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Capital Controls and the Global Financial Cycle[*]

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Abstract

Capital flows into emerging markets are volatile and associated with risks. A common prescription is to impose counter-cyclical capital controls that tighten during economic booms to mitigate future sudden-stop dynamics, but it has been challenging to document such patterns in the data. Instead, we show that emerging markets increase their capital controls in response to volatility in international financial markets and elevated risk aversion. We justify this behavior theoretically by a desire to manipulate the risk premium. When investors are more risk-averse or markets are volatile, investors require a high marginal compensation to hold risky emerging market debt. Regulators are able to exploit this tight link and raise capital inflow controls, thereby lowering the risk premium and reducing the overall debt burden. We emphasize that risk premium manipulations via capital controls are only rational from the perspective of the emerging market, but not from a global perspective. This adds a more cautious note on the use of capital controls in an international context.

Keywords: Capital Controls; Risk Aversion; Volatility; Risk Premium

JEL: F36, F38, F41

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1. Introduction

The financial integration of emerging markets (EMs) has rekindled a debate on the advantages and disadvantages of international financial flows. Despite widely recognized benefits of foreign capital in emerging markets, policymakers are worried about sudden stops, which tend to have sustained negative effects on macroeconomic and financial stability (Reinhart and Rogoff, 2011; Forbes and Warnock, 2012). The IMF shares this view and advocates capital controls under certain circumstances to address international capital surges (Ostry et al., 2010; Ostry et al., 2011). This policy proposal is supported by a new theoretical literature, which stresses that emerging markets may borrow excessively on international markets due to externalities that private agents do not internalize (see, for example, Bianchi, 2011). Though the specific externalities vary, the common policy prescription is to impose counter-cyclical (prudential) capital controls that is, to tighten restrictions during economic booms. However, recent applied work (Eichengreen and Rose, 2014; Fernández et al., 2015) has struggled to identify such counter-cyclical use in practice with the exception of Brazil (Chamon and Garcia, 2016).[1]

We show that in contrast to conventional policy advice, emerging markets actually impose pro-cyclical capital controls: they tend to increase capital inflow controls during periods of international financial distress and vice versa. We then propose a theoretical framework that justifies this pro-cyclical use. Specifically, we argue that regulators have an incentive to impose capital inflow controls to lower the risk premium of emerging market debt. Moreover, because investors are more sensitive to risk during periods of financial distress, restrictions increase with deteriorating financial conditions. Our results are complementary to the existing literature on the proper usage of capital controls. We do not question the externality view of counter-cyclical capital controls. Instead, we emphasize two realistic ingredients, risk-averse investors and risky emerging market debt. We then argue that these two ingredients lead to a pro-cyclical use of capital controls, consistent with their actual use in the data. An important lesson is that capital controls based on risk premium manipulations are only rational from the perspective of the emerging market, but not from a global perspective. This adds a more cautious note on the use of capital controls in an international context.

In the first part of the paper, we empirically assess how regulators adjust capital controls in response to global financial conditions using a large sample of emerging

[1] A complementary literature studies the effectiveness of capital controls. Rebucci and Ma (2019) and Erten et al. (2021) provide an extensive review of this literature.

markets that actively adjust capital inflow controls and more than two decades of data. Our sample covers three periods of global financial distress: the Asian Financial Crisis in 1997, the Dot-Com Bubble in the early 2000s and the Global Financial Crisis of 2007-2008. We show that during all three periods, a significant share of countries imposed additional restrictions. Moreover, we show that these countries tend to decrease capital inflow restrictions once financial distress moderates. These associations prevail even after we control for business cycle variables, such as current account deficits, currency appreciation, and institutional quality that should influence regulators to implement or discontinue capital controls based on the existing literature. Furthermore, we decompose financial distress, as proxied by the Chicago Board Options Exchange Volatility Index (VIX), into volatility and risk aversion following Bekaert and Hoerova (2014), which establishes a positive link between capital controls and the two aforementioned structural factors.

In the second part of the paper, we formally analyze these empirical facts. We build a stylized two-period open economy model with two agents: international investors and borrowers from an emerging market. To smooth consumption, borrowers issue international debt, which international investors purchase. Our model has three crucial features: First, international investors are risk-averse. Consequently, they require compensation in the form of a risk premium that is increasing in the share of risky assets in the total portfolio. Second, following empirical evidence, we allow for default in emerging market debt. This feature implies that borrowers are required to pay a risk premium that endogenously depends on the aggregate amount of debt issued by the emerging market. Third, based on empirical grounds, we impose a positive correlation between the risk profile of international financial markets and the emerging market. International investors, therefore, avoid emerging market bonds as a hedge against volatile international financial markets.

We then contrast the unregulated equilibrium with a national planner (regulator), who maximizes welfare on behalf of all households in the emerging market. Because the regulator controls aggregate debt, she internalizes the positive relationship between aggregate debt and the country-specific risk premium required by investors. This increases the perceived cost of debt and, as a consequence, a regulator issues less international debt than households.[2] The planner equilibrium is subsequently decentralized with a tax that is akin to price-based capital inflow controls. The basic concept is hence similar to the optimal tariff argument in Obstfeld and Rogoff (1996),

[2]Bocola and Lorenzoni (2020) also emphasize risk premium manipulations. In their model, a government optimally intervenes ex-post to improve domestic financial stability. These policies lower the risk-premium ex-ante and allow borrowers to borrow more in domestic rather than foreign currency.

who advocate imposing tariffs when households borrow and import to decrease the price of debt.

Because we do not introduce frictions in financial markets, capital controls are beggar-thy-neighbor. In essence, by acting like a monopolist, the regulator extracts rent from international investors. This approach distinguishes our paper from most of the literature on macroprudential capital controls, which justify capital controls to alleviate externalities.[3]

Importantly, optimal intervention via capital controls in our framework increases with the risk aversion of investors and volatility in international financial markets. The intuition is as follows: If investors are more risk-averse, they require a higher marginal compensation for holding emerging market debt. Because a monopolistic regulator internalizes this heightened sensitivity, debt becomes more expensive from the regulators' perspective. The regulator ceteris paribus issues less debt, which is decentralized with tighter capital inflow controls. The relationship between capital controls and international financial volatility is more nuanced. If international markets are more volatile, investors will attempt to hedge against this additional risk. However, emerging market bonds perform poorly when international markets are risky and are hence not a good hedge; as a result, volatility in international markets decreases the relative demand for emerging market bonds. Investors will thus require a higher marginal compensation to hold these bonds, which ceteris paribus increases intervention via capital controls similar to the argument on risk-aversion. We hence conclude that the pro-cyclical patterns in the data may indeed be rational.

The justification of pro-cyclical capital controls in our framework is tied to an emerging market's monopoly power over its own debt. Specifically, we assume that a regulator is able to influence the country-specific risk premium, even though we do not require any impact on world interest rates per se. An emerging market has a natural monopoly on its own debt. However most emerging markets are small and compete for funds with other countries, which may limit their influence on the risk premium. To shed light on these issues, we first vary the size of the emerging market. We find that intervention increases with country size, both in the model and in the data. Intuitively, investors are less sensitive to a smaller emerging market, because its debt constitutes a smaller fraction of the overall portfolio. As a second experiment, we add another emerging market that competes for funds from international investors. We analyze unilateral capital controls and a Nash equilibrium where both countries are allowed

[3] Papers with pecuniary externalities include Bianchi (2011), Benigno et al. (2013, 2016), Korinek and Sandri (2016), Korinek (2018) or Ma (2020). Aggregate demand externalities are featured in Farhi and Werning (2016), Korinek and Simsek (2016) or Schmitt-Grohe and Uribe (2016).

to impose capital controls taking the action of the other regulator as given. The main insight from this experiment is that intervention also depends on the business cycle comovement. If business cycles in the two economies are synchronous, bonds have a similar risk profile and are therefore jointly riskier. As a result, investors demand additional compensation, which ceteris paribus increases regulatory intervention.

The idea that countries have monopoly power and might wish to alter relative prices via capital controls is related to De Paoli and Lipinska (2012) and Costinot et al. (2014). In De Paoli and Lipinska (2012), a regulator has an incentive to manipulate the intratemporal terms of trade with foreign countries to smooth output fluctuations. In our framework, a regulator finds it optimal to alter the risk premium and hence intertemporal prices. This is similar to Costinot et al. (2014), where capital inflow controls are imposed to manipulate the world interest rate in order to adjust relative consumption prices in two consecutive periods. Our paper differs in two ways: first, we only require an influence on the domestic risk premium rather than world interest rates. Second, capital controls in our framework are driven by the risk aversion of investors and uncertainty in international financial markets, features that are not discussed in Costinot et al. (2014).

2. Stylized Facts

This section provides two new insights: First, we suggest a simple algorithm to identify emerging markets that actively evaluate their capital control policies. Second, we show that these "active" emerging markets respond to global financial conditions, particularly to investors' risk aversion and volatility in international financial markets.

2.1. Active Capital Control Management

Though capital controls are common among emerging markets, they tend to be persistent (Klein, 2012), which poses a challenge in detecting any regularities. We, therefore, first identify "active" countries that frequently adjust their capital controls.

We resort to Fernández et al. (2016) for annual data on capital controls. The authors manually interpret and code inflow and outflow information for up to ten asset categories provided by the Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) since 1995. The distinction between inflow and outflow restrictions is both policy-relevant and theoretically appealing. Much of the recent policy debate centers around managing capital inflows from international investors (see, for example, Ostry et al., 2010; Ostry et al., 2011; Forbes et al., 2015). Further, from a theoretical perspective, capital controls are meant to curb current account reversals for indebted countries, which subsequently justifies inflow restrictions (see, for example, Bianchi, 2011; Schmitt-Grohe and Uribe, 2016; Korinek, 2018). The model we propose in the next section also advocates inflow controls. We consider inflow restrictions from any asset category but exclude foreign direct investment (FDI), since FDI investments are long-term and politically motivated. Data is available for 68 EMs over 23 years.[4]

There is no established procedure to identify countries with active capital controls. Hence, we focus on a plausible condition and refer the reader to the appendix for a host of robustness checks. As a baseline, we identify a country as active if its inflow restrictions are more volatile than the sample average across all countries. We proceed in two steps. We first compute the standard deviation of changes in inflow restriction across all countries and years. We then compare this number to the standard deviation of each country and classify a country as active if its standard deviation is higher than the sample average. We prefer a threshold based on the standard deviation over a threshold based on the number of years in which a country changed its capital controls. The latter only captures the extensive margin, i.e., the frequency of adjustments, but not the number of adjustments during a year (intensive margin).

Table 1 lists the 22 EMs that satisfy our criterion ranked by the country-specific standard deviation (column 1). In column 2, we report the relative frequency at which countries adjust their capital controls. All countries except Uganda change their capital inflow controls at least every five years (Change > 0.2). Some countries like Brazil, Columbia, Kazakhstan, or Russia adjust their controls at least every second year on average (Change > 0.5). Columns 3 and 4 split changes in capital inflow restrictions into increases or decreases. As apparent, most countries tend to balance their adjustments.[5]

[4] Fernández et al. (2016) resort to binary indicators for restrictions on individual asset categories. We therefore cannot capture the intensity of capital controls nor higher frequency adjustments as for example in Ahmed and Zlate (2014), Forbes et al. (2015) or Ghosh et al. (2017). We nevertheless prefer this measure due to the distinction between inflow/outflow controls and the wide coverage across different asset classes, countries, and time.

[5] We provide a comparison between active and inactive countries along various dimensions in Table B7. Two differences are noticeable. First, active countries have a sizable current account deficit, while inactive countries experience a surplus. Second, active countries have a lower credit to GDP ratio.

Table 1: *Active Countries: Descriptive Statistics*

Country	Std. Dev.	Change	Increase	Decrease
Algeria	.294	.5	.318	.182
Moldova	.244	.478	.304	.174
Brazil	.23	.609	.348	.261
Argentina	.213	.522	.391	.13
Nigeria	.18	.391	.174	.217
Hungary	.172	.261	.174	.087
Kazakhstan	.169	.739	.261	.478
Bahrain	.165	.522	.261	.261
Venezuela	.152	.391	.304	.087
Chile	.147	.348	.087	.261
Ethiopia	.134	.391	.217	.174
Poland	.134	.478	.174	.304
Bulgaria	.132	.217	.087	.13
Vietnam	.122	.391	.217	.174
Colombia	.119	.609	.391	.217
Russian Federation	.118	.565	.217	.348
Ecuador	.113	.304	.13	.174
Uganda	.11	.087	.043	.043
Ghana	.109	.391	.174	.217
Tanzania	.109	.391	.174	.217
Lebanon	.105	.435	.261	.174
Mexico	.103	.435	.217	.217

Notes*: Column 1 displays the standard deviation of capital inflow control adjustments for each country. Columns 2-4 portray the relative frequency that a country changes/increases/decreases its capital inflow controls in any given year. The statistics are computed as the number of years with changes/increases/decreases divided by the number of years with available data. Sample: 1995-2017.*

2.2. Capital Controls during Global Financial Distress

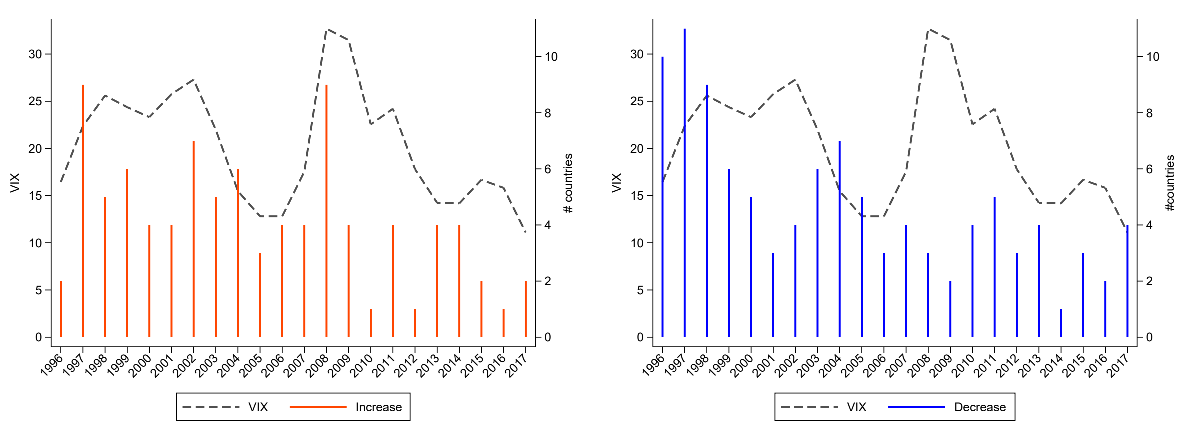
The new empirical insight from this paper is that active emerging markets adjust their capital inflow restrictions pro-cyclical in response to global financial conditions. In more detail, we show that countries tend to tighten restrictions during periods of global financial distress. A decomposition of financial distress into risk aversion and volatility reveals that both factors contribute to this finding.

We proxy international financial conditions by the VIX. This index measures the volatility of the U.S. stock market (S&P 500) and is based on option prices (so-called "implied volatility"). As high values of the VIX are associated with plummeting asset prices around the world, it has been widely used in the literature to proxy for global financial conditions (Bekaert et al., 2013; Bruno and Shin, 2014; Ghosh et al., 2014; Miranda-Agrippino and Rey, 2020).

Figure 1 provides descriptive statistics on the comovement of capital inflow restrictions and global financial distress. Both panels plot the VIX against the number of active countries that increased (Panel (a)) or decreased (Panel (b)) the number of inflow restrictions relative to the previous year.[6] Based on Panel (a), active emerging markets tend to increase capital controls during periods of global financial distress as identified by the Asian Crisis, the Dot-Com Bubble, and the 2008 Financial Crisis. At the height of the 2008 Financial Crisis, for example, nine countries (41% of all active countries) imposed additional restrictions. Further, only a few countries increase restrictions during financially stable periods, specifically between the years 2003 and 2007 or post 2008. On the other hand, we do not observe such patterns for decreases in Panel (b). In fact, it seems difficult to detect any specific regularities, besides spikes during the run-up to the Asian Crisis and after the Dot-Com Bubble.

Figure 1: *Capital Inflow Controls and the Global Financial Cycle*

(a) *Increase* ***(b)*** *Decrease*



Notes*: The orange (blue) bars represent the number of active emerging markets (counted on the right y-axis) that increased (decreased) their capital inflow controls during a given year. The dashed grey line displays the VIX (level displayed on the left y-axis).*

The evidence so far is purely descriptive. We next provide more nuanced results based on a formal regression analysis. First, we regress the two indicators (Increase, Decrease) on a cubic ln(VIX) polynomial. To fix ideas, we estimate

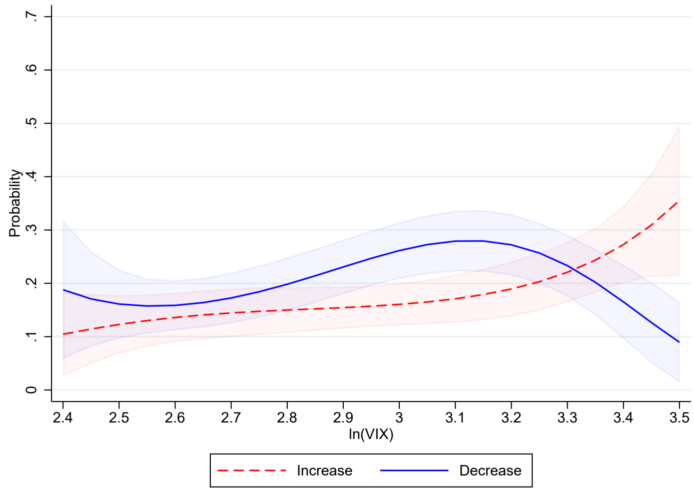
$$Prob(y_{i,t} = 1) = F\left(\beta_0 + \beta_1 ln(VIX)_t + \beta_2 ln(VIX)_t^2 + \beta_3 ln(VIX)_t^3\right) \quad (1)$$

where $y_{i,t} \in \{\text{Increase}_{i,t}, \text{Decrease}_{i,t}\}$. The term $F(\cdot)$ refers to the logistic function. We choose a third-order polynomial to capture a potentially non-linear relationship between the decision to increase/decrease capital flow restrictions and global financial conditions. As evident from Figure 2 and consistent with the previous descriptive analysis, countries are significantly more likely to increase restrictions

[6] The number of inflow restrictions is the sum over binary inflow restriction dummies for each asset category excluding FDI.

once international financial markets are in distress (dashed red line). On the contrary, countries are most likely to decrease restrictions during moderate levels of financial distress. The difference between the two regression lines is significant, particularly for moderate and high levels of the VIX. We thus conclude that countries tend to adjust capital inflow controls in a pro-cyclical manner, which is inconsistent with most theories on optimal capital controls in the literature.

Figure 2: *Capital Controls and the VIX*

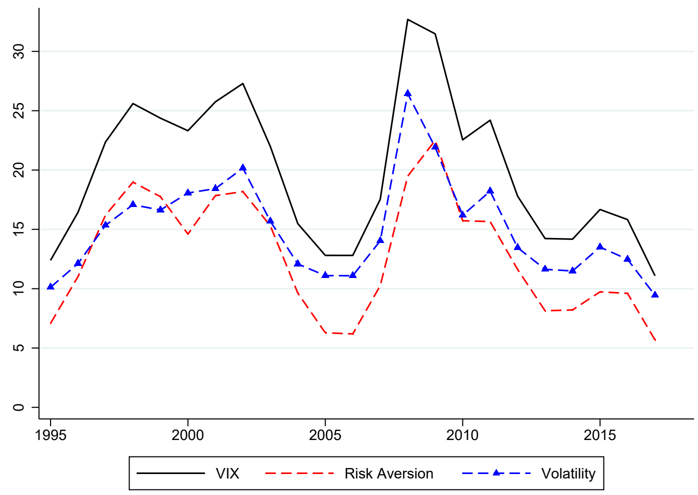


Notes: *The dashed red (solid blue) line displays the probability of increasing (decreasing) capital inflow controls (y-axis) as a function of ln(VIX) (x-axis). Shaded areas indicate 90% predictive margins. The underlying regression model is a logit model with a cubic polynomial and no control variables as portrayed in Equation (1). Active emerging markets only. Sample: 1995-2017.*

Decomposing the VIX

The VIX is a measure of implied volatility which estimates anticipated fluctuations in asset prices. Implied volatility is unobserved, but can be computed as a function of option prices. As is well known in the literature (see, for example, Bliss and Panigirtzoglou, 2004; Jackwerth, 2015) option prices contain information about risk aversion and volatility. Intuitively, if markets are volatile, it is more likely that options will be in the money at the expiration date, which increases the value of an option. Similarly, options can be used as a hedge against fluctuations. Thus if investors are more risk-averse, demand, and ultimately the price, for options increases. Since the VIX is a function of underlying option prices it is therefore possible to reverse engineer measures for risk aversion and uncertainty. We follow Bekaert and Hoerova (2014) and work with their decomposition of the VIX. Figure 3 displays the corresponding risk aversion and volatility series.[7] Both series exhibit similar patterns and are highly correlated with the VIX: they spike during the 2008 Financial Crisis and reach elevated levels during the Asian Crisis and the Dot-Com Bubble.

Figure 3: *Decomposing the VIX: Risk Aversion and Volatility*



Notes*: Time series of VIX (solid line), risk aversion (dashed red line) and volatility (dashed blue line with triangle markers) from 1995 until 2017.*

Since risk aversion and volatility closely track the VIX, it is not surprising that we obtain similar regression results when we replace the VIX with its subcomponents in Equation (1). We visualize the regression output in Figure 4. As evident, countries are significantly more likely to increase restrictions (dashed red line) if investors are more risk-averse or if markets are more volatile. In contrast, capital controls tend to decrease (solid blue line) once risk aversion or financial market volatility moderates.

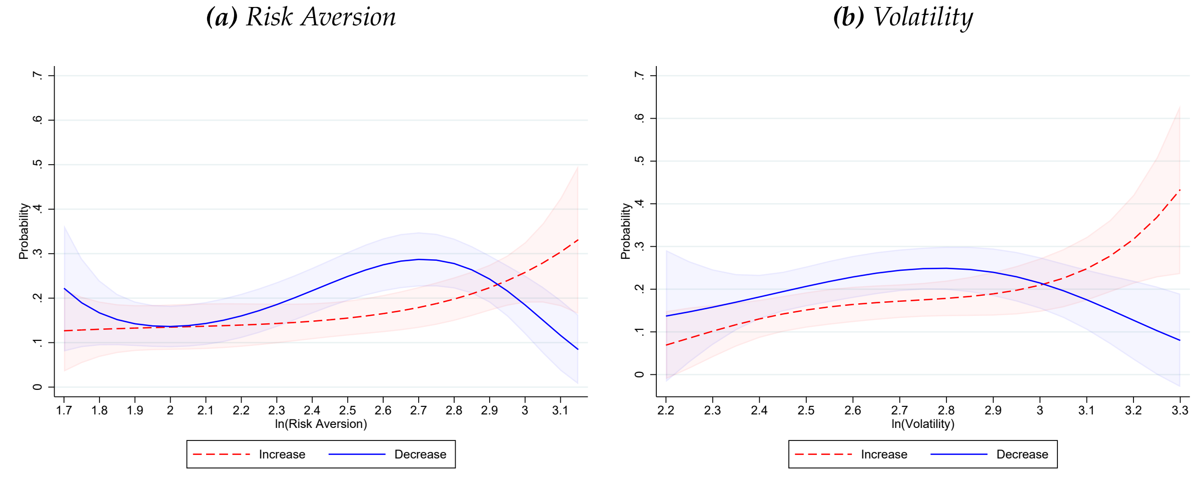
2.3. Robustness Checks

This section serves two purposes: First, we argue that global financial conditions influence capital inflow restrictions even when we control for various explanatory variables as suggested by the theoretical and empirical literature. Second, we verify that our results continue to hold if we resort to different (reasonable) classifications for active countries or alternative data for capital controls.

The theoretical literature on capital controls suggests that capital controls should be tightened if economies take on too much external debt. Crucially, these restrictions

[7] The volatility series depicts the conditional volatility of the S&P 500 index. The risk aversion series is referred to as variance premium in Bekaert and Hoerova (2014). The variance premium is a widely accepted proxy for the market-implied risk aversion (Bollerslev et al., 2009; Bekaert and Hoerova, 2014).

Figure 4: *Capital Controls, Risk Aversion and Volatility*



Notes: *The dashed red (solid blue) line displays the probability of increasing (decreasing) capital inflow controls (y-axis) as a function of risk aversion (Panel (a)) or volatility (Panel (b)) (x-axis). Shaded areas indicate 90% predictive margins. The underlying regression model is a logit model with a cubic polynomial and no control variables as portrayed in Equation (1), where we replaced ln(VIX) with the logarithmic volatility and risk aversion measure. Active emerging markets only. Sample: 1995-2017.*

should be imposed counter-cyclical, i.e., during periods of high growth and not during a recession (see, for example, Bianchi, 2011). We account for these arguments by adding GDP per capita growth, the change in the current account to GDP ratio to account for sudden stops, and credit to GDP growth (subsample only) to the regression. We also include a banking crisis indicator to explore if countries loosen their controls in response to severe domestic financial distress. The literature also motivates counter-cyclical restrictions due to nominal rigidities related to wage or price stickiness in combination with the zero lower bound or fixed exchange rates (see, for example, Farhi and Werning, 2016; Schmitt-Grohe and Uribe, 2016). Since data on wage growth is limited, we focus on inflation (subsample only) in our regression analysis. With downward wage or price stickiness, capital controls should increase when inflation is high to avoid price levels that are too high in future downturns.

From a policy perspective, capital controls are frequently motivated as a means to limit exchange rate overshooting and asset price bubbles. They may also prevent capital flows when interest rates among emerging markets and the base country differ (Ostry et al., 2010; Magud et al., 2018). We consequently control for exchange rate movements, stock markets (subsample only), and interest rate differentials (subsample only). Countries also require a proper institutional framework to implement capital controls in a meaningful way (Eichengreen and Rose, 2014). We, therefore, incorporate an institutional quality index.

To summarize this discussion, we estimate the following logit regression:

$$Prob(y_{i,t} = 1) = F\left(\beta_0 + X_t^G \beta_G + X_{i,t-1}^D \beta_D\right) \tag{2}$$

The dependent variable $y_{i,t}$ is binary and measures increases or decreases in capital inflow restrictions. Relative to Equation (1) and as explained above, we consider a variety of domestic variables in the vector $X_{i,t-1}^D$. We lag most domestic variables to mitigate reverse causality concerns. The vector X_t^G refers to global financial conditions (VIX, risk aversion or volatility, each separately considered).

Table 2 reports the regression results. As apparent, countries are more likely to increase inflow restrictions when financial distress is elevated (column 1). The VIX coefficients turn insignificant in column 2 due to the absence of third-order nonlinearities (Figure 2). However, a joint test reveals that the coefficients are overall highly significant (p-value: 0.023). We add domestic control variables in column 3. None of these variables explain the decision to increase capital controls. Further, financial distress remains a significant variable (p-value: 0.041), which suggests a direct effect on the decision to add restrictions. Countries tend to decrease inflow restrictions during somewhat moderate levels of financial distress (columns 4-6). Two domestic variables become relevant besides global financial conditions: Countries with better institutional quality and countries that experience a domestic banking crisis are more likely to decrease restrictions.[8]

Additional Checks

We perform various additional robustness checks. We delegate related regression tables to the appendix. Specifically, we obtain very similar results when we replace the VIX with its subcomponents, risk aversion and volatility (Table B1). We also experiment with additional control variables for which we have only limited data coverage (Table B2, B3). Though some variables are statistically significant, it is difficult to reconcile meaningful patterns. A widening interest rate differential, for example, reduces the likelihood of enhancing inflow controls, which contradicts existing wisdom. Countries, however, still respond to international financial conditions, despite the additional control variables. We also consider the Chinn-Ito Index (Chinn and Ito, 2006) as a measure for capital controls (Table B6, Figure C1). The results are qualitatively similar, but the significant difference between the likelihood to increase or decrease restrictions

[8] The result pertaining banking crises supports the theories on macroprudential capital controls due to pecuniary externalities. In this literature, capital controls should be imposed during tranquil periods and eased once the economy hits a (financial) recession. To our knowledge, this is the first panel study that finds empirical evidence supporting this complementary view.

Table 2: *Results Logit Model*

	Increase in Inflow Restrictions			Decrease in Inflow Restrictions		
	(1)	(2)	(3)	(4)	(5)	(6)
$ln(VIX)$	0.35**	24.31	18.83	0.09	-61.41*	-58.75*
	(0.14)	(33.19)	(34.11)	(0.11)	(35.19)	(34.88)
$ln(VIX) \times ln(VIX)$		-2.68	-2.08		6.86*	6.58*
		(3.54)	(3.64)		(3.78)	(3.75)
$ln(VIX) \times ln(VIX) \times ln(VIX)$		0.10	0.08		-0.25*	-0.24*
		(0.13)	(0.13)		(0.13)	(0.13)
$\Delta CA/GDP_{-1}$			-0.02			-0.03
			(0.03)			(0.03)
$\Delta log(GDP/CAP)_{-1}$			0.04			-0.05
			(0.04)			(0.03)
$\Delta log(ExchangeRate)_{-1}$			0.00			0.00
			(0.00)			(0.00)
$Inst.Quality$			-0.04			0.26**
			(0.12)			(0.11)
$BankingCrisis$			-0.30			1.25*
			(0.92)			(0.75)
p-value: Domestic = 0			0.793			0.085
p-value: VIX = 0	0.010	0.023	0.041	0.431	0.062	0.095
Pseudo R^2	0.017	0.021	0.026	0.001	0.018	0.041
Observations	451	451	451	451	451	451

Notes: *Institutional quality and ln(VIX) are standardized. A constant is estimated, but not displayed. Active emerging markets only. Sample: 1995-2017. Huber-White robust standard errors in parentheses. Stars indicate significance levels (*10%, **5%, ***1%).*

vanishes. We attribute this to the nature of the index. The Chinn-Ito Index aggregates over inflow and outflow restrictions. These restrictions have opposite effects on net flows and may hence offset each other. Last but not least, we vary the threshold for the definition of active countries (Tables B4, B5). We find that the significance of our results improves with the tightness of the classification. We conclude that global financial conditions are a significant factor in the decision to adjust capital flow restrictions.

3. Analytical Framework

This section provides a stylized model that ultimately justifies pro-cyclical capital inflow controls as a means to lower the overall debt burden, limit current account reversals and manipulate the risk premium. Three elements are crucial: First, we explicitly model risk-averse international investors who allocate their funds between safe and risky assets. Second, emerging market debt is subject to default. Third, emerging markets are more likely to default when international markets are riskier.

Consequently, investors are more sensitive to emerging market risk if (i) their risk aversion increases or if (ii) their international portfolio becomes riskier. As we show in Section 4.1, a domestic regulator, who exerts influence on the emerging market risk premium, exploits this heightened sensitivity and rationally increases inflow controls when international investors are more responsive to emerging market debt. All proofs are delegated to Appendix D.

3.1. Environment

The economy consists of two periods $\{t, t+1\}$ and features two agents, borrowers (B) in an emerging market of size χ and international investors (I) with measure one. Both agents are risk-averse and derive utility from consumption ($c_{i,t}$) with $i \in \{B, I\}$.

To intertemporally allocate funds, investors choose between two assets at the beginning of the first period. Risk-free one-period bonds (l_{t+1}) with inelastic supply that one can think of as a safe investment opportunity in advanced economies and risky one-period bonds ($b_{I,t+1}$) which are traded with borrowers from the emerging market. Investors also hold a risky exogenous portfolio (a_{t+1}) that represents international financial markets. Borrowers in the emerging market are required to issue debt to finance consumption in period t. The debt is subject to default. With probability p, all borrowers will decide to forgo their debt burden and hence not repay in period $t+1$. We can therefore define two states: If $s = 1$, the emerging market defaults. If $s = 0$, the emerging market repays its debt. There is no production, and endowments for both agents are exogenous. We subsequently characterize the environment in more detail.

International Investors: International investors are risk-averse. They maximize expected period $t+1$ utility by choosing consumption ($c_{I,t+1}$) and an appropriate portfolio of risk-free (l_{t+1}) and risky emerging market bonds ($b_{I,t+1}$). Since emerging market bonds are subject to default with probability p, investors require a risk premium RP_t beyond the normalized gross return of one on the safe asset. Investors also hold an exogenous risky asset (a_{t+1}). It is best to think about this risky asset as a "rest of the world" portfolio that has been selected before period t. We do not endogenize this object to gain analytical tractability. The objective function is characterized as

$$\max_{c_{I,t+1}, b_{I,t+1}, l_{t+1}} \left\{ E_t[v_{t+1}(c_{I,t+1})] \right\}. \tag{Po:I}$$

The assumption that investors do not consume in period t is without loss of generality. We impose exponential utility, i.e., $v_{t+1}(c_{I,t+1}) = -exp(-\lambda c_{I,t+1})$. The parameter λ

represents the level of risk aversion. If $\lambda > 0$, investors are risk-averse.[9] $E_t[\cdot]$ is the expectations operator with respect to time t.

Investors receive an initial endowment ($e_{I,t}$), but no endowment in $t+1$. With the previous information, the budget constraints of investors are[10]

$$b_{I,t+1} + l_{t+1} = e_{I,t} \tag{3}$$
$$c_{I,t+1} = (1 + RP_t)\overline{b_{I,t+1}} + l_{t+1} + a_{t+1}. \tag{4}$$

The process for $\overline{b_{I,t+1}}$ is described as:

$$\overline{b_{I,t+1}} = \begin{cases} b_{I,t+1} & \text{with probability } 1-p, \\ 0 & \text{with probability } p. \end{cases} \tag{5}$$

We do not take a stance on why emerging market bonds are risky. Instead, we simply model the observation that international debt financing in emerging markets is risky and frequently associated with sovereign default. We provide empirical support for this notion in Figure C2.[11]

International financial markets and hence the payoff from portfolio a_{t+1} are uncertain and follow a normal distribution with mean μ and standard deviation σ. The parameter σ characterizes international financial volatility, i.e., one of the two components of the VIX. We make one crucial assumption regarding the risk profile of emerging market debt and the international financial market:

Assumption 1 *International Comovement*

$$p(\sigma) \text{ and } \frac{\partial p(\sigma)}{\partial \sigma} > 0.$$

We hence assume that the emerging market is more likely to default when international financial markets are riskier. This notion captures the idea of a global financial cycle which manifests in the comovement of financial assets. The main implication of this dependency is that investors do not wish to purchase emerging market bonds as a hedge against risk from international markets. This assumption is based on empirical

[9] This specific functional form simplifies the analysis. We numerically verify the robustness of this choice with more standard CRRA preferences for investors and borrowers in the appendix.

[10] As apparent from the budget constraints, we model the risky portfolio (a_{t+1}) as a risky endowment in period $t+1$. We could subtract exogenous expenses for the portfolio in the first period. This would merely reduce available endowment with no consequences for any subsequent result.

[11] A variety of studies on emerging markets motivate default/credit spreads as a consequence of political instability (see, for example, Citron and Nickelsburg, 1987; Cuadra and Sapriza, 2008). Complementary literature argues that default depends on income fluctuations and hence the stance of the business cycle (see, for example, Arellano, 2008). In these papers, default is more likely in recessions when it is more costly for a risk-averse borrower to repay noncontingent debt.

grounds. In Table B8, we show that emerging markets are more likely to experience an external debt crisis if international markets have been volatile.

Emerging Market: The emerging market is populated by households who wish to consume during both periods ($c_{B,t}, c_{B,t+1}$). Unlike investors, households receive their endowment ($e_{B,t+1}$) in period $t+1$ and are therefore required to issue international debt ($b_{B,t+1}$) to finance consumption in the first period. Bonds are purchased by international investors and risky, as described previously. Throughout the paper, we maintain the assumption that investors are more wealthy than households from emerging markets, i.e., $e_{I,t} > e_{B,t+1}$. This assumption ensures an interior solution in which investors purchase both assets. Domestic borrowers maximize utility

$$\max_{c_{B,t}, c_{B,t+1}, b_{B,t+1}} \left\{ u_t(c_{B,t}) + E_t[u_{t+1}(c_{B,t+1})] \right\}. \tag{Po:EM}$$

We adopt a log-quasilinear utility function with $t+1$ consumption as the numéraire to gain analytical tractability. Therefore, $u_t(c_{B,t}) = ln(c_{B,t})$ and $u_{t+1}(c_{B,t+1}) = c_{B,t+1}$. Log-utility during period t ensures that households always borrow internationally. We assume that $e_{B,t+1}$ is large enough such that households are able to smooth their marginal utilities across both periods.

The budget constraints in both periods correspond to

$$c_{B,t} = b_{B,t+1} \tag{6}$$
$$c_{B,t+1} = e_{B,t+1} - (1 + RP_t)\overline{b_{B,t+1}}. \tag{7}$$

The term $\overline{b_{B,t+1}}$ captures the amount of debt that households repay to international investors (see Equation (5)). Since households simultaneously do not repay their debt with probability $p(\sigma)$, they are required to pay a risk premium (RP_t). This piece completes the description of the model.

3.2. Unregulated Equilibrium

We start by defining the unregulated equilibrium. Following the convention in the literature, we use aggregate letters to denote aggregate quantities. For example, $C_{B,t}$=$\int_0^{\chi} c_{B,t} dj$ = $\chi c_{B,t}$.

Definition 1 (Unregulated Equilibrium): *The unregulated equilibrium is characterized by the risk premium RP_t and endogenous quantities $\{c_{B,t}, c_{B,t+1}, c_{I,t+1}, b_{B,t+1}, b_{I,t+1}, l_{t+1}\}$ such that*

1. *international investors maximize utility* (Po:I) *subject to the constraints* (3) *and* (4) *taking the risk premium as given;*

2. *borrowers in the emerging market maximize utility* (Po:EM) *subject to the constraints* (6) *and* (7) *taking the risk premium as given;*

3. *the market for emerging market bonds clears, that is* $B_{I,t+1} = B_{B,t+1}$.

Analysis

International Investors: The first-order condition balances the marginal utilities from safe assets and risky emerging market bonds. Combined with the budget constraints, Equations (3) and (4), the first-order condition gives rise to a demand function for emerging market bonds. This investor-specific demand can be aggregated over all investors, which implicitly determines the required risk premium as a function of total bond purchases.

$$RP_t = \frac{p(\sigma)}{1-p(\sigma)} \frac{E_t[v'_{t+1}(E_{I,t} - B_{I,t+1} + A_{t+1})]}{E_t[v'_{t+1}(E_{I,t} + RP_t B_{I,t+1} + A_{t+1})]}. \tag{AD}$$

The required risk premium is a probability-weighted ratio of marginal utilities from consumption. The risk premium is high if consumption during default is scarce, i.e., when $E_t[v'_{t+1}|s{=}1]$ is large, or if the probability of default is high. In either case, safe assets become more desirable, which must be offset by a higher risk premium.[12]

The following assumption guarantees the existence of the aggregate demand curve.

Assumption 2 *Existence*

$$1 + \frac{p(\sigma)}{1-p(\sigma)} \frac{E_t[v'_{t+1}|s{=}1] E_t[v''_{t+1}|s{=}0] B_{I,t+1}}{E_t[v'_{t+1}|s{=}0]^2} > 0.$$

The assumption appears technical, but it ensures that (aggregate) demand has a fixed point in RP_t. In other words, with Assumption 2 the right hand side of Equation (AD) grows by less than one for a marginal change in the risk premium. This requirement is satisfied as long as p and investors' risk aversion are not too high.

Emerging Market: Optimization by borrowers leads to a standard Euler equation augmented for potential default. Similar to the demand equation for emerging market bonds, we can aggregate over all borrowers and plug in constraints (6) and (7). The resulting implicit aggregate supply curve links the aggregate supply of emerging market bonds to the prevailing risk premium:

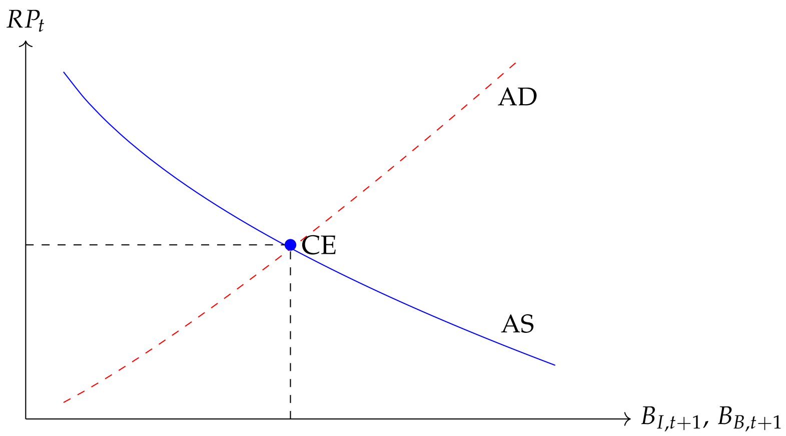
[12]The term $v'_{t+1}|s{=}1$ denotes the marginal utility during default. The expression is hence equivalent to $v'_{t+1}(E_{I,t} - B_{I,t+1} + A_{t+1})$.

$$u_t'(B_{B,t+1}) = (1 - p(\sigma)) \left(u_{t+1}'(E_{B,t+1} - (1 + RP_t)B_{B,t+1})\right)(1 + RP_t). \tag{AS}$$

The left hand side of the equation denotes the marginal utility from consumption in period t. The right hand side reflects the expected utility costs associated with borrowing one more unit. In case of default, households keep their borrowed funds and the costs are zero.

The Bond Market Equilibrium: The equilibrium is derived by setting aggregate demand equal to aggregate supply as illustrated in Figure 5. As apparent, aggregate demand for emerging market bonds is increasing in the risk premium. A higher risk premium makes emerging market bonds more attractive for international investors. Conversely, more emerging market debt increases the wedge between the marginal utilities in the default/no default state and mandates a higher risk premium.

Figure 5: *Bond Market Equilibrium*



Notes: *The solid blue line characterizes the aggregate supply and the dashed red line the aggregate demand of emerging market bonds as a function of the risk premium. The unregulated equilibrium is marked (CE).*

Aggregate supply is downward sloping. The risk premium decreases available consumption in period $t + 1$ if borrowers do not default. A higher risk premium, therefore, reduces the willingness to issue debt. Equivalently, the marginal period t utility for households is decreasing in consumption. Since date t consumption equals borrowings, households issue additional bonds only at a lower risk premium.

We formally prove the existence of a unique equilibrium in the appendix and state this observation in Lemma 1.

Lemma 1: *The bond market equilibrium exists and is unique.*

4. Optimal Pro-cyclical Capital Controls

Can a regulator of an emerging market increase domestic welfare relative to the unregulated equilibrium? In other words, would a planner distort the supply of emerging market debt? The answer to these questions is affirmative. We model the regulator as a monopolist on the supply of bonds who internalizes the positive relationship between debt absorption and the risk premium as postulated by the aggregate demand curve. More intuitively, a regulator understands that more debt leads to a higher risk premium, making issuing debt ceteris paribus less attractive. She consequently reduces the amount of debt relative to the unregulated equilibrium, which also diminishes the current account reversal between periods t and $t+1$. Since a regulator intervenes due to monopoly power, she effectively extracts rent from international investors. Any intervention, therefore, does not maximize the combined welfare of international investors *and* domestic borrowers. As such, a regulator improves welfare in the emerging market at the expense of international investors. The justification for intervention in this model is hence fundamentally different from the literature on aggregate demand or pecuniary externalities where competitive allocations are inefficient.

We follow the dynamic public finance literature and use the primal approach (Lucas and Stokey, 1983). That is, a national planner directly chooses the consumption path of domestic households and the supply of emerging market bonds (Section 4.1). Subsequently, we decentralize the allocation via capital inflow controls (Section 4.2). Afterward, we discuss how capital controls respond to volatility in international financial markets and investor risk aversion (Section 4.3). We conclude this chapter with numerical illustrations where we vary the size of the emerging market and include a second (foreign) emerging market (Section 4.4). Throughout the analysis, we assume that international investors continue to act competitively, i.e., they still demand risky bonds according to Equation (AD).

4.1. National Planner Equilibrium

The national planner maximizes utility on behalf of all households in the emerging market

$$\max_{C_{B,t}, C_{B,t+1}, B_{B,t+1}} \int_0^{\chi} \left\{ u_t\left(\frac{C_{B,t}}{\chi}\right) + E_t\left[u_{t+1}\left(\frac{C_{B,t+1}}{\chi}\right)\right]\right\} dj, \tag{Po:NP}$$

subject to the budget constraints and an implementability constraint

$$C_{B,t} = B_{B,t+1} \tag{8}$$
$$C_{B,t+1} = E_{B,t+1} - (1 + RP_t)\overline{B_{B,t+1}} \tag{9}$$
$$RP_t = \frac{p(\sigma)}{1 - p(\sigma)} \frac{E_t[v'_{t+1}(E_{I,t} - B_{B,t+1} + A_{t+1})]}{E_t[v'_{t+1}(E_{I,t} + RP_t B_{B,t+1} + A_{t+1})]}. \tag{10}$$

There are two differences relative to the unregulated optimization problem: First, the national planner chooses aggregate quantities as represented by capital letters. Second, the planner internalizes the dependency between the risk premium and the aggregate demand of bonds, which in equilibrium must equal supply. The planner hence de-facto chooses the level of bond supply on the aggregate demand curve that maximizes domestic welfare. Equation (10) reflects this notion and consequently serves as an implementability constraint.

Definition 2 (National Planner Equilibrium): *The planner equilibrium is characterized by the risk premium RP_t and endogenous quantities $\{c_{B,t}, c_{B,t+1}, c_{I,t+1}, b_{B,t+1}, b_{I,t+1}, l_{t+1}\}$ such that*

1. *international investors maximize utility (Po:I) subject to the constraints (3) and (4) taking the risk premium as given;*
2. *a national planner maximizes utility (Po:NP) subject to the constraints (8), (9) and (10);*
3. *the market for emerging market bonds clears that is $B_{I,t+1} = B_{B,t+1}$;*
4. *aggregate quantities are proportionally distributed, e.g., $c_{B,t} = \frac{C_{B,t}}{\chi}$.*

Analysis

We focus on the emerging market, since international investors do not change their behaviour. The Euler equation for the national planner is summarized as

$$u'_t = (1 - p(\sigma))(u'_{t+1}|s = 0)\Bigg(\underbrace{(1 + RP_t)}_{\text{Quantity Effect}} + \underbrace{\frac{\partial RP_t}{\partial B_{I,t+1}} B_{B,t+1}}_{\text{Price Effect}} \Bigg). \tag{AS:NP}$$

The national planner Euler equation equalizes the marginal utility from consumption in period t with its expected utility costs. The costs can be split into two parts: a quantity effect and a price effect, each multiplied by the marginal utility. The quantity effect states that borrowings in period t require a repayment of 1+RP_t in case the emerging market does not default. The price effect is absent in the unregulated first-order condition. A national planner internalizes that international investors demand a higher marginal compensation for each additional bond they are holding ($\frac{\partial RP_t}{\partial B_{I,t+1}} > 0$). This derivative is positive as emphasized in Figure 5 and multiplied by the total number of bonds that the national planner supplies. Importantly, the price effect makes period t consumption more costly. The national planner therefore issues strictly less debt than households in the unregulated equilibrium. We summarize this finding in the first proposition.

Proposition 1 (Overborrowing): *The national planner internalizes the positive link between the issuance of risky bonds and the required risk premium as postulated by the aggregate demand curve* (AD). *As a consequence, she issues strictly fewer bonds than individual households in the unregulated equilibrium.*

4.2. Implementation

The national planner solution can be decentralized by a period t tax (τ) on emerging market debt akin to price-based capital inflow controls. The budget constraint for borrowers becomes

$$c_{B,t} = (1-\tau)b_{B,t+1} + T.$$

The term $T = \tau b_{B,t+1}$ represents lump sum transfers from tax revenues to avoid wealth effects. A positive value of τ induces households to borrow less. With this adjustment, the Euler equation in the regulated equilibrium aggregated over all individuals is

$$u'_t(1-\tau) = (1-p(\sigma))(u'_{t+1}|s=0)(1+RP_t). \tag{AS:CC}$$

Optimization with the tax leads to a modified aggregate supply curve that resembles the unregulated supply curve apart from the additional term $1-\tau$. The optimal level of capital controls is then chosen to close the wedge between the regulated aggregate supply curve and the national planner's first-order condition. We characterize this optimal level in the following proposition.

Proposition 2 (Optimal Capital Controls): *Capital controls on inflows maximize domestic welfare by implementing the national planner allocation. The optimal level of capital controls (τ) is characterized as*:

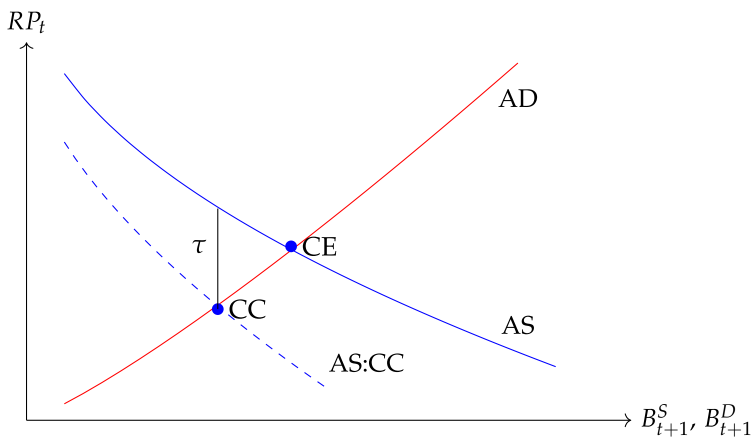
$$\tau = \underbrace{(1-p(\sigma))\frac{(u'_{t+1}|s=0)}{u'_t}}_{\text{Rel. Cost}}\underbrace{\frac{\partial RP_t}{\partial B_{I,t+1}}B_{B,t+1}}_{\text{Price Effect}}.$$

All quantities are evaluated at the national planner equilibrium.

The second proposition characterizes the optimal level of capital controls. It can be decomposed into two parts. The first component reflects the relative costs in terms of marginal utilities. If consumption is scarce in period t, u'_t is large and it is not optimal to tax period t consumption/borrowings heavily. On the other hand, if consumption in case of no default is small, u'_{t+1} is large, and a high tax is optimal to shift consumption towards period $t+1$. The second term of the optimal tax formula reflects the monopoly power of the national planner. The derivative $\frac{\partial RP_t}{\partial B_{I,t+1}}$ determines the extent to which a national planner is able to manipulate the risk premium. The term is multiplied by $B_{B,t+1}$, which essentially reweighs the monopoly power by its relevance akin to the actual bond supply.

We illustrate the regulated equilibrium in Figure 6. The regulated aggregated supply curve (AS:CC) is below the aggregate supply curve of the unregulated equilibrium. The wedge between both curves equals τ and hence the level of capital controls.

Figure 6: *Regulated versus Unregulated Solution*



Notes: *The solid blue line characterizes the aggregate supply of emerging market bonds in the unregulated equilibrium and the dashed blue line the aggregate supply in the regulated equilibrium with capital controls (τ). The solid red line represents aggregate demand by international investors. The two equilibria are marked.*

4.3. Volatility and Investor Risk Aversion

How should regulators adjust capital controls in response to elevated volatility and risk aversion? With the previous analysis in mind, we are now able to characterize this link theoretically, which is the central contribution of this model.

The main takeaway from this section is that increasing capital inflow controls during periods of high volatility and risk aversion, as observed in the data, is consistent with a rational, domestic welfare-maximizing regulator in an emerging market. To justify this observation within our framework, we require that $\frac{\partial \tau}{\partial \lambda} > 0$ and $\frac{\partial \tau}{\partial \sigma} > 0$. As a reminder, the parameter λ captures international investors' risk aversion. The parameter σ characterizes the standard deviation of the international portfolio and hence reflects global financial volatility.

Risk Aversion

Proposition 3: *A national regulator optimally raises the level of capital inflow controls in response to elevated international risk aversion and vice versa, i.e.,*

$$\frac{\partial \tau}{\partial \lambda} > 0.$$

This proposition provides a normative justification for the empirical regularities uncovered earlier. The intuition for this result is as follows: As investors become more risk-averse, they increasingly care about the riskiness of their portfolio and hence the mixture of risky and risk-free bonds. Consequently, investors are more responsive to portfolio adjustments, and their sensitivity to risky asset holdings increases. This manifests in a steeper aggregate demand curve ($\frac{\partial^2 RP_t}{\partial B_{I,t+1} \partial \lambda} > 0$), as risk-averse investors require additional compensation for risky assets compared to less risk-averse investors. A steeper aggregate demand curve has immediate effects on the monopoly power of a national regulator. The planner has more impact on the required risk premium by choosing a point on the aggregate demand curve, i.e., the price effect mentioned earlier in Proposition 2 increases, and a planner would issue less risky bonds. Since households do not internalize this effect, the wedge between the planner and the unregulated allocation widens. To close this wedge, capital controls must increase.

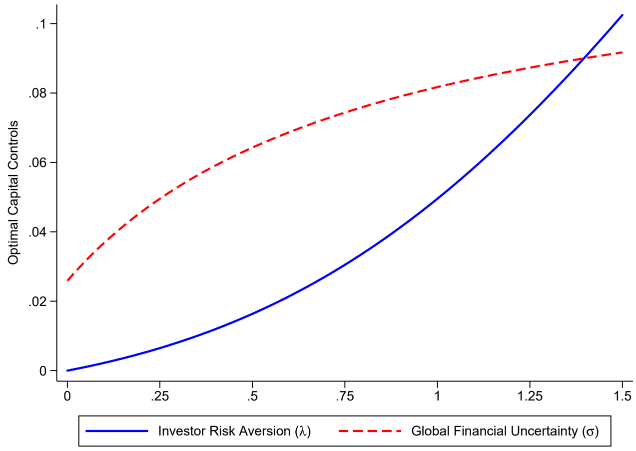
We illustrate the proposition in Figure 7 (solid blue line). Clearly, as the risk aversion of investors rises (x-axis), the optimal level of capital controls (y-axis) increases. Notice that optimal capital controls are zero if investors are risk neutral. In this case, investors do not care about the riskiness of their assets and the aggregate demand curve is flat.

Financial Volatility

Proposition 4: *A national regulator optimally raises the level of capital inflow controls in response to global financial volatility and vice versa, i.e.,*

$$\frac{\partial \tau}{\partial \sigma} > 0.$$

Figure 7: Optimal Capital Controls, Risk Aversion and Volatility



***Notes**: The plot displays the optimal level of capital controls τ (y-axis) as a function of the risk aversion of international investors (λ, solid blue line) or volatility in international financial markets (σ, dashed red line). Calibration: χ=1, p=0.02 (solid blue line), p=$0.05\frac{\sigma}{1+\sigma}$+0.01 (dashed red line), λ=1 (dashed red line).*

The proposition justifies the behavior of various emerging markets in our empirical exercise. But what drives this result? First, international investors dislike risk, hence investors prefer to hedge against a riskier international portfolio. Second, since risky emerging market bonds are more likely to default during periods of global financial distress, investors increase their relative demand for safe assets. Similar to our previous exposition on risk aversion, investors consequently require a higher marginal compensation for risky emerging market debt. As a result, the aggregate demand curve becomes steeper, which increases intervention via capital controls.

The positive relationship between capital controls and volatility is displayed in Figure 7 (dashed red line). As markets are generally more uncertain (x-axis), optimal capital controls (y-axis) increase.

4.4. Monopoly Power Revisited

The previous narrative provides a clear justification for regulatory intervention via capital controls from the perspective of an emerging market: Intervention in international capital markets reduces the amount of international debt, diminishes current account reversals and lowers the required risk premium. The strength of intervention is thereby tied to the monopoly power of the emerging market, which is increasing in risk aversion and volatility. An emerging market has a natural monopoly on its own debt, but how relevant is this characteristic in practice? To shed light on this issue, we examine two experiments. First, we vary the size of the emerging market and analyze its implication on the optimal tax. Second, we add a second emerging market that competes with the other emerging market for funds from international investors.

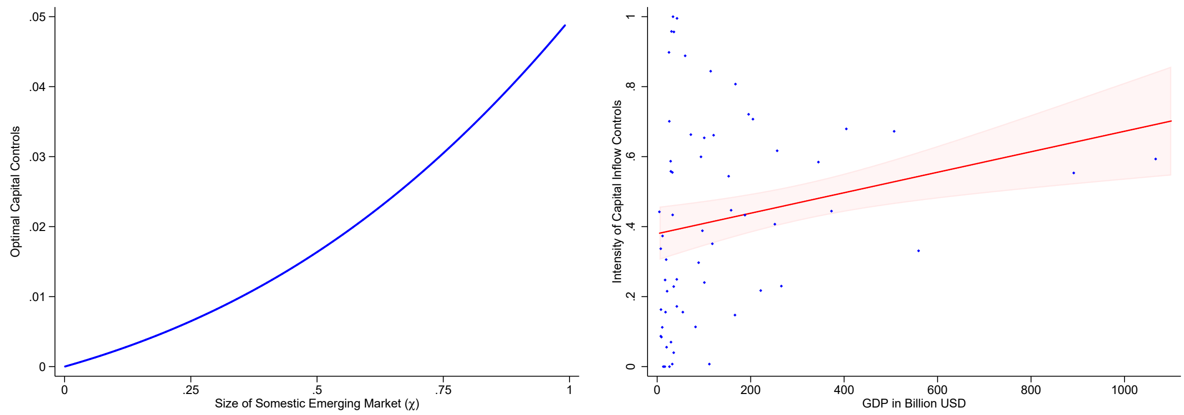
Country Size

Small emerging markets naturally issue less debt and are hence quantitatively less relevant in international portfolios. As such, a regulator may have limited ability to manipulate the risk premium simply because investors are less sensitive to debt from the specific emerging market. As a consequence, intervention via capital controls would be muted. Indeed, this is what we observe both in our model and the data, as Figure 8 emphasizes.

Concerning the model, we capture the size of an emerging market with the parameter χ, which essentially determines the size of the country relative to the size of international investors. If χ is low, aggregate debt becomes negligible from the perspective of investors which diminishes the responsiveness to changes in emerging market debt. As a consequence, the monopoly power declines. Optimal capital controls are therefore small as we illustrate in Panel (a) of Figure 8.

Figure 8: *Country Size and Capital Controls*

(a) *Model* ***(b)*** *Data*



__Notes__: Panel (a): The plot displays the optimal level of capital controls τ (y-axis) as a function of the size of the emerging market (χ). Calibration: p=0.02, λ=1. Panel (b): The panel presents results from a bivariate OLS regression with robust standard errors. Dependent variable (y-axis): Capital inflow control intensity. Independent variable: Domestic GDP in Billion USD (x-axis). Both variables are averaged over 1995 until 2017 for each emerging market. The plot considers active and inactive countries. 90% predictive margins as well as country-specific observations are added. We delete the top and bottom 5% observations in GDP for robustness. The results are insensitive to this choice.

It is reassuring that we observe a similar pattern in the data. In Panel (b) of Figure 8, we provide results from a simple bivariate OLS regression where we regress the capital inflow control intensity on the size of the domestic economy as measured by

GDP in USD. The intensity index represents an average over all inflow restrictions excluding FDI and is normalized to range between zero and one. As apparent from the plot, the relationship between capital inflow controls and GDP is positive and significant. Countries with a higher GDP tend to have more controls.[13] The empirical evidence is therefore consistent with the idea that larger countries have more pricing power, which ceteris paribus should increase intervention via capital controls.[14]

Two Competing Emerging Markets

We consider two emerging markets ("domestic" and "foreign") that compete for funds from international investors. Specifically, we address the following two questions: First, how do capital controls depend on the correlation structure between emerging markets? In other words, what is the optimal level of capital controls when domestic and foreign emerging market debt are substitutes or complements in their risk structure? Second, are capital controls tighter or looser when multiple countries resort to capital flow restrictions?

We model both emerging markets equivalently, that is, both emerging markets follow the same setup as described in Section 3.1. We denote the default probability of the second (foreign) emerging market as $q(\sigma)$ with $\frac{\partial q(\sigma)}{\partial \sigma} > 0$. Throughout the analysis, we set the default probability of both emerging markets equal. The most notable difference between the basic setup and this extended framework pertains to the default structure among both emerging markets. To be more precise, we define the probability that both emerging markets default on their debt as d, where d is necessarily smaller than p or q, i.e., $d \leq min\{p, q\}$. Consequently, we can determine four regimes. We display these regimes and their associated probabilities in Figure 9.

In this extended framework, international investors can choose between three assets, the riskless asset and two risky emerging market bonds. Their optimization problem is therefore summarized as

$$\max_{c_{I,t+1}, b_{I,t+1}, b^*_{I,t+1} l_{t+1}} \left\{ E_t[v_{t+1}(c_{I,t+1})] \right\}, \tag{Po:I}$$

where we characterize foreign variables with an asterix (*). The augmented budget constraints are

[13] Two outliers (Mexico, Russia) are visible in Figure 8, Panel (b). Since these outliers are below the regression line, estimates are conservative, that is, the slope coefficient would be more positive without the two observations.

[14] Ideally, we would want to directly test the implications of capital controls on the risk premium controlling for size, and compare these results for countries that increased restrictions during periods of international financial distress versus countries that did not. However risk premiums and capital controls likely influence each other. This would cause serious endogeneity concerns.

Figure 9: *Payment Structure*

		Foreign EM	
		Default	Payment
Domestic EM	Default	d	$p-d$
	Payment	$q-d$	$1-p-q+d$

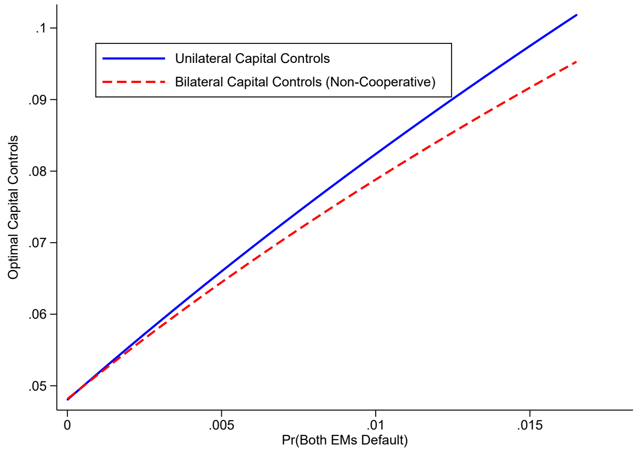
$$b_{I,t+1} + b^*_{I,t+1} + l_{t+1} = e_{I,t} \tag{11}$$

$$c_{I,t+1} = (1+RP_t)\overline{b_{I,t+1}} + (1+RP^*_t)\overline{b^*_{I,t+1}} + l_{t+1} + a_{t+1}. \tag{12}$$

We first focus on a scenario with unilateral capital controls where the domestic regulator takes the actions of the foreign emerging market as given. Figure 10 portrays the optimal level of capital controls as a function of the probability that both emerging markets default (d). Since default is Bernoulli distributed, d also captures the correlation in the risk profile among both emerging markets. Specifically, if $d > pq$, default among the two emerging markets is positively correlated and vice versa. On an abstract level, we also interpret d as the comovement of business cycles given that default is more likely during recessions. Based on the solid blue line, which captures unilateral capital controls, it becomes apparent that capital flow restrictions increase with a more similar risk structure. Intuitively, as debt from both emerging markets becomes more similar (substitutes), international investors have fewer options to hedge one risky asset with the other. On the contrary, if the default probabilities were negatively correlated, investors purchase both bonds in equal amounts (complements) and thus mitigate the aggregate risk from emerging market bonds. Consequently, they do not require a high marginal compensation for additional emerging market debt, which decreases the scope of the domestic emerging market to manipulate the risk premium. In reality, many emerging markets face similar business cycle dynamics, especially countries that are geographically close. Hence, the fact that countries compete for funds does not necessarily imply that countries should impose fewer capital controls, even when the sole motivation for capital controls relates to monopolistic risk premium manipulations.

In the second experiment, we analyze capital controls in a Nash equilibrium where both emerging markets resort to capital controls in a non-cooperative manner. This scenario emerges when both regulators maximize domestic welfare without taking

Figure 10: Two Emerging Markets: The Correlation Structure and Optimal Taxes



***Notes**: The plot displays the optimal level of capital controls τ (y-axis) as a function of the probability that both emerging markets default simultaneously (d). The solid blue line considers a scenario where only one emerging market imposes capital controls. The dashed red line displays the level of capital controls if both emerging markets implement capital controls non-cooperatively. Calibration:* χ=1, p=q=0.02, λ=1.

general equilibrium effects on the second emerging market into account. The dashed red line in Figure 10 displays this experiment. As evident, capital controls are generally lower, specifically when bonds from the emerging markets are substitutes rather than complements. In either case, emerging markets on aggregate issue less debt than with unilateral controls. When emerging market debt from both countries are substitutes (large d), the required marginal compensation for debt from one emerging market is closely tied to the level of aggregate debt. With less aggregate debt, emerging market bonds become less important as part of the overall portfolio, and investors are less responsive. On the contrary, if bonds are complements (small d), a reduction in foreign emerging market debt makes domestic debt riskier from the perspective of investors, as they have fewer foreign bonds to hedge the risk associated with the domestic bond. This in turn requires a higher marginal compensation and can offset the implications from a general decline in emerging market debt.

5. Conclusion

Capital controls receive significant attention from international policymakers as a tool to mitigate boom-bust cycles in international financial flows and to limit external overborrowing. However, though emerging markets make heavy use of capital controls, several questions remain open (Rebucci and Ma, 2019).

In this paper, we focus on the disconnect between the theoretical and applied literature. For example, while the theoretical literature advocates counter-cyclical restrictions, the applied literature has not been able to detect such patterns except for a few case studies like Brazil (Chamon and Garcia, 2016).

The first contribution of this paper is a series of new empirical facts. We show that countries that actively re-evaluate their capital controls respond to global financial conditions, in particular volatility and risk aversion. Specifically, countries tighten capital controls during periods of high financial distress and decrease restrictions once financial conditions moderate. This pro-cyclical implementation is inconsistent with the existing theoretical literature.

As a second contribution, we provide a simple model that justifies pro-cyclical capital controls in response to global financial distress. In other words, the empirical regularities may be rational from the perspective of emerging markets. Because debt is risky and investors are risk-averse, investors are sensitive to emerging market debt and require a risk premium. Regulators can exploit this relationship. A regulator, who acts as a monopolist on domestic debt, reduces emerging market debt, lowers the risk premium and diminishes current account reversals. This choice is subsequently implemented via capital inflow controls. Since investors are particularly sensitive when they are very risk-averse or when international financial markets are volatile, it is optimal to increase restrictions during periods of financial distress.

This paper is complementary to the macroprudential capital control literature. We fully acknowledge the rationale to address externalities via counter-cyclical capital controls. Hence, a more sophisticated model with externalities would lead to a trade-off between counter-cyclical and pro-cyclical capital controls that emerge from risk-averse international investors and risky debt. We leave a detailed exploration of these trade-offs for future research. As another avenue for future work, it would be useful to systematically document the decision process of countries to add or eliminate capital controls. This would shed light on the relevance of the different rationales proposed in the literature.

To conclude, we emphasize that risk premium manipulations as discussed in this paper do not address externalities per se. As such, the resulting capital controls are only rational from the perspective of the emerging market, but not from a global perspective. This adds a more cautious note on the use of capital inflow controls in an international context.

A. Appendix: Data

Table A1: *Country List - Active and Inactive*

Algeria	Egypt	Mexico	South Africa
Angola	El Salvador	Moldova	Sri Lanka
Argentina	Ethiopia	Morocco	Swaziland
Bahrain	Georgia	Myanmar	Tanzania
Bangladesh	Ghana	Nicaragua	Thailand
Bolivia	Guatemala	Nigeria	Togo
Brazil	Hungary	Oman	Tunisia
Brunei Darussalam	India	Pakistan	Turkey
Bulgaria	Indonesia	Panama	Uganda
Burkina Faso	Jamaica	Paraguay	Ukraine
Chile	Kazakhstan	Peru	United Arab Emirates
China	Kenya	Philippines	Uruguay
Colombia	Kuwait	Poland	Uzbekistan
Costa Rica	Kyrgyz Republic	Qatar	Venezuela
Côte d'Ivoire	Lebanon	Romania	Vietnam
Dominican Republic	Malaysia	Russia	Yemen
Ecuador	Mauritius	Saudi Arabia	Zambia

Variables and Data Sources

Banking Crises: Indicator for systemic banking crises (Source: Laeven and Valencia, 2018).

Capital Controls: We consider two measures. For our baseline we resort to Fernández et al. (2016) and use the average level of inflow restrictions among all asset groups but exclude FDI. We consider the Chinn-Ito Index (Chinn and Ito, 2006) as a robustness check.

CA/GDP: Current account balance (% of GDP) (Source: IMF).

Credit/GDP: Domestic credit to the private sector (% of GDP) (Source: World Bank).

Country Classification: The classification into EMs follows the convention in the International Monetary Fund's World Economic Outlook database.

CPI: Consumer price index. We construct inflation as the log difference (Source: IMF).

Exchange Rates: Nominal exchange rates vis-a-vis the US dollar. Daily quotes are averaged over each year (Source: Bloomberg).

External Debt Crises: Indicator from Reinhart and Rogoff (2009).

Gross Domestic Product: (i) GDP per capita in constant local currency (Source: World Bank) and (ii) GDP in US dollar (Source: IMF).

Institutional Quality: Index constructed as the average over all 12 political risk categories from the International Country Risk Guide (Source: Political Risk Group).

Interest Rate Differential: Domestic policy rate minus US policy rate in percent per annum (Source: IMF).

Risk Aversion/Volatility: Series from the VIX decomposition of Bekaert and Hoerova (2014). The daily values are averaged over each year.

Stock Market Indices: The daily quotes are averaged over each year (Source: Bloomberg).

VIX: Implied Volatility index of the S&P 500. The daily quotes are averaged over each year (Source: Bloomberg).

B. Appendix: Tables

Table B1: *Comparison: VIX, Risk Aversion and Volatility*

	Increase in Inflow Restrictions			Decrease in Inflow Restrictions		
	(1)	(2)	(3)	(4)	(5)	(6)
$ln(VIX)$	24.31			-61.41*		
	(33.19)			(35.19)		
$ln(VIX) \times ln(VIX)$	-2.68			6.86*		
	(3.54)			(3.78)		
$ln(VIX) \times ln(VIX) \times ln(VIX)$	0.10			-0.25*		
	(0.13)			(0.13)		
$ln(RA)$		3.30			-34.11**	
		(14.88)			(15.79)	
$ln(RA) \times ln(RA)$		-0.67			6.18**	
		(2.59)			(2.77)	
$ln(RA) \times ln(RA) \times ln(RA)$		0.05			-0.37**	
		(0.15)			(0.16)	
$ln(VOL)$			32.64			-10.98
			(30.93)			(36.28)
$ln(VOL) \times ln(VOL)$			-3.14			1.29
			(2.94)			(3.48)
$ln(VOL) \times ln(VOL) \times ln(VOL)$			0.10			-0.05
			(0.09)			(0.11)
p-value: VIX/RA/VOL= 0	0.023	0.069	0.017	0.062	0.045	0.371
Pseudo R^2	0.021	0.016	0.023	0.018	0.017	0.010
Observations	451	451	451	451	451	451

Notes: *Robustness checks based on the VIX decomposition into risk aversion (RA) and volatility (VOL). ln(VIX), ln(RA) and ln(VOL) are standardized. A constant is estimated, but not displayed. Active emerging markets only. Sample: 1995-2017. Huber-White robust standard errors in parentheses. Stars indicate significance levels (*10%, **5%, ***1%).*

__Table B2:__ Additional Domestic Variables: Increase in Inflow Restrictions

	Increase in Inflow Restrictions				
	(1)	(2)	(3)	(4)	(5)
$ln(VIX)$	18.83	21.82	17.98	19.75	40.88
	(34.11)	(42.45)	(51.38)	(38.76)	(47.69)
$ln(VIX) \times ln(VIX)$	-2.08	-2.31	-2.01	-2.08	-4.49
	(3.64)	(4.56)	(5.52)	(4.13)	(5.11)
$ln(VIX) \times ln(VIX) \times ln(VIX)$	0.08	0.08	0.08	0.07	0.16
	(0.13)	(0.16)	(0.20)	(0.15)	(0.18)
$\Delta CA/GDP_{-1}$	-0.02	-0.06	-0.01	-0.01	0.00
	(0.03)	(0.05)	(0.06)	(0.04)	(0.05)
$\Delta log(GDP/CAP)_{-1}$	0.04	0.03	0.08	0.03	0.05
	(0.04)	(0.05)	(0.07)	(0.04)	(0.05)
$\Delta log(ExchangeRate)_{-1}$	0.00	-0.00	-0.01	0.01	-0.03
	(0.00)	(0.01)	(0.02)	(0.01)	(0.02)
$Inst.Quality$	-0.04	-0.03	-0.23	-0.13	-0.25
	(0.12)	(0.15)	(0.21)	(0.13)	(0.17)
$BankingCrisis$	-0.30		-1.00	0.20	
	(0.92)		(1.23)	(1.00)	
$\Delta log(StockIndex)_{-1}$		0.01**			
		(0.01)			
$\Delta(Dom.PolicyRate - USRate)_{-1}$			-0.12**		
			(0.06)		
$\Delta(Credit/GDP)_{-1}$				0.03	
				(0.03)	
π_{-1}					-0.01
					(0.07)
p-value: Domestic= 0	0.793	0.164	0.361	0.829	0.326
p-value: VIX= 0	0.041	0.072	0.038	0.061	0.326
Pseudo R^2	0.026	0.065	0.066	0.033	0.042
Observations	451	271	205	368	295

***Notes**: Institutional quality and ln(VIX) are standardized. Periods with more than 10% inflation are excluded. Active emerging markets only. The banking crisis indicator perfectly predicts the dependent variable in columns 2 and 5 and is hence omitted. A constant is estimated, but not displayed. Sample: 1995-2017. Huber-White robust standard errors in parentheses. Stars indicate significance levels (*10%, **5%, ***1%).*

Table B3: *Additional Domestic Variables: Decrease in Inflow Restrictions*

	Decrease in Inflow Restrictions				
	(1)	(2)	(3)	(4)	(5)
$ln(VIX)$	-58.75*	-62.84	-96.29**	-71.07*	-67.36
	(34.88)	(42.94)	(49.09)	(37.96)	(41.68)
$ln(VIX) \times ln(VIX)$	6.58*	6.72	10.46**	7.79*	7.55*
	(3.75)	(4.63)	(5.31)	(4.10)	(4.50)
$ln(VIX) \times ln(VIX) \times ln(VIX)$	-0.24*	-0.24	-0.38**	-0.28*	-0.28*
	(0.13)	(0.17)	(0.19)	(0.15)	(0.16)
$\Delta CA/GDP_{-1}$	-0.03	-0.07	-0.01	-0.04	-0.07
	(0.03)	(0.05)	(0.05)	(0.04)	(0.04)
$\Delta log(GDP/CAP)_{-1}$	-0.05	-0.06	0.00	-0.04	-0.06
	(0.03)	(0.05)	(0.06)	(0.04)	(0.05)
$\Delta log(ExchangeRate)_{-1}$	0.00	0.01	0.00	-0.01	-0.01
	(0.00)	(0.01)	(0.02)	(0.01)	(0.02)
$Inst.Quality$	0.26**	0.33**	0.06	0.21	0.24
	(0.11)	(0.16)	(0.22)	(0.13)	(0.16)
$BankingCrisis$	1.25*		0.60	0.77	
	(0.75)		(1.27)	(0.93)	
$\Delta log(StockIndex)_{-1}$		0.01**			
		(0.01)			
$\Delta(Dom.PolicyRate - USRate)_{-1}$			0.02		
			(0.05)		
$\Delta(Credit/GDP)_{-1}$				-0.03	
				(0.02)	
π_{-1}					0.03
					(0.06)
p-value: Domestic= 0	0.085	0.093	0.999	0.341	0.269
p-value: VIX= 0	0.095	0.467	0.272	0.243	0.090
Pseudo R^2	0.041	0.055	0.020	0.030	0.048
Observations	451	271	205	368	295

Notes*: Institutional quality and ln(VIX) are standardized. Periods with more than 10% inflation are excluded. A constant is estimated, but not displayed. Active emerging markets only. The banking crisis indicator perfectly predicts the dependent variable in columns 2 and 5 and is hence omitted. Sample: 1995-2017. Huber-White robust standard errors in parentheses. Stars indicate significance levels (*10%, **5%, ***1%).*

Table B4: Robustness: Lenient Threshold Classification

	Increase in Inflow Restrictions			Decrease in Inflow Restrictions		
	(1)	(2)	(3)	(4)	(5)	(6)
$ln(VIX)$	0.21*	7.42	7.27	0.11	-53.22*	-55.34*
	(0.12)	(29.84)	(30.57)	(0.10)	(31.41)	(31.74)
$ln(VIX) \times ln(VIX)$		-0.90	-0.89		6.04*	6.28*
		(3.18)	(3.26)		(3.36)	(3.41)
$ln(VIX) \times ln(VIX) \times ln(VIX)$		0.04	0.04		-0.23*	-0.24*
		(0.11)	(0.12)		(0.12)	(0.12)
$\Delta CA/GDP_{-1}$			-0.02			-0.03
			(0.03)			(0.03)
$\Delta log(GDP/CAP)_{-1}$			0.00			-0.01
			(0.03)			(0.03)
$\Delta log(ExchangeRate)_{-1}$			0.00			0.00
			(0.00)			(0.01)
$Inst.Quality$			0.05			0.22**
			(0.11)			(0.11)
$BankingCrisis$			0.16			1.31**
			(0.66)			(0.54)
p-value: Domestic = 0			0.947			0.052
p-value: VIX = 0	0.069	0.151	0.231	0.279	0.013	0.022
Pseudo R^2	0.006	0.009	0.011	0.002	0.020	0.039
Observations	581	581	581	581	581	581

***Notes**: This table provides result from a more lenient classification requirement (domestic std. dev. above 0.8 of avg. std. dev.). This lower threshold classifies six more countries as active: Bolivia (std. dev. 0.101), Saudi Arabia (0.100), Romania (0.95), Ukraine (0.094), Dominican Republic (0.89) and Jamaica (0.85). Institutional quality and ln(VIX) are standardized. A constant is estimated, but not displayed. Active emerging markets only. Sample: 1995-2017. Huber-White robust standard errors in parentheses. Stars indicate significance levels (*10%, **5%, ***1%).*

Table B5: *Robustness: Strict Threshold Classification*

	Increase in Inflow Restrictions			Decrease in Inflow Restrictions		
	(1)	(2)	(3)	(4)	(5)	(6)
$ln(VIX)$	0.47***	17.54	14.00	0.09	-101.40**	-109.29**
	(0.18)	(41.05)	(45.21)	(0.14)	(43.88)	(44.70)
$ln(VIX) \times ln(VIX)$		-2.09	-1.69		11.14**	12.01**
		(4.37)	(4.82)		(4.73)	(4.83)
$ln(VIX) \times ln(VIX) \times ln(VIX)$		0.08	0.07		-0.40**	-0.44**
		(0.15)	(0.17)		(0.17)	(0.17)
$\Delta CA/GDP_{-1}$			-0.01			-0.07*
			(0.04)			(0.04)
$\Delta log(GDP/CAP)_{-1}$			0.08*			-0.05
			(0.04)			(0.04)
$\Delta log(ExchangeRate)_{-1}$			0.01			-0.00
			(0.01)			(0.01)
$Inst.Quality$			-0.07			0.18
			(0.13)			(0.14)
$BankingCrisis$			-0.83			1.26
			(1.42)			(1.05)
p-value: Domestic = 0			0.454			0.236
p-value: VIX = 0	0.008	0.007	0.007	0.523	0.060	0.067
Pseudo R^2	0.031	0.041	0.058	0.001	0.029	0.055
Observations	283	283	283	283	283	283

Notes*: This table provides result from a more strict classification requirement (domestic std. dev. above 1.2 of avg. std. dev.). With this tighter threshold only 14 countries are classified as active with Vietnam as the last country included (see Table 1). Institutional quality and ln(VIX) are standardized. A constant is estimated, but not displayed. Active emerging markets only. Sample: 1995-2017. Huber-White robust standard errors in parentheses. Stars indicate significance levels (*10%, **5%, ***1%).*

Table B6: *Robustness: Chinn-Ito Index*

	Increase in Restrictions			Decrease in Restrictions		
	(1)	(2)	(3)	(4)	(5)	(6)
$ln(VIX)$	0.33**	20.04	29.06	0.15	-36.42	-38.11
	(0.15)	(60.14)	(59.19)	(0.14)	(35.71)	(36.87)
$ln(VIX) \times ln(VIX)$		-1.86	-2.87		4.04	4.23
		(6.27)	(6.18)		(3.82)	(3.95)
$ln(VIX) \times ln(VIX) \times ln(VIX)$		0.06	0.09		-0.15	-0.15
		(0.22)	(0.21)		(0.14)	(0.14)
$\Delta CA/GDP_{-1}$			-0.01			0.01
			(0.04)			(0.03)
$\Delta log(GDP/CAP)_{-1}$			-0.07			0.02
			(0.05)			(0.04)
$\Delta log(ExchangeRate)_{-1}$			0.00			0.00
			(0.00)			(0.00)
$Inst.Quality$			0.02			0.17
			(0.16)			(0.15)
$BankingCrisis$			0.67			0.54
			(0.83)			(0.83)
p-value: Domestic = 0			0.653			0.756
p-value: VIX = 0	0.032	0.247	0.349	0.285	0.457	0.485
Pseudo R^2	0.014	0.018	0.031	0.003	0.008	0.015
Observations	450	450	450	450	450	450

Notes*: We classify countries into active and inactive using our baseline metric, but use the Chinn-Ito Index to construct the Increase and Decrease indicators. Institutional quality and ln(VIX) are standardized. A constant is estimated, but not displayed. Active emerging markets only. Sample: 1995-2017. Huber-White robust standard errors in parentheses. Stars indicate significance levels (*10%, **5%, ***1%).*

Table B7: *Active versus Inactive Countries*

	Active	Inactive
Inflow Restrictions	0.488	0.424
CA/GDP (in %)	-2.140	0.432
Credit/GDP (in %)	35.054	47.686
Inst. Quality	63.099	63.665
GDP, Billions USD	262.919	273.339
Exchange Rate (CV)	0.475	0.350
Banking Crisis	0.021	0.018

Notes*: Comparison between EMs which actively adjust their capital inflow restrictions and the remaining (inactive) countries. The exchange rate statistic displays the coefficient of variation (standard deviation/mean).*

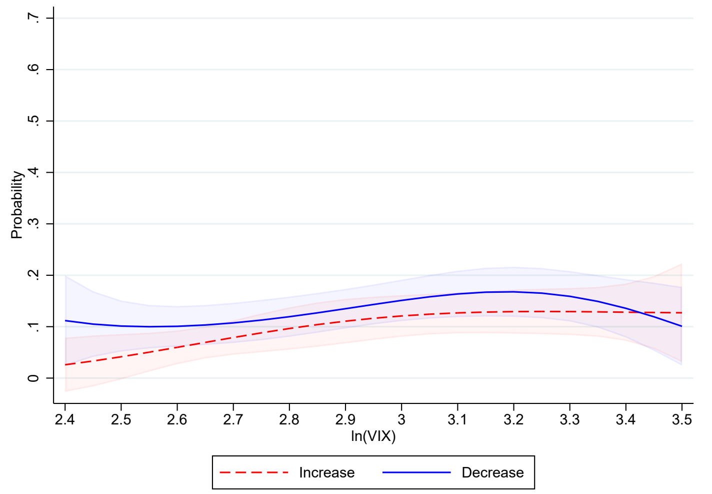
Table B8: *Calibration: Default in Emerging Markets and Financial Distress*

	External Debt Crisis					
	Active Countries			All Countries		
	(1)	(2)	(3)	(4)	(5)	(6)
$ln(VIX)$	0.12			0.24		
	(0.41)			(0.27)		
$ln(VIX)_{-1}$		0.35*			0.44***	
		(0.19)			(0.16)	
$ln(VOL)_{-1}$			0.29*			0.35***
			(0.15)			(0.14)
Pseudo R^2	0.002	0.012	0.009	0.005	0.017	0.013
Observations	208	195	195	672	630	630

Notes*: The table presents result from bivariate logit models. Dependent variable: Start of external debt crisis (Reinhart and Rogoff, 2009). Independent Variables: logarithm of VIX or volatility (VOL) (Bekaert and Hoerova, 2014). ln(VIX) and ln(VOL) are standardized. A constant is estimated, but not displayed. Sample: 1995-2010. Huber-White robust standard errors in parentheses. Stars indicate significance levels (*10%, **5%, ***1%).*

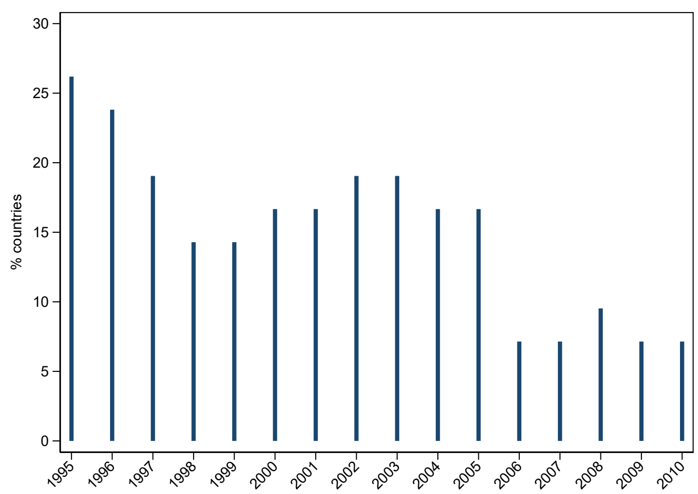
C. Appendix: Figures

Figure C1: *The Chinn-Ito Index and the VIX*



Notes: *We classify countries into active and inactive using our baseline metric, but use the Chinn-Ito Index to construct the Increase and Decrease indicators. The dashed red (solid blue) line displays the probability of increasing (decreasing) capital inflow controls (y-axis) as a function of ln(VIX) (x-axis). Shaded areas indicate 90% predictive margins. The underlying regression model is a logit model with a cubic polynomial and no control variables as portrayed in Equation (1). Active emerging markets only. Sample: 1995-2017.*

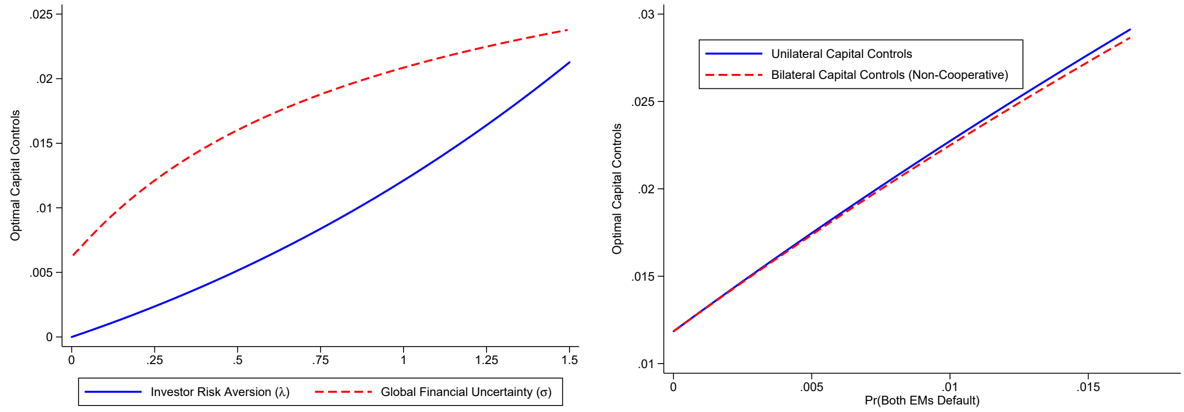
Figure C2: *External Debt Crises: Emerging Markets*



Notes: *The graph depicts the share (%) of EMs in an ongoing external debt crisis (y-axis) as defined in Reinhart and Rogoff (2009) between 1995 and 2010 (x-axis). We include all active and inactive EMs for which data is available. Advanced economies, as defined by the World Economic Outlook (IMF), did not experience a debt crisis during this period.*

Figure C3: Optimal Capital Controls with CRRA Preferences

(a) *Risk Aversion and Volatility* ***(b)*** *Two Emerging Markets: The Correlation Structure*



Notes: *Panel (a): The plot displays the optimal level of capital controls* τ *(y-axis) as a function of the risk aversion of international investors (*λ*, solid blue line) or volatility in financial markets (*σ*, dashed red line). Calibration:* $E_{B,t+1}$=20, $E_{I,t}$=30, μ=3, θ=1 *(risk aversion borrowers),* χ=1, p=0.02 *(solid blue line),* σ=0.25 *(solid blue line),* p=0.05$\frac{\sigma}{1+\sigma}$+0.01 *(dashed red line),* λ=1 *(dashed red line). Panel (b): The plot displays the optimal level of capital controls* τ *(y-axis) as a function of the probability that both emerging markets default simultaneously (d). The solid blue line considers a scenario where only one emerging market imposes capital controls. The dashed red line displays the level of capital controls if both emerging markets implement capital controls non-cooperatively. Calibration:* $E_{B,t+1}$=$E^*_{B,t+1}$=20, $E_{I,t}$=30, μ=3, σ=0.25, χ=1, p=q=0.02, θ=λ=1.

D. Appendix: Model

Proof of Lemma 1: We formally prove the uniqueness of the bond market equilibrium. Existence is trivial due to sufficient endowments as described in Section 3 and the Inada condition on borrowers' period t utility function, which ensures that borrowers issue (some) debt at any finite risk premium. We first derive the slope of the aggregate demand curve. The aggregate demand equation can be rewritten as

$$RP_t - \frac{p(\sigma)}{1-p(\sigma)} \frac{E_t[v'_{t+1}(E_{I,t} - B_{I,t+1} + A_{t+1})]}{E_t[v'_{t+1}(E_{I,t} + RP_t B_{I,t+1} + A_{t+1})]} = 0.$$

We exploit the Implicit Function Theorem and obtain

$$\frac{\partial RP_t}{\partial B_{I,t+1}} = \frac{-\frac{p}{1-p}\left(E_t[v'_{t+1}|s=0]E_t[v''_{t+1}|s=1] + E_t[v'_{t+1}|s=1]E_t[v''_{t+1}|s=0]RP_t\right)}{E_t[v'_{t+1}|s=0]^2 + \frac{p}{1-p}E_t[v'_{t+1}|s=1]E_t[v''_{t+1}|s=0]B_{I,t+1}}.$$

Since v_{t+1} is strictly concave, the numerator is positive. The denominator is positive with Assumption 2. The derivative is therefore strictly positive. The procedure for the aggregate supply curve is similar. The aggregate supply curve corresponds to

$$u'_t\left(\frac{B_{B,t+1}}{\chi}\right) - (1-p(\sigma))u'_{t+1}\left(\frac{E_{B,t+1} - (1+RP_t)B_{B,t+1}}{\chi}\right)(1+RP_t) = 0.$$

Applying the Implicit Function Theorem yields

$$\frac{\partial RP_t}{\partial B_{B,t+1}} = \frac{-\left(u''_t + (1-p)(u''_{t+1}|s=0)(1+RP_t)^2\right)}{(1-p)\left((u''_{t+1}|s=0)(1+RP_t)B_{B,t+1}) - \chi(u'_{t+1}|s=0)\right)}.$$

The numerator is greater than zero since $t+1$ utility is strictly concave. The denominator is negative under the same condition. The supply curve is therefore strictly decreasing. As a consequence, aggregate demand and supply intersect exactly once. ■

Proof of Proposition 3: The aggregate demand and supply curves with exponential and log-quasilinear utility are:

$$RP_t = \frac{p(\sigma)}{1-p(\sigma)} exp\left(\lambda(1+RP_t)B_{I,t+1}\right) \tag{AD}$$

$$B_{B,t+1} = \frac{\chi}{(1-p(\sigma))(1+RP_t)} \tag{AS}$$

$$B_{B,t+1} = \frac{\chi}{(1-p(\sigma))(1+RP_t)+\chi\lambda RP_t}. \tag{AS:NP}$$

Capital controls are characterized as

$$\tau = \frac{\chi\lambda RP_t}{(1-p(\sigma))(1+RP_t)+\chi\lambda RP_t}.$$

The derivative $\frac{\partial\tau}{\partial\lambda}|_{\text{total}}$ is

$$\left.\frac{\partial\tau}{\partial\lambda}\right|_{\text{total}} = \frac{\partial\tau}{\partial\lambda} + \frac{\partial\tau}{\partial RP_t}\frac{\partial RP_t}{\partial\lambda}.$$

It is straight forward to verify that $\frac{\partial\tau}{\partial\lambda} > 0$ and $\frac{\partial\tau}{\partial RP_t} > 0$. With regard to $\frac{\partial RP_t}{\partial\lambda}$ we plug Equation (AS:NP) into Equation (AD):

$$RP_t - \frac{p(\sigma)}{1-p(\sigma)}exp\left(\frac{\lambda(1+RP_t)\chi}{(1-p(\sigma))(1+RP_t)+\chi\lambda RP_t}\right) = 0.$$

We apply the Implicit Function Theorem and obtain $\frac{\partial RP_t}{\partial\lambda} > 0$. Thus, $\frac{\partial\tau}{\partial\lambda}|_{\text{total}} > 0$, i.e., capital controls are increasing in risk aversion. ■

Proof of Proposition 4: The proof is similar to the one for Proposition 3. Following the same steps, the derivative $\frac{\partial\tau}{\partial\sigma}|_{\text{total}}$ equals

$$\left.\frac{\partial\tau}{\partial\sigma}\right|_{\text{total}} = \frac{\partial\tau}{\partial\sigma} + \frac{\partial\tau}{\partial RP_t}\frac{\partial RP_t}{\partial\sigma}.$$

Based on the tax formula provided in the previous proof it becomes apparent that $\frac{\partial\tau}{\partial\sigma} > 0$ as $p'(\sigma) > 0$ and $\frac{\partial\tau}{\partial RP_t} > 0$. Combining Equation (AS:NP) and Equation (AD) as before, one obtains $\frac{\partial RP_t}{\partial\sigma} > 0$. Therefore, $\frac{\partial\tau}{\partial\sigma}|_{\text{total}} > 0$. In other words capital controls increase in volatility. ■

Two Country Model: The extended model features two aggregate demand curves, one for each emerging market bond.

$$RP_t = exp\left(\lambda(1+RP_t)B_{I,t+1}\right)\frac{d\,exp(\lambda B^*_{I,t+1})+(p-d)exp(-\lambda RP^*_t B^*_{I,t+1})}{(q-d)exp(\lambda B^*_{I,t+1})+(1-p-q+d)exp(-\lambda RP^*_t B^*_{I,t+1})} \tag{AD}$$

$$RP^*_t = exp\left(\lambda(1+RP^*_t)B^*_{I,t+1}\right)\frac{d\,exp(\lambda B_{I,t+1})+(q-d)exp(-\lambda RP_t B_{I,t+1})}{(p-d)exp(\lambda B_{I,t+1})+(1-p-q+d)exp(-\lambda RP_t B_{I,t+1})} \tag{AD*}$$

Aggregate supply curves are isomorphic to the one country model with $p(\sigma)$ replaced by $q(\sigma)$ and asterisk (*) symbols for foreign supply.

The tax formulas for both countries are equivalent to the one country model, except for the relabeling of parameters/variables in case of foreign capital controls. This is a consequence of exponential utility and the observation that each planner treats foreign variables as given. The domestic regulator for example does not internalize the endogenous adjustments in RP_t^* or $B_{I,t+1}^*$ when calculating the response of the required domestic risk premium for a change in domestic bonds.

CRRA utility: We impose CRRA utility for borrowers (in both periods) and investors. The relative risk aversion parameter of investors (borrowers) is denoted as λ (θ). This gives rise to the following demand and supply schedules for the variant with one emerging market:

$$RP_t = \frac{p(\sigma)}{1-p(\sigma)} \frac{E_t\left[(E_{I,t} - B_{I,t+1} + A_{t+1})^{-\lambda}\right]}{E_t\left[(E_{I,t} + RP_t B_{I,t+1} + A_{t+1})^{-\lambda}\right]} \tag{AD}$$

$$\left(\frac{B_{B,t+1}}{\chi}\right)^{-\theta} = (1-p(\sigma))\left(\frac{E_{B,t+1}}{\chi} - (1+RP_t)\frac{B_{B,t+1}}{\chi}\right)^{-\theta}(1+RP_t) \tag{AS}$$

$$\left(\frac{B_{B,t+1}}{\chi}\right)^{-\theta} = (1-p(\sigma))\left(\frac{E_{B,t+1}}{\chi} - (1+RP_t)\frac{B_{B,t+1}}{\chi}\right)^{-\theta}\left(1+RP_t + \frac{\partial RP_t}{\partial B_{I,t+1}} B_{B,t+1}\right). \tag{AS:NP}$$

The derivative $\frac{\partial RP_t}{\partial B_{I,t+1}}$ is based of the aggregate demand curve and characterized as

$$\frac{\partial RP_t}{\partial B_{I,t+1}} = \frac{\lambda RP_t\left[\frac{E_t\left[C_{I,t+1}^{-\lambda-1}|s=1\right]}{E_t\left[C_{I,t+1}^{-\lambda}|s=1\right]} + \frac{RP_t E_t\left[C_{I,t+1}^{-\lambda-1}|s=0\right]}{E_t\left[C_{I,t+1}^{-\lambda}|s=0\right]}\right]}{1-\lambda RP_t B_{I,t+1}\frac{E_t\left[C_{I,t+1}^{-\lambda-1}|s=0\right]}{E_t\left[C_{I,t+1}^{-\lambda}|s=0\right]}}.$$

Optimal capital inflow controls equal

$$\tau = (1-p(\sigma))\frac{\left(E_{B,t+1} - (1+RP_t)B_{B,t+1}\right)^{-\theta}}{\left(B_{B,t+1}\right)^{-\theta}}\frac{\partial RP_t}{\partial B_{I,t+1}} B_{B,t+1}.$$

In the two country version, aggregate supply curves are isomorphic to the one country model with $p(\sigma)$ replaced by $q(\sigma)$ and asterisk (*) symbols for foreign emerging market variables. A similar argument holds for the tax formulas. We subsequently describe aggregate demand. To save space, we define a state vector $s = (d, f)$ with $d, f \in \{0, 1\}$ that characterizes four possible states. $s = (1, 0)$ for example corresponds to a state where the home country defaults, while the foreign emerging market does not default.

$$RP_t = \frac{dE_t\left[C_{I,t+1}^{-\lambda}|s=(1,1)\right] + (p-d)E_t\left[C_{I,t+1}^{-\lambda}|s=(1,0)\right]}{(q-d)E_t\left[C_{I,t+1}^{-\lambda}|s=(0,1)\right] + (1-p-q+d)E_t\left[C_{I,t+1}^{-\lambda}|s=(0,0))\right]} \tag{AD}$$

$$RP_t^* = \frac{dE_t\left[C_{I,t+1}^{-\lambda}|s=(1,1)\right] + (q-d)E_t\left[C_{I,t+1}^{-\lambda}|s=(0,1)\right]}{(p-d)E_t\left[C_{I,t+1}^{-\lambda}|s=(1,0)\right] + (1-p-q+d)E_t\left[C_{I,t+1}^{-\lambda}|s=(0,0)\right]} \tag{AD*}$$

Since consumption is a function of bond holdings and risk premiums according to Equation (12), we can rewrite the domestic aggregate demand curve as $h(RP_t, B_{I,t+1}, RP_t^*, B_{I,t+1}^*) = 0$. Domestic regulators treat foreign variables as given. The derivative $\frac{\partial RP_t}{\partial B_{I,t+1}}$ from the perspective of the domestic emerging market is therefore

$$\frac{\partial RP_t}{\partial B_{I,t+1}} = -\frac{\partial h/\partial B_{I,t+1}}{\partial h/\partial RP_t}$$

with

$$\begin{aligned}\frac{\partial h}{\partial B_{I,t+1}} =& -\lambda RP_t\left[\frac{dE_t[C_{t+1}^{-\lambda-1}|s=(1,1)] + (p-d)E_t[C_{I,t+1}^{-\lambda-1}|s=(1,0)]}{dE_t[C_{I,t+1}^{-\lambda}|s=(1,1)] + (p-d)E_t[C_{I,t+1}^{-\lambda}|s=(1,0)]}\right. \\ &\left. + RP_t\frac{(q-d)E_t[C_{t+1}^{-\lambda-1}|s=(0,1)] + (1-p-q+d)E_t[C_{I,t+1}^{-\lambda-1}|s=(0,0)]}{(q-d)E_t[C_{I,t+1}^{-\lambda}|s=(0,1)] + (1-p-q+d)E_t[C_{I,t+1}^{-\lambda}|s=(0,0)]}\right]\end{aligned}$$

and

$$\frac{\partial h}{\partial RP_t} = 1 - \lambda RP_t B_{I,t+1}\left[\frac{(q-d)E_t[C_{I,t+1}^{-\lambda-1}|s=(0,1)] + (1-p-q+d)E_t[C_{I,t+1}^{-\lambda-1}|s=(0,0)]}{(q-d)E_t[C_{I,t+1}^{-\lambda}|s=(0,1)] + (1-p-q+d)E_t[C_{t+1}^{-\lambda}|s=(0,0)]}\right].$$

The derivation for $\frac{\partial RP_t^*}{\partial B_{I,t+1}^*}$ is isomorphic and hence omitted.

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