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The impact of exchange rate volatility on plant-level investment: Evidence from Colombia ☆

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ABSTRACT

We estimate the impact of exchange rate volatility on firms' investment decisions in a developing country setting. Employing plant-level panel data from the Colombian Manufacturing Census, we estimate a dynamic investment equation using the system-GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998). We find a robust negative impact of exchange rate volatility, constructed either using a GARCH model or a simple standard deviation measure, on plant investment. Consistent with theory, we also document that the negative effect is mitigated for establishments with higher mark-up or exports, and exacerbated for lower mark-up plants with larger volume of imported intermediates.

1. Introduction

In this paper, we estimate the impact of real exchange rate uncertainty on plant-level investment in the Colombian manufacturing sector. Existing theoretical studies show that uncertainty can affect firm's investment either positively or negatively, depending on the assumptions about adjustment costs (Dixit and Pindyck, 1994), the degree of competition in the industry (Caballero, 1991), as well as risk-aversion (Zeira, 1990). Because the investment-uncertainty relationship is theoretically ambiguous, most studies resort to empirical evaluation to reach conclusions. Previous empirical work on this relationship has considered various dimensions of uncertainty, such as the manager's perception about future demand (Guiso and Parigi, 1999) and share price volatility (e.g., Leahy and Whited, 1996; Bloom et al., 2007). Here we focus on the impact of real exchange rate volatility on the firm's investment decision. Further, we show that the firm's mark-up, which reflects market power, and international exposure (exports and imports) affect the sensitivity of investment to exchange rate volatility. Finally, we demonstrate that the impact of volatility on investment differs substantially across manufacturing industries.

While there is some empirical literature on the impact of exchange rate volatility on investment, there are only a few studies that have considered the mediating role of the firm's mark-up and external exposure, or have documented cross-industry heterogeneity in the impact of exchange rate volatility on investment.[2] Using industry-level data for the U.S., Campa and Goldberg (1995) find that the impact of volatility depends on exposure to foreign markets, but the effect is quantitatively small. In a panel of developing countries, Serven (2003) finds a sizeable negative impact of exchange rate volatility on aggregate investment. Moreover, he also shows that greater trade openness and a weak financial system aggravate the negative impact. Similarly, Fuentes (2006) finds a negative relationship for Chilean manufacturing plants and provides evidence that the relationship is different for importers and non-importers.

In this paper, we analyze four issues. We start by showing that real exchange rate volatility affects firm-level investment adversely in a developing country context. Second, we demonstrate the importance

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[2] Additionally, there exists empirical literature on the effects of the exchange rate itself on firm-level performance. For recent examples see Nucci and Pozzolo (2001) and Fung (2008).

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of the firm's mark-up in determining the impact of exchange rate volatility on investment decisions. The mark-up reflects the firm's market power and depends on industry concentration and import competition, among other factors. A higher mark-up can partially insulate the firm's investment from exchange rate volatility by allowing the firm to absorb some of the fluctuations in its profit margin. Third, we document the role of firm's external exposure in mediating the relationship between real exchange rate volatility and investment. External exposure depends on the firm's reliance on foreign markets for exporting output (export exposure) and for importing inputs (import exposure). Since export exposure and import exposure affect marginal profitability differently, the relative importance of the two channels determines whether openness mitigates or exacerbates the negative effect of exchange rate volatility on investment. Given limited hedging opportunities in developing countries such as Colombia, due, among other reasons, to low financial development, external exposure can potentially be an important factor in determining the impact of exchange rate volatility.[3] Finally, we uncover substantial heterogeneity in the impact of volatility on firm-level investment across different manufacturing industries.[4]

To motivate our empirical investigation, we first present a simple theoretical model where we consider the investment problem of a representative firm which can sell its output at home or abroad, and may import some of its inputs. The theory implies a conventional dynamic investment equation augmented with measures of foreign exposure (export and import channels), and it highlights the importance of the firm's mark-up in determining the sensitivity of the relationship between investment and exchange rate uncertainty. We estimate the implied dynamic investment equation using panel data techniques developed by Arellano and Bover (1995) and Blundell and Bond (1998). An advantage of using plant-level panel data is that it allows us to control for unobservable plant effects that likely affect investment, sales, cash flow, and foreign exposure simultaneously. Our data on Colombian manufacturing plants comes from Colombia's Departamento Administrativo Nacional de Estadistica, and it spans the period from 1981 to 1987. Previous work that has employed the plant-level panel data from the Colombian Manufacturing Census includes Roberts and Skoufias (1997), Roberts and Tybout (1997), and Das et al. (2007). Roberts and Skoufias (1997) estimate the long-run demand for skilled and unskilled labor in Colombian manufacturing plants; Roberts and Tybout (1997) quantify the effect of sunk costs associated with export market entry, while Das et al. (2007) estimate a dynamic structural model of export supply for three Colombian manufacturing industries.[5] The data include information on investment, domestic and imported inputs, domestic sales and exports, and purchases and re-sales of capital goods. The availability of plant data on exports and imports allows us to investigate the importance of plant-level foreign exposure in mediating the relationship between investment and exchange rate volatility. Our baseline industry-level measure of real exchange rate uncertainty is constructed using a GARCH process for the exchange rate between the Colombian peso and the currencies of Colombia's trading partners.[6] We construct trade-weighted, 3-digit ISIC industry-specific real exchange volatility measures using bilateral exchange rate data from the IMF's International Financial Statistics and industry trade data from the World Bank's Trade and Production database.

We find an economically and statistically significant negative impact of exchange rate volatility on plant-level investment. Our baseline estimates suggest that one standard deviation increase in the real exchange rate volatility reduces investment by 12%. The estimated effect is smaller in magnitude for higher mark-up plants, indicating that they can partially offset the impact of volatility on investment by adjusting their profit margin.[7] We further estimate the sensitivity of the impact of exchange rate volatility by including interaction terms between volatility and export exposure, as well as volatility and import exposure. Consistent with the derived theoretical implications, we show that export exposure reduces the magnitude of the negative effect of exchange rate volatility on investment in all plants. The impact of import exposure, however, is heterogeneous in the plant's mark-up: it magnifies the negative effect of volatility for low mark-up plants, but it reduces the negative effect for high mark-up establishments. Finally, we estimate the model by 2-digit ISIC industry. The results show that, while the impact of exchange rate volatility is negative in 6 out of 7 manufacturing industries, the magnitude of the impact varies considerably. We also find that the mediating role of the mark-up and external exposure differs across the industries.

The rest of the paper is organized as follows. Section 2 illustrates theoretically the channels through which exchange rate volatility affects investment. We present the empirical specification of the investment equation and discuss the estimation issues in Section 3. Section 4 describes the Colombian plant-level data we employ and the exchange rate uncertainty measures that we construct. We discuss the results in Section 5. The last section concludes.

2. Simple model of investment and exchange rate volatility

To motivate the empirical specification, and to highlight the relationship between exchange rate volatility and investment, we present a simple model. Consider the investment problem of a firm that sells its output in the domestic and foreign markets and imports some of its variable inputs of production. Assume that at the beginning of period t, the firm optimally chooses the level of variable inputs, the output prices it charges in the domestic and foreign markets, and investment before the realization of the exchange rate.[8] Due to a one period time-to-build lag, the new capital resulting from investment becomes productive in the following period.

Let Π_{it} be the maximum profit of firm i obtained by choosing the optimal level of inputs and prices. The firm enters period t with K_{it-1} units of capital and chooses investment I_{it} to maximize the expected present value of current and future profits subject to the standard capital accumulation equation. The maximized value of the expected present value of profits is given by:

$$V_{it}(K_{it-1}) = \max_{I_{it}} \{\Pi_{it} - G(K_{it-1}, I_{it}) - I_{it} + \beta_t E_t[V_{it+1}(K_{it})]\} \quad (1)$$

subject to

$$K_{it} = (1-\delta)K_{it-1} + I_{it}, \quad (2)$$

where β_t is the discount factor from period t to period $t+1$, δ is the rate of depreciation, and $G(K_{it-1}, I_{it})$ denotes the cost of altering the

[3] A related and important issue is the impact of foreign currency exposure, or balance sheet effects, on firm-level investment in the face of exchange rate changes. We cannot investigate foreign currency exposure because balance sheet information is not available in our data set. Echeverry et al.(2003) and Aguiar (2005) are two examples of the growing body of literature that study balance sheet effects for Colombian and Mexican firms, respectively.

[4] Goldberg (1993) finds mixed evidence on heterogeneity of the effect of exchange rate volatility on industry-level investment in the U.S.

[5] In related work, Goldberg and Pavcnik (2003), Attanasio et al. (2004), and Goldberg and Pavcnik (2005) use household-level data to investigate the impact of the Colombian trade liberalization during the 1980s and 1990s on wage inequality and employment in the informal sector.

[6] The results are robust to using other simpler measures of exchange rate volatility, such as the standard deviation of the monthly exchange rate growth.

[7] The mitigating effect of the firm's mark-up is non-linear, i.e., a given increase in market power reduces the magnitude of the negative impact of volatility more for lower mark-up firms than for higher mark-up establishments.

[8] For simplicity, we assume that all investment is in domestic capital goods, since in our data we cannot differentiate between investment in domestic or foreign capital goods.