IMF Economic Review
Vol. 65, No. 2
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Macroeconomic Effects of Capital Account Regulations

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We analyze the effects of capital account regulations (CARs) across a large sample of emerging economies on a range of macroeconomic outcomes. We use composite indices of these regulations to capture their intensity in coverage and employ an instrumental variables strategy to overcome the endogeneity of regulations to outcomes. We estimate the effects of CARs on real exchange rate appreciation, foreign exchange pressure, crisis resilience, and post-crisis overheating using annual data from 1995 to 2011 for 51 emerging economies. We find that all CARs, except the financial sector-specific restrictions, reduce foreign exchange pressure and real exchange rate appreciation, contributing to greater macroeconomic stability. Our results further indicate that increasing the restrictiveness of CARs in the run-up to the crisis moderates the growth decline, thus enhancing crisis resilience, and that countries that used CARs experienced less overheating from capital inflow surges during post-crisis recovery. The latter two results imply that CARs are useful countercyclical policy instruments. Our estimates provide evidence in favor of models in which imperfect capital mobility can generate sustained effects on real exchange rates. [JEL F21, F32, F41]
IMF Economic Review (2017) ***65,*** 193–240. doi:10.1057/s41308-016-0013-1;
published online 22 November 2016

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Introduction

The procyclical volatility of capital flows across countries has increased to historically high levels since the global financial crisis. In response to this process, many developing countries have adopted regulations to manage capital flows, motivating a growing literature examining the effects of capital account regulations (CARs) on various financial and macroeconomic outcomes. There is a wide range of views on these effects in the literature. On the one hand, the institutional view of the International Monetary Fund advocates the use of CARs in case of residual risk associated with capital flow volatility, a view that is motivated by the relatively large and significant reductions in financial fragility and improved crisis resilience associated with such regulations. On the other hand, other studies argue that these effects are substantially smaller and largely insignificant. In particular, if restrictions on capital flows change the composition but not the volume of flows, then tightening restrictions may reduce the short-term component of total liabilities without altering equilibrium levels of key macroeconomic variables, including the real exchange rate.

The wide range of views on the effects of CARs arises in part from the difficulty of measuring both the intensity of regulations and their effects. Most studies have used *de jure* restrictions on capital account transactions coded from the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions* (AREAER) database, leading to indices that vary widely depending on the classification approach.[1] While some indices capture only the presence of a restriction by coding it as a dummy variable, others are averages of several dummy variables representing a range of asset classes and are generally used to measure the intensity of restrictions. Another difficulty is that changes in these regulations are generally endogenous to changes in capital flows, leading to a large variety of estimates depending on the estimation approach.[2] In the cross-country literature, most studies report OLS estimates, which are likely to be downward biased and, to a certain extent, insignificant due to the endogeneity of CARs.

The wide range of views on the effects of regulations also stems from contrasting results in the theoretical literature. Earlier works generally assumed that perfect capital mobility is efficient and that any restriction on such mobility leads to Pareto suboptimal outcomes. This view contrasts with the implications of recent models that have shown that capital inflow taxes can enhance social welfare by diminishing the negative feedback effects resulting from capital flow volatility (Korinek 2011; Jeanne and Korinek 2010). Related models have shown that capital account regulations—herein, CARs—can help depreciate the real exchange rate by reducing borrowing and tradable consumption and that these effects can be supported by interventions in the foreign exchange market and active foreign exchange reserve management (Jeanne 2012; Korinek 2013). The

[1]See Schindler (2009) for a comparison of different classifications of regulations.

[2]For literature reviews, see Magud and others (2011); Klein (2012).

key difference between these recent models and earlier ones is the incorporation of financial amplifier effects associated with the volatility of capital flows and the failure of Ricardian equivalence due to policy frictions.

In this paper, we analyze the effects of CARs across a large sample of emerging economies and a range of macroeconomic outcomes. We use composite indices of these regulations to capture their coverage intensity and employ an instrumental variables strategy to overcome the endogeneity of regulations to outcomes. We estimate the effects of CARs on real exchange rate appreciation, foreign exchange pressure, crisis resilience, and post-crisis overheating using annual data from 1995 to 2011 for 51 emerging and developing economies.[3]

The macroeconomic stability effects we estimate are complementary to financial stability effects that have been previously documented and used to support CARs in countries that are most prone to the negative externalities of capital flow volatility. This evidence is important for guiding policy-making in countries that are vulnerable to such volatility because if one assumes that regulatory action only stabilizes financial outcomes, then distortions in macroeconomic prices may not be considered valid reasons for regulating capital flows. In this paper, we present evidence that countries that adopt restrictions on capital inflows are effective in reducing real exchange rate appreciation, which is particularly important for developing countries that wish to avoid costly resource movements out of the tradable goods sector.

Capital account restrictions are generally tightened in response to large increases in capital inflows or outflows and are thus likely to be endogenous to national economic conditions. We therefore use an instrumental variables approach to estimate the macroeconomic effects of these regulations. Our instruments are based on the presence of other agreements that restrict the use of CARs. In particular, we use bilateral investment treaties with the United States and membership of the European Union, which prohibit restrictions on international capital flows. There is considerable heterogeneity across countries in the existence of these agreements. We use this heterogeneity to identify the effects of CARs on indicators of macroeconomic stability. It is true that countries may sign bilateral investment treaties to attract more foreign direct investment (FDI) and that, to the extent that this occurs, greater appreciation of the exchange rate is expected, not less. Hence, if these treaties affect macroeconomic stability indicators, the effect is likely to go in the opposite direction. In any case, there is mixed evidence for whether countries signing investment treaties receive more FDI inflows, and there is only moderate correlation between bilateral investment treaties/ EU membership and macroeconomic stability indicators used in this paper.

We find that all CARs, except financial sector-specific restrictions, reduce foreign exchange pressure and real exchange rate appreciation, contributing to greater macroeconomic stability. Our results further indicate that increasing the restrictiveness of CARs in the run-up to the crisis moderates the growth decline, thus enhancing crisis resilience, and that countries that used CARs experienced

[3]The capital account regulation data we use are only available over this period and for these developing countries. See the Appendix Table A1 for the list of countries in our sample.

less overheating from new surges in capital inflows during post-crisis recovery. The latter two results imply that CARs are useful countercyclical policy instruments.

We develop a conceptual framework to help us interpret our estimated effects of CARs on the real exchange rate and foreign exchange pressure. Using this framework, we show that the estimated real exchange rate effects of CARs favor models with frictions that generate imperfect capital mobility. Such frictions can be either borrowing constraints on private sector access to international funds or deviation from Ricardian equivalence preventing the private sector from offsetting public sector purchases of foreign assets. Ricardian equivalence, a characteristic of frictionless rational expectations models, requires that any capital outflow from the public sector be offset by a capital inflow to the private sector, so there is no effect on net capital flows. A deviation from Ricardian equivalence can emerge as a result of financial frictions that restrict private sector borrowing from abroad or delay its response to an accumulation of reserves by the public sector. Such a deviation can also result from policy frictions that restrict flows of capital by imposing taxes and other forms of regulation. We present a simple model that shows how CARs as a policy friction can result in a reduction in private sector from borrowing abroad and thus reduce real exchange rate appreciation and foreign exchange pressure.

This paper makes contributions to three related strands of literature. First, it contributes to the empirical literature on the capital flow-driven business cycles in emerging economies and the management of their associated macroeconomic stability risks through the use of countercyclical capital flow regulations (Binici and others 2010; Farhi and Werning 2012; Hutchison and others 2012; IMF 2012; Magud and Reinhart 2007; Ocampo 2003; Ocampo and Tovar 2003; Ostry and others 2011, 2012; Patnaik and Shah 2012; Rodrik and Velasco 2000). The central issue is whether restrictions on inflows or outflows of capital are effective in smoothing business cycles that are induced by boom–bust cycles of capital flows. During capital inflow booms, the real exchange rate may appreciate due to either nominal appreciation in a flexible exchange rate regime, or increased inflation in a fixed exchange rate regime (or a combination of the two in intermediate regimes, such as managed floating or crawling peg systems). Real appreciation is generally undesirable due to its negative effects on external competitiveness and adverse Dutch disease effects if the tradable sector is crowded out.[4] Restrictions on capital inflows, such as taxes on inflows or unremunerated reserve requirements (URRs), may reduce these adverse effects to the extent that they are not circumvented. On the other hand, capital outflow restrictions may also reduce short-term portfolio inflows if investors are forward looking, i.e., if they realize the costs of moving the funds abroad and decide to reduce their investments. During episodes of large capital outflows, regulators may react by partially liberalizing capital inflow

[4]There are also adverse (positive) effects of overvaluation (undervaluation) of real exchange rates on the economic growth of developing countries, which are well documented in the empirical literature (Rodrik 2008; Rajan and Subramanian 2011). Persistent appreciation may also lead to irreversible damage to the export sector that may justify exchange rate intervention (Caballero and Lorenzoni 2014).

restrictions or by strengthening capital outflow restrictions to reduce depreciation pressures and reserve losses. Briefly, the restrictiveness of capital flow regulations has to be countercyclically adjusted to manage macroeconomic stability risks (Ocampo 2008; Ocampo and Palma 2008). The empirical analysis in this paper documents that the use of CARs by emerging economies reduces such risks and smooths out business cycle fluctuations.

Second, this paper contributes to the literature on measuring foreign exchange pressure (Klaassen and Jager 2011; Frankel and Saravelos 2010; Eichengreen and others 1995; Weymark 1995; Pentecost and others 2001). We define foreign exchange pressure as the sum of real exchange rate appreciation and foreign exchange reserve accumulation, weighted by the inverse of their standard deviations to compensate for the different volatilities of each variable. This is analogous to measures of foreign exchange pressure that are often used to capture countries' exposure to sudden stops in capital inflows and their effects on nominal depreciation and loss of reserves. The advantage of our measure is that it accounts for changes in the real exchange rate, which may not remain constant as commonly assumed in a trilemma setting wherein the nominal exchange rate responds to capital flows, and subsequent price-level adjustments offset the effects on the real exchange rate. As we show in the conceptual framework, imperfect capital mobility resulting from a policy-induced friction may affect the real exchange rate and, thus, foreign exchange pressure in cases where Ricardian equivalence fails to hold.

Third, our empirical findings contribute to the literature on identifying the macroeconomic determinants of foreign exchange pressure (Aizenman and others 2012; Aizenman and Hutchison 2012; IMF 2011c; Weymark 1997). Using the Chinn—Ito capital account openness index and focusing on the subset of emerging market economies that experienced a rise in foreign exchange pressure—measured as the sum of nominal depreciation and reserve loss—during the global financial crisis, Aizenman and Hutchison (2012) find no significant effect of capital account openness on foreign exchange pressure. This may be partly due to the limited number of observations in their cross-country comparison and the use of a capital account restrictiveness measure that does not distinguish between inflow and outflow restrictions. The empirical strategy that we use not only allows us to make that distinction but also explicitly addresses the endogeneity problem using an instrumental variables approach.

The remainder of this paper is organized as follows: Section 2 outlines a simple conceptual framework; Section 3 describes the measurement of CARs and foreign exchange pressure; Section 4 presents our empirical methodology and reports the results; and Section 5 concludes.

Conceptual Framework

In this section, we will present a simple two-sector model of a small open economy in order to provide a framework in which to analyze the key empirical predictions. The model aims at capturing in a simple way the essential effects of

CARs on the foreign exchange market in a small open economy context. The model heavily draws on models in Korinek (2013) and Jeanne (2012).[5]

Consider a small open economy populated by consumers who consume a tradable good and a nontradable good. We assume that there is a single homogenous tradable good and denote the relative price of nontradable goods by p_N, which constitutes a measure of the real exchange rate.[6] The utility of the consumer is given by a standard utility function, $U = \sum_{t=0}^{\infty} \beta^t u(c_{T,t}, c_{N,t})$, where $c_{T,t}$ is the consumption of the tradable good, $c_{N,t}$ is the consumption of the nontradable good, $u(.)$ is a standard neoclassical period utility function, and $\beta \in (0,1)$ is a time discount factor. We assume that the utility function is strictly concave in both arguments and the arguments are complements.[7]

At the beginning of period t, the consumer has an endowment of $y_{T,t}$ of tradable goods, $y_{N,t}$ of nontradable goods, and financial net worth b_t, where the initial financial assets b_0 in period 0 are given. He makes consumption and saving decisions by buying b_{t+1} zero coupon bonds at a price $1R_{t+1}$ that pay off one unit of tradable goods in period $t+1$, where R_{t+1} denotes the world interest rate between periods t and $t+1$. The budget constraint of the consumer in period t is

$$c_{T,t} + p_{N,t}c_{N,t} + \frac{(1-\tau_{t+1})b_{t+1}}{R_{t+1}} = y_{T,t} + p_{N,t}y_{N,t} + b_t - T_t, \tag{1}$$

where τ_{t+1} represents a proportional subsidy to bond purchases $b_{t+1}R_{t+1}$. The required revenue for the subsidy is assumed to be raised as a lump-sum tax $T_t = \tau_{t+1}b_{t+1}R_{t+1}$. If the country is a net saver, $b_{t+1} > 0$, τ_{t+1} is a subsidy to saving, i.e. a subsidy to capital outflows. If the country is a net borrower, $b_{t+1} < 0$, τ_{t+1} is a tax on foreign borrowing, or a tax on capital inflows. We will refer to τ_{t+1} as CARs. The consumer maximizes utility subject to the budget constraint, yielding the following first-order conditions:

$$(1-\tau_{t+1})u_T(c_{T,t}, c_{N,t}) = \beta R_{t+1}u_T(c_{T,t+1}, c_{N,t+1}), \tag{2}$$

$$p_{N,t} = \frac{u_N(c_{T,t}, c_{N,t})}{u_T(c_{T,t}, c_{N,t})}. \tag{3}$$

[5]It focuses only on partial equilibrium effects tested in the empirical section of our paper, and it begins with the case of two goods: a tradable and a nontradable good. A Keynesian model, including tradable and nontradable sectors with imperfect substitution between domestic and external assets, would have similar results.

[6]The real exchange rate is officially defined as the price of a consumption basket of domestic goods expressed in terms of a consumption basket of foreign goods. All else equal, an increase in the relative price of nontradables raises the price of a consumption basket of domestic goods, which indicates a strictly monotonic relationship between the official real exchange rate and our measure p_N.

[7]The partial derivatives of the utility function are expressed as $u_T = \partial u \partial c_{T,t}$ and similar for u_N, u_{NT}, etc. The assumption is that the tradable and nontradable goods are complements or mild substitutes in the utility function of domestic consumers such that $u_T > 0 > u_{TT}$, $u_N > 0 > u_{NN}$, and $u_{NT}u_T - u_N u_{TT} > 0$.

The first optimality condition defines bond demand b_{t+1} as an increasing function of the world interest rate R_{t+1} and τ_{t+1} (see Appendix B1 for the derivation). The second optimality condition states that the real exchange rate is the marginal rate of substitution between tradable and nontradable goods. The market for nontradable goods clears when $c_{N,t} = y_{N,t}$. After substituting the market-clearing condition $c_{N,t} = y_{N,t}$ in (3), we observe that tradable consumption is the only endogenous variable driving the real exchange rate, and a rise (fall) in tradable consumption appreciates (depreciates) the real exchange rate[8]:

$$\frac{\partial p_{N,t}}{\partial c_{T,t}} = \frac{u_{NT}u_T - u_N u_{TT}}{(u_T)^2} > 0. \tag{4}$$

This model has several simple predictions.[9] First, an increase in the CARs τ_{t+1} in a given period t (i) increases saving $\partial(b_{t+1}R_{t+1})\partial\tau_{t+1} > 0$ and bond holdings $\partial b_{t+1}\partial\tau_{t+1} > 0$ or, conversely, reduces borrowing, and reduces tradable consumption $\partial c_{T,t}\partial\tau_{t+1} < 0$, and (ii) depreciates the real exchange rate $\partial p_{N,t}\partial\tau_{t+1} < 0$ for a given world interest rate R_{t+1}. The intuition is that when the supply of tradable goods increases, nontraded goods, which are in fixed supply in the economy, become relatively more valuable. CARs increase savings and thus reduce tradable consumption; the real exchange rate moves in line with tradable consumption. Therefore, an increase in CARs depreciates the exchange rate $\partial p_{N,t}\partial\tau_{t+1} < 0$ for a small open economy.

A second prediction is that a given level of restrictions on capital flows under open capital accounts is equivalent to a given amount of reserve accumulation under closed capital accounts. To see this point, consider a policy authority who accumulates bond holdings a_t on behalf of domestic consumers, where he finances or rebates any accumulation or decumulation $a_{t+1}R_{t+1} - a_t$ by lump-sum transfers. These bond holdings can be considered as reserves. This modifies the consumer's budget constraint to

$$c_{T,t} + p_{N,t}c_{N,t} + \frac{a_{t+1} + (1-\tau_{t+1})b_{t+1}}{R_{t+1}} = y_{T,t} + p_{N,t}y_{N,t} + a_t + b_t - T_t. \tag{5}$$

The model has implications for two opposite cases: (i) the case of open capital accounts when domestic consumers can trade international bonds b_{t+1}, as assumed so far; and (ii) the case of closed capital accounts when domestic consumers are not allowed to lend or borrow from abroad, i.e. $b_{t+1} = 0\ \forall t$. Under open capital accounts, domestic consumers reverse and cancel out any reserve holdings a_{t+1} by changing their private bond holdings such that $b_{t+1} = \tilde{b}_{t+1} - a_{t+1}$, where $\tilde{b}_{t+1}$ is the optimal bond holding choice when there is no reserve accumulation. However,

[8]The derivative is positive by our earlier assumptions for the utility function. We imposed the assumption that the two goods are complements or mild substitutes in the utility function of domestic consumers such that $u_T > 0 > u_{TT}$, $u_N > 0 > u_{NN}$, and $u_{NT}u_T - u_N u_{TT} > 0$.

[9]See Appendix B1. for a proof of these predictions.

under closed capital accounts, domestic consumers cannot reverse accumulation of reserves, which decreases tradable consumption $\partial c_{T,t}\partial a_{t+1} < 0$ and depreciates the real exchange rate $\partial p_{N,t}\partial a_{t+1} < 0$. It follows that a given level of CARs τ_{t+1} under open capital accounts corresponds one-to-one to a given amount of reserve accumulation a_{t+1} under closed capital accounts.

Finally, a third prediction is that an increase in CARs reduces the foreign exchange pressure, a combination of reserve accumulation and real exchange rate appreciation, in a given time period as long as the government aims to smooth trade balance by restricting trade deficits. To see this point, suppose that (for a reason outside of the model, which could be technological spillover effects or learning by doing) the government tries to smooth the trade balance by limiting trade deficits, or even maintaining a surplus as in Jeanne (2012). Therefore, the government intervenes to accumulate reserves to reduce real exchange rate appreciation when the real exchange rates begin to appreciate. This defines the reaction function of the government in response to a change in the real exchange rate as follows:

$$\frac{\partial a_{t+1}}{\partial p_{N,t}} > 0. \tag{6}$$

This reaction function generates the prediction that an increase in the CARs τ_{t+1} in a given period t reduces the foreign exchange pressure $\partial FXP_t\partial\tau_{t+1} < 0$ for a given world interest rate R_{t+1}. The intuition is that stricter CARs generate two complementary effects. First, they induce private agents to increase their bond holdings, and the reduction in tradable consumption depreciates the real exchange rate, which is the first component of FXP_t. The second effect is that since the CARs would reduce the appreciation of the real exchange rate, they reduce the need for the government to accumulate reserves for resisting such appreciation. Thus, a rise in CARs would reduce foreign exchange pressure by depreciating the real exchange rate and reducing need for reserve accumulation.

The main point of the model can be stated succinctly. A small open economy can resist the real appreciation of its currency by imposing a tax on capital inflows (or a subsidy on capital outflows). This will reduce borrowing from abroad and encourage savings, leading to a depreciated real exchange rate. The intuition is that for a fixed supply of nontradable goods, a reduction in the demand for tradable goods induced by the additional savings generated by CARs creates relative scarcity and thus generates higher prices for nontradables relative to tradables, which is, by definition, a depreciated real exchange rate. The same result would be obtained in the presence of financial frictions that restrict private sector borrowing from abroad. The key point is that the borrowing constraint has to be binding for these results to hold, regardless of whether it is a "natural" financial friction or a "policy-induced" friction that comes with the use of CARs. The policy implication is that these regulations can be used to resist real exchange rate appreciation to the extent that their evasion is prevented.

A complementary prediction of the model is that the accumulation of reserves by the public sector will reduce real appreciation of the currency but generally only if they are complemented by CARs that prevent private sector borrowing from abroad. This combination results in a deviation from Ricardian equivalence, which requires that any accumulation of foreign assets by the public sector be offset by international borrowing by the private sector—a condition that is expected to hold under perfect capital mobility. Ricardian equivalence may also fail under other conditions of imperfect capital mobility, such as financial frictions that restrict the ability of the private sector to borrow relative to that of the public sector. The key point is that "policy-induced" frictions, such as a taxes on capital inflows, may generate the same outcome by repressing private borrowing abroad, which, coupled with reserve accumulation by the public sector, results in a depreciated real exchange rate.

A final insight from the model is that the use of CARs would reduce the two components of foreign exchange pressure. First, it would reduce real exchange rate appreciation by inducing the private sector to save more and to consume fewer tradable goods. Second, it would reduce the public sector's need to accumulate reserves in order to resist appreciation pressure. This is important from a policy point of view not only because of the social and economic costs associated with currency appreciation (e.g., reducing the expansion of tradable sectors and associated learning by doing) and investing in very low-return foreign assets (e.g., net resource transfers to advanced countries that have access to cheap long-term funding). There are also limits to the degree to which the accumulation of foreign assets can be sterilized in developing countries with shallow domestic bond markets. Sales of sterilization bills in such countries may result in higher interest rates and attract further capital inflows, defeating the purpose of reserve accumulation to resist currency appreciation.

To sum up, the simple model highlights that in countries that have capacity to implement binding CARs, there will be a decline in borrowing from abroad and increase in domestic savings, which induces a depreciation of the real exchange rate. Another prediction is that the use of CARs reduces foreign exchange pressure by either reducing appreciation of the real exchange rate, or accumulation of reserves, or a combination of the two. These are the predictions that will be tested in the empirical analysis.

Measurement of Capital Account Regulations and Foreign Exchange Pressure

Measurement of Capital Account Regulations

We use four indices of *de jure* capital account regulations: (i) capital inflow restrictions, (ii) foreign exchange (FX)-related regulations, (iii) financial sector regulations, and (iv) capital outflow restrictions.[10] The first and fourth indices are

[10]See Appendix Table A2 for the descriptions of and data sources for the variables used in this study.

developed by Schindler (2009) based on the IMF's AREAER database, and they provide an average of binary regulations across six asset categories: money market instruments, bonds, equities, financial credits, collective instruments, and direct investment. They range between 0 and 1; the absence of regulations in any category is coded as 0, the presence of regulations across any category is coded as 1, and the other values represent a mix of regulations in these categories. The second and third indices are developed by Ostry and others (2012). The second, FX-related regulations, provides a simple average of restrictions on lending locally in foreign exchange, restrictions on purchase of locally issued securities denominated in foreign currencies, differential treatment of deposit accounts in foreign currencies, and limits on foreign exchange positions. The third, financial sector regulations, is composed of the simple average of differential treatment of accounts held by nonresidents, limits on borrowing from abroad, and restrictions on the maintenance of accounts abroad.

We extend the data for capital inflow and outflow restrictions from 2006 to 2011 and the data for FX-related regulations and financial sector restrictions from 2008 to 2011 using the raw data from the IMF's AREAER database.

Figure 1 shows the incidence of CARs for the countries in our sample[11] from 1995 to 2011, i.e., the percentage of countries with a capital inflow regulation at a point in time. Several interesting patterns emerge from these plots. First, while roughly 90 percent of countries use FX-related regulations to reduce currency mismatch and other exchange rate risks, direct restrictions on capital inflows and outflows are used by a smaller proportion of countries, ranging from 65 to 80 percent. Restrictions that are specific to the financial sector are imposed by 50 to 65 percent of countries, on average.

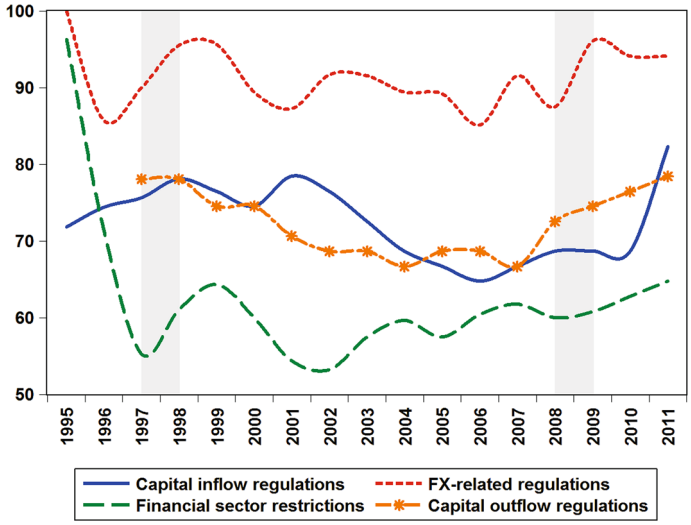
Figure 2 plots the country average for CARs, which represents the intensity of their use from 1995 to 2011. Two points are worth highlighting. First, the average scores for FX-related regulations are the highest, followed by those for capital outflow restrictions, which are followed by the averages for capital inflow restrictions and financial sector regulations. This pattern is similar to trends in share of countries adopting regulations, and, taken together, it indicates that even though the shares of countries adopting capital inflow and outflow regulations are similar, the index scores are higher for outflow restrictions.

Figure 3 plots the index for CARs from 1995 to 2011 across different regions of developing countries.[12] Three interesting regularities emerge from this disaggregation. First, South and East Asia has the highest average scores for all indicators of capital account restrictiveness, thus reaffirming the view that countries in this region have the most closed capital accounts. The region with the second highest scores is the Middle East and North Africa, followed by Eastern Europe and Latin America. Second, in the run-up to the global financial crisis, regional responses to capital inflows varied considerably. All regions except Eastern Europe responded by implementing higher FX-related and financial sector regulations from 2003 to 2007. While Latin America increased

[11]See Appendix Table A1 for a list of countries used in the study.

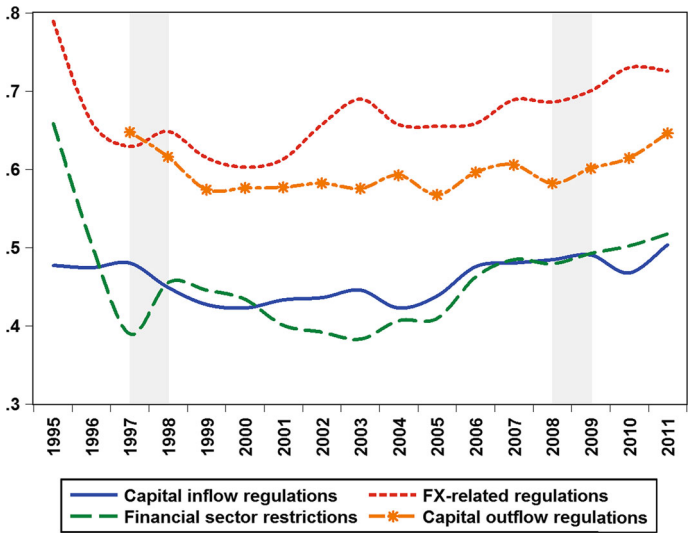
[12]The country list for each region is provided below the figure.

Figure 1. Incidence of Capital Account Regulations



Note: Indices are constructed based on the data from the IMF's AREAER database. Numbers show the percentage of countries with a capital account regulation over time.

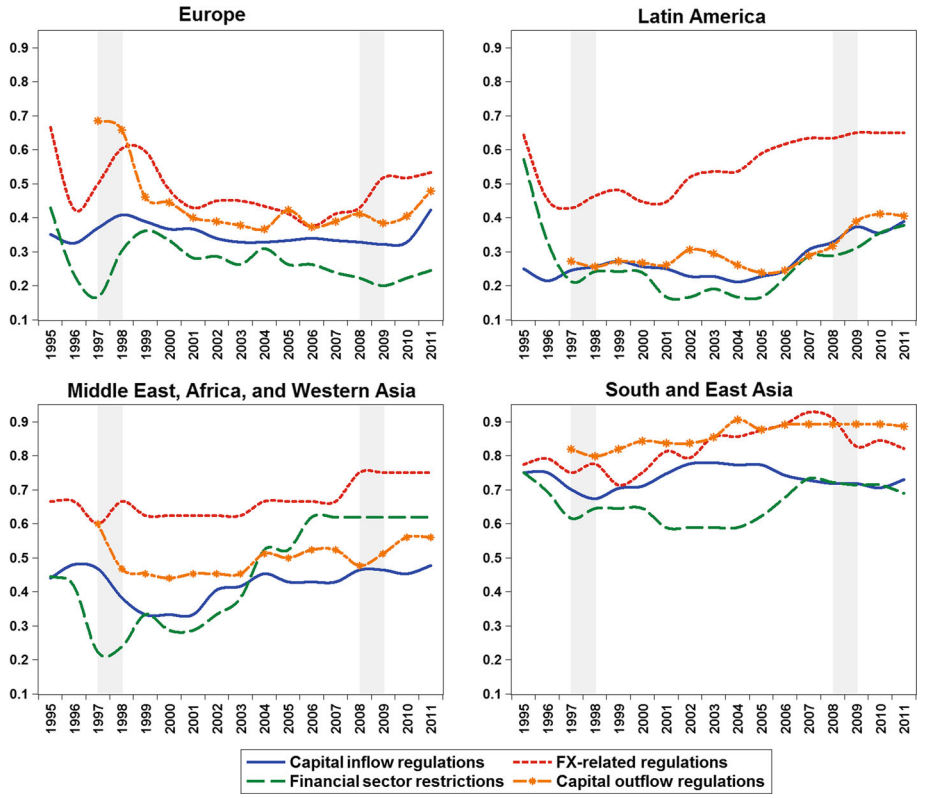
Figure 2. Evolution of Capital Account Regulations, Cross-Country Average



Note: Indices are constructed based on the data from the IMF's AREAER database. Numbers show the average of CARs across countries over time.

its capital inflow restrictions during the same period, South and East Asia slightly reduced them, and the Middle East and North Africa and Eastern Europe kept them more or less unchanged.

Figure 3. Evolution of Capital Account Regulations, Regional Averages



Note: Indices are constructed based on the data from the IMF's AREAER database. Numbers show the average of CARs across countries for each region over time. Regional country list is as follows: Europe: Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Iceland, Latvia, Lithuania, Poland, Romania, Russia, Serbia, Turkey, Ukraine; Latin America: Argentina, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Jamaica, Mexico, Panama, Peru, Uruguay, Venezuela; Middle East, Africa, and Western Asia: Algeria, Armenia, Egypt, Georgia, Israel, Jordan, Kazakhstan, Lebanon, Morocco, South Africa, Tunisia; South and East Asia: China, India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand, Vietnam.

Panel A of Table 1 presents the correlation coefficients for CAR measures from 1995 to 2011. The index of capital inflow regulations is highly positively correlated with capital outflow regulations, with a correlation coefficient of 0.84, and moderately positively correlated with FX-related regulations and financial sector restrictions (0.60 and 0.54, respectively). In addition, the latter two measures are moderately positively correlated with each other and with capital outflow regulations. The fact that these measures are highly to moderately correlated may give rise to multicollinearity in regressions that use them simultaneously as explanatory variables.

Panel B of Table 1 presents the between-country and within-country variation in CARs. For example, for capital inflow regulations, the between-country standard deviation is 0.31, while the within-country standard deviation is only

Table 1. Correlations and Between- vs. Within-Country Variation of Capital Account Regulations, 1995–2011

	Capital Inflow regulations	FX-Related Regulations	Financial Sector Regulations	Capital Outflow Regulations
Panel A: Correlations between CARs				
Capital inflow regulations	1			
FX-related regulations	0.60	1		
Financial sector restrictions	0.54	0.57	1	
Capital outflow regulations	0.84	0.60	0.54	1
Panel B: Between-country and within-country variation of CARs				
Between-country standard deviation	0.31	0.27	0.29	0.36
Within-country standard deviation	0.18	0.16	0.20	0.18
Share of variance due to between-countryvariance	0.75	0.73	0.69	0.80

Notes: Panel A reports the contemporaneous Pearson correlation coefficients for the period 1995–2011; the coefficients are significant at 1 percent level for all indices. Panel B presents between-country variance, within-country variance, and share of variance that is explained by between-country variance. Appendix Table A1 provides the list of countries and Table A2 provides the description and source of variables.

0.18. For all indices, the between-country standard deviation is 1.5 to 1.7 times larger than the within-country standard deviation. The last row shows that the share of variation due to the between-country component ranges from 69 to 80 percent, indicating that much of the variation comes from the variation between countries rather than variation within countries. This should not be surprising given that the indices are averages of dummy variables indicating whether a regulation is present in a country, capturing differences across countries. Moreover, they vary over time only to the extent that countries change older restrictions or implement new ones in any asset category. This low within-country variation tells us that countries do not make such regulatory changes very frequently, and most of the variation therefore comes from the cross-country differences in the use of these regulations. Low within-country variation prevents us from using country fixed effects in our model; however, we augment the specifications using fixed effects to control for time-invariant heterogeneity at the region level.

Measurement of Foreign Exchange Pressure

We define the foreign exchange pressure index as the weighted average of changes in reserve accumulation and the real exchange rate weighted by the inverse of the standard deviations of each variable. This measure is comparable across countries and over time. We use data on consumer price index-based real effective exchange rates (denoted by p_N) from Darvas (2012)—which covers 178 countries, including those in our sample, and derives the indices from 172 trading partners—and international reserves minus gold (denoted by a) in U.S. dollars

from the IMF's the *International Financial Statistics* to calculate our index of foreign exchange pressure (*FXP*):

$$FXP_{it} = (1\sigma_i^{\hat{p}_N})\hat{p}_{N,it} + (1\sigma_i^{\hat{a}})\hat{a}_{it+1}, \tag{7}$$

where i is an index for countries, t is an index year-long period, and σ is the standard deviation. An increase in p_N indicates real appreciation of the exchange rate, and an increase in a indicates an accumulation of international reserves.

Our measurement is similar to recent studies using various foreign exchange pressure indices or exchange market pressure (Aizenman and Hutchison 2012; Frankel and Saravelos 2010). The main difference is that while most of these studies calculate the index as the (weighted) sum of nominal depreciation plus the loss of international reserves, we use an index of real appreciation and reserve accumulation. Our method seems preferable for studying the cross-country effects of a surge in net capital flows to emerging market economies, while theirs seems useful for studying speculative attacks on the currency and large capital outflows during crises. Another possible difference is the weighting scheme, where some studies use equal weights. For instance, Aizenman and Hutchison (2012) initially use equal weights and then conduct a robustness check using a standardized index, concluding that their results are robust to this alternative weighting scheme.[13] Our results are robust to using an equal-weighting scheme, but as the results are very similar, they are not reported to save space.

Macroeconomic Effects of Capital Account Regulations

Effects of Capital Account Regulations on Foreign Exchange Pressure

Specification

The dataset consists of a maximum of 51 emerging and developing countries covering the period from 1995 to 2011. Our baseline specification for estimating the relationship between foreign exchange pressure and CARs takes the form:

$$FXP_{it} = \alpha + \beta CAR_{it-1} + \delta X_{it} + f_t + r_i + u_{it}, \tag{8}$$

[13]The concept of exchange market pressure originates in the work of Girton and Roper (1977) who focused on quantifying the pressure in any exchange rate regime. This was formalized by Weymark (1995) and Weymark (1997), who defined the exchange market pressure on a currency as its positive (or negative) excess supply in the foreign exchange market in the absence of policy actions to eliminate that excess supply. As a result, in a pure float, the exchange market pressure is the observed depreciation, whereas in fixed or managed float regimes, the exchange market pressure is the depreciation-equivalent of excess supply based on the counterfactual of no intervention in the market. Other studies include Eichengreen and others (1995), Eichengreen and others (1996), Sachs and others (1996a), Corsetti and others (1998), Fratzscher (1998), Kaminsky and others (1998), Berg and Pattillo (1999), Tornell (1999), Bussiere and Mulder (2000), Pentecost and others (2001), Collins (2003), Frankel and Wei (2005), Frankel and Xie (2010), Frankel and Saravelos (2010), and IMF (2007, 2009).

where FXP_{it} is the foreign exchange pressure index for country i at time t, as defined in Eq. (1); CAR_{it-1} is the capital account regulation index of country i at time $t-1$; X_{it} is a set of control variables, including real GDP growth rate, log of real per-capita GDP, overall institutional quality, and inflation rate; f_t is a full set of year fixed effects, controlling for macroeconomic shocks that affect all countries in any year; r_i denotes the region-specific fixed effects,[14] controlling for time-invariant heterogeneity at the region level; and u_{it} is the error term. We use annual panel data for 51 emerging economies from 1995 to 2011 and account for the overlapping nature of our observations in the regression by clustering the standard errors by country. Our primary interest lies in $\hat{\beta}$.

An important challenge to identifying the effects of CARs is that these regulations are potentially endogenous because countries may respond to increases in capital inflows by strengthening capital account restrictions. To the extent that such endogeneity exists, it would bias the results toward finding no effect. We therefore use lagged values of CARs in all regressions to reduce the bias, and we complement the OLS estimations with an instrumental variables approach to explicitly address endogeneity. Our instruments are based on the presence of agreements that restrict the use of CARs. In particular, we use bilateral investment treaties with the United States and membership in the European Union, which prohibit the use of restrictions on international capital flows. There is considerable heterogeneity across countries in the existence of these agreements.[15] We use this heterogeneity in U.S. bilateral investment and E.U. membership agreements to identify the effects of CARs on macroeconomic stability indicators. Our identifying assumption is that countries do not sign these agreements to directly reduce real exchange rate appreciation or influence macroeconomic instability.

It should be recognized that, in general, countries sign bilateral investment treaties to attract more foreign direct investment (FDI); to the extent that this occurs, the expectation would be greater appreciation of the exchange rate, not less. Hence, although we cannot rule out direct effects of these treaties on macroeconomic stability indicators, these alternative channels of influence are likely to go in the opposite direction. In any case, the evidence that parties to investment treaties receive more FDI, as well as the extent to which they improve investor confidence, is mixed.[16] The fact that there are only moderate correlations

[14]The list of countries for regional categories is provided below Figure 3.

[15]The source of variance in the presence of these agreements is primarily between-country variation rather than within-country variation. For example, the between-country standard deviation of bilateral investment treaties with the United States is 0.45, while the within-country standard deviation is only 0.19. Therefore, the identifying component of the variation is variation across countries rather than within countries. This does not pose an identification problem because the CARs that we predict using these instruments also vary largely across countries and much less within countries.

[16]Hallward-Driemeier (2003) does not find any statistically significant effects of bilateral investment treaties on FDI flows into developing countries. Tobin and Rose-Ackerman (2005) find that bilateral investment treaties negatively impact the ability to attract FDI at high levels of risk, positively affecting FDI only at low levels of risk. However, the majority of developing countries are classified as high risk.

between bilateral investment treaties/EU membership and macroeconomic stability indicators supports our identifying assumption that countries do not sign these agreements to influence foreign exchange market outcomes.

Baseline Panel Evidence

Table 2 presents the results from the IV estimation in the left panel and those of the OLS estimation in the right panel. The coefficient estimates in columns (1), (2), and (4) show that capital inflow regulations, FX-related regulations, and capital outflow regulations are significantly and negatively related to foreign exchange pressure. Financial sector restrictions are also negatively associated with foreign exchange pressure but are significant only at the 10 percent level. The Hansen test of overidentifying restrictions cannot be rejected for the IV regressions for capital inflow regulations, FX-related regulations, or capital outflow regulations, supporting the validity of the instruments for these specifications. In the right panel, not controlling for endogeneity seems to have biased the OLS estimates toward zero. Our IV estimates of the effects of CARs on foreign exchange pressure are likely to be conservative, underestimating these cross-country effects by roughly 10 percent (implying that the true coefficient in column 1 is 0.85 rather than 0.77). The reason for this downward bias is that the instrumental variables fail to completely correct for endogeneity in small samples in the presence of weak instruments or many instruments, biasing the IV estimates in the direction of the OLS results.[17]

On the conservative side, column (1) estimates show that moving from the 25th to the 75th percentile of capital inflow regulations reduces foreign exchange pressure by 0.52 percentage points (0.67×0.77), controlling for real GDP growth, real GDP per capita, overall institutional quality, inflation, and region and year fixed effects. This is a sizable effect considering that the foreign exchange pressure has a mean of 0.78 and a standard deviation of 1.47 percentage points. Having capital inflow restrictions in place reduces foreign exchange pressure by 35 percent of one standard deviation.

Column (2) indicates that moving from the 25th to the 75th percentile of FX-related regulations generates a 0.30 percentage point reduction in the foreign exchange pressure, which corresponds to 20 percent of one standard deviation of foreign exchange pressure. Finally, column (4) shows that moving from the 25th to the 75th percentile of capital outflow regulations results in a 0.63 percentage

[17]For a useful discussion of this issue, see Stock and others (2002). The partial F statistic of the excluded instruments, a statistic commonly used to test the strength of instruments is 11 percent for regressions using capital inflow regulations and outflow regulations and 6 percent for regressions using FX-related regulations. Using the Stock–Yogo weak identification test critical values, the IV relative bias decreases to between 10 and 15 percent. Because the OLS estimates in our case are close to zero, and the IV estimates are biased toward the OLS results in cases of weak instruments, the true coefficients are 10 to 15 percent higher than those reported in the left panel of Table 2. This point also applies to the IV regression estimates reported in Tables 3, 4, and 5.

Table 2. Panel Estimation of the Effects of Capital Account Regulations on Foreign Exchange Pressure, 1995–2011

	Instrumental Variables-2SLS						OLS							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Capital inflow regulations	−0.77**				−3.91	−2.09	11.86	−0.27				−0.25	−0.16	−0.39
	(0.35)				(9.39)	(1.73)	(49.22)	(0.19)				(0.24)	(0.19)	(0.35)
FX-related regulations		−1.18**			4.34				−0.02			0.15		
		(0.60)			(12.93)				(0.20)			(0.26)		
Financial sector restrictions			−1.28			2.31				−0.09			0.00	
			(0.79)			(2.85)				(0.18)			(0.20)	
Capital outflow regulations				−0.68*			−11.48				−0.07			0.20
				(0.39)			(44.88)				(0.14)			(0.26)
Real GDP growth	0.07***	0.08***	0.07***	0.08***	0.08***	0.08***	0.05	0.07***	0.08***	0.07***	0.08***	0.08***	0.07***	0.09***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.17)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Real GDP per capita (log)	−0.14**	−0.08	−0.16	−0.09	−0.34	0.00	0.26	−0.08	−0.05	−0.03	−0.03	−0.07	−0.04	−0.05
	(0.06)	(0.07)	(0.12)	(0.09)	(0.68)	(0.19)	(1.48)	(0.06)	(0.07)	(0.07)	(0.08)	(0.07)	(0.07)	(0.08)
Institutional quality	−0.16	−0.80	−0.27	0.34	2.06	−0.23	2.27	−0.18	−0.30	−0.41	0.21	−0.18	−0.37	0.17
	(0.57)	(0.86)	(0.70)	(0.73)	(7.14)	(1.14)	(8.72)	(0.57)	(0.65)	(0.63)	(0.70)	(0.66)	(0.65)	(0.69)
ln (1 + inflation)	−0.32***	−0.36***	−0.30***	−0.42***	−0.24	−0.30**	−0.68	−0.31***	−0.33***	−0.30**	−0.40***	−0.32***	−0.29**	−0.40***
	(0.09)	(0.11)	(0.11)	(0.09)	(0.29)	(0.12)	(1.08)	(0.10)	(0.12)	(0.12)	(0.09)	(0.11)	(0.11)	(0.09)
Observations	672	625	614	602	608	595	602	672	625	614	602	608	595	602
Hansen overidentification test	0.21	0.22	0.06	0.26										
R^{-2}								0.15	0.15	0.14	0.19	0.15	0.14	0.19
25th to 75th percentile difference in policy measures	0.67	0.25	0.67	0.92	0.67, 0.25	0.67, 0.67	0.67, 0.92	0.67	0.25	0.67	0.92	0.67, 0.25	0.67, 0.67	0.67, 0.92

Notes: Dependent variable is the index of foreign exchange pressure (Mean = 0.78, Std. Dev. = 1.47). In columns (1) to (7), all CARs are instrumented with binary variables that take the value of 1 if the country has a bilateral investment treaty with the U.S. in year t (and zero otherwise), and if the country is in the European Union (and zero otherwise). Capital inflow regulations, FX-related regulations, financial sector-specific restrictions, and capital outflow regulations are lagged one year. All specifications control for real GDP growth, log real GDP per capita, institutional quality, inflation, year fixed effects, and region fixed effects. The row for the Hansen overidentification test of instruments reports the p value. The last row reports the difference between 25th and 75th percentiles of policy measures used in each regression. Standard errors are clustered at the country level. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

Table 3. Additional Covariates in IV–2SLS Panel Estimation of the Effects of Capital Account Regulations on Foreign Exchange Pressure, 1995–2011

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Capital inflow regulations	−0.76**	−0.88**						
	(0.36)	(0.37)						
FX-related regulations			−1.15*	−1.37**				
			(0.60)	(0.62)				
Financial sector restrictions					−1.01	−1.31		
					(0.98)	(1.09)		
Capital outflow regulations							−0.85***	−0.97***
							(0.30)	(0.31)
Real GDP growth	0.09***	0.09***	0.09***	0.10***	0.09***	0.09***	0.09***	0.09***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Real GDP per capita (log)	−0.15	−0.17*	−0.11	−0.12	−0.15	−0.18	−0.12	−0.13
	(0.09)	(0.10)	(0.10)	(0.11)	(0.13)	(0.15)	(0.10)	(0.10)
Institutional quality	0.08	0.11	−0.25	−0.25	0.08	0.17	0.35	0.38
	(0.70)	(0.73)	(1.02)	(1.05)	(0.82)	(0.85)	(0.75)	(0.79)
ln (1 + inflation)	−0.37***	−0.36***	−0.42***	−0.40***	−0.38***	−0.36***	−0.40***	−0.39***
	(0.09)	(0.08)	(0.09)	(0.09)	(0.09)	(0.09)	(0.10)	(0.09)
Exchange rate regime	−0.20	−0.23*	−0.35*	−0.42**	−0.21	−0.26	−0.38***	−0.42***
	(0.12)	(0.13)	(0.18)	(0.19)	(0.15)	(0.16)	(0.13)	(0.13)
Terms of trade (log)	0.90	1.59**	0.52	1.29	0.50	1.01	0.88	1.73*
	(0.71)	(0.79)	(0.82)	(0.87)	(0.64)	(0.73)	(0.78)	(0.89)
FDI inflows (% of GDP)		0.03***		0.03***		0.03***		0.03***
		(0.01)		(0.01)		(0.01)		(0.01)
Gross domestic saving		−0.04		−0.05		−0.03		−0.05*
(% of GDP)		(0.03)		(0.03)		(0.03)		(0.03)
Government consumption		0.01		0.06		0.06		0.01
(% of GDP)		(0.06)		(0.05)		(0.07)		(0.06)
Observations	599	596	553	550	545	542	549	546
Hansen overidentification test	0.23	0.27	0.28	0.34	0.10	0.13	0.46	0.52

Table 3: (*Continued*)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
25th to 75th percentile difference in policy measures	0.67	0.67	0.25	0.25	0.67	0.67	0.92	0.92

Notes: Dependent variable is the index of foreign exchange pressure (Mean = 0.78, Std. Dev. = 1.47). All CARs are instrumented with binary variables that take the value of 1 if the country has a bilateral investment treaty with the U.S. in year t (and zero otherwise), and if the country is in the European Union (and zero otherwise). Capital inflow regulations, FX-related regulations, financial sector-specific restrictions, and capital outflow regulations are lagged one year. All specifications control for real GDP growth, log real GDP per capita, institutional quality, inflation, year fixed effects, and region fixed effects. Terms of trade (log), gross domestic saving (share of GDP), government consumption (share of GDP), FDI inflows (share of GDP), and ln (1+ inflation) are in differenced form. Exchange rate regime (binary variable equal to 1 for a de facto fixed exchange rate regime and 0 otherwise) is lagged one period. The row for the Hansen overidentification test of instruments reports the *p* value. The last row reports the difference between 25th and 75th percentiles of policy measures used in each regression. Standard errors are clustered at the country level. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

Table 4. Panel Estimation of the Effects of Capital Account Regulations on the Percentage Change in Real Exchange Rates, 1995–2011

	Instrumental Variables - 2SLS						OLS							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Capital inflow regulations	−5.95**				−13.95	−6.57	−13.34	−2.12**				−1.84*	−1.26	−2.66
	(2.33)				(50.49)	(5.78)	(24.54)	(0.86)				(0.99)	(0.95)	(1.89)
FX-related regulations		−9.25**			10.66				−0.93			0.05		
		(3.90)			(66.03)				(1.15)			(1.33)		
Financial sector restrictions			−9.05			1.79				−0.53			−0.00	
			(6.63)			(9.77)				(0.79)			(0.87)	
Capital outflow regulations				−4.85**			6.66				−1.35*			0.55
				(2.27)			(21.53)				(0.78)			(1.65)
Real GDP growth	0.54***	0.60***	0.58***	0.59***	0.60***	0.59***	0.64***	0.53***	0.59***	0.58***	0.60***	0.58***	0.58***	0.61***
	(0.13)	(0.14)	(0.14)	(0.14)	(0.16)	(0.14)	(0.13)	(0.13)	(0.13)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
Real GDP per capita (log)	−1.07**	−0.63	−1.52	−0.75	−1.27	−0.84	−0.96	−0.73*	−0.43	−0.58	−0.45	−0.58	−0.60	−0.53
	(0.50)	(0.58)	(0.93)	(0.49)	(2.41)	(0.90)	(0.78)	(0.44)	(0.46)	(0.47)	(0.44)	(0.44)	(0.48)	(0.46)
Institutional quality	−3.03	−7.44	−1.43	−1.84	−1.18	−4.34	−5.43	−2.95	−4.86	−3.73	−2.41	−4.20	−3.93	−3.06
	(4.12)	(5.19)	(4.32)	(3.63)	(20.02)	(5.33)	(8.25)	(3.56)	(3.33)	(3.26)	(3.54)	(3.19)	(3.46)	(3.76)
Reserves (% of GDP)	0.06***	0.04***	0.04***	0.06***	0.04*	0.04***	0.06***	0.06***	0.04**	0.04**	0.06***	0.04**	0.04**	0.06***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Observations	732	684	671	656	667	652	656	732	684	671	656	667	652	656
Hansen overidentification test	0.77	0.44	0.24	0.43										
R^2								0.23	0.18	0.18	0.23	0.18	0.18	0.23
25th to 75th percentile difference in policy measures	0.67	0.25	0.67	0.92	0.67,	0.67,	0.67,	0.67	0.25	0.67	0.92	0.67,	0.67,	0.67,
					0.25	0.67	0.92					0.25	0.67	0.92

Notes: Dependent variable is the percentage change in real exchange rate (Mean = 1.83, Std. Dev. = 10.45). In columns (1) to (7), all CARs are instrumented with binary variables that take the value of 1 if the country has a bilateral investment treaty with the U.S. in year t (and zero otherwise), and if the country is in the European Union (and zero otherwise). Capital inflow regulations, FX-related regulations, financial sector-specific regulations, and capital outflow regulations are lagged one year. All specifications control for real GDP growth, log real GDP per capita, institutional quality, reserves as a share of GDP, year fixed effects, and region fixed effects. The row for the Hansen overidentification test of instruments reports the *p* value. Reserves as a share of GDP is lagged one period. The last row reports the difference between 25th and 75th percentiles of policy measures used in each regression. Standard errors are clustered at the country level. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

Table 5. Additional Covariates in IV–2SLS Panel Estimation of the Effects of Capital Account Regulations on the Percentage Change in Real Exchange Rates, 1995–2011

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Capital inflow regulations	−4.66**	−6.10**						
	(2.30)	(2.41)						
FX-related regulations			−7.56***	−9.75***				
			(2.91)	(3.06)				
Financial sector restrictions					−13.06	−16.89		
					(9.33)	(11.44)		
Capital outflow regulations							−4.24**	−5.68**
							(2.12)	(2.23)
Real GDP growth	0.63***	0.71***	0.65***	0.73***	0.63***	0.74***	0.63***	0.71***
	(0.13)	(0.14)	(0.15)	(0.17)	(0.15)	(0.17)	(0.14)	(0.15)
Real GDP per capita (log)	−1.12**	−1.26**	−0.69	−0.77	−1.88	−2.32	−0.90*	−1.00*
	(0.46)	(0.51)	(0.52)	(0.59)	(1.20)	(1.50)	(0.51)	(0.56)
Institutional quality	−2.22	−1.80	−7.61	−7.53	−0.79	0.44	−1.35	−1.04
	(3.63)	(3.76)	(4.77)	(5.02)	(6.11)	(7.10)	(3.83)	(3.89)
Reserves (% of GDP)	0.03**	0.03**	0.04**	0.04**	0.04**	0.04**	0.04**	0.03**
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ln (1 + inflation)	−3.24***	−3.06***	−3.56***	−3.35***	−3.24***	−2.97***	−3.40***	−3.23***
	(0.81)	(0.74)	(0.85)	(0.77)	(0.83)	(0.76)	(0.86)	(0.79)
Exchange rate regime	−0.98*	−1.36**	−1.97**	−2.62**	−1.21	−1.77	−1.35*	−1.82**
	(0.56)	(0.60)	(0.90)	(1.02)	(1.07)	(1.35)	(0.73)	(0.78)
Terms of trade (log)	−4.26	6.45	−5.36	4.94	−8.18	2.58	−4.18	7.48
	(5.48)	(4.78)	(6.87)	(5.89)	(5.85)	(5.18)	(5.52)	(5.05)
FDI inflows (% of GDP)		0.11		0.13		0.15**		(0.08)
		(0.07)		(0.08)		(0.07)		
Gross domestic saving		−0.65***		−0.63***		−0.68***		−0.71***
(% of GDP)		(0.19)		(0.20)		(0.23)		(0.22)
Government consumption		0.37		0.64*		0.83		0.36
(% of GDP)		(0.36)		(0.35)		(0.59)		(0.36)

Table 5: (*Continued*)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Observations	600	597	554	551	546	543	550	547
Hansen overidentification test	0.57	0.64	0.91	0.90	0.75	0.66	0.37	0.45
25th to 75th percentile difference in policy measures	0.67	0.67	0.25	0.25	0.67	0.67	0.92	0.92

Notes: Dependent variable is the percentage change in real exchange rate (Mean = 1.83, Std. Dev = 10.45). All CARs are instrumented with binary variables that take the value of 1 if the country has a bilateral investment treaty with the U.S. in year t (and zero otherwise), and if the country is in the European Union (and zero otherwise). Capital inflow regulations, FX-related regulations, financial sector-specific regulations, and capital outflow regulations are lagged one year. All specifications control for real GDP growth, log real GDP per capita, institutional quality, reserves as a share of GDP (lagged one period), year fixed effects, and region fixed effects. Terms of trade (log), gross domestic saving (share of GDP), government consumption (share of GDP), FDI inflows (share of GDP), and ln (1 + inflation) are in differenced form. Exchange rate regime (binary variable equal to 1 for a de facto fixed exchange rate regime and 0 otherwise) is lagged one period. The row for the Hansen overidentification test of instruments reports the *p* value. The last row reports the difference between 25th and 75th percentiles of policy measures used in each regression. Standard errors are clustered at the country level. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

point decline in the foreign exchange pressure, which amounts to 43 percent of one standard deviation.[18] Overall, CARs have a statistically significant and economically large impact on foreign exchange pressure. However, the results in columns (5)–(7) do not provide any evidence for their complementarity, which is likely to result from multicollinearity.[19]

It is important to reflect on the sources of endogeneity bias. Many possible potential sources of bias would induce a positive relationship between CARs and foreign exchange pressure rather than the negative relationship we have documented. To the extent that endogenous mechanisms are at play, it is not clear that they tend to generate bias that works against our findings. An increase in foreign exchange pressure due to a surge in capital inflows is expected to increase restrictions on capital inflows as authorities try to limit appreciation pressure. Similarly, a decrease in foreign exchange pressure is expected to decrease restrictions on capital inflows. Thus, it is unlikely that our negative coefficients, even in the OLS case, result from the reverse effect of foreign exchange pressure on CARs.

We augment the baseline specification and undertake a series of robustness tests using additional covariates. We include measures of terms of trade, gross domestic saving, government consumption, FDI inflows, and exchange rate regime—all of which are empirically documented important covariates of real exchange rate changes and reserve accumulation.[20]

The results reported in Table 3 show that including these additional regressors does not greatly affect the coefficients on CARs. The estimated values of the coefficients shift slightly (e.g., from a low of −0.76 to a high of −0.88 in case of capital inflow regulations), but they remain strongly significant across specifications.[21] The specifications with the full set of controls presented in columns (2), (4), and (8) show that the estimated effects of capital inflow regulations, FX-related regulations, and capital outflow regulations increase slightly. Despite the wide range of controls included, the central finding on CARs remains robust.

[18]This finding indicates that increasing capital outflow restrictiveness is associated with a decline in foreign exchange pressure. This may result from investor perception that the cost of moving funds out of the country has risen, which might in turn induce them not to make inward investments in the first place. As this would reduce capital inflows, we would expect a decline in foreign exchange pressure. In recent years, however, some countries (e.g., South Africa and Thailand) have responded to surges in inflows by liberalizing outflows. In this case, we would expect reducing capital outflow restrictiveness to alleviate foreign exchange pressure. However, we do not find support for this mechanism.

[19]Joint significance tests failed to reject that the pairwise regulations are jointly significantly different from zero.

[20]See Rodrik (2008) for an empirical analysis of the determinants of undervalued real exchange rates and how they influence long-term growth.

[21]The estimates for financial sector restrictions remain insignificant in these regressions, although they continue to have the expected negative sign seen in columns (5) and (6) of Table 3.

Effects of Capital Account Regulations on the Real Exchange Rate Changes

For many developing countries, the major motivation for implementing CARs during periods of massive capital inflows include diminishing real appreciation pressure and preventing "currency wars." To examine whether CARs negatively affect real exchange rate appreciation, we estimate the effects of these regulations on the annual percentage changes in the real exchange rates of the same 51 emerging countries over the period from 1995 to 2011. Our baseline specification includes a lagged dependent variable, real income growth, real income per capita, reserves as a share of GDP, institutional quality, as well as a full set of year fixed effects and region-specific fixed effects. Given the endogeneity of CARs to real exchange rate movements, we use an instrumental variables approach to estimate the effects of these regulations on real exchange rate changes. Our instruments are bilateral investment treaties with the United States and membership agreement in the E.U. We also present OLS estimates for comparison.

The two panels of Table 4 present the results from the IV estimation on the left and OLS estimation on the right, respectively. The Hansen test of overidentifying restrictions cannot be rejected for the case of IV regressions, supporting the validity of the instruments. The results in columns (1)–(4) show that capital inflow regulations, FX-related regulations, and capital outflow restrictions have a significant (at the 5 percent level) and negative effect on real exchange rate appreciation. The estimated effect of financial sector restrictions is negative but insignificant. In the right panel, not controlling for endogeneity appears to have biased the OLS estimates toward zero, although there is evidence of a negative correlation between capital inflow regulations and real exchange rate appreciation.

Column (1) shows that moving from the 25th to the 75th percentile of capital inflow regulations generates a 3.99 percentage point reduction in real exchange rate appreciation, controlling for real GDP growth, real GDP per capita, reserves as a share of GDP, and overall institutional quality. This is a sizable effect given that the annual percentage change in real exchange rate has a mean of 1.83 and a standard deviation of 10.45 percentage points. Having capital inflow restrictions in place reduces real exchange rate appreciation by 38 percent of one standard deviation.

Column (2) of Table 4 indicates that moving from the 25th to the 75th percentile of FX-related regulations reduces real exchange rate appreciation by 2.31 percentage points, which corresponds to 22 percent of one standard deviation of changes in the real exchange rate. Column (4) shows that moving from the 25th to the 75th percentile of capital outflow regulations results in a 4.46 percentage point decline in real exchange rate appreciation, corresponding to 43 percent of one standard deviation. Columns (5)–(7) do not provide any evidence of their complementarity, which may be due to the presence of multicollinearity.[22]

[22]Joint significance tests failed to reject that the pairwise regulations are jointly significantly different from zero.

We include a set of additional covariates to check the robustness of our results. In particular, we include terms of trade, gross domestic saving, government consumption, FDI inflows, exchange rate regime, and inflation rate. The results presented in Table 5 show that including these covariates slightly increases the estimated coefficients for CARs without changing their significance. If we consider the results of the regressions with the full set of covariates, then the effects reported in Table 4 are revised slightly upward. Moving from the 25th to the 75th percentile of capital inflow regulations (FX-related regulations or capital outflow regulations) results in a 4.09 (2.44 or 5.23, respectively) percentage point decline in real exchange rate appreciation, thus yielding a 0.10 (0.13 or 0.77, respectively) percentage point difference compared to the baseline estimates. These small differences, despite the reduced sample size and the range of controls used, indicate that the key findings for the effects of these measures on the real exchange rate remain strong.

Our results parallel those reported by Rodrik (2008) and Ahmed and Zlate (2013). Rodrik (2008) finds a significant positive relation between undervaluation of the real exchange rate and economic growth among developing countries. In addition, he finds that an undervalued real exchange rate is negatively correlated with the degree of capital account openness represented by the Chinn–Ito index. In other words, countries with more open capital accounts are more likely to have overvalued real exchange rates. This finding directly parallels to our finding that the use of CARs reduces real exchange rate appreciation in emerging economies. Ahmed and Zlate (2013) find that capital control measures introduced in recent years discourage both total and portfolio inflows, indicating the likely channel through which these real exchange rate effects work.

Our results differ from those reported by Klein (2012), who finds that the sub-indices of capital controls developed by Schindler (2009) do not have statistically significant impacts on real exchange rate changes based on a sample of 23 advanced and 21 emerging economies. Appendix Table A3 replicates his results in columns (1)–(3). In columns (4) and (5), we present the results estimated using bilateral trade agreements with the U.S. and E.U. membership as instruments for those capital control sub-indices (i.e., bond and money market restrictions and financial credits, equities, and collective instruments restrictions). The results remain insignificant, but when the policy instruments are regressed separately, their coefficients have consistent negative signs. In columns (6) and (7), we included the developing countries that were excluded from the original sample. While the negative coefficients increase in magnitude, they remain insignificant in these specifications. In columns (8) and (9), we keep the additional developing countries in the sample and exclude the advanced countries. In this case, the estimated coefficients become significant and remain negative for both policy measures. Overall, it is fair to conclude that the results for the effects of capital controls on real exchange rates differ due to the different country samples and estimation methods employed.

Effects of Capital Account Regulations on Crisis Resilience and Post-crisis Performance

If CARs help reduce foreign exchange pressure and real exchange rate appreciation, as Tables 2, 3, 4, and 5 suggest, this would smooth out macroeconomic fluctuations and enhance *real* macroeconomic stability—i.e., the stability of real GDP growth—by reducing excessive spending and current account deficits during booms and mitigating economic vulnerability during crises. Further, one would expect a quicker recovery from a crisis if a country has sound macroeconomic fundamentals that are not distorted by surges of capital inflows or outflows. In this section, we test whether (i) CARs increase resilience during crises and (ii) whether they enhance post-crisis macroeconomic performance by preventing overheating following post-crisis surges in capital flows into emerging economies.

To investigate the first hypothesis, we estimate the effects of CARs on changes in real GDP growth in 2009 relative to the average growth over the 2003–2008 period. As the growth rates did not become negative in most emerging and developing countries in 2008 (in fact, several countries had positive growth rates in 2008), treating 2008 as a crisis year reduces the growth decline experienced by the vast majority of countries. For this reason, we use the growth decline in 2009 as the reference year for the crisis in emerging markets and calculate its difference from average growth over 2003–2008 to measure the growth decline during crisis. This yields an average growth decline of 7.5 percentage points across the countries in our sample.

Table 6 presents the OLS regression results. Controlling for changes in terms of trade, growth rates of trading partners, and overall institutional quality, we find that countries that implemented CARs prior to the crisis had significantly higher growth rates during the crisis. The odd columns report the results for average regulations over the 2007–2009 period, while the even ones report the results for 2005–2007. First, column (2) shows that moving from the 25th to the 75th percentile of capital inflow regulations averaged over 2005–2007 is associated with a reduction in growth decline of 4 percentage points during the crisis. Second, column (4) indicates that moving from the 25th to the 75th percentile of FX-related regulations averaged over 2005–2007 is associated with a reduction in growth decline of 6.6 percentage points during the crisis.[23]

Third, although we find no evidence of significant effects of financial sector-specific restrictions on real exchange rate changes or foreign exchange

[23]Ostry and others (2012) find a significant effect for FX-related regulations if these are narrowly defined to cover only lending locally in foreign currencies and differential treatment of deposit accounts denominated in foreign currencies, excluding restrictions on purchases of locally issued securities denominated in foreign currencies and limits on open foreign exchange positions. Our results show that the composite index covering all of these restrictions is significantly and positively related to crisis resilience. We show the robustness of our results to alternative GDP growth decline measures in Table 9.

Table 6. OLS Cross-Section Estimation of the Effects of Capital Account Regulations on Crisis Resilience: Global Financial Crisis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	z(8)
Capital inflow regulations	5.56**	5.61**						
	(2.25)	(2.52)						
FX-related regulations			9.91***	9.82**				
			(3.62)	(3.75)				
Financial sector restrictions					6.69**	7.20**		
					(3.04)	(3.17)		
Capital outflow regulations							6.50***	5.73**
							(2.31)	(2.36)
Terms of trade change	0.26*	0.25*	0.26*	0.26**	0.23*	0.23*	0.22*	0.23
	(0.14)	(0.14)	(0.13)	(0.13)	(0.12)	(0.13)	(0.13)	(0.14)
Growth in trading partners	1.30	1.45*	0.10	0.22	2.24*	2.43**	1.54**	1.52*
	(0.82)	(0.86)	(0.76)	(0.76)	(1.21)	(1.18)	(0.75)	(0.80)
Institutional quality	−7.28	−7.14	−14.27	−12.43	−8.85	−9.18	−6.50	−7.41
	(11.37)	(11.18)	(12.08)	(12.97)	(10.22)	(9.90)	(10.70)	(10.69)
Observations	40	40	38	37	36	35	40	40
R^2	0.29	0.29	0.39	0.40	0.36	0.36	0.34	0.32
25th to 75th percentile difference in policy measures	0.72	0.72	0.67	0.67	0.67	0.67	0.94	0.92

Notes: Dependent variable is the difference between real GDP growth rates in 2009, and averaged over 2003–2008 (in percentage points; Mean = −7.5; Std. Dev. = 6.5). Capital inflow regulations, FX regulations, financial sector-specific restrictions, and capital outflow regulations are averaged over 2007–2009 for columns (1), (3), (5), and (7), and over 2005–2007 for columns (2), (4), (6), and (8). Institutional quality index is for 2007. Robust standard errors are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

pressure, column (6) shows that moving from the 25th to the 75th percentile of these policy measures averaged over 2005–2007 is associated with a reduction in growth decline of 4.8 percentage points during the crisis. Finally, we examine the effects of capital outflow restrictions on crisis resilience. The estimate in column (8) of Table 6 indicates that moving from the 25th to the 75th percentile of capital outflow restrictions decreases the growth decline during the crisis by 5.3 percentage points. This effect presumably works via the capacity to limit large flows of capital when a crisis is imminent and to reduce speculative capital inflows by making it harder to move funds abroad in the subsequent period. The estimates in the odd columns are very close in magnitude to these estimates. Given that the standard deviation of the growth decline during crisis is 6.5 percentage points, these estimates indicate economically large effects, ranging from roughly two-thirds to one standard deviation on average.

Next, we test whether the use of CARs during the crisis period helped prevent overheating economies during the post-crisis period. To examine the relationship between CARs and post-crisis performance, we estimate the effect of these measures averaged over 2007–2009 and 2005–2007 on the change in average post-crisis real income growth in 2010–11 relative to

Table 7. OLS Cross-Section Estimation of the Effects of Capital Account Regulations on Post-Crisis Performance: Global Financial Crisis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Capital inflow regulations	−5.14**	−5.11**						
	(2.06)	(2.22)						
FX-related regulations			−6.16*	−5.70*				
			(3.09)	(3.10)				
Financial sector restrictions					−5.11**	−4.68*		
					(2.49)	(2.74)		
Capital outflow regulations							−3.76*	−3.42
							(2.14)	(2.06)
Terms of trade change	0.01	−0.00	0.11**	0.10**	0.10*	0.09	0.07	0.07
	(0.07)		(0.05)	(0.04)	(0.06)	(0.06)	(0.06)	(0.06)
Growth in trading partners	−2.35	−3.09	−4.37	−4.69	−4.41	−4.36	−4.34	−4.62
	(3.21)	(3.43)	(3.06)	(3.09)	(2.83)	(2.91)	(3.02)	(3.03)
Institutional quality	12.73*	12.92*	8.10	7.01	11.36	12.25	14.20**	13.57**
	(7.45)	(7.43)	(7.03)	(7.76)	(7.22)	(7.53)	(6.37)	(6.50)
Observations	42	42	44	43	43	42	47	47
R^2	0.21	0.21	0.21	0.19	0.21	0.19	0.19	0.18
25th to 75th percentile difference in policy measures	0.72	0.72	0.67	0.67	0.67	0.67	0.94	0.92

Notes: Dependent variable is the difference between real GDP growth rates averaged over 2010–11 and 2008–2009 (in percentage points; Mean = 6.02; Std. Dev. = 5.59). Capital inflow regulations, FX regulations, financial sector-specific restrictions, and capital outflow regulations are averaged over 2007–2009 for columns (1), (3), (5), and (7), and over 2005–2007 for columns (2), (4), (6), and (8). Institutional quality index is for 2008. Robust standard errors are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

average growth in 2008–2009, controlling for changes in terms of trade, growth in trading partners income, and overall institutional quality. First, columns (1) and (2) in Table 7 indicate that countries that used capital inflow regulations experienced less overheating during the post-crisis period when there was a new surge in capital inflows. Column (2) indicates that moving from the 25th to the 75th percentile of capital inflow regulations averaged over 2005–2007 is associated with a reduction in post-crisis overheating of 3.7 percentage points. This is an economically large effect given that the average post-crisis growth in our sample is 6 percentage points with a standard deviation of 5.6 percentage points. Second, columns (3)–(4) and (5)–(6) indicate that countries that used FX-related regulations and financial sector-specific restrictions, respectively, also experienced less overheating after the crisis. Moving from the 25th to the 75th percentile of FX-related regulations and financial sector restrictions averaged over 2005–2007 is associated with growth that is 3.8 to 3.1 percentage points slower in the post-crisis period. Third, column (7) shows that capital outflow regulations averaged over 2007–2009 are also negatively associated with post-crisis overheating; however, column (8) shows that the estimate is

not significant if capital outflow regulations are averaged over 2005–2007 instead.

In combination with improved crisis resilience, there is significant evidence that CARs smooth out the macroeconomic fluctuations associated with large and volatile capital flows by slowing the growth collapse during a bust and by preventing the excessive growth during booms. These results imply that using CARs in a countercyclical fashion represents an important macroeconomic stability policy in emerging and developing countries.

Sensitivity Analysis

The findings presented in Tables 2, 3, 4, 5, 6, and 7 imply that CARs are strongly associated with a reduction in macroeconomic stability risks. In this section, we examine the sensitivity of our results to alternative measures of outcome variables, changes in country sample, and alternative measures of CARs.

Alternative Measures of Outcome Variables

Since the data for real exchange rates are not readily available in commonly used IMF or World Bank databases for nearly one-half of the countries in our sample, we used data from Darvas (2012) in the baseline estimates presented in Tables 2, 3, 4, and 5. To show that our results are robust to alternative measures of real exchange rates, we use data from the Penn World Tables (PWT) 8.1 and the IMF *International Financial Statistics* (IFS) to construct alternative real exchange rate series. Following Rodrik (2008), we use the price level of GDP in the PWT database to calculate a real exchange rate.[24] Next, following Rodrik (2008), we construct a bilateral real exchange rate with the United States using consumer prices from the IFS.[25]

Table 8 reports the results obtained using these alternative real exchange variables. In column (2), we present the results obtained using the PWT 8.1 data for real exchange rate changes. We find that the estimates in Panel (a) are slightly smaller for foreign exchange pressure, while the estimates in Panel (b) are slightly larger for real exchange rate changes compared to the baseline results reproduced in column (1). While capital inflow regulations, FX-related regulations, and capital outflow regulations remain significant and negatively related to real exchange rate appreciation, only capital inflow and outflow regulations remain significant and negatively associated with foreign exchange pressure.

[24]The PWT variable *pl_gdpo* (called the price level of GDP from the output side (*PPP* / *XR*)) is equivalent to the real exchange rate. Rodrik (2008) uses the inverse of this variable to represent depreciation, and we use the variable itself to represent appreciation.

[25]We construct the bilateral real exchange rate (*RER*) as follows: $RER = CPI/(E \times PPI_{US})$, where *CPI* is the home country's consumer price index, *E* is the home country's nominal exchange rate against the U.S. dollar (in units of home currency per dollar), and PPI_{US} is the producer price index for the United States. As our index represents appreciation, it is written as the inverse of Rodrik's index, which represents depreciation.

Table 8. Sensitivity Analysis: 1995–2011 Panel Data Results

	(1) Baseline with full controls[1]	(2) Using PWT data for RER[2]	(3) Using IMF data for RER[3]	(4) Excl. Baltic countries[4]	(5) Excl. advanced countries[5]	(6) Bond – money market restr.[6]	(7) Fin. credits, equities restr.[7]	(8) Debt liabilities[8]	(9) Private credit[9]
Panel A. Foreign Exchange Pressure									
Capital inflow regulations	−0.88**	−0.63*	−0.90***	−0.94**	−0.73**	−0.82**	−0.90**	−0.99**	−0.91**
	(0.37)	(0.35)	(0.30)	(0.37)	(0.34)	(0.39)	(0.45)	(0.41)	(0.42)
FX-related regulations	−1.37**	−1.10	−1.30***	−1.44**	−0.93*			−1.38**	−1.24*
	(0.62)	(0.69)	(0.45)	(0.58)	(0.53)			(0.67)	(0.64)
Financial sector restrictions	−1.31	−1.01	−2.60*	−1.13	−0.96			−2.68*	−2.15*
	(1.09)	(1.32)	(1.49)	(0.88)	(1.11)			(1.41)	(1.21)
Capital outflow regulations	−0.97***	−0.66**	−0.91***	−1.15***	−0.70***			−1.03***	−0.94***
	(0.31)	(0.32)	(0.24)	(0.34)	(0.25)			(0.32)	(0.31)
Panel B. Real Exchange Rate Change									
Capital inflow regulations	−6.10**	−6.82**	−7.23***	−7.42***	−4.17*	−4.70**	−5.33*	−5.30**	−3.98
	(2.41)	(3.07)	(2.70)	(2.82)	(2.16)	(2.08)	(2.73)	(2.41)	(2.44)
FX-related regulations	−9.75***	−11.26**	−9.70***	−11.47***	−5.71***			−8.26***	−6.16**
	(3.06)	(5.18)	(2.91)	(3.15)	(1.99)			(2.82)	(2.65)
Financial sector restrictions	−16.89	−12.95	−22.35	−16.72*	−11.15			−19.36*	−14.35
	(11.44)	(15.49)	(13.92)	(9.92)	(8.72)			(11.36)	(8.87)

Table 8: (*Continued*)

	(1) Baseline with full controls[1]	(2) Using PWT data for RER[2]	(3) Using IMF data for RER[3]	(4) Excl. Baltic countries[4]	(5) Excl. advanced countries[5]	(6) Bond – money market restr.[6]	(7) Fin. credits, equities restr.[7]	(8) Debt liabilities[8]	(9) Private credit[9]
Capital outflow regulations	−5.68**	−6.13**	−7.25***	−8.03***	−3.40**			−4.67**	−3.40
	(2.23)	(2.64)	(2.58)	(2.85)	(1.60)			(2.29)	(2.12)

Notes: The dependent variables are (a) foreign exchange pressure index, which is the standardized sum of percentage change in international reserves and percentage change in real exchange rate, and (b) the percentage change in real exchange rate. Capital inflow regulations, FX-related regulations, financial sector-specific restrictions, and capital outflow regulations are lagged one year. All CARs are instrumented with binary variables that take the value of 1 if the country has a bilateral investment treaty with the U.S. in year t (and zero otherwise), and if the country is in the European Union (and zero otherwise). All specifications control for real GDP growth, log real GDP per capita, institutional quality, inflation, terms of trade, gross domestic saving, government consumption, FDI inflows, exchange rate regime, year fixed effects, and region fixed effects. The specifications in panel (b) also control for reserves as a share of GDP. Standard errors are clustered at the country level. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

[1] Baseline specification with full set of controls refers to columns (2), (4), (6), and (8) in Tables 3 and 5.

[2] Dependent variables are constructed using the Penn World Tables (PWT) data on real exchange rate changes.

[3] Dependent variables are constructed using the IMF International Financial Statistics data on real exchange rate changes. Since data are not available for all countries used, the real exchange rates are constructed using consumer price level and nominal exchange rate data.

[4] Baseline specification is estimated by excluding the Baltic countries (Estonia, Latvia, and Lithuania) from the sample.

[5] Baseline specification is estimated by excluding the relatively advanced countries (Iceland, Israel, and Korea) from the sample.

[6] Capital inflow regulations are replaced by an index of cross-border bond and money market restrictions.

[7] Capital inflow regulations are replaced by an index of cross-border financial credits, equities, and collective instruments restrictions.

[8] The percent change in share of debt liabilities in total liabilities variable is added to the baseline specification in lagged form.

[9] The percent change in private credit-to-GDP ratio variable is added to the baseline specification in lagged form.

In column (3), we present the results obtained using real exchange rates constructed from the IMF data. The estimates reported in Panels (a) and (b) remain significant and are slightly larger than the baseline estimates. We find a negative association between capital inflow regulations, FX-related regulations, and capital outflow regulations with real exchange rate appreciation and foreign exchange pressure. Moreover, we also find a significant and negative relationship between financial sector-specific restrictions and foreign exchange pressure. This differs from both our baseline results in column (1) and the PWT results in column (2).

Table 9 conducts a similar robustness analysis by changing the outcome variables used in crisis resilience and post-crisis performance results reported in Tables 6 and 7. To compare our results on crisis resilience to those reported in Ostry and others (2012), in Panel (a) of column (2), we use the difference between real GDP growth rates in 2008 and the rates averaged over 2003–2007, which is the outcome variable used in Ostry and others (2012). We find that the results reported in Table 6 generally survive the use of this alternative measure of growth decline during crisis. The coefficients are smaller because using 2008 as the major crisis year generates a smaller growth decline measure given that most developing countries continued to grow at moderate rates in 2008 but contracted in 2009. Hence, finding smaller effects using 2008 as the crisis year is not surprising.

In Panel (b) of Table 9, we use an alternative post-crisis growth variable to test whether our baseline results in column (1) survive. In particular, we use the difference between real GDP growth rates in 2011 and 2009 as the baseline rather than the difference between real GDP growth rates averaged over 2010–11 and 2008–2009. As the average GDP growth rate was higher in 2011 than that in 2010, the former generates a larger post-crisis growth measure. Therefore, we find that the negative association between post-crisis overheating and capital account regulation remains robust, and it is slightly larger if we use this alternative post-crisis growth measure. All estimates are significant at the 5 percent level, including the one for capital outflow regulations shown in the last column. The latter differs from the baseline estimates, where we failed to find a robust relationship between capital outflow regulations and post-crisis overheating.

Country Sample

In this section, we test whether our baseline results are robust to changing the country sample. In particular, we re-estimate our results after excluding the Baltic countries and relatively advanced countries. The results in column (4) of Table 8 indicate that the estimates for foreign exchange pressure and changes in real exchange rates are slightly larger when the Baltic countries are excluded from the sample. On the other hand, the results in column (5) of Table 8 show that the estimates are slightly smaller when relatively advanced countries are excluded from the sample. Nevertheless, the estimates for FX-related regulations

Table 9. Sensitivity Analysis: Cross-Sectional Data Results

	(1) Baseline with full controls[1]	(2) Alternative real GDP growth[2]	(3) Excl. Baltic countries[3]	(4) Excl. advanced countries[4]	(5) Bond – money market restr.[5]	(6) Fin. credits, equities restr.[6]	(7) Debt liabilities[7]	(8) Private credit[8]
(a) Crisis Resilience								
Capital inflow regulations, 2007–2009	5.56**	2.92	3.71*	6.30**	6.35**	5.72**	5.59**	8.32**
	(2.25)	(1.84)	(2.12)	(2.45)	(2.52)	(2.64)	(2.20)	(3.61)
Capital inflow regulations, 2005–2007	5.61**	3.62*	3.42	6.35**	5.38**	5.51**	5.94**	7.45*
	(2.52)	(1.95)	(2.28)	(2.80)	(2.37)	(2.44)	(2.31)	(3.78)
FX-related regulations, 2007–2009	9.91***	6.18**	5.51*	10.50**			10.06***	11.26**
	(3.62)	(3.00)	(3.10)	(3.84)			(3.61)	(4.44)
FX-related regulations, 2005–2007	9.82**	6.11*	5.84*	10.32**			10.00**	11.48**
	(3.75)	(3.14)	(3.24)	(3.91)			(3.76)	(4.81)
Financial sector restrictions, 2007–2009	6.69**	4.95*	5.35**	7.05**			7.01**	10.07**
	(3.04)	(2.61)	(2.54)	(3.14)			(3.01)	(3.69)
Financial sector restrictions, 2005–2007	7.20**	5.50**	5.58**	7.34**			8.01**	10.53**
	(3.17)	(2.67)	(2.49)	(3.26)			(3.21)	(4.12)
Capital outflow regulations, 2007–2009	6.50***	4.24**	3.68*	7.63***			6.86***	8.76***
	(2.31)	(2.00)	(1.87)	(2.56)			(2.42)	(2.84)
Capital outflow regulations, 2005–2007	5.73**	3.82*	2.55	6.36**			6.49***	7.37**
	(2.36)	(1.92)	(1.89)	(2.59)			(2.33)	(2.96)
(b) Post-Crisis Performance								
Capital inflow regulations, 2007–2009	−5.14**	−6.12**	−3.63*	−5.58**	−3.28	−2.81	−5.46**	−8.37***
	(2.06)	(2.43)	(1.87)	(2.23)	(2.19)	(2.10)	(2.09)	(2.93)
Capital inflow regulations, 2005–2007	−5.11**	−6.54**	−3.42	−5.59**	−3.38*	−2.87	−5.85***	−7.60**
	(2.22)	(2.57)	(2.06)	(2.37)	(1.93)	(2.05)	(2.15)	(3.00)
FX-related regulations, 2007–2009	−6.16*	−8.07**	−2.26	−6.29*			−6.35*	−6.16*
	(3.09)	(3.39)	(2.59)	(3.28)			(3.15)	(3.09)
FX-related regulations, 2005–2007	−5.70*	−7.67**	−2.40	−5.87*			−5.92*	−5.60
	(3.10)	(3.36)	(2.72)	(3.27)			(3.18)	(4.13)

Table 9: (*Continued*)

	(1) Baseline with full controls[1]	(2) Alternative real GDP growth[2]	(3) Excl. Baltic countries[3]	(4) Excl. advanced countries[4]	(5) Bond – money market restr.[5]	(6) Fin. credits, equities restr.[6]	(7) Debt liabilities[7]	(8) Private credit[8]
Financial sector restrictions, 2007–2009	−5.11**	−6.79**	−4.32*	−5.13*			−5.30**	−7.42**
	(2.49)	(2.73)	(2.35)	(2.53)			(2.49)	(3.19)
Financial sector restrictions, 2005–2007	−4.68*	−6.62**	−4.01	−4.72			−5.24*	−7.14*
	(2.74)	(3.01)	(2.55)	(2.83)			(2.90)	(3.55)
Capital outflow regulations, 2007–2009	−3.76*	−5.06**	−1.79	−4.21*			−4.24*	−5.37*
	(2.14)	(2.40)	(1.88)	(2.28)			(2.43)	(2.98)
Capital outflow regulations, 2005–2007	−3.42	−4.81**	−1.34	−3.67			−4.04*	−5.05*
	(2.06)	(2.30)	(1.77)	(2.18)			(2.37)	(2.73)

Notes: The dependent variables are (a) crisis resilience, which is defined as the difference between real GDP growth rates in 2009 and averaged over 2003–2008, and (b) post-crisis performance, which is defined as the difference between real GDP growth rates averaged over 2010–2011 and 2008–2009. Capital inflow regulations, FX-related regulations, financial sector-specific restrictions, and capital outflow regulations are lagged one year. All specifications control for terms of trade change, growth in trading partners, and institutional quality. Robust standard errors are reported. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

[1] Baseline specification with full set of controls refers to columns (1)–(8) in Tables 6 and 7.

[2] Dependent variables are constructed using alternative time periods for real GDP changes. In panel (a), the dependent variable is the difference between real GDP growth rates in 2008 and averaged over 2003–2007. In panel (b), the dependent variable is the difference between real GDP growth rates in 2011 and 2009.

[3] Baseline specification is estimated by excluding the Baltic countries (Estonia, Latvia, and Lithuania) from the sample.

[4] Baseline specification is estimated by excluding the relatively advanced countries (Iceland, Israel, and Korea) from the sample.

[5] Capital inflow regulations are replaced by an index of cross-border bond and money market restrictions.

[6] Capital inflow regulations are replaced by an index of cross-border financial credits, equities, and collective instruments restrictions.

[7] The percent change in share of debt liabilities in total liabilities in 2008 variable is added to the baseline specification.

[8] The percent change in private credit-to-GDP ratio in 2008 variable is added to the baseline specification.

and capital inflow and outflow regulations remain significant despite changes in the country sample.

In Table 9, columns (3) and (4) check robustness of the results for crisis resilience and post-crisis performance outcomes to changes in the country sample. In Panel (a), we find that a large majority of the results for crisis resilience hold when the Baltic countries are excluded, with the exception of two of the eight regulations. We also find that the results for crisis resilience remain significant throughout if we exclude relatively advanced countries. In Panel (b), we find that the results for post-crisis overheating largely become insignificant if we exclude the Baltic countries. This is not surprising given that some of the Baltic countries experienced substantial overheating during the post-crisis period. However, the results largely survive the exclusion of relatively advanced countries from the sample; only one previously significant coefficient becomes insignificant. When we replicate the results using the alternative real GDP growth measure in column (2), the results (not reported here) are more robust to changes in country sample.

Alternative Measures of Capital Account Regulations

Finally, we check whether alternative measures of CARs yield similar effects on macroeconomic stability indicators. In particular, we use two policy measures that aggregate capital controls into two categories: (i) bond and money market restrictions and (ii) financial credits, equities, and collective instruments restrictions. The former takes the value of one if a country has a restriction on cross-border capital inflow or outflow transactions in bond markets or money markets and zero otherwise. The latter takes the value one if a country has a restriction on cross-border capital inflows or outflows of financial credits, equities, or collective instruments and zero otherwise. These indices do not capture the intensity of regulations because they are indicator variables.[26]

Table 8 provides the results using these alternative policy measures as explanatory variables. In column (6), we find that bond and money market restrictions are negatively associated with foreign exchange pressure and real exchange rate appreciation. Similarly, column (7) indicates that cross-border restrictions on transactions in financial credits, equities, or collective instruments are negatively associated with foreign exchange pressure and real exchange rate appreciation. Moving from the 25th to the 75th percentile of bond and money market restrictions, which is an increase from 0 to 1 in the index, generates a 4.7 percentage point reduction in real exchange rate appreciation and a 0.82 percentage point reduction in foreign exchange pressure. The corresponding effects for financial credits, equities, and collective instruments restrictions are slightly larger. Overall, these effects are slightly larger than the baseline estimates if we

[26]These capital control policy measures were also used by Klein (2012).

interpret them by comparing shifts from the 25th to the 75th percentiles of the indices.

Table 9 presents the robustness checks for the effects of these alternative policy measures on crisis resilience and post-crisis performance. In Panel (a), the estimates in columns (5) and (6) show that both policy measures have significant effects of similar magnitudes on crisis resilience. In Panel (b), although all of the estimates have the correct negative sign, most are imprecisely estimated. This could be due to the fact that capital outflow regulations had a less significant impact on post-crisis overheating and that the alternative policy measures combine capital inflow and outflow regulations. The combination of capital outflow regulations might have produced some additional noise, increasing the standard errors. In addition, the estimates obtained with the alternative real GDP growth measure in column (2) provides a better fit (these results are omitted here) for the regressions using bond and money market restrictions and restrictions on financial credits, equities, and collective instruments.

Other Control Variables

Finally, while the estimation results reported in Tables 2, 3, 4, 5, 6, and 7 include many relevant control variables, in order to make sure that the strong relationship between CARs and macroeconomic stability indicators is not an outcome of omitted variable bias, we include other control variables to reflect additional country characteristics such as the degree of financial fragility (as proxied by the share of debt liabilities in total liabilities) and the level of domestic credit expansion (as proxied by the private credit-to-GDP ratio). These variables are added with one period lag and in percent change form.

Columns (8) and (9) in Table 8 present the results with these additional control variables included in the baseline specifications. We find that the results for foreign exchange pressure remain significant and large—specifically, capital account inflow and outflow regulations as well as FX-related regulations are associated with a lower foreign exchange pressure. In addition, we find that the inclusion of these variables also render the negative relationship between financial sector-specific restrictions and foreign exchange pressure significant. Furthermore, while the baseline results for real exchange rate changes survive the inclusion of debt-to-total liabilities ratio to the estimation, when the private credit-to-GDP ratio is included, we find that the capital inflow and outflow regulations are no longer significant at the conventional levels. This latter could be due to the high degree of correlation between domestic credit booms and real exchange rate appreciation that are driven by foreign capital inflows. On the other hand, the estimates for FX-related regulations remain significant in these specifications.

Columns (7) and (8) in Table 9 report the results with the inclusion of these control variables to baseline specification for crisis resilience and post-crisis performance. We find that all of the estimates for crisis resilience remain highly significant and the magnitudes of the estimates remain roughly the same or

increase in some cases (mostly when the private credit-to-GDP ratio is added). Moreover, we also find that the estimates for post-crisis overheating remain robust (only one out of 16 estimates becomes insignificant) to the inclusion of these additional control variables.

Conclusion

This paper analyzes the effects of CARs on macroeconomic stability risks related to large and volatile capital inflows, focusing on their effectiveness for reducing foreign exchange pressure, diminishing real exchange rate appreciation, and enhancing crisis recovery and post-crisis economic performance. Our findings indicate that capital inflow and outflow regulations, as well as foreign exchange-related regulation and financial sector-specific restrictions, help reduce foreign exchange pressures and real exchange rate appreciation resulting from capital inflow surges. Capital outflow regulations may reduce the entry of speculative foreign capital by making it more costly to exit, and our estimates show that they tend to have a larger effect than capital inflow regulations and other prudential policy measures. Foreign exchange-related regulations that do not discriminate based on residence can also help diminish the buildup of foreign exchange pressure during booms. By smoothing out macroeconomic fluctuations associated with foreign exchange markets and reducing current account deficits related to real exchange rate appreciation during booms, these regulations can reduce economic vulnerability during crises when external financing dries up rapidly. Our empirical results indicate that increasing the restrictiveness of CARs in the run-up to the crisis reduced growth declines, thus enhancing crisis resilience, and the effects of capital outflow regulations appear larger than the other measures. Finally, this result, together with our finding that countries that use capital inflow regulations over 2008–2011 experienced less overheating, indicates that these regulations are particularly useful for dampening the intensity of business cycles associated with the boom–bust pattern of external financing in emerging and developing countries.

This paper has not examined various issues related to the design of CARs, which include whether they should be temporary or permanent, whether they need to be price or quantity based, or whether their scope should be narrow or broadly defined. Each of these questions has been subject to an extensive debate that is beyond the focus of this paper. However, it is clear that the countercyclical use of CARs that are strengthened during booms and relaxed during busts would serve as an effective macroeconomic policy tool for many financially open countries that are vulnerable to large swings in capital flows. While the IMF has recognized that these policy measures can enhance financial stability and help reduce financial fragility during pre-crisis periods and enhance resilience to

crises (IMF, 2011a, b, c, 2012), it has not sufficiently underscored their importance and effectiveness as a macroeconomic policy tool with crucial effects on key macroeconomic variables, including the real exchange rate. Despite endorsing the new "institutional view" and providing some policy space for countries to use CARs to manage financial stability risks, the IMF stands by its previous view that these measures should be used as policies of last resort, after fiscal tightening, to manage large capital inflows and that their use should be mostly temporary. In addition, it supports the imposition of such measures in the steady state to support financial stability. Our findings indicate that every developing country that is subject to large swings in procyclical capital flows must have the policy space to use CARs as countercyclical tools as a first-best policy response, as they directly target the source of disturbance, excessive capital inflows during booms; they should in turn be relaxed during busts when external financing becomes scarcer. CARs should, of course, be used as part of a countercyclical macroeconomic policy package and not as a substitute for a broader package of this sort. In this sense, our results suggest that CARs should be viewed as a permanent macroeconomic policy tool whose restrictiveness is adjusted countercyclically to dampen macroeconomic fluctuations and reduce vulnerability to crises.

Appendix A

Additional Tables

Table A1. List of Countries

Algeria	Costa Rica	Guatemala	Korea	Peru	Tunisia
Argentina	Croatia	Hungary	Latvia	Philippines	Turkey
Armenia	Czech Republic	Iceland	Lebanon	Poland	Ukraine
Bosnia & Herzegovina	Dominican Republic	India	Lithuania	Romania	Uruguay
Brazil	Ecuador	Indonesia	Malaysia	Russian Federation	Venezuela, Rep. Bol.
Bulgaria	Egypt	Israel	Mexico	Serbia, Republic of	Vietnam
Chile	El Salvador	Jamaica	Morocco	South Africa	
China P.R.: Mainland	Estonia	Jordan	Pakistan	Sri Lanka	
Colombia	Georgia	Kazakhstan	Panama	Thailand	

Table A2. Description and Sources of Variables

Variable	Description	Obs.	Mean	Std. Dev.	Source
Capital inflow regulations	Index between 0 (no restrictions) and 1 (restrictions)	823	0.4	0.4	Schindler (2009) and authors' update over 2006–2011 based on AREAER, IMF
FX-related regulations	Index between 0 (no restrictions) and 1 (restrictions)	767	0.6	0.3	Ostry and others (2012), broad index (fxreg2), and authors' update over 2009–2011 based on AREAER, IMF
Financial sector restrictions	Index between 0 (no restrictions) and 1 (restrictions)	760	0.4	0.3	Ostry and others (2012), broad index (fincont2), authors' update over 2009–2011 based on AREAER, IMF
Capital outflow regulations	Index between 0 (no restrictions) and 1 (restrictions)	745	0.5	0.4	Schindler (2009) and authors' update over 2006–2011 based on AREAER, IMF
International reserves minus gold, percent change	In percent	856	19.4	39.0	International Financial Statistics, IMF
Real exchange rate	CPI-based real effective	864	102.0	21.7	Darvas (2012)
Real GDP growth	In percent	858	4.2	4.2	WEO database, IMF
Real GDP per capita (log)	log, constant 2005 USD	857	7.9	0.9	World Development Indicators, World Bank
Exchange rate regime	Binary variable equal to 1 if a de facto pegged exchange rate regime, and 0 otherwise	867	0.3	0.5	Ghosh and others (2010) and authors' update over 2009–2011 based on AREAER, IMF
Institutional quality (ICRG) index	Index between 0 (high) and 1 (low)	833	0.7	0.1	International Risk Country Guide, updated from 2009–2011
Bilateral investment treaty	Binary variable equal to 1 if a bilateral investment treaty with the U.S. exists, and 0 otherwise	867	0.4	0.5	Trade Compliance Center
Inflation rate	In percent, consumer prices	807	12.1	43.3	World Development Indicators, World Bank
Terms of trade	Index, net barter (2000 = 100)	748	105.7	25.1	World Development Indicators, World Bank
Gross domestic saving (share of GDP)	In percent	863	19.3	12.7	World Development Indicators, World Bank
Government consumption (share of GDP)	In percent	855	14.9	5.0	World Development Indicators, World Bank
FDI inflows (share of GDP)	In percent	850	4.0	4.4	World Development Indicators, World Bank
Growth in trading partners	In percent, only in 2008	41	−1.7	1.0	Ostry and others (2012)

Table A3. Replication and Extension of Results in Table 7, Klein (2012)—Capital Controls and Change in Real Exchange Rate

	(1) 1995–2010	(2) 2000–2010	(3) 2007–2010	(4) 1995–2010	(5) 1995–2010	(6) 1995–2010	(7) 1995–2010	(8) 1995–2010	(9) 1995–2010
	Baseline OLS[1]			IV with same sample[2]		IV with additional developing countries[3]		IV with additional developing countries and without advanced countries[4]	
L.dlrer	0.168***	0.135***	0.075	-0.005	−0.004	−0.068	−0.067	−0.100	−0.096
	(0.045)	(0.041)	(0.091)	(0.080)	(0.080)	(0.113)	(0.113)	(0.115)	(0.116)
L2.dlrer	−0.126	−0.067	−0.022	−0.072	−0.071	−0.047	−0.047	−0.050	−0.055
	(0.076)	(0.092)	(0.106)	(0.053)	(0.053)	(0.050)	(0.050)	(0.049)	(0.050)
L.dlngdp	−0.000	0.001	0.003**	0.002	0.002	0.004*	0.004*	0.004	0.003
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
cl	0.002	−0.007	−0.014	0.001	0.006	0.005	0.008	0.025	0.038
	(0.007)	(0.010)	(0.010)	(0.015)	(0.019)	(0.010)	(0.011)	(0.016)	(0.025)
L.bomm	−0.005	0.001	0.003	−0.007		−0.023		−0.078**	
	(0.009)	(0.008)	(0.012)	(0.026)		(0.018)		(0.036)	
L.fec	0.009	0.002	0.011		−0.017		−0.031		−0.111*
	(0.010)	(0.009)	(0.011)		(0.034)		(0.022)		(0.057)

Table A3. (Continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	1995–2010	2000–2010	2007–2010	1995–2010	1995–2010	1995–2010	1995–2010	1995–2010	1995–2010
	Baseline OLS[1]			IV with same sample[2]		IV with additional developing countries[3]		IV with additional developing countries and without advanced countries[4]	
Observations	504	396	144	572	572	931	931	658	658

Notes: Dependent variable is annual percentage change in real exchange rate. For consistency with the extension of results that includes other countries, we use the complete real exchange rate data from Darvas (2012). The results are qualitatively the same if other real exchange rate variables are used. The variables included in the regression are as follows: cl is a dummy variable that takes the value of 1 if a country is persistently close to capital inflows and 0 otherwise, L.bomm is a dummy variable that takes the value of 1 if a country has controls on either money market instruments or bonds in the previous period and zero otherwise, L.fec is a dummy variable that takes the value of 1 if a country has controls on financial credits, equities, or collective investments in the previous period and 0 otherwise, L.dlrer and L2.dlrer are 1 and 2 lag change in real exchange rate, respectively, L.dlngdp is the lag change in real GDP. All specifications include year fixed effects. Standard errors are clustered at country level. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

[1] Baseline specifications in Table 7, Klein (2012).

[2] The same sample is used to estimate an IV specification using bilateral investment treaties with the US and EU membership as instrumental variables.

[3] Additional developing countries are added into the same sample and the regression is estimated with the same IV specification. The additional developing countries that are added to the sample are Algeria, Armenia, Bosnia and Herzegovina, Bulgaria, Costa Rica, Croatia, Dominican Republic, Ecuador, El Salvador, Estonia, Georgia, Guatemala, Iceland, Israel, Jamaica, Jordan, Kazakhstan, Latvia, Lebanon, Lithuania, Pakistan, Panama, Romania, Serbia, Sri Lanka, Tunisia, Ukraine, Uruguay, Venezuela, and Vietnam.

[4] Additional developing countries are added and advanced countries are left out from the same sample and the regression is estimated with the same IV specification. The additional developing countries that are added to the sample are Algeria, Armenia, Bosnia and Herzegovina, Bulgaria, Costa Rica, Croatia, Dominican Republic, Ecuador, El Salvador, Estonia, Georgia, Guatemala, Iceland, Israel, Jamaica, Jordan, Kazakhstan, Latvia, Lebanon, Lithuania, Pakistan, Panama, Romania, Serbia, Sri Lanka, Tunisia, Ukraine, Uruguay, Venezuela, Vietnam. The advanced countries that are left out of the same are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

Appendix B

Mathematical Appendix

B1. Derivation of the Bond Demand Function

When we substitute the market-clearing condition for nontraded goods $c_{N,t} = y_{N,t}$, the utility function becomes $u(c_{T,t}) = u(c_{T,t}, y_{N,t})$, and nontraded consumption and endowment cancel from the budget constraint:

$$c_{T,t} + p_{N,t}c_{N,t} + \frac{(1-\tau_{t+1})b_{t+1}}{R_{t+1}} = y_{T,t} + p_{N,t}y_{N,t} + b_t - T_t \tag{B.1}$$

$$c_{T,t} + p_{N,t}c_{N,t} + \frac{(1-\tau_{t+1})b_{t+1}}{R_{t+1}} = y_{T,t} + p_{N,t}c_{N,t} + b_t - T_t \tag{B.1$'$}$$

$$c_{T,t} + \frac{(1-\tau_{t+1})b_{t+1}}{R_{t+1}} = y_{T,t} + b_t - T_t \tag{B.1$''$}.$$

The consumers budget constraint (1′), after substituting the government budget constraint $T_t = \tau_{t+1}b_{t+1}R_{t+1}$, becomes

$$c_{T,t} + \frac{(1-\tau_{t+1})b_{t+1}}{R_{t+1}} = y_{T,t} + b_t - \tau_{t+1}b_{t+1}R_{t+1}$$
$$c_{T,t} = y_{T,t} + b_t - b_{t+1}R_{t+1}.$$

Substituting this expression into the consumer's Euler equation, we define an implicit function

$$\begin{aligned} F = {} & (1-\tau_{t+1})u_T(y_{T,t} + b_t - b_{t+1}R_{t+1}, c_{N,t}) - \beta R_{t+1}u_T(y_{T,t+1} + b_{t+1} \\ & - b_{t+2}R_{t+2}, c_{N,t+1}) \\ = {} & 0, \end{aligned}$$

which satisfies

$$\frac{\partial F}{\partial b_{t+1}} = -(1-\tau_{t+1})u_{TT}(c_{T,t}, c_{N,t})R_{t+1} - \beta R_{t+1}u_{TT}(c_{T,t+1}, c_{N,t+1}) > 0 \tag{B.2}$$

$$\frac{\partial F}{\partial R_{t+1}} = (1-\tau_{t+1})u_{TT}(c_{T,t}, c_{N,t})b_{t+1}(R_{t+1})^2 - \beta u_T(c_{T,t+1}, c_{N,t+1}) \gtrless 0 \tag{B.3}$$

$$\frac{\partial F}{\partial \tau_{t+1}} = -u_T(c_{T,t}, c_{N,t}) < 0. \tag{B.4}$$

The first partial derivative (9) is always positive, which lets us implicitly define a demand function $b_{t+1}(R_{t+1};\tau_{t+1})$ by the implicit function theorem.[27]

The second partial derivative (10) is negative given that saving b is sufficiently high. Specifically, we rewrite the condition by multiplying (12) by R_{t+1} to derive b under which (12) is less than zero.

$$(1-\tau_{t+1})u_{TT}(c_{T,t},c_{N,t})b_{t+1}R_{t+1}-\beta R_{t+1}u_T(c_{T,t+1},c_{N,t+1})<0$$

Substituting the Euler equation $(1-\tau_{t+1})u_T(c_{T,t},c_{N,t})=\beta R_{t+1}u_T(c_{T,t+1},c_{N,t+1})$ for the second term, we have

$$u_{TT}(c_{T,t},c_{N,t})b_{t+1}R_{t+1}-u_T(c_{T,t},c_{N,t})<0$$

which we rearrange to

$$b_{t+1}R_{t+1}>\frac{u_T(c_{T,t},c_{N,t})}{u_{TT}(c_{T,t},c_{N,t})}$$

$$\text{or}\quad \frac{b_{t+1}R_{t+1}}{c_{T,t}}>\frac{u_T(c_{T,t},c_{N,t})}{c_{T,t}u_{TT}(c_{T,t},c_{N,t})}\equiv-\sigma(c_{T,t}),$$

which states that the savings/consumption ratio is higher than the negative of the elasticity of intertemporal substitution $\sigma(c_{T,t})$. We will refer to this condition as Assumption 1. If this inequality holds, the demand function $b_{t+1}(R_{t+1};\tau_{t+1})$ is strictly increasing in R_{t+1}, which can be inverted into a strictly increasing inverse demand function $R_{t+1}(b_{t+1};\tau_{t+1})$.

The third partial derivative (11) is always negative—this is because of the assumption that the revenue from CARs is rebated so that CARs have only substitution effects and no income effects.

B2. Proofs

Proof of the First Prediction

Based on the derivation of the bond demand function, we use the implicit function theorem to obtain the partial derivatives listed below.

We implicitly differentiate consumer's Euler function to express

$$\frac{\partial b_{t+1}}{\partial\tau_{t+1}}=-\frac{\partial F\partial\tau}{\partial F\partial b}>0.$$

Similarly, because R_{t+1} is constant, we can write

[27]The implicit function theorem states that for an implicit function of the form $g(x,y)=0, x,y\in\Re$, provided continuity of the function and a nonzero denominator, then $\frac{dy}{dx}=-\frac{(\partial g\partial x)}{(\partial g\partial y)}$.

$$\frac{\partial b_{t+1} R_{t+1}}{\partial \tau_{t+1}} = \frac{\partial b_{t+1}}{\partial \tau_{t+1}} = -\frac{\partial F \partial \tau}{\partial F \partial b} > 0.$$

We implicitly differentiate consumer's Euler function to show

$$\frac{\partial c_{T,t}}{\partial \tau_{t+1}} = -\frac{\partial F \partial \tau}{\partial F \partial c_T} < 0$$

because the denominator is negative

$$\frac{\partial F}{\partial c_{T,t}} = -(1 - \tau_{t+1}) u_{TT}(c_{T,t}) < 0$$

The derivative

$$\frac{\partial p_{N,t}}{\partial \tau_{t+1}} = -\frac{\partial p_{N,t}}{\partial c_{T,t}} \frac{\partial c_{T,t}}{\partial \tau_{t+1}} < 0$$

is negative because the first term is positive and the second term is negative.

Proof of the Second Prediction

Under open capital accounts, first suppose an equilibrium with zero reserves $a_{t+1} = 0 \; \forall t$ and denote the associated level of private bond holdings by $\tilde{b}_{t+1}$. When a policy authority accumulates/decumulates reserves $a_(t+1) \neq 0$ in some periods, consumers would adjust their holdings of private bonds such that $b_{t+1} = \tilde{b}_{t+1} - a_{t+1}$ to satisfy the optimality conditions by keeping all other variables unchanged. Therefore, in case of unconstrained access of consumers to capital markets, reserve accumulation loses its effectiveness. This is true even if the government uses price controls τ_{t+1} to tax international capital flows since the real allocations of the consumer depend only on the level of capital controls τ_{t+1} and not the level of reserves a_{t+1}. Notice that this proposition is a form of Ricardian equivalence—a representative consumer internalizes that government bond holdings are equivalent to private bond holdings, and suffers therefore from the same limitations as Ricardian equivalence. It strictly relies on the assumption that consumers can access bond markets in the same conditions as governments. If the consumers cannot access bond markets in the same conditions as governments, which might be the case if they are perceived to be riskier by international lenders, then Ricardian equivalence fails to hold. Therefore, there might be a case of imperfectly open capital markets due to differences between the perceived riskiness of individuals and governments.

Closed capital accounts restrict private consumers to a zero international bond position $b_{t+1} = 0$. Therefore, reserve accumulation is the only borrowing/lending from international capital markets. Since consumers adjust their

optimal allocation by reducing their tradable consumption, reserve accumulation constitutes forced saving and depreciates the real exchange rate. We can show this formally as follows. Since $b_{t+1} = 0$, $c_{T,t} + a_{t+1} = y_{T,t}$. By substituting $c_{T,t} = y_{T,t} - a_{t+1}$, we observe that the real exchange rate is a function of reserve accumulation and exogenous tradable and nontradable income under closed capital accounts:

$$p_{N,t} = \frac{u_N(y_{T,t} - a_{t+1}, y_{N,t})}{u_T(y_{T,t} - a_{t+1}, y_{N,t})}.$$

In order to show how the real exchange rate changes in response to a change in reserve accumulation, we take the derivative

$$\frac{\partial p_{N,t}}{\partial a_{t+1}} = \frac{u_{NT}(-1)u_T - u_N u_{TT}(-1)}{(u_T)^2} < 0.$$

The derivative is negative by our earlier assumptions of the utility function. This confirms that a rise in reserve accumulation depreciates the real exchange rate under closed capital accounts.

Since under open capital accounts a CAR τ_{t+1} induces private consumers to accumulate $b_{t+1}(R_{t+1}; \tau_{t+1})$ bonds, it is equivalent to reserve accumulation $a_{t+1} = b_{t+1}(R_{t+1}; \tau_{t+1})$ under closed capital accounts. This implies that any level of reserve accumulation can be replicated by a proportional CAR given that bond holdings $b_{t+1}(R_{t+1}; \tau_{t+1})$ are strictly increasing in τ_{t+1} and their range is $\Re$.

Proof of the Third Prediction

We know from the first prediction that the first component of FXP_t responds negatively to a change in capital controls, i.e. the real exchange rate depreciates in response to a rise in capital inflows, $\partial p_{N,t} \partial \tau_{t+1} < 0$.

In order to show how the second component of FXP_t responds to a change in capital controls, we need to show how reserve accumulation changes in response to a change in CARs. We take the derivative

$$\frac{\partial a_{t+1}}{\partial p_{N,t}} \frac{\partial p_{N,t}}{\partial \tau_{t+1}} < 0.$$

The derivative is negative by our earlier assumption about the government's reaction function and the first prediction. Therefore, the total effect of rise in CARs on FXP_t would be negative, i.e. $\partial FXP_t \partial \tau_{t+1} < 0$.

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