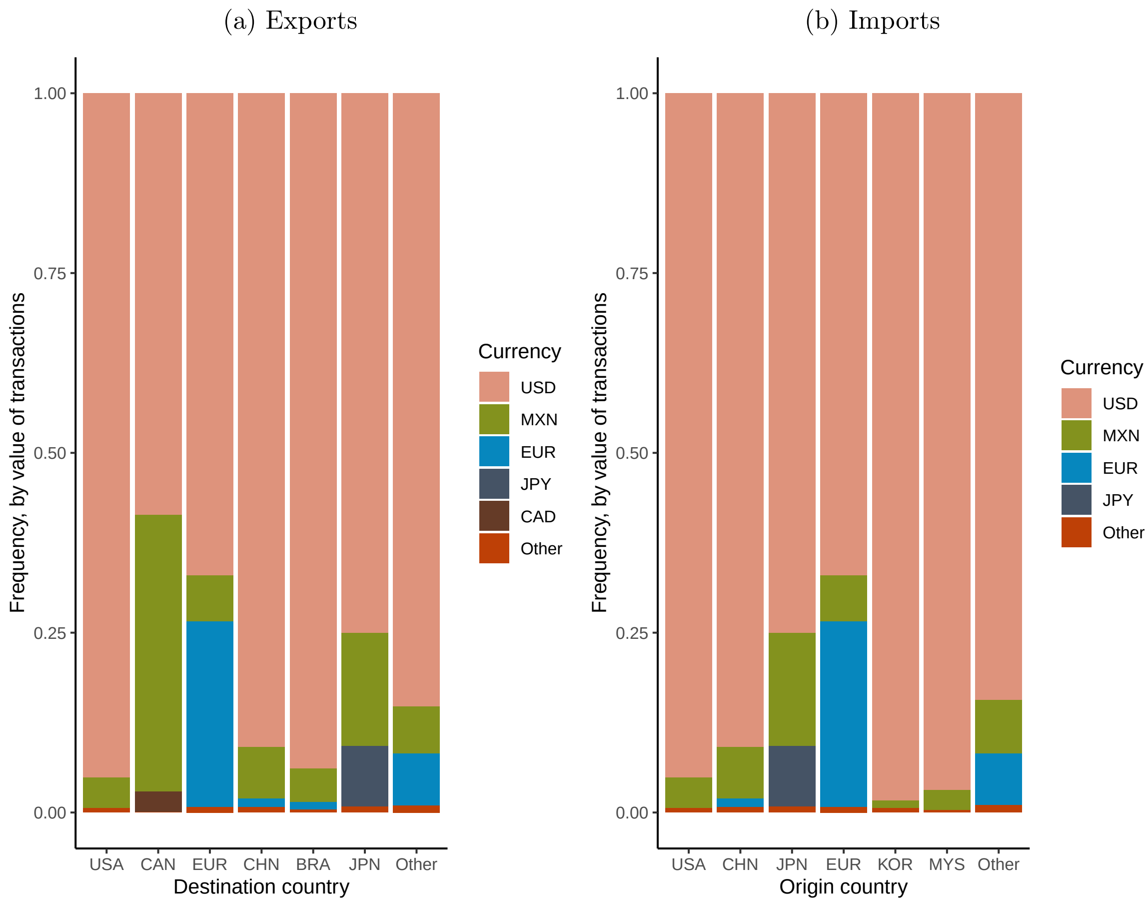
These results make it clear that most net importers have a natural short exposure to the USD; that is, the value of their operational profits drop when the USD appreciates with respect to the MXN. Importers receive the same amount from their sales regardless of exchange rate movements, but they must pay more for their imported inputs when the USD appreciates. Even if their imports are invoiced in EUR or JPY, we can still think of these firms as having a short exposure to the USD. As Table 2 shows, the exchange rates of these currencies with the Mexican peso are all highly correlated.

Table 1: 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: Authors' calculations using publicly available anonymized transaction-level customs data published by the Mexican Tax Administration Services.

Figure 2: Currency of invoicing of Mexican customs transactions by country, 2018



Source: Authors' calculations using publicly available anonymized transaction-level customs data published by the Mexican Tax Administration Services.

Table 2: Daily exchange rate correlation matrix

	MXN/USD	MXN/EUR	MXN/JPY
MXN/USD	1.00	0.90	0.94
MXN/EUR		1.00	0.89
MXN/JPY			1.00

1.2 Constructing firm-level exchange rate exposure

To understand individual firms' exchange rate exposure from their international trade, we use the unanonymized version of the Mexican customs database.[9] For each international trade transaction, we observe the firm's ID (specifically, its tax code number, or RFC), the type of transaction (import or export), the month and year in which the transaction cleared customs, the USD value of the transaction, the destination/origin country, and the HS-8-digit code of the product. Notably, we do not observe the invoicing currency of the transaction. We instead use our analysis of the anonymized data to guide our analysis of the unanonymized data. Specifically, we assume that all international trade transactions are invoiced in USD, an assumption supported by three facts from the previous subsection: (1) 88.6 percent of trade value is invoiced in USD, (2) an additional 5.55 percent of trade value is invoiced in EUR or JPY, and (3) the MXN/EUR and MXN/JPY exchange rates are both highly correlated to the MXN/USD exchange rate. Because firms are aware of their future cross-border transactions before they actually occur, we construct each firm's monthly natural MXN/USD exchange rate exposure by summing its next three months of net imports.[10] When we use the term "net importer," we refer to firm-months in which this value is positive. These net importers face a natural short USD exposure.

In addition to exchange rate exposure from their international trade, firms may also be

[9] This database is provided by the Comité Técnico Especializado de Estadísticas de Comercio Exterior (CTE-ECE), or the Specialized Technical Committee for Statistics of Foreign Trade, and is administered by the Gerencia de Análisis y Medición del Sector Real (GAMSR), or the group for Management of Analysis and Measurement of the Real Sector.

[10] This three-month window was specifically chosen for two reasons. First, trade contracts have a mean length of 59 days, with a standard deviation of 26 days (Klapper, Laeven and Rajan, 2012). Second, the vast majority of forwards are taken out with a maturity of 90 days or less, with liquidity severely dropping off after 90 days (Table 3).

exposed to exchange rate fluctuations through their foreign currency debt. For example, if a firm takes out a USD-denominated loan, and the USD appreciates, the firm will be responsible for repaying a higher principle in terms of MXN; that is, they will be short the USD. To assess hedging behavior around foreign-currency-denominated loans, we use the universe of commercial loans extended by banks regulated in Mexico (the R04 database). These data include firm identifiers (their RFC), the size of the loan, the dates associated with the start of the loan and loan payments, and the currency denomination of the loan, as well as a host of other loan characteristics. We find that in the Mexican context, firms hedge their international trade exposure much more than their USD-denominated loan exposure. Specifically, in 2018, only 15 percent of firms with financial derivatives also had USD-denominated loans,[11] while 78 percent of these firms engaged in international trade. Thus, for the majority of this paper, we simplify our analysis by considering only firms with operational exposure through their international trade; we drop firms with USD-denominated loans from our sample.

1.3 Derivatives data

For regulatory purposes, banks regulated in Mexico are required to report all of their derivatives transactions at the transaction-level to Banco de México. This results in a detailed data set that includes the tax ID of the counterparty (the RFC), the type of instrument (for example, forward or option), the type of underlying (for example, currency or interest rate), the exact underlying (for example, the MXN/USD exchange rate), the face value, the price, the date (month, day, and year) when the derivative was purchased, and the date (month, day, and year) of the maturity of the derivative. Importantly, because the data include the tax ID of the counterparty, we can match these data to our other data sets at the firm level to obtain a complete picture of firm currency exposure and hedging behavior. Because derivative reporting standards were last updated in June 2015, we start our analysis

[11] Additionally, a small percentage of loans extended in Mexico are denominated in foreign currency, representing just 14 percent.

in September 2015.[12] Our analysis ends in June 2019.

We focus our analysis on MXN/USD currency forwards, as forwards comprise the majority of the currency derivative transactions of nonfinancial firms in Mexico. Specifically, in 2018, these firms purchased a gross notional value of $19.9 billion in MXN/USD forwards, $2.4 billion in MXN/USD options, and less than $0.16 billion in MXN/USD cross-currency swaps. To ensure we are cleanly isolating the effects of currency forwards, we include only transactions that expired when a firm did not have an open non-forward currency derivatives position.

In the majority of our empirical analysis (all analyses after Fact 1 in Section 2), we focus on forwards taken out by net-importing firms. This sample includes 183,597 transactions by 2,852 nonfinancial corporations. The aggregate gross notional value of these transactions is approximately $110.4 billion. Table 3 shows detailed summary statistics. The median notional value is $100,000, and the 25th–75th percentile range for transaction length (from purchase to maturity) is 25 to 90 days. The median number of days between expiration of one position and the opening of a firm's next position is 12 days. Finally, throughout the sample period, the median firm took 16 different forward positions.

Table 3: Summary statistics for USD-MXN forward positions

	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

Source: Authors' calculations using data from the Banco de México.

[12] We crop the first three months of data because the vast majority of forward positions have a tenor of three months or less (Table 3).

2 Empirical Facts

We now present three facts on firm hedging behavior.

Fact 1: *Even with access to the derivatives market, firms with currency exposure often choose not to hedge.* We start by considering whether firms hedge at all when exposed to currency fluctuations. For each firm in the derivatives data that does not have USD-denominated loans, we calculate both the direction of their natural exposure each month and their net USD-MXN forward position. Because we wish to understand firm behavior given derivatives market access, we consider only observations starting on the first month for which there's a record of the firm taking a forward position in our sample. In months when a firm is a net importer, it is short the USD in its operational exposure, and we would expect it to be long the USD in its financial derivatives exposure in order to properly hedge. Similarly, in months when a firm is a net exporter, it is long the USD in its operational exposure, and we would expect it to be short the USD in its financial derivatives exposure.

Table 4 displays the distribution of our month-firm observations according to the direction of their natural exposure and their financial derivatives exposure. More than one-third (specifically, 37.6 percent) of our observations are of months in which firms have either a long or short exposure to the USD through their international trade but choose not to hedge it through forwards. It is also interesting to note that the majority of firms in the derivatives data tend to be net importers; specifically, 70 percent of our firm-month observations are of net-importing firms. When we focus on this subsample, firms hedge their exposure only about half of the time; the other half of the time, they choose not to (this subsample rarely seems to speculate). Because the majority of hedging is done by net-importing firms, we simplify our subsequent empirical analyses by considering only these net importers.[13]

Figure 3 focuses on net importers that are long the USD in forwards. It plots the

[13]This is not to say that the firms in our sample do not export, merely that over the next three months, they will do more importing than exporting.

Table 4: Distribution of operational exposure and financial hedging

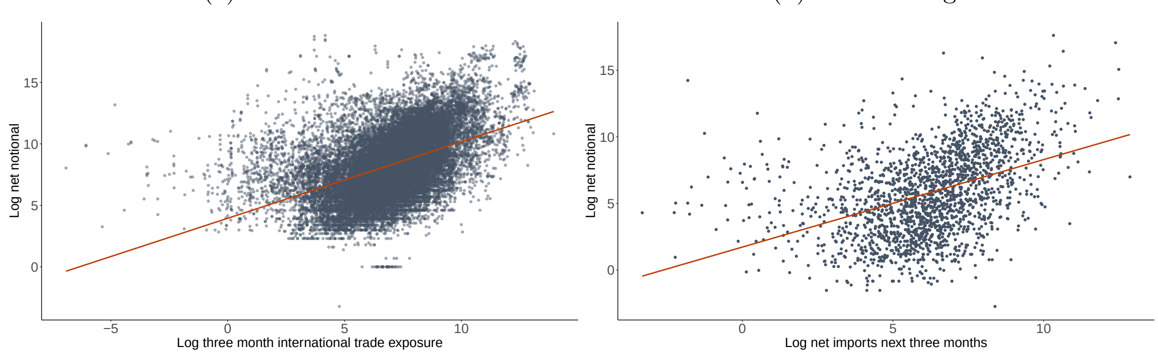
		International Trade		
		Short	None	Long
Forwards	Long	35.2%	7.3%	3.3%
	None	34.1%	15.1%	3.5%
	Short	0.7%	0.4%	0.4%

Notes: This table shows the proportion of firm-month observations in buckets that correspond to the direction of their exposure in their international trade operations and their USD-MXN forward positions. It considers firms only after the first time they engage in the forwards market. A firm is counted as being short (long) the USD in its operations if, over the next three months, the sum of its net exports is negative (positive).
Source: Authors' calculations using data from the Banco de México.

relationship between their exposure to the USD through international trade on the horizontal axis and forwards on the vertical axis. Panel (a) displays each firm-month observation, while panel (b) shows within-firm averages. Both panels show that this relationship is positive, implying that firms are indeed hedging the exposure coming from their international trade activities.

Figure 3: Relationship between size of exposure and size of hedging for firms that are operationally short the USD and have long USD forward positions.

(a) Pooled data (b) Firm average

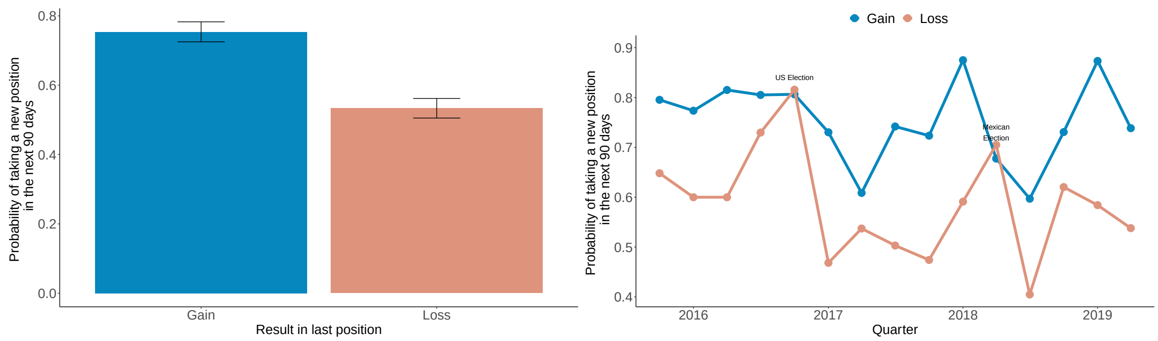


Notes: Panel (a) shows the scatter plot of the log of the sum of firms' net imports over the next three months against the log of the notional value of its net position in the USD-MXN forward market. Panel (b) considers the log of the average of this variable by firm.
Source: Authors' calculations using data from the Banco de México.

Fact 2: *Firms are less likely to take a new position after experiencing a loss in their most recent expiration.* We focus now on the likelihood of firms taking a new position in the

Figure 4: Probability of taking a new position conditional on most recent outcome

(a) Full time period (b) Quarterly cuts



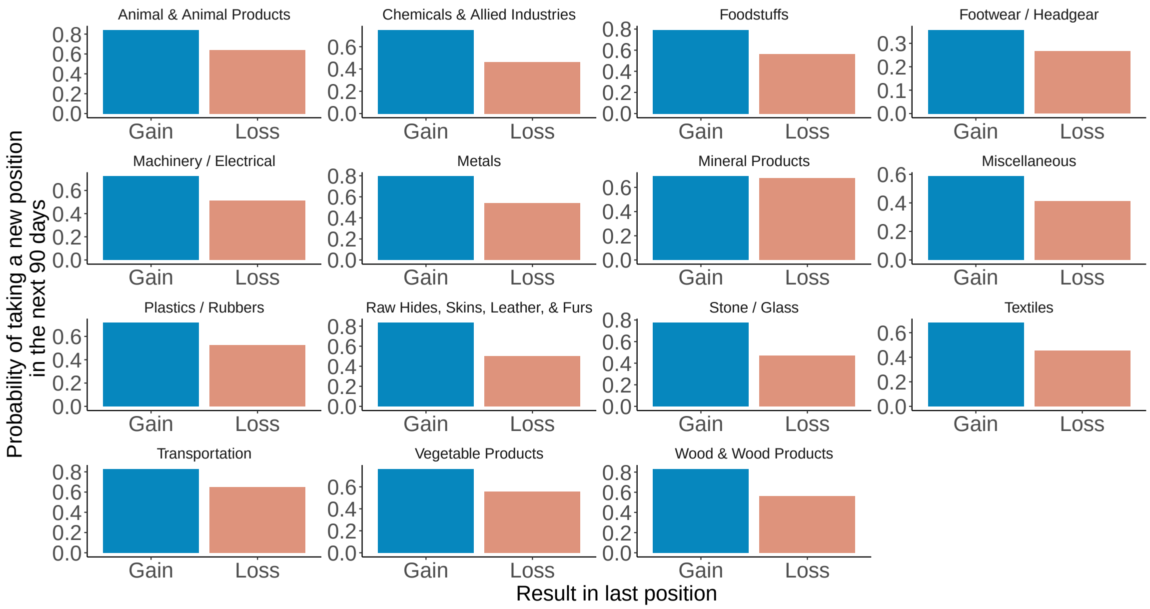
Notes: Panel (a) calculates the proportion of firms that took a new position within 90 days after an expiration in the USD-MXN forward market, conditional on whether the expiring position yielded gains and losses. For dates on which a firm had multiple positions expire, we consider the overall gain or loss across positions. The data set is restricted to firms with no other outstanding positions at the time of expiration. Panel (b) shows the same statistic calculated for quarterly cuts of the data.
Source: Authors' calculations using data from the Banco de México.

90 days after a forward position expires, conditional on whether said expiration resulted in gains or losses for the firm.[14] We calculate this statistic as the proportion of times that a firm that incurred gains or losses took a new forward in the 90 days following the expiration date. Figure 4, panel (a) shows the results of this exercise. Firms that experience a gain are 19 percentage points more likely to take a new forward position in the 90 days following expiration as compared with those that incurred losses.

This fact is robust across time and industry. We repeat the exercise for quarterly cuts of the data, creating a time series of these statistics. Figure 4, panel (b) shows how the gap between the likelihood of taking out a new position conditional on a previous gain and a previous loss remains throughout the sample period with two notable exceptions: the quarters containing the Trump election in the United States and the AMLO election in Mexico. The gap does not seem to be driven by times of exceptional exchange rate volatility and macroeconomic uncertainty; rather, in these times, the gap seems to disappear.

[14] A long USD forward position makes money (that is, results in a gain) when at expiration the USD is appreciated relative to the agreed on price. For example, imagine that the firm purchased \$100,000 worth of USD versus the MXN via a two-month forward at a price of 14.6, and on the expiration date the MXN/USD exchange rate is 14.7. The firm has made a financial profit of 10,000 MXN (or 680 USD).

Figure 5: Probability of taking a new position conditional on most recent outcome by type of imports

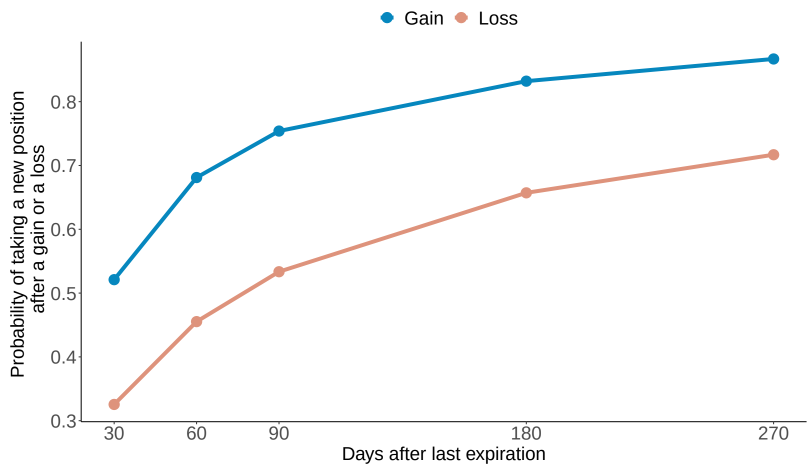


Notes: The figure shows the proportion of firms that took a new position within 90 days after an expiration in the USD-MXN forward market, conditional on whether the expiring position yielded gains or losses. For dates on which a firm had multiple positions expire, we consider the overall gain or loss across positions. The statistic is calculated for firms according to their most common import sector. For each firm, we calculate the total USD value of imports by HS2 code; we assign each firm to the HS2 code with the highest value. The data set is restricted to firms with no other outstanding positions at the time of expiration.
Source: Authors' calculations using data from the Banco de México.

To verify the robustness of this fact across industries, we split firms by the most common sector (HS2 code) of their imported goods. Figure 5 shows how Fact 2 holds true regardless of a firm's most common import sector, with the exception of mineral products.

Fact 2 is also robust to different window lengths. While our main specification examines the probability of taking out a new position in the next 90 days, conditional on the previous position having expired as a gain or a loss, Figure 6 shows how these probabilities change when we adjust the 90-day window.

Figure 6: Probability of taking a new position after an expiration for different time horizons

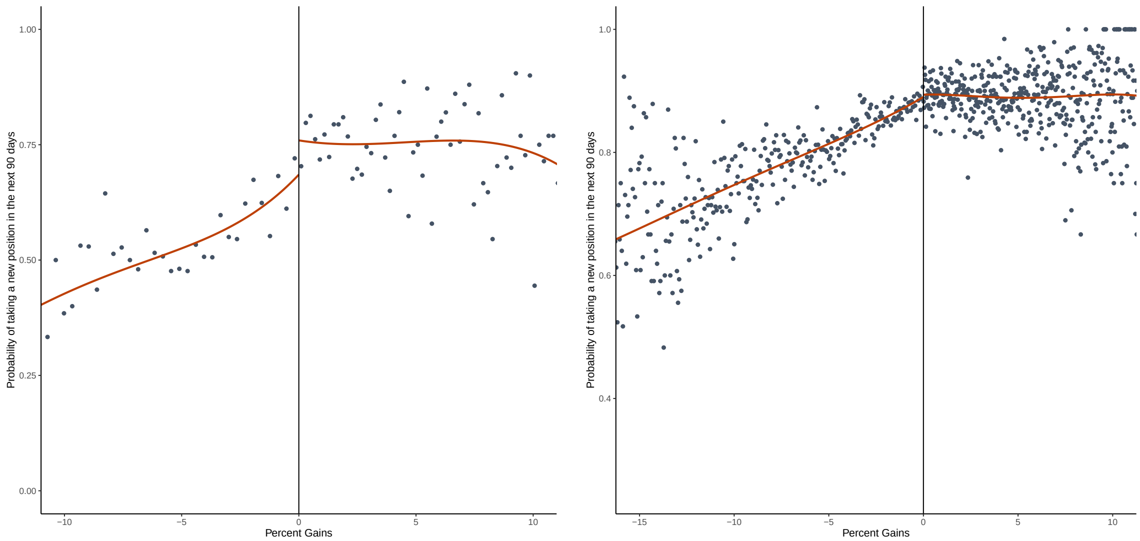


Notes: The figure shows the proportion of firms that took a new position in windows of different time horizons after an expiration in the USD-MXN forward market, conditional on whether the expiring position yielded gains or losses. For dates on which a firm had multiple positions expire, we consider the overall gain or loss across positions. The data set is restricted to firms with no other outstanding positions at the time of expiration.
Source: Authors' calculations using data from the Banco de México.

Fact 3: *The empirical likelihood of taking a new position after an expiration is a kinked function of the percentage gain/loss of the previous expiration, with the kink at zero.* We now extend Fact 2 to understand how the likelihood of taking out a new position varies depending on the magnitude of a firm's gain or loss on its most recently expired position. Empirically, we estimate the statistic of interest as a function of the percentage gain or loss using a fourth-degree global polynomial approach at each side of zero, as specified in Calonico, Cattaneo and Titiunik (2015). To avoid possible running variable manipulation (described in detail in Section 4), we consider both the full sample and the subsample of observations in which the firm doesn't have other outstanding positions. Figure 7 shows how the function has a sharp change of behavior when moving from losses to gains. To the left of zero (that is, when the previous position resulted in a loss), the function appears linear with a positive slope–larger losses imply a smaller likelihood of taking a new position. On the other hand, to the right of zero (that is, when the previous position resulted in a gain), the function is flat. Regardless of the size of the previous gain, the firm is equally likely to

Figure 7: Probability of taking a new position as a function of the percentage gain or loss on the previous expiring position

(a) No other outstanding position (b) Full sample



Notes: The figure uses a global polynomial of order 4 on each side of zero to estimate the probability of taking a new position 90 days after an expiration as a function of the percentage gain or loss of the expiration. Panel (a) restricts the data to firms with no other outstanding positions at the time of the expiration. Panel (b) considers the full sample. The percentage gains is calculated as the ratio between the MXN gain or loss at expiration (specifically, the product of the notional value of the position and the difference between the spot rate at the time of the expiration and the agreed forward rate) and the notional value of the position times the spot rate at the time of the expiration. If more than one position expires on the same date, the percentage gain is calculated by aggregating the numerator and denominator across positions before taking the ratio. When two or more positions that expire on the same date have opposite directions, the denominator is calculated by aggregating only positions in the direction of the oldest expiring position.
Source: Authors' calculations using data from the Banco de México.

take a new position.

3 Potential Mechanisms

Perhaps the simplest way to explain Facts 1 through 3 is a correlation between the realization of the underlying and future hedging motives. For example, we might think of a bank that hedges against a low interest rate regime and then stops hedging when the regime actually arrives. However, the robustness of Fact 2 to splits in both the time series and the cross section of industries provides evidence against this simple explanation. Furthermore, in our specific case of firms hedging their international trade exposure, it would be hard to argue that specific realizations of the exchange rate reduce their hedging motives.

Beyond this, the facts established in the previous section are not consistent with a rational and frictionless setting.[15] Because hedging involves smoothing future states of the world, it should not be backward looking. In this section, we consider three deviations from the rational and frictionless setting: (1) narrow framing, a behavioral bias by which firms consider their financial profits/losses separately from their overall profits/losses, combined with loss aversion, (2) organizational frictions which cause a similar decoupling of financial and overall profits/losses, and (3) a collateral constraint that forces firms to post their scarce collateral in order to engage in financial hedging.

Narrow framing and loss aversion: First introduced by Kahneman and Lovallo (1993), narrow framing proposes that agents may separately consider decisions that are otherwise related. This causes them to make decisions that don't necessarily maximize the aggregate outcome. Although narrow framing may have different causes (for example, organizational frictions as in Kahneman and Lovallo, 1993; regret; intuitive thinking as in Barberis, Huang and Thaler, 2006; or accessibility as in Kahneman, 2003), in our setting it is triggered by experiencing losses. For example, a CEO might learn about the disutility of regret after incurring losses from a derivative position.

In this sense, narrow framing is consistent with Facts 1 and 2. Initially a firm chooses to take a derivatives position, but as losses take place, the firm reassesses financial hedging in a narrow frame and stops using derivatives altogether. The mechanism is also consistent with the fact that our phenomenon of interest disappears around the Mexican and US presidential elections (Figure 4, panel b). When high-profile currency shocks take place, the effect of currency movements on *both* types of profit may become more salient to firm management,

[15] We recognize that, absent frictions, risk-neutral firms don't have an incentive to hedge. Yet simpler frictions that induce hedging by themselves need not generate the facts we observe in the data. We then make this statement taking a hedging motive as given.

prompting it to recouple operational and financial outcomes.

Crucially, the narrow framing mechanism is also compatible with Fact 3. Since losses act as a trigger for narrow framing, this mechanism would predict a kink at the specific point where losses first materialize. Moreover, narrow framing is consistent with the fact that the function is flat in the domain of gains. If narrow framing is triggered by losses, and if losses don't take place, we should not expect any change in firm behavior.[16]

Organizational frictions: In another version of the decoupling story, organizational frictions might place the responsibility for operational P&L and financial P&L under separate managers, and the financial risk manager might see their personal compensation fall as a result of a (correctly implemented) derivatives strategy. In this sense, it is analogous in outcome to the narrow framing and loss aversion channel, though the underlying mechanism differs. Importantly, it is also consistent with all three facts. In addition, it is consistent with the disappearance of our phenomenon around the Mexican and US presidential elections, as risk managers may be less likely to face punishment after a high-profile currency shock.

Net worth channel: Rampini and Viswanathan (2010) and Rampini, Sufi and Viswanathan (2014) emphasize the role that collateral requirements play in determining firms' risk-management practices. Specifically, because purchasing a derivative involves posting collateral, firms may refrain from taking out derivatives or reduce their use when they face financial constraints. This is consistent with Fact 1. Firms may choose not to hedge any of their exposure when they are financially constrained, even if they have access to derivatives markets.

This channel may also be consistent with Fact 2. Consider a firm that takes a forward position at time zero that expires at time t with nominal value $N_{0,t}$ at forward rate $F_{0,t}$ (denominated in MXN per one USD). The firm, a net importer, buys net imports $NM_{i,t} > 0$

[16]While we would expect the function to be naturally bound due to its nature as a probability function, we would not expect a kink simply due to the probabilistic nature of the function. Most probabilistic functions have an upper bound at one, though other factors may cause the bound to be below one.

abroad at USD price Q^{USD} and sells them domestically at MXN price P^{MXN}. The firm's net worth after the expiration of the forward position is given by:

$$NW_{i,t} = NW_{i,0} + (S_t - F_{0,t})N_{i,t} + (P^{MXN} - S_t Q^{USD})NM_{i,t} + \eta_{i,t},$$

where S_t is the spot exchange rate (also denominated in MXN per one USD). In principle, depending on the relative sizes of $N_{i,t}$ and $NM_{i,t}$ (that is, if the firm is over-hedged), the firm may incur financial losses that are not offset by its operational gains, reducing its net worth. If the firm's ability to post collateral is tied to its net worth, it may choose to use its scarce collateral in activities other than financial hedging. Even if the firm is not over-hedged, its operational profits ($(P^{MXN} - S_t Q^{USD})NM_{i,t}$) may not become pledgeable until after some time has passed, reducing the pledgeable net worth of the firm and its ability to post collateral at time t.

Nevertheless, it is hard to explain Fact 3 through a net worth channel. Fact 3 establishes that the probability of taking a new derivatives position as a function of the percentage gains (or losses) from the previous expiration has a kink at zero. If this fact operated through a net worth channel, it would imply that even the smallest of losses would restrict firms' financial capacity in a way that would prompt them to choose not to continue their risk-management activities. In a Froot, Scharfstein and Stein (1993) setting, firms engage in financial hedging to avoid being financially constrained in states of the world characterized by high investment opportunities. The fact that a small MXN appreciation (relative to the agreed upon forward rate) would actually restrict the firm's financial capacity is inconsistent with a firm hedging in order to avoid financial constraints. Indeed, this inconsistency would imply that either investment opportunities change drastically with small changes in the exchange rate or that the original strategy was not optimal. Thus, while the behavioral bias and organizational friction channels are consistent with all three facts presented in Section 2, the net worth channel is not.

4 Empirical Strategy

In the preceding section, we considered three possible mechanisms to explain the empirical facts presented in Section 2. We showed how Facts 1 and 2 can be explained by all mechanisms. Fact 3 (that the probability of taking a new position is a kinked function of the previously incurred percentage gain), however, is consistent only with the decoupling of operational and financial profits. In this section, we take advantage of this unique implication of decoupling. Specifically, we use a regression kink design (RKD) to show the significance of the kink and to measure the impact of decoupling on risk management.

Call $Y_{i,t}$ the probability that firm i takes a new position at time t, and call $V_{i,t} = S_t - F_{0,t}$, our running variable, the result in the most recent forward expiration of firm i at time t. As defined in the preceding section, both net worth and losses are a function of $V_{i,t}$. Namely,

$$NW_{i,t}(V_{i,t}) = NW_{i,0} + V_{i,t}N_{i,t} + (P^{MXN} - S_tQ^{USD})NM_{i,t} + \eta_{i,t}$$

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

We can write $Y_{i,t}$ as a function of net worth and losses, both of which are functions of the result of the most recent forward expiration, as well as a function of exposure:

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

Fully differentiating this expression yields:

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

This expression makes clear that our effect of interest, which we call τ, cannot be identified through simple variation in the size of the gains or losses (dV), as this variation identifies both the effect of changes in net worth (ξ) as well as the effect of narrow framing (that is, losses).

Notice also that $\frac{dNW_{i,t+1}}{dV_{i,t}} = N_{i,t}$ and $\frac{dL}{dV_{i,t}} = \mathbb{1}\{V_{i,t} < 0\}N_{i,t}$. Then, by considering the limit of $\frac{dY_{i,t}}{dV_{i,t}}$ when $V_{i,t}$ approaches zero from the right and from the left and taking the difference, we recover our effect of interest, τ:

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

Our identifying assumption is that the probability of taking a new position after an expiration is a continuously differentiable function. In other words, the kink in this function comes from the fact that losses have a kink at zero. Firms do not change their behavior due to marginal increases or decreases in net worth.

Another key assumption is that firms don't manipulate the result of their derivatives positions. That is, firms cannot choose to be on the right or left of $V_{i,t} = 0$. The facts that $V_{i,t}$ (conditional on an agreed upon forward rate) is fully determined by the spot rate and that firms are atomistic in foreign exchange markets should sufficiently support this assumption.

We do, however, observe that a small number of firms have positions of opposite directions that expire on the same date. This may constitute running variable manipulation in the following sense. A firm that observes its mark-to-market position is approaching zero from the right may choose to lock in gains by taking out an additional, opposite position expiring on the same day.[17] To avoid this possibility, we drop those observations from our sample. Figure 8 shows that the density of $V_{i,t}$ is continuous, which implies that the no-manipulation assumption is satisfied in the data.

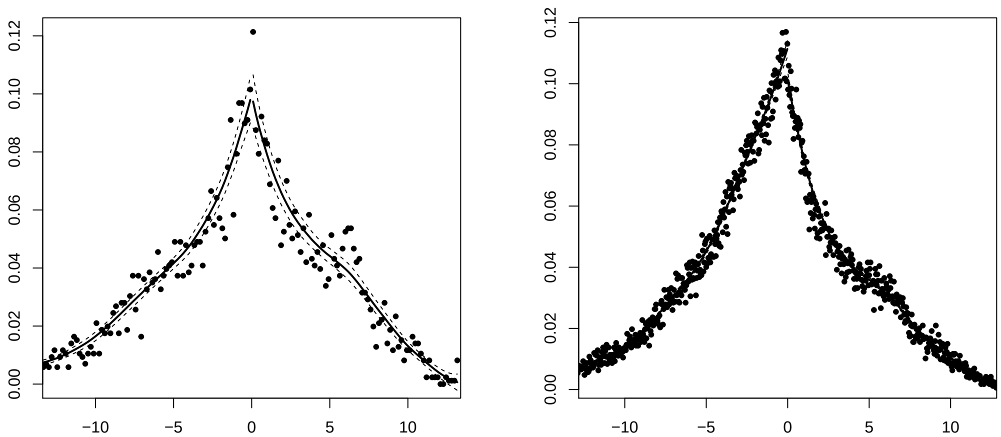
Table 5 shows the results of estimating τ using a local polynomial approach. The first two rows display the results for the sample of firms with no other outstanding positions. We present the conventional estimate as well as the bias-corrected one as in Calonico, Cattaneo

[17] To exit an existing forward position, a firm must take out an identical position in the opposite direction.

Figure 8: Density of percentage gains and losses

(a) No other outstanding positions

(b) Full sample



Notes: In these figures, the horizontal axis gives the percentage gain or loss, while the vertical access gives the density of the distribution estimated according to McCrary, 2008.
Source: Authors' calculations using data from the Banco de México.

and Titiunik (2014). The last two rows show the results for the full sample. All estimates are significant, demonstrating that the kink described in Fact 3 is indeed a salient feature of the risk management function. This allows us to rule out the net worth mechanism in favor of a decoupling mechanism, either due to behavioral biases or organizational frictions.

For the sample of firms that don't have other outstanding positions, our estimate implies that an increase of 1 percentage in the size of percentage losses implies a drop of 4.24 percentage points in the probability of taking a new position within 90 days after the recent expiration. Multiplying this 4.24 percentage point estimate by the average percentage loss in the sample (5.3 percent), we find that on average, firms become approximately 22.4 percent less likely to take a new position after incurring a loss. This back-of-the-envelope calculation thus yields an estimate close to our initial estimate of 19 percent. When we include firms that have other outstanding positions, our estimate is reduced. As these firms are more likely to have a larger hedging program, they may instead be adjusting on the intensive margin (considered in Section 5).

Table 5: Effect of narrow framing on risk management

Coefficient	95% C.I.	Sample	N	Type
-0.0424	[-0.0845,-0.0004]	No outstanding	4,785	Conventional
-0.0535	[-0.0955,-0.0115]	No outstanding	4,785	Bias-corrected
-0.0163	[-0.0303,-0.0023]	Full	79,244	Conventional
-0.0179	[-0.0319,-0.0039]	Full	79,244	Bias-corrected

Notes: Confidence intervals are constructed using heteroskedastic-robust nearest neighbor s.e. clustered at the firm level.
Source: Authors' calculations using data from the Banco de México.

We repeat our RKD procedure after splitting our sample according to whether the firm's previous position expired in a time of higher than median or lower than median volatility. This builds off our finding that differentiated hedging behavior between firms that incurred gains and those that incurred losses disappears around the Trump election in the United States and the AMLO election in Mexico (Figure 4, panel b). These periods were characterized by increased uncertainty in the MXN/USD exchange rate markets.

Table 6 displays the estimated effects. The large difference in point estimates between periods of high and low volatility suggests that the decoupling phenomenon is reduced when uncertainty increases. This is consistent with both an organizational approach and a behavioral one. From an organizational perspective, the risk manager may be allowed more leeway if losses seem justified given the volatile environment. Perhaps the risk manager may be seen as having avoided a more catastrophic outcome. From a behavioral perspective, regret may be reduced, as responsibility for the loss may be attributed to the volatile environment.

Appendix A develops a simple model of a mean-variance risk manager that rationalizes what we observe in the data. In the model, the variance of the exchange rate counteracts the narrow framing motive. That is, as the volatility of the exchange rate increases, the original hedging motive prevails, and the narrow framing motive diminishes. In the limit, when the volatility tends to infinity, the rational hedging strategy is recovered.

Confidence intervals become large after we split our sample based on volatility. This is because RKDs and other non-parametric methods are highly demanding in sample size. Concerns about sampling in different parts of the domain are mitigated by the fact that our data-driven bandwidth selection is estimation-specific.

Table 6: Effect of narrow framing on risk management conditional on USD-MXN volatility level

Panel a: No other outstanding positions				
Coefficient	95% C.I.	Volatility	N	Type
-0.0036	[-0.0858,0.0786]	Above median	4,785	Conventional
0.0194	[-0.0629,0.01016]	Above median	4,785	Bias-corrected
-0.067	[-0.2274,0.0933]	Below median	2,422	Conventional
-0.0413	[-0.2016,0.119]	Below median	2,422	Bias-corrected
Panel b: Full sample				
Coefficient	95% C.I.	Volatility	N	Type
-0.0062	[-0.0196,0.0071]	Above median	40,086	Conventional
-0.0035	[-0.0168,0.0098]	Above median	40,086	Bias-corrected
-0.0205	[-0.0507,0.0096]	Below median	39,158	Conventional
-0.0203	[-0.0505,0.0098]	Below median	39,158	Bias-corrected

Notes: Confidence intervals are constructed using heteroskedastic-robust nearest neighbor s.e. clustered at the firm level.
Source: Authors' calculations using data from the Banco de México.

5 Intensive Margin

The previous sections demonstrate how the decoupling of financial and operational P&L causes firms to stop using forwards to hedge their currency risk. However, there is no reason for this channel to operate only through the extensive margin. After facing a loss, a firm may choose to reduce its derivatives positions rather than eliminate them altogether. This may especially be true if the firm has outstanding positions after experiencing a loss. In this section, we extend our analysis to include the intensive margin response to financial losses.

We find that our channel operates at both the intensive and extensive margin.

To assess the effects of losses on the intensive margin of risk management, we consider the end-of-month net positions in the USD-MXN forwards of each firm. Using an event-study-like design, we focus on expiration months (setting $t = 0$ in these months) and split our sample according to whether the firm experienced gains or losses at expiration. We examine how firms' net forward positions evolve relative to their positions in the expiration month. Specifically, we consider the median across firms conditional on gains and losses.

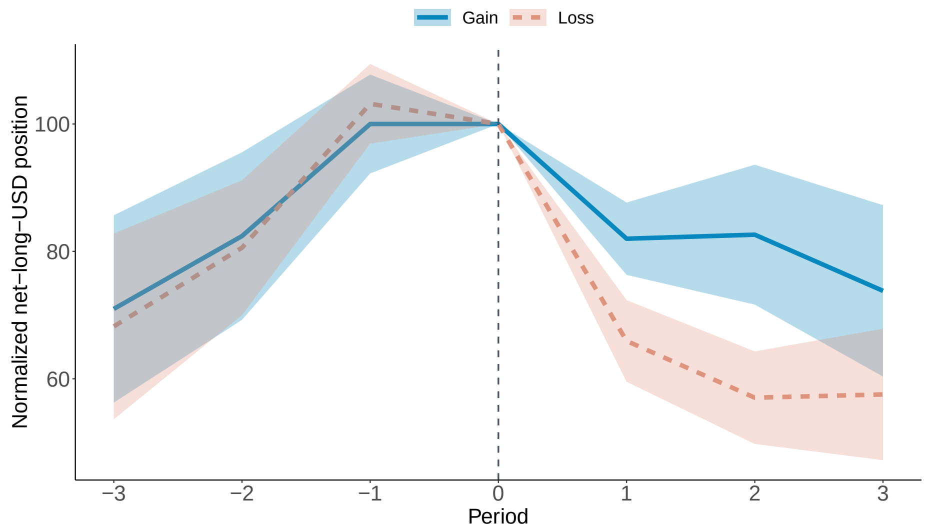
Figure 9, panel (a) shows the results of this exercise. The periods preceding the expiration show similar behavior across firms, regardless of whether their expiring positions will result in gains or losses. This suggests that the parallel-trends assumption is satisfied. In the first post-period, we observe a drop in the derivatives positions of both groups. This is expected, as period zero is characterized by expiring positions. However, the drop in the position of firms that incur losses is 16.05 percentage points larger than the decline of those that enjoy gains. This implies an adjustment at the intensive margin, as well as the extensive margin, of their derivatives use.

However, given only this evidence, it is not necessarily true that firms are reducing their hedge ratios. Instead, they may be making adjustments at the intensive margin of their operational exposure, in addition to their derivatives use, keeping hedging ratios relatively stable. Panel (b) of Figure 9 considers the evolution of firms' operation exposure (as defined in Section 1) around derivatives expirations.[18] Although point estimates for firms experiencing losses are smaller than those for firms experiencing gains, the difference is only 4.49 percentage points, roughly one-quarter of the difference we observe for financial hedging. Overall, it seems that firms are not adjusting their operational exposure differentially based on gains or losses in their derivatives positions. Instead, they seem to be reducing their hedge ratios after incurring losses.

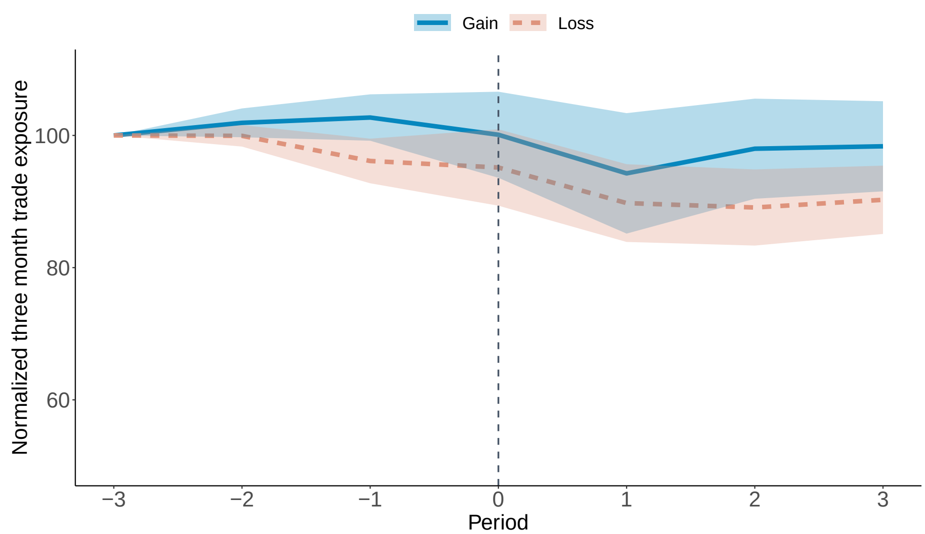
[18]Since our operational-exposure variable is forward looking, we normalize with respect to three months before the reference period. This assures that the normalization period does not take into account any observation that happens after the gains or losses take place. Regardless, the relative magnitude of the results shouldn't change as this is simply a rescaling of the series.

Figure 9: Intensive margin response

(a) Net position in USD-MXN forwards



(b) International trade exposure



Notes: Panel (a) calculates the median trajectory of the end-of-month net notional position of a firm after it has experienced gains or losses; the bands show standard errors. This value is normalized so the net position of the firm at the end of the month (including expiring positions) is 100. Panel (b) does the same exercise but considers operational exposure as measured by the next three months of net imports. In this second exercise, we normalize to the value three months before the event in question.
Source: Authors' calculations using data from the Banco de México.

6 Conclusion

This paper examines a new channel explaining the limited use of financial derivatives among nonfinancial corporations. Using a unique data set including all individual derivatives transactions with banks regulated by the Banco de México, we find that firms that experience previous derivatives losses are less likely to continue using derivatives in their risk-management program. We also find that the empirical likelihood of taking a new position is a kinked function of the percentage gain/loss of the previous position. This latter fact is not consistent with a net worth channel; rather, it can be explained by the decoupling of financial and operational P&L, combined with an increased punishment or aversion to financial losses. We then use a regression kink design to quantify the impact of decoupling on risk management, demonstrating that the effect is sizable and significant. Our paper lays the groundwork for future work that continues to investigate the behavioral and organizational determinants of corporate risk management.

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A Mean-variance, Narrow-framing Risk-manager Model

Consider a risk manager who chooses the notional value, N, of an exchange rate forward with forward rate F in order to hedge the operational profits of an importing firm. Operational profits are a function of exchange rate S measured in MXN per USD. Operational profits are given by:

$$\Pi^{op}(S) = (P^{MXN} - SQ^{USD})M,$$

where P is the MXN sale price of imports M, and Q is the USD import price that the firm pays. To keep the model simple, we assume no pass-through from exchange rate to domestic prices. The financial profit from the firm's activity in the forwards markets is given by:

$$\Pi^{fin}(S, N) = (S - F)N.$$

In order to introduce a reduced form hedging motive, we consider a risk manager with mean-variance preferences and a risk coefficient $\frac{\gamma}{2}$. We also assume that the risk manager dislikes expected losses from the use of derivatives. The problem of the risk manager is then given by:

$$\max_N \mathbb{E}(\Pi^{op} + \Pi^{fin}) - \frac{\gamma}{2} \operatorname{Var}(\Pi^{op} + \Pi^{fin}) + \lambda \mathbb{E}\left(L(\Pi^{fin})\right),$$

with $L(t) = \min\{0, t\}$. If we assume a no-arbitrage condition such that $\mathbb{E}(S) = F$ and call $\sigma^2 = \operatorname{Var}(S)$, the problem is equivalent to solving:

$$\max_N -\frac{\gamma}{2}\sigma^2 \left(N^2 - 2Q^{USD}MN\right) + \lambda\, \mathbb{E}\,(S - F|S < F)\, \mathbb{P}(S < F)N.$$

The optimal notional value for the forward is then given by:

$$N = Q^{USD}M + \frac{\lambda}{\gamma\sigma^2}\, \mathbb{E}\,(S - F|S < F)\, \mathbb{P}(S < F).$$

The first term is a full hedge of risk. If $N = Q^{USD}M$, then the firm's total income becomes independent of the realization of the exchange rate. This is the rational hedging strategy. Given narrow framing ($\lambda > 0$), the firm does not fully hedge (notice that the second term is negative). As the volatility of the exchange rate increases, the narrow framing motive diminishes, approaching the optimal hedging policy under a rational agent.