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Are Capital Controls Effective in the 21st Century? The Recent Experience of Colombia

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Abstract

This paper assesses the effects of capital controls imposed in Colombia in 2007 on capital flows and exchange rate dynamics. The results suggest that the controls were successful in reducing external borrowing, but had no statistically significant impact on the volume of non-FDI flows as a whole. We find no evidence that restrictions to capital mobility moderated the appreciation of Colombia's currency, or increased the degree of independence of monetary policy. We also find that controls have significantly increased the volatility of the exchange rate. Additional research is needed to assess the effects of capital controls on financial stability.

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I. INTRODUCTION

The sharp appreciation of currencies experienced by a number of emerging market countries through mid-2008 has reawakened interest in capital controls. These appear an especially attractive option for inflation targeting countries attempting to address overheating pressures while limiting currency appreciation. By slowing down the inflows triggered by higher domestic interest rates, controls appear to offer a way out of the difficult choice between choosing either domestic price stability or a less competitive exchange rate.

Confronted with rapid currency appreciation and a surge in capital inflows, market-based controls were imposed in Colombia in May 2007.[2] The main instrument to limit inflows was the imposition of an unremunerated reserve requirement (URR) on foreign borrowing and portfolio inflows. The purpose of these measures was to dampen short-term financial inflows, by making short-term debt costlier and reducing the returns on short-term portfolio investment. The authorities also implemented, simultaneously, new limits on banks' currency derivative positions, which addressed systemic risk concerns related to the buildup of large derivative holdings in some banks. Beyond its prudential objectives, the measure was also designed to limit the possibility of circumventing capital controls.

The Colombian experience with the imposition of capital controls has sparked a lively debate in Colombia, but one which is far from settled. Capital controls are not new in Colombia, having first been imposed in the 1990s, reintroduced in December 2004, and lifted during the period of global turbulence in June 2006. The Colombian experience of the 1990s has been studied extensively (see section III below), and has yielded results which are in line with the literature: controls have been ineffective in altering the real exchange rate, while nevertheless enhancing the independence of monetary policy. Regarding the most recent episode, the observed decline in net private capital inflows after the controls were implemented would appear to suggest that the controls have been effective (Vargas and Varela, 2008). Cardenas (2007), however, concludes that the controls have not had an independent effect on total net private capital inflows, based on an econometric model that takes account of other determinants of these movements. Galindo (2007) and Concha and Galindo (2008) conclude that the controls have had a transitory effect on net private capital inflows, but without significant effects on the real exchange rate.

This paper attempts to add to this literature by assessing the effect of the recent controls on capital flows and the exchange rate, while addressing a number of unresolved issues. First, additional study is needed on the effects of the controls on separate categories of capital inflows. Second, most—if not all—assessments of the effects of capital controls have focused on their impact on net, rather than gross, flows, including recent studies (Cardenas, 2007; Concha and Galindo, 2008). A disaggregation of the effects on both inflows and outflows could

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[2] Controls were removed during the market turbulence of October 2008. Section II.C provides a detailed account.

potentially yield rich insights into how the controls affect capital markets. While the controls were imposed on gross inflows, they may also have affected outflows, owing to the effect of the new limits imposed on derivative positions and the need of some market participants to unwind their positions. Third, there is scope to more precisely quantify the effects of the controls on the exchange rate and the degree of independence of monetary policy, which has received relatively less attention in recent studies.

The analysis in this paper focuses on an assessment of the effectiveness of capital controls, but not their costs and benefits. The paper does not analyze the microeconomic costs of controls or their adverse effects on market development. It also does not assess the potential role of the controls in helping protect financial stability by reducing the risks associated with the sudden reversal of inflows or exposure to counterparty risk associated with large increases in derivative positions.

This paper is organized as follows. First, a description of the database used for the study, and developments in exchange rates and capital flows in the periods immediately preceding and following the introduction of capital controls, is provided. This section also includes a description of the controls imposed in Colombia in May 2007. Second, a review of the literature is provided, focusing on studies assessing the Colombian experience. Third, the empirical methodology used to isolate and measure the effects of the controls is described. Fourth, the empirical results are given, followed by a summary section that also includes suggestions for further research.

II. DATABASE AND STYLIZED FACTS ON CAPITAL FLOWS AND EXCHANGE RATES

A. Database

The data used in this study capture all capital account transactions by the private sector that are intermediated in the foreign exchange market and recorded by the central bank (Banco de la República, BdR). Data on foreign exchange flows are derived from the BdR's *balanza cambiaria* (foreign exchange balance). The categories of foreign exchange transactions included are external borrowing, portfolio investment, foreign direct investment (FDI), and other movements that involve changes in bank accounts held abroad by residents and registered at the BdR (*cuentas corrientes de compensación)*. They exclude capital account transactions that are undertaken without an exchange of currency (e.g., certain forms of FDI).

The *balanza cambiaria* data includes foreign currency transactions between residents. Traditional balance of payments data only capture transactions between residents and nonresidents. In contrast, operations between residents are included in the *balanza cambiaria* data. For example, when a Colombian pension fund acquires foreign exchange to purchase a dollar-denominated bond owned by a Colombian investment fund, this is registered as a foreign exchange outflow. If the investment fund takes these dollars and converts them into pesos, this would be registered as an inflow. Thus, on a gross basis, the *balanza cambiaria* data tend to indicate a greater level of transactions than balance of payments data, although on a net basis,

they present a similar picture. The data is available on a weekly basis, which makes them an attractive source of information for studying the short-term behavior of capital flows. Because of its broad coverage and availability at high frequency, these data have also been employed in other studies assessing Colombia's experience with capital controls (Rincon, 2000 and recently Concha and Galindo, 2008).

B. Capital Flows and Exchange Rates in the Pre-Controls Era

Following the turmoil in global markets in mid-2006, the peso appreciated significantly in the second half of the year.[3] The peso recovered steadily from July through December, appreciating by about 9 percent in nominal effective terms. With the BdR beginning a period of monetary tightening (commencing in April 2006) to address overheating concerns, interest rate differentials also began to rise. Net FDI inflows were strong, while net non-FDI flows remained muted.

Exchange Rates

Source: IMF Information Notice System.
1/ An increase denotes an appreciation.

FDI and Non-FDI Private Inflows

Source: Banco de La Republica, *balanza cambiaria*.
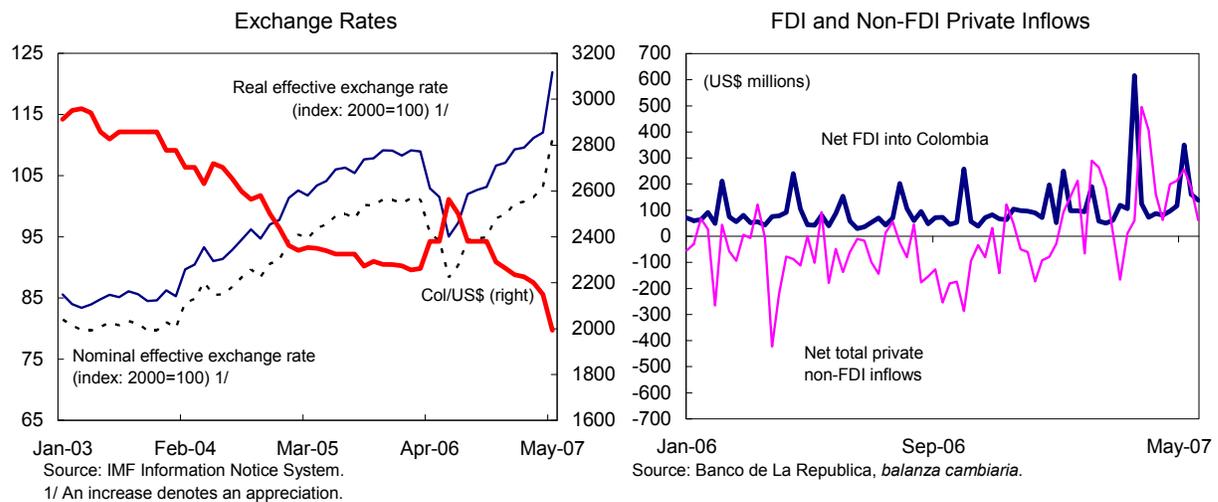
Non-FDI inflows increased sharply and the exchange rate continued to appreciate in early 2007. With inflation and inflation expectations rising beyond the BdR's inflation target, policy rates were increased by an additional 75 basis points in the first four months of the year. The exchange rate appreciated an additional 5 percent in nominal effective terms. Gross inflows rose sharply, spurred on by rising interest rate differentials and market expectations of a peso appreciation.

Sterilized intervention failed to quell the surging peso. The authorities attempted to resist appreciation pressures with a large dose of sterilized intervention (starting in mid-January 2007), accumulating about 38 percent of base money in the first four months of the

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[3] From mid-December 2004 through mid-June 2006, capital controls were also imposed in the form of a minimum one-year stay for nonresident portfolio inflows.

year. Nevertheless, with markets expecting even further appreciation of the peso—in part linked to markets' belief that the authorities' commitment to the inflation target would lead to increasing interest rate differentials—the strategy became unsustainable, and the BdR abandoned its policy of discretionary foreign exchange intervention by the end of April 2007.[4]

C. Capital Flows and Exchange Rates in the Controls Era

On May 6, 2007, the authorities introduced capital controls as part of a new strategy to slow the appreciation of the peso. The primary measure comprised an unremunerated reserve requirement (URR) on external borrowing of 40 percent. This revived the capital controls in place in Colombia between 1993 and 2000. The URR was to be held for six months in the BdR and applied to both the private and public sectors.

As a prudential measure, a ceiling on currency derivative positions was also imposed. Banks were henceforth required to keep their overall gross positions in these instruments to no more than 500 percent of their capital. Market participants were allowed some time to unwind positions to meet the new ceiling, which became binding on July 4. The measure addressed prudential concerns based on the high exposures of some banks and potential counterparty risks involved with these large positions. By restricting derivative positions, this measure also potentially affected capital flows and the exchange rate, and helped prevent circumvention of the URR.[5]

The capital controls were extended in late May 2007 to portfolio inflows. With portfolio inflows accelerating the first weeks of May, the URR was extended on May 23 to portfolio inflows by foreign residents. Investors were given the option of early withdrawals of funds from the URR, but with substantial penalties, ranging from 9.4 percent of the reserve requirement (for immediate withdrawals) to 1.6 percent (if held for 5 months).

Colombian institutional funds, including pension funds, were excluded from the capital controls. The exclusion of the pension funds is of particular importance, as they are highly active in trading in the foreign exchange market (Gómez, Jara, and Murcia, 2006). Their exclusion is also important in light of the fact that Colombian residents and firms, rather than nonresidents, accounted for about three-fourths of portfolio inflows in the pre-controls era. In addition, in June 2007, an exemption was granted for equities issued abroad. This effectively exempted from the controls the issuance of stock through American Depository Receipts (ADRs).

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[4] See Kamil (2008) for an analysis of the effectiveness of intervention policies in Colombia during this period.

[5] Non-deliverable forward transactions had facilitated the carry trade by providing a conduit for investors seeking to purchase Colombian assets (see Kamil and Reveiz, 2008).

Capital controls regulations underwent a further series of changes, beginning in late 2007, and were eliminated in October 2008. Controls were relaxed in December 2007, as the URR for initial public offerings of equities was eliminated, and penalties for early withdrawal of funds were reduced. Controls were subsequently tightened in May of 2008, as the URR on portfolio inflows was raised from 40 percent to 50 percent, and a minimum stay of two years was imposed on FDI.[6] Also in May, the limit on gross derivatives positions was increased from 500 percent of capital to 550 percent. In June, the penalty for early withdrawal of deposits under the URR (which had previously been relaxed in December of 2007) was also raised. Controls were subsequently loosened in September as the minimum stay requirement on FDI was revoked, and purchases of equities were exempted from the URR. In October, the capital controls were eliminated, although the limit on the derivative position of banks of 550 percent of capital remained.

Several aspects of the nature of private capital flows in Colombia are worth noting when analyzing the potential effects of capital controls. In net terms, FDI accounts for the vast majority of inflows (Table 1). In the pre-controls era, for example, FDI accounted for 96 percent of net private inflows, as net non-FDI flows had been close to zero. FDI was not targeted by the controls—except in the later period, via a minimum stay rule. Second, portfolio flows by residents are substantially more important than nonresidents, in gross terms; in net terms, however, the opposite is the case. Third, for resident portfolio flows, the weekly net movements are dwarfed by the size of gross inflows (net are between 2 and 8 percent of gross, depending on the period). Fourth, gross flows—which are several orders of magnitude of net flows—are inflated by the high level of transactions between residents that involve offsetting inflows and outflows.[7] Indeed, as Figure 1 demonstrates, periods of high inflows have corresponded to periods of high outflows.

A comparison of mean weekly gross inflows across periods suggests that the effects of the controls was strongest for foreign borrowing and portfolio inflows from non-residents, but its overall effect on non-FDI gross inflows was insignificant. Table 1 provides mean statistics for weekly average flows across different categories. The table also reports tests for the equality of first moments between the capital control period (May 2007–July 2008) and the immediate pre-controls era (July 2006 to April 2007).[8] Means tests indicate the controls have been associated

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[6] This followed less important extensions of the controls in end-April that broadened the coverage of transactions classified as foreign borrowing (and hence subject to the URR). These included (1) import financing of greater than six months (financing of capital goods and loans under US$10,000 were excluded); and (2) credit obtained from abroad by Colombian firms for the purpose of financing outward FDI.

[7] This can be seen be the high correlation (about 90 percent) between Colombian resident portfolio inflows and outflows.

[8] This pre-controls era captures a period when international markets were relatively calm and during which interest rate differentials in Colombia, vis-à-vis the rest of the world, started to rise. Thus, it represents a good period for establishing a baseline before the start of the capital controls.

with statistically significant reductions in foreign borrowing and nonresident portfolio gross inflows. Combined, these two categories accounted for about 11 percent of average total gross inflows in the pre-controls era. With respect to other flows, we find that portfolio inflows of Colombian residents have actually increased relative to the pre-controls era, while FDI inflows have also been higher.

Table 1. Private Capital Flows Before and After Capital Controls

(Weekly average flows in US$ millions)

Category	Type of flow	Before 1/	After 2/	Change in Average (After minus Before)
Total	Net inflows	99.6	104.9	5.3
	Gross inflows	671.1	727.7	56.7
Total non-FDI	Net inflows	3.7	-32.8	-36.4
	Gross inflows	565.6	580.6	15.0
Borrowing	Net inflows	-10.8	-17.1	-6.3
	Gross inflows	41.1	17.1	-24.1 ***
Portfolio (Non-residents)	Net inflows	25.2	-3.6	-28.8 ***
	Gross inflows	31.9	9.9	-22.0 ***
Portfolio (Colombian residents)	Net inflows	-4.7	-18.1	-13.3
	Gross inflows	155.9	227.5	71.5 ***
Drawdown of bank accounts abroad	Net inflows	-0.9	0.3	1.2
	Gross inflows	347.4	320.6	-26.9
FDI	Net inflows	95.9	137.7	41.8 **
	Gross inflows	105.5	147.6	42.2 **
Memorandum items 3/:				
Total (percent of GDP)	Net flows	2.8	2.4	
Total non-FDI (percent of GDP)	Net flows	0.1	-0.8	
Total non-FDI (percent of GDP)	Gross inflows	16.0	13.5	

Source: Authors' estimates.

Note: ***, **, and * indicate that average flows in the post control period are statistically significantly different from the pre-control period, at the 1%, 5%, and 10% levels, respectively.

1/ Average flow for the period July 6th, 2006 to May 6th (for portfolio May 23rd) , 2007.

2/ Average flow for the period May 7th (for portfolio May 24th), 2007 to Jul 4th, 2008.

3/ Average weekly flows, annualized as a share of GDP.

Figure 1. Private Capital Flows Before and After Capital Controls

(weekly, in US$ millions)
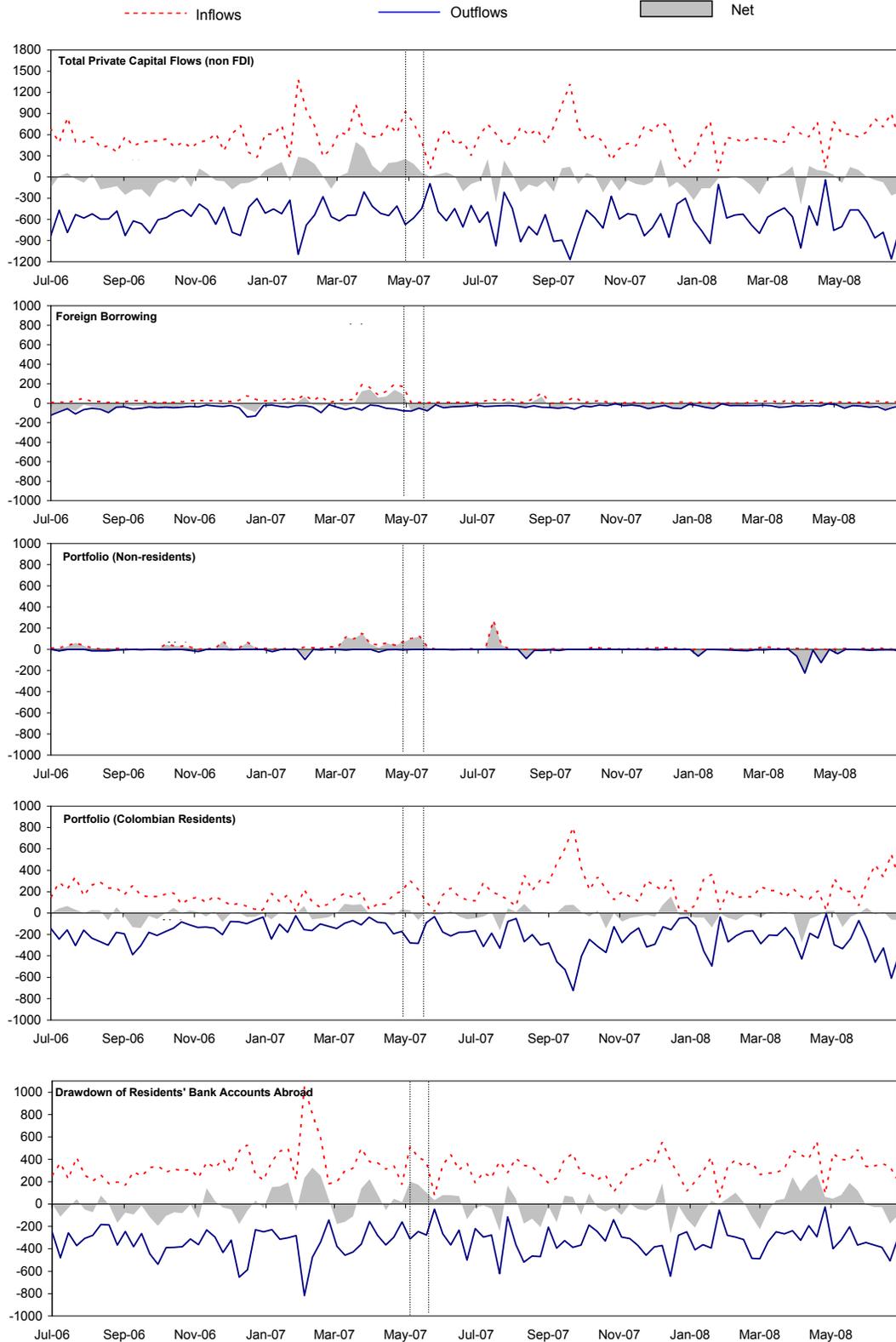
Source: Banco de la Republica, *balanza cambiaria.*
Note: The dashed lines correspond to the dates when capital controls were first imposed in 2007 (May 6th and May 23rd 2007 respectively).

On a net basis, capital inflows have not declined in the controls era. A statistically significant decline was found for just one subcategory (non-resident portfolio inflows) in net terms. This accounted, during the pre-controls period, for about 25 percent of net inflows. For foreign borrowing, resident portfolio flows, and the drawdown of bank accounts abroad monetized in local foreign exchange markets, the changes were statistically insignificant. For combined non-FDI net inflows as a whole, no statistically significant reduction was found. Because of the strong increase in gross inflows, FDI also increased, in net terms, in the controls era.

The capital controls have also been associated with an increase in off-shore derivative trading by pension funds. BdR survey data suggest that cross-border transactions in foreign currency derivative contracts between domestic pension funds and offshore entities have increased sharply since mid-2007. The average monthly value traded rose from US$6 million in the pre-control period to an average of about US$405 million since—over a 60-fold increase.[9] The average monthly value of contracts traded between off-shores and local banks, on the other hand, increased much

Total Value Traded in Foreign Currency Derivatives between Pension Funds and Off-Shore Entities
(in million of US dollars)

more modestly (250 percent). The large increase in off-shore derivative trading with the pension funds was probably a consequence of the ceiling of derivative positions imposed on local financial institutions. In particular, the ceiling may have led to an increase in the role of the offshore sector in providing currency hedges.[10] This could also help explain the observed increase in gross weekly inflows for Colombian residents and institutions since May 2007, while their net position has stayed roughly unchanged.

[9] This reached US$800 million in July 2008.

[10] Another reason may have to do with the imposition of higher reserve requirements on new deposits in May 2007. While not part of the capital controls per se, this *encaje marginal* constrained the ability of local banks to offer forwards to pension funds, as it reduced their liquidity and thus their ability to hedge their forward currency transactions.

The exchange rate continued to appreciate after the implementation of capital controls. The capital controls were not associated with an immediate effect on the exchange rate, which continued to appreciate until a period of brief global turbulence in June–August 2007. Afterwards, the peso resumed its upward climb, spurred on by the global weakness of the dollar, strong FDI flows, and improving terms of trade. From the start of the controls to end-July 2008, the bilateral rate appreciated by 16 percent.[11]

Simple comparisons of the pre-controls and controls era, however, do not take into account changes in the domestic and external environment that may also have affected capital flows and exchange rates. On the domestic front, these included the BdR's decision to refrain from discretionary foreign exchange intervention, and the further tightening of monetary policy, which increased interest rate differentials. Exchange rate volatility also increased, reducing the appetite of foreign investors seeking to exploit interest rate differentials. Externally, EMBI spreads increased, and the VIX—a measure of volatility in international markets—also rose. At the same time, commodity prices rose, strengthening Colombia's trade balance, while a favorable environment for FDI and an improved security situation also helped bolster the peso. In this light, a proper

Exchange Rate Volatility, Central Bank Intervention and Capital Controls

Discretionary Intervention (US$ millions)

Exchange rate volatility, percent (rhs)

Capital controls imposed
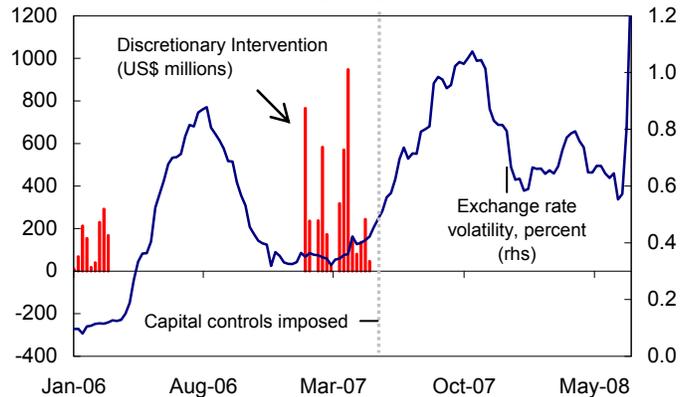
Source: Authors' estimates.

Nominal and Real Exchange Rates

Real effective exchange rate (index: 2000=100) 1/

Nominal effective exchange rate (index: 2000=100) 1/

Capital control imposed

Col/US$ (right)
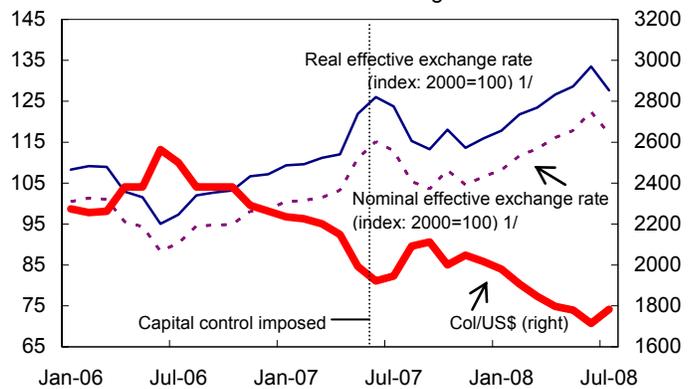
Source: IMF Information Notice System.
1/ An increase denotes an appreciation.

EMBI spread, VIX and Interest Rate Differential 1/

VIX (right)

interest rate differential

Capital controls imposed

EMBI spread
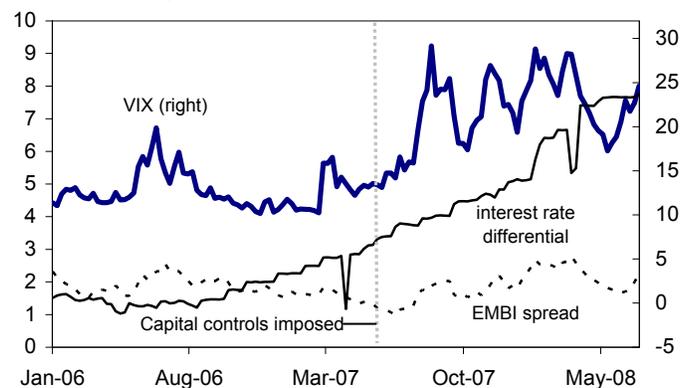
Source: Bloomberg, GP Morgan and Authors' estimates.
1/ Interest rate differential is the difference between domestic interbank rate and Fed funds rate.

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[11] Following the weakening of commodity prices and global financial turbulence, the peso, like many other emerging market currencies, depreciated sharply in the second half of 2008.

assessment of the effect of the capital controls requires the development of a model that accounts for these changes in the determinants of capital flows, as attempted in Section IV below.

III. THE EFFECTIVENESS OF CAPITAL CONTROLS IN EMERGING MARKETS: INSIGHTS FROM PREVIOUS RESEARCH

Empirical studies find that capital controls have had mixed success in emerging market countries.[12] As suggested by Magud and Reinhart (2007), the effectiveness of capital controls can be assessed from the standpoint of their ability to (1) limit capital inflows; (2) change the composition of flows (in particular, by shifting flows to long-term assets); (3) alleviate real exchange rate pressures; and (4) provide more independence for monetary policy by severing the link between domestic and international interest rates. The area where capital controls have been most successful is in providing more autonomy for monetary policy and altering the composition of capital inflows, while success on reducing the volume of inflows and reducing exchange rate pressures has been mixed.[13]

Previous research on the experience of Colombia in the 1990s with capital controls is broadly consistent with these findings. Most studies, but not all, have concluded that capital controls have been ineffective in reducing inflows or influencing the real exchange rate, but did affect the composition of inflows and monetary policy autonomy.[14] Cárdenas and Barrera (1997) find that capital controls between 1985 and 1995 had no impact on total capital flows but changed their composition. A similar finding is reported in Rocha and Mesa (1998) who argue that capital controls reduced the short-term interest rate differential, increasing medium- and long-term foreign debt. Using a data set that covers the period between 1993 and 1998, Ocampo and Tovar (1999, 2003) argue that capital controls diminished not only short-term but also long-term capital flows, while Rincón (2000) finds that capital controls reduced short-term flows. Using a similar data set, Villar and Rincón (2001) find that capital controls allowed the authorities to increase domestic real interest rates without creating pressures for real appreciation of the peso.

Three recent studies on the 2007 controls arrive at mixed results. Cardenas (2007) examines the effects of the 2007 controls, using weekly data on total capital inflows on assets of more than

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[12] For cross country reviews of the evidence on capital controls, see also De Gregorio et al. (2000), Edwards (2007a), IMF (2007), and Magud and Reinhart (2007).

[13] Studies in this area have confronted a minefield of methodological issues, and not always with great success (Forbes, 2007; Montiel and Reinhart, 1999; and Prasad et al., 2003). Among these challenges is the difficulty of isolating the effects of capital controls per se on capital flows and exchange rates, as well as endogeneity issues.

[14] See also Uribe (2005) for a review of the Colombian literature. For a minority view—arguing that capital controls were effective in influencing both short and long-term capital flows—see David (2007).

one year of maturity. Using ordinary least squares, and controlling for other determinants of inflows such as interest rate differentials, he finds that controls had no statistically significant effect on capital inflows. This approach, however, may be biased towards finding that capital controls are ineffective, as the dependent variable—total capital inflows of more than one year—misses the effect of controls on inflows seeking to purchase short-term assets. In addition, the inclusion of foreign direct investment (FDI) is problematic, as FDI flows are unlikely to be influenced by the same factors that drive portfolio inflows, such as interest rate differentials. As such, the model is unlikely to find that the controls affect total inflows, even if they have a tangible effect on portfolio inflows or external borrowing. Galindo (2007) and Concha and Galindo (2008), using a vector error correction model (VECM) with monthly data, find that capital controls had a significant effect on short-term capital inflows, but not the real exchange rate. They find that capital controls do, however, reduce the volatility of the real exchange rate.

IV. EMPIRICAL METHODOLOGY

The empirical analysis is based on econometric models of capital flows and the exchange rate. An OLS model is developed to assess the determinants of capital flows on a weekly basis, using the *balanza cambiaria* data. For the exchange rate model, daily data are used to construct a GARCH model, drawing on Kamil (2008). Capital controls are then assessed in the context of these models that control for the underlying determinants of capital flows and the exchange rate. Both the capital flows and exchange rate models are estimated using data spanning from end-July 2006 to early July 2008.

The focus of the analysis on both net *and* gross capital inflows represents a significant departure from previous work for Colombia and other emerging markets (see Edwards, 2007b). Both flows are important to assess, as they provide different insights. Net inflows, which have traditionally been the focus of previous studies, are often seen as the clearest signal of demand pressures on the domestic currency. At the same time, gross inflow data also offer important insights for exchange rate determination, as each gross transaction provides an opportunity for the underlying asset to be repriced. The econometric results from the gross flows data— especially for the category of resident portfolio flows—should nevertheless be assessed with caution, for the reasons described earlier. The analysis also draws on more disaggregated data than previous studies. This allows us to exclude FDI flows from the analysis, which is difficult to model on a high-frequency (weekly) basis.

The methodology employed here overcomes many of the econometric problems of previous empirical work. First, endogeneity issues are much less severe than in many other studies. This owes to the fact that under Colombia's inflation targeting regime, interest rates are set to achieve the inflation target, and capital inflows are fully sterilized. Thus, there is no two-way causality between capital flows and interest rate differentials. Second, in light of the use of high-frequency, weekly data over a relatively short period of time—with no discernable trend—there

are no issues related to unit roots in the data. In contrast, studies using lower frequency data over a long period of time must take into account the possible nonstationarity of these series.

Identifying the effects of capital controls nevertheless presents several empirical challenges that need to be borne in mind when analyzing the results. First, the capital controls—in the form of the URR—was also accompanied by a limit on gross derivative positions. Thus, assessing the separate effect of the URR, and the limit on the derivative position, is particularly difficult, and is beyond the scope of the study. Second, the capital controls were imposed in stages (with the initial controls introduced on May 6 and later in May 23 of 2007). Third, the controls have undergone additional (though minor) modifications, in both December of 2007 and throughout 2008. Given the large number of changes, it was not possible to control, with dummy variables, all of these modifications.

Our explicit focus on assessing the effects of the controls on capital flows differs from earlier studies on the experience of Colombia in the 1990s. Villar and Rincón (2001) argue that the effect of the controls on the quantity of inflows is ambiguous, and thus of less relevance in assessing the impact of the controls. They argue that the controls impose a tax on foreign borrowing that brings about an increase in interest rates, which tends to offset the dampening effect of the controls on inflows. In the context of Colombia's current inflation targeting regime, however, capital controls—even if they effectively place a tax on foreign borrowing—would not necessarily lead to an increase domestic interest rates, which are determined by the BdR in light of inflation objectives. Thus, the capital controls could be expected to affect the quantity of inflows, without any effect on interest rates.

A.   The Effectiveness of Controls: Impact on Capital Flows

We consider four broad categories of flows: foreign borrowing, portfolio investment (bond and equity flows), movements that involve changes in bank accounts held abroad by residents (*cuentas corrientes de compensación)*, and total non-FDI flows.[15] We assess the behavior of capital flows for categories not directly covered by the controls (such as the drawdown of bank accounts), given the possibility that the controls could divert carry trade towards these categories of inflows. The analysis is carried out separately for each type of capital flow, and we estimate the following OLS regression:

$$Flow_{j,t} = \delta_0 + \delta_1 INT_t + \delta_2 \left(i - r^*\right)_t + \delta_3 \left(EMBI\ spread\right)_t + \delta_4 VOL_t + \delta_5 App^E_t$$

$$+ \delta_6 DCC_{jt} + \varepsilon_t \tag{1}$$

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[10]   For total non-FDI, we also analyze the determinants of gross outflows.

where: $Flow_j$ corresponds to the weekly inflow for each category j of capital (either net or gross), in millions of dollars; INT is the weekly amount of the BdR's discretionary intervention in the foreign exchange market, in millions of dollars; $(i - r^*)$ is the weekly average interest rate differential between the domestic interbank rate and the U.S. Fed's fund rate, in percent per year; $EMBI\ spread$ is the weekly average yield spread on a sovereign foreign currency bond over a comparable U.S. treasury bond in percent per year; VOL is the unconditional volatility of daily changes in the nominal exchange rate, over the previous three-month period; and App^E_t is a proxy for the expected appreciation of the exchange rate, obtained as the weekly average of the percentage difference between the spot and forward exchange rates in on-shore non-deliverable forward contracts of 15 to 35 days maturity. As a proxy for capital controls, we use a dummy variable (DCC) that takes a value of 1 in the weeks after capital controls were imposed and zero otherwise.[16] The main parameter of interest is δ_6, the average impact of capital controls on the weekly level of capital flows. If the imposition of capital controls led to a lower level of capital inflows, then δ_6 should be negative and statistically significant.

B. The Effectiveness of Controls: Evidence from Daily Exchange Rate Data

To analyze the effects of capital controls on the nominal exchange rate, we estimate a generalized autoregressive conditional heteroskedasticity (GARCH) model[17] of the daily peso-dollar exchange rate return with the following general specification:

$$\Delta\left(\ln s_t\right) = \mu + \beta_0 \Delta\left(\ln s_{t-1}\right) + \beta_1 INT_t + \beta_2\left(i - r^*\right)_t + \beta_3 \Delta\left(EMBI\ spread\right)_t + \beta_4 VIX_t +$$
$$+ \beta_5 Comm_t + \beta_6 DCC_t + \varepsilon_t \tag{2}$$

$$\varepsilon_t \big| \Omega_{t-1} \sim N\left(0, \sigma_t^2\right) \tag{3}$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \sigma_{t-1}^2 + \alpha_2 \varepsilon_{t-1}^2 + \alpha_3\ INT_t + \alpha_4\left(i - r^*\right)_t + \alpha_5 \big|\Delta\left(EMBI\ spread\right)_t\big| + \alpha_6 VIX_t +$$
$$+ \alpha_7 \big|Comm_t\big| + \alpha_8\ DCC_t + \sum_{i=1}^{4} \delta_i D_{it} + v_t \tag{4}$$

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[11] For total non-FDI, foreign borrowing, and the net drawdown of bank accounts abroad, the dummy takes on a value of one from May 6, 2007 onward. For portfolio flows, the starting date is May 23.

[12] In all cases a GARCH (1,1) model was estimated as it is typical in the literature. Given the presence of heteroskedastic disturbances in our sample, we use the methods described in Bollerslev and Wooldridge (1992) to compute standard errors.

where: $\Delta(\ln s)$ is the daily percentage change in the nominal exchange rate (such that a positive change is a depreciation of the Colombian peso); VIX is the implied volatility of the U.S. stock market; $Comm_t$ is the daily percentage change in a representative commodity export price index of the Colombian economy,[18] and the rest of the variables are defined as above. D_{it} are day-of-the-week dummy variables (for example, $D_{1t} = 1$ for Mondays, where Friday is the omitted category); and $|\;|$ denotes the absolute number operator. ε_t is the unexpected return, which is used to model the conditional volatility of the exchange rate in the volatility equation (4). Finally, σ_t^2 is the conditional variance and allows for the possibility of time-varying and clustering conditional volatility. The conditional distribution of the disturbance term is normal with variance σ^2.

Several features of the specification are worth noting. Equation (2) of the empirical model (the "mean" equation) analyzes changes in the exchange rate return (depreciation or appreciation against the dollar) as a function of the capital controls, controlling for other factors affecting exchange rates at a daily frequency.[19] The main focus is on the estimate of β_6, the average impact of capital controls on the level of the exchange rate. If the imposition of capital controls led to a more depreciated (less appreciated) exchange rate, then β_6, the parameter of interest, should be positive and statistically significant. This would imply that the capital controls were effective in stemming the appreciation of the currency in the context of a cycle of monetary tightening.

The estimation controls for financial and current account developments affecting short-term exchange rate movements. The interest differential aims to capture the possible impact of monetary policy and local money market conditions on the exchange rate. Yield spreads on sovereign external debt are included as a measure of country risk and foreign investor sentiment, which are potentially key determinants of foreigners' demand for local currency. We also include an index of the implied volatility of the U.S. stock market, the VIX index, which we take as a proxy for investors' perception of global financial risk. We also control for daily changes in commodity prices, to capture pressures on the exchange rate associated with current account developments.

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[18] The commodity price index was constructed as a weighted average of daily commodity prices for the main commodities exported by Colombia, using weights from 2006. The variable EMBI enters the equation in first differences as this increases the explanatory power of the model significantly.

[19] Given the reduced-form nature of the estimation, the framework can only identify the average response of exchange rate returns to the imposition of capital controls. It does not identify a structural relationship, or the channels through which these restrictions affect exchange rates.

V. EMPIRICAL RESULTS

A. Controls and Capital Flows

The econometric results suggest that the controls did not result in a reduction in aggregate non-FDI inflows (Table 2). The estimates yield a good fit for weekly data, especially for the equation estimated in net terms. They suggest that capital controls had no statistically significant impact on either gross or net non-FDI capital flows, once we control for other drivers of capital movements. [20]

The empirical evidence also suggests that the impact of the controls varied across different categories of inflows. The results indicate that the controls have contributed to a significant decline in foreign borrowing in both gross and net terms (Table 3). The point estimates imply that the controls led to a reduction in weekly gross foreign currency borrowing of approximately US$44 million—about equal to their average level in the pre-controls era. The controls also led to a reduction in foreign borrowing on net terms, although only at the 10 percent confidence level. Nevertheless, the econometric results provide some evidence that the controls were effective in reducing at least one category of capital inflows.[21]

We also find no statistical evidence that the controls reduced aggregate portfolio inflows and the bank account transfers of Colombian residents, which represent the majority of total non-FDI flows (Tables 3 and 4). The estimated effect on the drawdown of bank accounts is insignificant at standard confidence levels. In addition, the controls had no impact on total portfolio inflows, in both gross and net terms. Looking at the impact on portfolio flows by residence, the results for non-resident bond and equity flows are mixed: there does appear to be an effect on gross inflows, but not on net flows.[22] For resident flows, however, the effect is unambiguously insignificant in both net and gross terms. This most likely reflects the fact that the controls did not cover domestic institutional funds, and the continued high level of inflows of foreign currency from Colombian residents and firms to purchase peso-denominated assets. Taken together, this explains why total portfolio flows appear to show little response to capital account restrictions.

Estimates of the other covariates in the regression appear generally reasonable and consistent with past research and economic theory. An increase in interest rate spreads, a reduction in

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[20] We also estimated the model with all regressors lagged one period, in an attempt to reduce simultaneity bias. The main results were unaltered. The results were also similar when the estimated over the period January 2007–July 2008. Results are available upon request.

[21] During the peak period of appreciation pressures—during the first four months of 2007—these inflows, in net terms, equaled ¾ percentage point of annualized GDP.

[22] Non-resident gross portfolio inflows averaged about 5 percent of total gross capital inflows in the pre-controls era.

exchange rate volatility, and an increase in expected appreciation are all typically expected to lead to higher net inflows. The results are consistent with these priors. Exchange rate intervention is also found to lead to higher non-FDI net inflows. This is consistent with the results reported in Kamil (2008), who shows that central bank intervention to resist currency appreciation during the first four months of 2007 was ineffective.

In sum, the evidence on the effects of the controls on capital flows is mixed. Foreign borrowing appears to have declined in net terms, but only at the 10 percent confidence level. Given the modest share of foreign borrowing in total flows, however, and the statistically insignificant relationship found for other flows, the effect of the controls on total non-FDI flows is economically and statistically insignificant.

Table 2. Impact of Capital Controls on Non-FDI Private Capital Flows

(OLS model for weekly flow of capital: July 2006 - July 2008)

Dependent Variable:	Total Non-FDI					
	Net Inflows		Gross Inflows		Gross Outflows	
Explanatory Variables:						
α1 (EMBI Sovereign Spread)	-28.3		-48.6		-20.3	
α2 (Interest Rate Spread)	42.9	***	52.4	**	9.5	
α3 (Exchange Rate Volatility)	-126.2	*	166.5		292.7	***
α4 (Expected Appreciation)	37.8	***	23.3		-14.5	
α5 (Discretionary Intervention)	0.31	***	0.21		-0.08	
Effect of Capital Controls:						
α6 (Dummy for period 6th May 2007 onwards)	14.2		-104.1		-118.3	
Number of Observations	101		101		101	
R-Squared	0.36		0.13		0.12	

Source: Authors' estimates.

Note: Asterisks denote significance of coefficients, with ***, ** and * indicating significance at the 1%, 5% and 10% level, respectively.

Table 3. Impact of Capital Controls on Foreign Borrowing and Drawdown of Residents' Bank Accounts Abroad

(OLS model for weekly flow of capital: July 2006 - July 2008)

Dependent Variable:	Foreign Borrowing		Drawdown of Residents' Bank Accounts Abroad	
	Net Inflows	Gross Inflows	Net Inflows	Gross Inflows
Explanatory Variables:				
α_1 (EMBI Sovereign Spread)	3.6	-0.3	-11.0	-80.1 *
α_2 (Interest Rate Spread)	12.1 **	12.2 **	40.6 ***	8.7
α_3 (Exchange Rate Volatility)	24.2	26.0	-119.4 **	-76.8
α_4 (Expected Appreciation)	8.0	9.0 *	25.2 **	-14.4
α_5 (Discretionary Intervention)	0.1 ***	0.1 *	0.1	0.2
Effect of Capital Controls:				
α_6 (Dummy for Period May 6th 2007 onwards)	-32.5 *	-44.2 ***	5.7	-50.9
R-Squared	0.28	0.42	0.20	0.14

Source: Authors' estimates.

Note: Asterisks denote significance of coefficients, with ***, ** and * indicating significance at the 1%, 5% and 10% level, respectively.

Table 4. Impact of Capital Controls on Portfolio Inflows

(OLS model for weekly flow of capital: July 2006 - July 2008)

Dependent Variable	Total Portfolio Investment		Resident Portfolio Investment		Non-Resident Portfolio Investment	
	Net Inflows	Gross Inflows	Net Inflows	Gross Inflows	Net Inflows	Gross Inflows
Explanatory Variables:						
α_1 (EMBI Sovereign Spread)	-18.5	30.7	-10.3	25.6	-6.3	-2.0
α_2 (Interest Rate Spread)	-2.5	39.1 ***	-3.9	33.0 **	0.8	6.7 **
α_3 (Exchange Rate Volatility)	-6.7	261.4 ***	1.3	264.8 **	-12.0	3.7
α_4 (Expected Appreciation)	4.6	25.6 *	1.4	21.4 *	3.7	2.9
α_5 (Discretionary Intervention)	0.1 *	0.0	0.1 **	-0.1	0.1	0.1 ***
Effect of Capital Controls:						
α_6 (Dummy for Period May 23rd 2007 onwards)	-4.2	-74.3	15.1	-49.9	-13.3	-34.6 ***
R-Squared	0.28	0.33	0.07	0.35	0.45	0.66

Source: Authors' estimates.

Note: Asterisks denote significance of coefficients, with ***, ** and * indicating significance at the 1%, 5% and 10% level, respectively.

B. Controls and Exchange Rates

Results for estimates based on the entire sample period (July 2006-July 2008) are presented in Table 5. The first two columns present estimates of the baseline model described in equations (2)-(4). The first column reports results for the mean exchange rate equation, while the conditional variance equation estimates are presented in the second column.[23] In addition, a slightly modified version of these equations was estimated to assess whether the sensitivity of the exchange rate to the explanatory variables differed under capital controls. Under this specification, we augment the model with terms that interact the CC dummy with the interest rate differential, the VIX, EMBI, and commodity prices. If capital controls were effective in decreasing the sensitivity of the exchange rate to interest rate differentials, for example, then the coefficient in the interaction term should be positive and significant.[24] If capital controls were effective in muting the transmission of global financial shocks to Colombia, then the EMBI and VIX interaction should be negative and significant.

There is no statistical evidence that the capital controls have resulted in a more depreciated exchange rate, or reduced the sensitivity of the exchange rate to interest rate differentials. Using a standard t-test, the coefficient on the capital control dummy (column 1) and the interaction term of capital controls on the interest rates differential (column 3) are found to be statistically insignificant. Capital controls have also not reduced the sensitivity of the exchange rate to global developments, as indicated by the insignificant coefficient for the interaction terms for the VIX and EMBI spreads.

Capital controls appear to have increased exchange rate volatility. The results indicate that the controls have had the unintended consequence of increasing the conditional volatility of exchange rate returns (column 2). This finding is consistent with Edwards and Rigobón (2005), who show that capital controls increased the unconditional volatility of the exchange rate in Chile.[25]

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[23] In the results presented below, central bank intervention is expressed per US$100 million.

[24] Given that an increase in interest rates typically leads to an appreciation of the currency (i.e., it has a negative coefficient), then a decrease in the sensitivity under capital controls would imply that the sign of the coefficient in the interaction term is positive. In this case, the sum of the lower-order coefficient on the interest spread and the corresponding interaction term (which measures the effect of interest rates on the exchange rate during the capital controls period) would be reduced in absolute value.

[25] We cannot reject the null hypothesis that all interaction terms in the variance equation in the augmented model (column 2) are jointly equal to zero. As such, the model suggests that the effect of the key explanatory variables on the variance of the exchange rate did not change with the imposition of controls.

Table 5. Impact of Capital Controls on the Exchange Rate

(GARCH (1,1) model for daily percentage changes in the US dollar-peso exchange rate)

	Baseline Model		Augmented Interaction Model	
	Mean	Variance	Mean	Variance
Explanatory Variables:				
Lagged Exchange Rate	0.10 **	---	0.09 *	---
Central Bank Intervention	0.03	0.04	0.08	0.02
Interest Rate Spread	-0.02	-0.01	-0.09 *	-0.01
Change in EMBI Sovereign Spread	2.96 ***	0.73 *	2.90 ***	0.21
VIX	0.01	0.00	0.00	0.01
Commodity Price Change	-0.04 ***	-0.02 **	-0.04 ***	-0.04 ***
Effect of Capital Controls:				
Dummy Capital Controls (DCC)	-0.07	0.16 **	-0.47	0.03
DCC * Interest Rate Spread			0.07	0.01
DCC * Change in EMBI			0.3	0.53
DCC * VIX			0.02	0.00
DCC * Commodity Price Change			0.03	0.05
Number of Observations	477	477	477	477
Adjusted R-Squared	0.15	0.15	0.14	0.14

Source: Authors' estimates.

Note: Asterisks denote significance of coefficients, with ***, ** and * indicating significance at the 1%, 5% and 10% level, respectively.

Several factors could explain why exchange rates tended to be more variable following the introduction of capital controls. First, it may be that case that with controls on the quantity of inflows, more of the burden of adjustment falls on prices when demand for the currency changes. A weakness in this line of argumentation, however, is that the controls appear to have had no effect on the quantity of total flows affecting the exchange rate. Second, controls are likely to have segmented the foreign exchange market further, increasing conditional volatility. Third, and related to this segmentation, the capital account restrictions on nonresidents placed the pension funds in a privileged position, as they were excluded from the controls. This may have increased the importance of domestic pension funds in exchange rate market trading. For example, the average weekly trading in foreign exchange markets by pension funds (as proxied by the sum of gross portfolio inflows and outflows by residents in *balanza cambiaria*) increased 52 percent across periods. Given that minimum return rules provide a strong penalty for deviations from average performance in the industry and encourage herd behavior, increased activity of pension funds may have contributed to large and sudden movements of pension fund assets between peso- and foreign-currency denominated assets, exacerbating volatility. More

work is needed, however, to shed light on the role of pension funds during capital controls and their impact on foreign exchange market conditions.

VI. CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

We find that capital controls have been successful in reducing foreign borrowing. The controls do not appear, however, to have had an effect on other, more significant categories of inflows, including portfolio inflows. For non-FDI net flows as a whole, we find the controls have had no statistically significant impact. The model estimates suggest that capital flows to Colombia are well explained by our theoretical priors, as an increase in interest rate spreads, a reduction in exchange rate volatility, and an increase in expected appreciation are all estimated to lead to higher net inflows. In addition, the econometric estimates point to exchange rate intervention as an important driver of capital inflows.

Our results also suggest that capital controls have not affected the level of the exchange rate, but have been associated with an increase in volatility. Exchange rate levels do not appear to have been affected by the capital controls. In addition, the controls did not reduce the sensitivity of the exchange rate to global financial developments and external shocks. We consistently find that controls have actually increased the volatility of the exchange rate, which over the past two years has well exceeded the Latin American average. Capital controls also appear to have had no effect on the independence of monetary policy, given the failure to identify a statistically significant relationship between capital controls and the interface between interest rate differentials and the exchange rate.

Further research is needed to fully understand the effects of the controls. Additional study of the channels through which carry trades are executed could provide important insights into the effectiveness of capital controls. In particular, the role of the offshore sector and pension funds in the exchange rate market could be more fully explored. Further empirical work on the effects of capital controls on the volatility of the exchange rate is also warranted. In addition, there is room to use different measures of capital controls in future empirical work. In particular, a "tax equivalent" measure—which quantifies the implicit premium that must be paid on local returns to compensate investors for the financial costs associated with capital controls—could be utilized (Villar and Rincón, 2001; Concha and Galindo, 2008). A measure of the effect of capital controls could also be derived from information on banks' gross derivatives positions, in particular how closely these have come to the ceiling of 550 percent of gross capital. Finally, a broader assessment of the effects of controls on financial stability could be conducted, in particular their role in reducing the vulnerabilities associated with rapid increases in capital inflows and the buildup of derivative positions in the banking system.

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