Firm size, liquidity and optimal heterogeneous hedging

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Abstract

This paper studies the heterogeneous hedging strategies of non-financial firms in emerging market economies. We show that even if large firms are prevalent in the derivatives market, they present smaller shares of covered Foreign Currency (FC) debt in comparison to smaller firms. We rationalize this pattern in two ways: i) The market of covered FC debt presents lack of liquidity which limits entry of small firms and the extent of large firms' hedges. ii) Sterilized foreign exchange interventions distort firms use of covered FC debt. Moderate interventions reduce hedge size and the probability of entry for small firms that are implicitly protected by the monetary authority, enabling them to bypass fixed entry costs. Large interventions spill FC liquidity to the derivatives market, increasing the hedges of big firms as these interventions reduce their variable costs. We provide theoretical and empirical evidence for these two explanations with rich firm-level panel data for Colombia.

Research Question

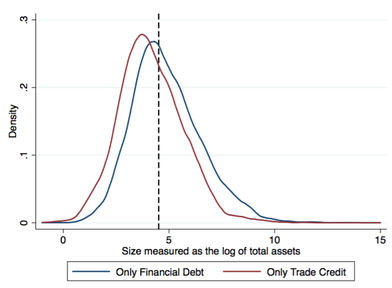
What are the reasons behind the heterogeneous hedging of non-financial firms in an Emerging Market Economy such as Colombia?

Stylized Facts: Firm size and the use of hedging

Figure 1, panel a) exhibits the firm size distributions of firms with financial Foreign Currency (FC) debt or trade credit exclusively. Panel b) shows the same distributions excluding firms without FC forwards. In general, firms that only have financial FC debt are larger than firms that only have trade credit (the distribution of the former is at the right of the distribution of the latter). However this distinction no longer holds when restricting the sample to firms that use FC forwards. These facts are suggestive evidence of a fixed cost of entry to the covered FC debt market.

Figure 1: Size and the extensive margin: Fixed cost

a) Size by type of FC debt



b) With FC forwards

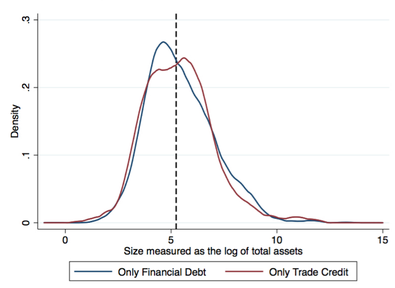
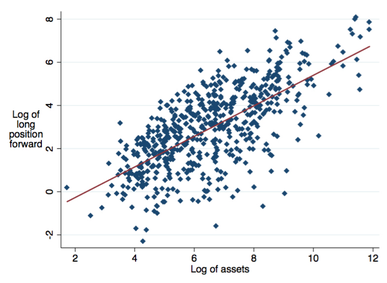


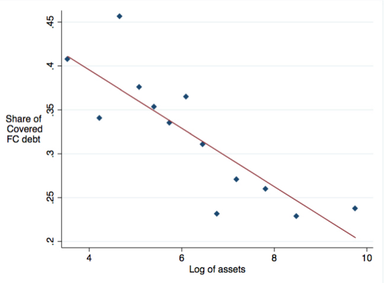
Figure 2 panel a), shows the correlation between the log of the long positions in the FC forward market and firm size. The bigger the firm, the longer the forward positions. Panel b), on the other hand, shows a negative relationship between firm size and the shares of covered FC debt (defined as: long position FC forward/FC debt). Why do larger firms hedge less?

Figure 2: Size and the intensive margin: Bigger firms hedge less?

a) Long position forward vs size



b) Share of covered FC debt



Theory

The economy is populated by a continuum of firms, indexed by $i \in [0, 1]$, which live for two periods. They are born with different expectations about the second period's spot exchange rate $E_i[s]$, risk aversion Ψ_i, productivity z_i, size m_i and currency composition of revenue ($1 - \theta_i$ FC share). They are also aware of the relative liquidity conditions of the debt markets ϵ. The only source of uncertainty in this economy is the second period's exchange rate $s \sim \mathcal{N}(E[s], \sigma_s^2)$). In the first period is normalized to 1.

Firms maximize the second period utility $E_i[U(\pi_i)] = E_i[-e^{-\Psi_i \pi_i}]$ by choosing in the first period the currency composition of their principal (normalized to 1). Part of their borrowings are in domestic currency γ_i and the other part in FC. Firms can opt to have uncovered α_i and/or covered FC debt δ_i. In the second period, the exchange rate is realized and firms pay what they owe for their financial products with their realized revenues.

In this economy both the Covered Interest Rate Parity (CIP) and the Uncovered Interest Rate Parity (UIP) hold and are set by a representative risk neutral foreign investor. This implies that $E[s] = F$, where F is the forward exchange rate and $E[s]$ is the foreign investor's expectation of the second period's exchange rate.

It is assumed that the representative investor faces market imperfections that limit the liquidity in the covered FC debt market. ϵ is the inverse of these market imperfections. Higher ϵ means lower market imperfections and higher liquidity.

As a consequence of these market imperfections, for the representative investor, the marginal cost to procure an extra unit of covered FC debt is a positive and convex function of the size of the firm. In comparison to small firms, big firms need a larger portion of the aggregate liquidity of the market in order to hedge a similar share of their principal. Therefore, the representative investor charges a firm-specific forward exchange rate F^{m_i}, which is an increasing function of size.

Conditional on firm i using all types of debt, her second-period expected profit per unit of debt in local currency terms is given by:

$$E_i[\pi_i] = z_i[\theta_i + (1-\theta_i)E_i[s]] - R^l\gamma_i - R^{FC}\alpha_i E_i[s] - R^{FC}\delta_i^{\epsilon} F^{m_i} - \frac{K}{m_i}. \quad (1)$$

Where R^l is the interest rate in domestic currency, R^{FC} is the interest rate of FC, and K is a fixed cost of entry to the covered FC debt market.

Optimal shares: Intensive margin

From the first-order conditions, the optimal share of uncovered FC debt α_i^*, covered FC debt δ_i^* and domestic currency debt γ_i^* are given by:

$$\alpha_i^* = \frac{R^l - R^{FC}E_i[s]}{\Psi_i {R^{FC}}^2 \sigma_s^2} + \frac{z_i(1-\theta_i)}{R^{FC}} \quad (2)$$

$$\delta_i^* = \left(\frac{R^l}{\epsilon R^{FC} F^{m_i}}\right)^{\frac{1}{\epsilon-1}} = \left(\frac{F^{1-m_i}}{\epsilon}\right)^{\frac{1}{\epsilon-1}} \quad (3)$$

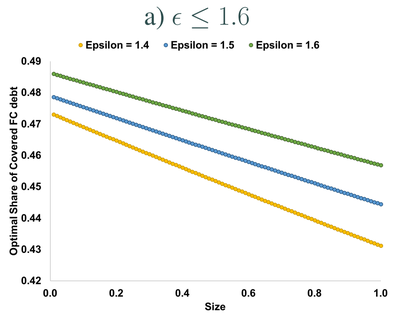
$$\gamma_i^* = 1 - \alpha_i^* - \delta_i^*. \quad (4)$$

Intuitively, the first term on the right hand side of equation (2) captures the funding cost saving characteristic of uncovered FC debt. The second term depicts the natural hedging provided by the share of FC revenues in firm i's income.

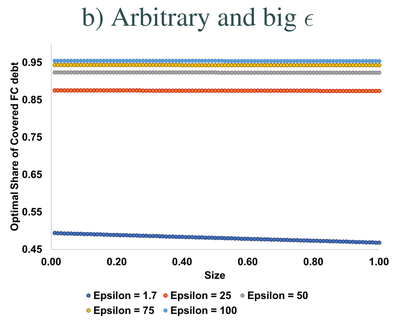
Equation (3) shows that covered FC debt is an increasing function of the relative cost of domestic currency borrowing. Once the CIP is introduced, the last equality of equation (3) shows that a higher market's expectation about tomorrow's depreciation would imply larger hedges irrespective of firm size or market liquidity.

Figure 3: Optimal share of covered FC debt δ_i^* vs ϵ and firm size

a) $\epsilon \leq 1.6$



b) Arbitrary and big ϵ



The characterization provided by panel a) and b) of figure 3, tells us that the bigger ϵ (more liquidity), the larger and more homogeneous the optimal shares across firms of different sizes. Intuitively, the lower the market imperfections faced by the representative investor, the easier to procure and supply funds to the covered FC debt market, the less constrained and more similar the optimal hedges of firms irrespective of their size.

Extensive margin

The decision to enter or not enter the covered FC debt market is summarized in the comparison of the expected profits of the firm when using the optimal debt shares ($\alpha_i^*, \delta_i^*, \gamma_i^*$), with respect to the expected profits in the case that the firm chooses the optimal share of uncovered FC debt, and the remainder of her principal as debt in domestic currency. ($\gamma_i = 1 - \alpha_i^* = \delta_i^* + \gamma_i^*$). The firm will use the covered FC debt market if her expected profits are greater or equal to her expected profits without covered FC debt:

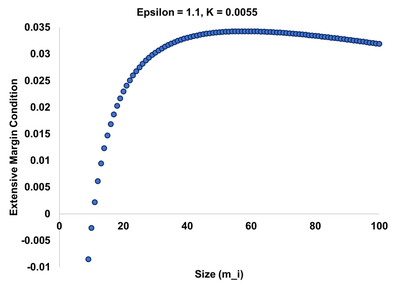
$$E_i[\pi_i | \alpha_i^*, \delta_i^*, \gamma_i^*] \geq E_i[\pi_i | \alpha_i^*, \gamma_i = 1 - \alpha_i^*] \iff \quad (5)$$

$$R^l\delta_i^* - [R^{FC}\delta_i^{*\epsilon} F^{m_i} + \frac{K}{m_i}] \geq 0. \quad (6)$$

As it is shown in equation (5), firm i will use a share δ_i^* of its principal as covered FC debt instead of domestic currency debt, if and only if the total cost of hedging the share δ_i^*, is below the total cost of using it as domestic currency debt.

Figure 4: Extensive margin condition: concave and non-monotonic in firm size

a) High ϵ & low K



b) Low ϵ & high K

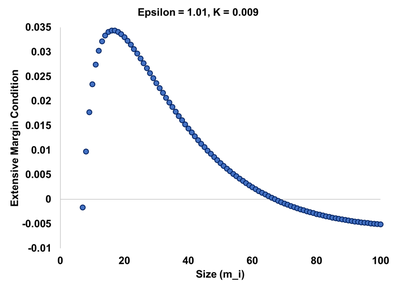


Figure 4, panel a) and b) plot this discontinuity region as a function of firm size. Very interestingly, this condition follows a concave and non-monotonic function of firm size. While the fixed cost is more stringent with small firms, the combination of the variable and fixed cost is heavy on big firms.

The model and Foreign Exchange Intervention (FXI)

Through the lens of the model, the sterilized FXI could impact firms' decisions through three different channels. The first two channels conditional on the UIP not to hold. On the one hand, equation (2) tells us that the shares of uncovered FC debt would increase given i) a lower expectation of exchange rate depreciation and ii) lower exchange rate volatility: The action of the Central Bank (CB) in the spot market might be perceived by firms as an implicit protection against exchange rate risk, making them reduce their long positions in the FC derivatives market. On the other hand, equation (3) and (6) show that the FXI could iii) increase the covered FC debt market liquidity, increasing the shares of covered FC debt and the marginal probability of entry.

Empirical Strategy

We use a two-stage tobit model with an instrumental variable. In the first stage, we instrument firm level FC debt with the interaction of exports to sales ratio at the firm level and aggregate excess reserves of credit establishments. In the second stage the dependent variable is firm level FC forwards and the variable of interest is the first stage predicted firm level FC debt. With the help of the censored tobit we are able to estimate the Average Marginal Effect (AME) of the increase of 1 p.p of the FC debt to liabilities ratio on the FC forwards to liabilities ratio, evaluated in different sections of the distribution of a third variable such as size or FXI.

Identification

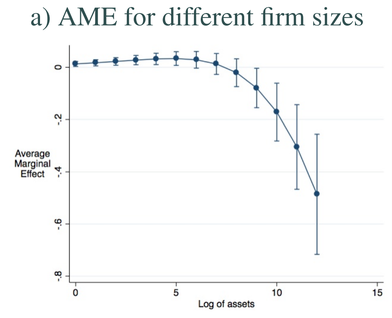
Aggregate excess reserves are exogenous to firm level FC debt as the CB sets (shocks) required reserves as a function of domestic credit variables. In order to cleanse the indicator from supply side confounding variation we use the residual of a preliminary regression that controls for such determinants. Therefore, we claim that we construct and exogenous aggregate domestic currency demand shock that correlates with firm level FC debt. The extent of this correlation, is captured by firm level exposure to FC markets proxied by the export to sales ratio.

Results

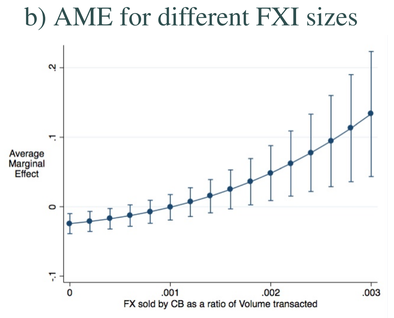
Figure 5 panel a) shows that for firms below the median (log of assets = 6.4) the AME of FC debt on FC forwards is positive and statistically significant (although economically small). For firms above the median there is a negative and economically important effect. For firms in the P99, an increase of 1 p.p of the share of FC debt implies a reduction in the share of FC forwards of 0.45 p.p. The bigger the firm, the lower the hedges.

Figure 5: Average Marginal Effect of FC debt on FC forwards

a) AME for different firm sizes



b) AME for different FXI sizes



Panel b) shows that moderate FXI (the average of interventions during the period was equivalent to 0.2% of the volume transacted in the spot market) reduces the incentives of firms to use the financial sector to protect themselves against exchange rate risk: they are implicitly protected by the monetary authority. Interventions above a certain threshold, spill FC liquidity to the hedging market increasing the shares of FC debt that are hedged by firms.

Conclusions

- We find that the heterogeneous hedging in an emerging market economies comes from two sources:
  - Market distortions: The lack of liquidity in the FC forwards market and a high entry cost limit the entrance of small firms and the hedges of big firms
  - Policy-induced distortions: Given FXI, firms in the margin opt not to hedge → they feel implicitly protected by the CB

Policy Recommendations

- When an extreme exchange rate depreciation hits the economy:
  - The CB should provide ample liquidity in the derivatives market to avoid higher demand pressures on the spot exchange rate
  - This might reduce the increase in the policy rate and would imply a lower contractionary impact on economic activity
  - Such a strategy might be more cost-effective than using other policy tools such as Sterilized FXI
  - And most importantly it would not distort the optimal FC derivatives' decisions of firms
- In order to increase liquidity, the CB could reassess the calibration of the banks' FC exposure regulation → trade-off between the exchange rate risk faced by banks vs exchange rate risk faced by the real sector