

# Motivations for capital controls and their effectiveness

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## Abstract

We assess the motivations for changing capital controls and their effectiveness in India, a country where there is a comprehensive capital control system covering all cross-border transactions. We focus on foreign borrowing by firms, where systemic risk concerns could potentially play a role. A novel fine-grained data set of capital control actions is constructed. We find that capital control actions are potentially motivated by exchange rate considerations, but not by systemic risk issues. A quasi-experimental design reveals that the actions appear to have no impact either on the exchange rate or on variables connected with systemic risk.

JEL Classification: F38, G15, G18

Keywords: Capital controls, capital flows, exchange rate, foreign borrowing

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# 1 Introduction

The global financial crisis has re-opened the debate on the place of capital controls in the policy toolkit of emerging-market economies (EMEs). The volatility of capital flows during and after the global financial crisis, and the use of capital controls in major EMEs, spawned a vigorous debate among policy-makers on the legitimacy and usefulness of capital controls. In order to aid the development of best practices in capital controls policy, the literature needs to address four questions: First, under what circumstances do policy makers utilise capital controls? Do policy-makers use capital controls as macroprudential tools as envisioned in the recent literature? Second, what impact do different capital controls have? Third, do the benefits outweigh the costs? Fourth, how should real world institutional arrangements be constructed, to utilise these tools appropriately?

A rich literature has re-engaged with these questions, in recent years, through various papers which examine cross-country evidence and through single-country analyses [Alfaro et al., 2014, Fernandez et al., 2015, Forbes and Klein, 2015, Pasricha et al., 2015]. Several researchers have argued that capital controls may be particularly effective in a country like India with the legal and administrative machinery to implement controls [Habermeier et al., 2011, Klein, 2012]. Further, Indian policy makers have modified the capital control framework frequently to address concerns about the exchange rate, country risk perception and other issues. India is thus a good laboratory for studying the motivations and consequences of capital controls.

Credible research designs in this field require precise measurement of capital controls or capital control actions (CCAs). There are many concerns about the measurement obtained through conventional multi-country databases. In this paper, we comprehensively analyse primary legal documents from 2004 to 2013, in order to construct a new instrument-level dataset about every capital control action for one asset class (foreign borrowing by firms) for one country (India).

We use event studies to ask the question: Under what circumstances do policy makers utilise capital controls? The results suggest that the prime motivation is exchange rate policy and not systemic risk regulation. On average, the four weeks before a capital controls tightening have a nominal USD/INR appreciation of 5%, and the four weeks before a capital controls easing have a nominal USD/INR depreciation of 3%. This shows a certain gap between capital controls in the ideal world and capital controls as they operate in the field.

We turn to measuring the impact of capital control actions. In order to obtain a credible estimation strategy, we utilise propensity score matching to identify

*time points* which are counterfactual. For each week in which a capital control action was taken, we identify a week in which macro/financial stress was similar, but no capital control action was taken. This yields a quasi-experimental design where the treatment effect can be measured. Our results suggest that there was no significant impact of the capital control actions, either on the exchange rate or on measures connected with systemic risk.

The remainder of this paper is organised as follows. Section 2 reviews the existing literature on the motivation and consequences of capital control actions. Section 3 describes recent developments in the measurement of CCAs, and documents the construction of the novel data set about Indian CCAs on foreign borrowing. Section 4 describes the observation of exchange rate versus systemic risk objectives. Section 5 identifies the factors that shape the use of CCAs. Section 6 measures the impact of these actions. Section 7 shows the means for reproducing this research. Section 8 concludes.

## 2 The questions around capital control actions

After the collapse of the Bretton-Woods system, there was a global movement towards removal of capital controls, starting from the richest countries, and gradually going all over the world. This was consistent with an extensive academic literature which found poor evidence about the usefulness of capital controls as tools of policy [Edwards, 1999, Forbes, 2007, 2005, De Gregorio et al., 2000].

After the 2008 crisis, there was fresh interest in the possibility that capital controls could be a useful part of the policy toolkit [Ostry et al., 2011, IMF, 2012, Ostry et al., 2012]. A large literature since 2008 envisions capital controls as prudential tools, that can help mitigate systemic financial sector risk, and therefore views them in a more benign light than controls aimed at managing the exchange rate [Jeanne and Korinek, 2010, Korinek, 2011, Bianchi, 2011]. This has sparked off a new literature which analyses the conditions under which countries undertake capital control actions (CCAs), and the consequences thereof [Pasricha, 2012, Chamon and Garcia, 2016, Warnock, 2011, Klein, 2012, Patnaik and Shah, 2012, Forbes et al., 2015, Jinjara et al., 2013, Fernandez et al., 2015, Forbes and Klein, 2015].

In a sophisticated economy, capital controls would be evaded through financial engineering and trade misinvoicing [Carvalho and Garcia, 2008]. It is useful to think about three levels of impact of capital controls.

1. *Impact of a narrowly targeted capital control upon its target.* The smallest extent

of impact is one where a variable targeted by policy – e.g. debt flows – is adversely affected by capital controls against debt flows. While this may come about, the interpretation may be clouded as financial engineering may be underway to label debt as equity, to utilise put-call parity, etc.

2. *The ability of capital controls to create pricing distortions.* An extensive literature has demonstrated that capital controls are able to create wedges in international asset pricing [Yeyati et al., 2010].
3. *The ability of capital controls to deliver on the objectives of macroeconomic policy or systemic risk regulation.* If policy makers desire to uphold an exchange rate regime, or ensure that monetary policy is counter-cyclical, or utilise capital controls for the purpose of systemic risk regulation, there are concerns about whether these objectives are attained.

In this paper, we focus on the third and overall outcome. If capital controls are ultimately motivated by exchange rate or systemic risk policy objectives, we would like to measure the extent to which these desired outcomes are achieved.

## 2.1 The challenges for research design

The two problems faced by this literature are endogeneity bias and measurement of capital controls. The contemporary global policy debate about capital controls would be illuminated by research which makes causal statements about the circumstances under which capital controls could be applied and the benefits that would be obtained. In this field, however, persuasive causal research designs are the exception. Conventional observational studies are hampered by endogeneity bias. High income countries, and countries with good institutional quality, are also generally countries with open capital accounts. CCAs tend to be utilised more in less developed countries, and in times of macro-financial stress. This raises concerns about the possibility of underlying factors such as institutional quality, or macro-financial stress, influencing both capital account restrictions and macroeconomic outcomes.

The measurement of the intensity of capital controls that are prevalent at any point in time is also a daunting problem. Measures of capital controls are often too broad to provide useful guidance to regulators about the impact of specific interventions.<sup>1</sup> Emerging economies use many different types of regulations on cross-border transactions, ranging from quantitative controls (for example, on foreign investment in

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<sup>1</sup>See Magud et al. [2011] for a survey. The exceptions are some country specific studies, most of which assess the impact of unremunerated reserve requirements or inflow taxes in Latin American countries [Chamon and Garcia, 2016].

the securities market), to price-based restrictions (such as the maximum interest rate payable on foreign borrowings) and approval and reporting requirements. It is difficult to represent the complexity of this landscape in standardised datasets that are comparable across countries, and it is difficult to construct high quality datasets which correctly reflect subtleties of the capital controls regime.

## 2.2 The two groups of questions

There are two main strands in this literature. The first examines conditions under which countries utilise CCAs. The second addresses the impact of these.

The key puzzle in the first strand of the literature is about the true objectives of policy makers who employ CCAs. EME policy-makers may use capital controls to achieve exchange rate objectives and to pursue systemic risk objectives. While the recent debate has largely focused on what EMEs *should* do, it is also important to examine what they actually do.

Pasricha [2012] uses data on CCAs on a broad range of international capital transactions for 18 EMEs over the period 2004-10 and finds that the use of CCAs follows trends in net capital inflows — measures to reduce net capital inflows were at their peak in 2007 and 2010, when net capital inflows to EMEs were at their peak. This analysis shows that the majority of CCAs were not motivated by systemic risk regulation. Aizenman and Pasricha [2013] focus on only CCAs on outflows by residents and find that these were also motivated by net capital inflow pressures. Fratzscher [2012] uses the measures of *de jure* levels of capital controls ([Chinn and Ito, 2008] and [Schindler, 2009]) to assess systemic risk vs. exchange rate objectives and finds that exchange rate and overheating pressures primarily drove CCAs in a broad sample of countries. This paper uses an event study to provide a systematic evaluation of systemic risk vs. macroeconomic objectives using detailed data on a type of instrument — controls on foreign currency borrowing — that could be used to address systemic-risk concerns.

Fernandez et al. [2015] analyse a large dataset of CCAs by 78 countries over 1995–2011 and point out a remarkable fact: capital control policy as it is practised in the field is not counter-cyclical. They document a ‘quasi-perfect acyclicity’ of capital controls during the global crisis of 2007–2009. This emphasises the gap between the capital control policies being analysed in the literature and the capital controls being used in the field.

In the second strand of the literature, on the causal impact of CCAs, Ostry et al. [2010] suggest that countries with controls on debt flows fared better during the recent global financial crisis. Ostry et al. [2012] find a statistically significant

association between financial sector-specific capital controls and lower foreign exchange borrowing. However, empirical analysis by Blundell-Wignall and Roulet [2013] qualifies these results, finding that while certain kinds of restrictions on inflows (particularly debt liabilities) were most useful in good times, lower controls on bonds and on FDI inflows were associated with better growth outcomes during the recent global financial crisis period. Chamon and Garcia [2016] analyse the impact of capital controls that Brazil adopted since late 2009. The authors find limited success of controls in mitigating exchange rate appreciation.

Forbes and Klein [2015] analyse four classes of policy responses by countries faced with a crisis: selling reserves, currency depreciation, large changes in the policy rate and capital controls. They combat problems of endogeneity by utilising tools of quasi-experimental econometrics, where a dataset is constructed where a country which undertook a policy action at a certain time is matched against a country placed under similar circumstances which did not take that policy action. They find that large increases in interest rates, and new capital controls, cause a significant decline in GDP growth.

In this paper, we pursue three key themes of this emerging literature: (a) The need to improve measurement of capital controls; (b) The need to analyse motivations for CCAs as used in the field; and (c) The need to achieve greater credibility in assessing their impact.

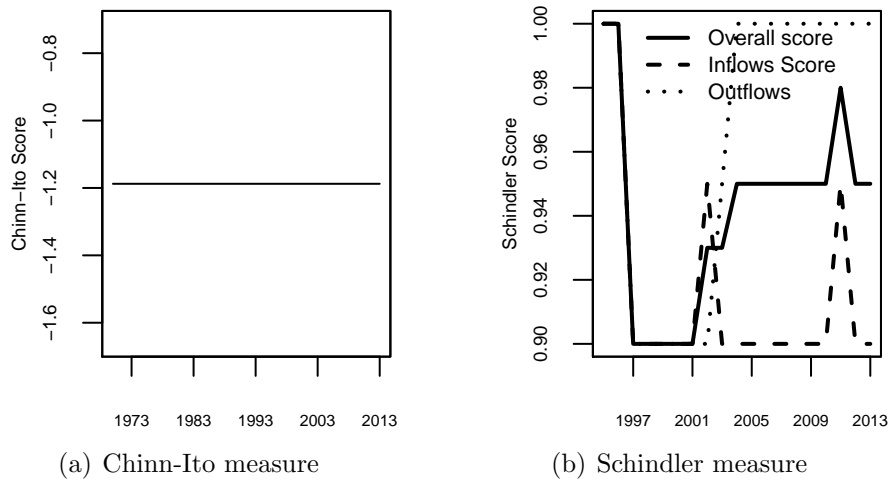
### 3 Improved measurement of capital control actions

The assessment of the motivations for and effectiveness of capital controls is complicated by the challenges involved in the measurement of capital control actions (CCAs). It is difficult to capture the various kinds of capital controls in a simple measure. The mainstream cross-country literature has relied on summary indexes of capital controls. Existing measures of *de jure* capital account openness, such as the Chinn and Ito [2008]<sup>2</sup> and the Schindler [2009] indexes,<sup>3</sup> measure the level of capital controls using the summary classifications table published by the IMF in the AREAER.<sup>4</sup> While these measures are easily compiled and helpful in cross-country

<sup>2</sup>The Chinn-Ito measure ranges from -1.83 to 2.53, with -1.83 being a closed capital account economy and 2.53 being an open economy.

<sup>3</sup>The Schindler measure ranges from 1 to 0, with 1 being a closed capital account economy and 0 being an open economy.

<sup>4</sup>The IMF has been reporting on exchange arrangements and restrictions from 1950 onward and provides a description of the foreign exchange arrangements, exchange and trade systems,

**Figure 1** *De jure* measures of capital account openness: India

comparisons, they do not capture the complexity of capital controls, particularly when a detailed administrative system of capital controls is in use, as is the case in China or India.<sup>5</sup>

In order to obtain improvements in measurement, we narrow our focus to one country, India. This is a large and important emerging market in its own rights, and a prime exponent of a comprehensive capital controls system. Capital controls were brought in as a wartime measure under colonial rule, in 1942, and have evolved into a large complex system with rules that are tailored to the asset class, investor type, recipient type, transaction magnitude, etc. The capital controls system is encoded into thousands of pages of law, and is administered by a team of over 10,000 officials. From the early 1990s onwards, a process of capital account liberalisation has taken place, though parametric changes in the capital controls system. Unlike all developed countries and many EMEs, the overall capital controls system was never dismantled. For treatments of the Indian capital controls and capital flows, see Patnaik and Shah [2012], Shah and Patnaik [2007], Mohan and Kapur [2009].

As Figure 1 shows, the Chinn and Ito [2008] measure does not detect any change

and capital controls of all IMF member countries. The AREAER has provided a summary of capital controls for a wide cross section of countries since 1967.

<sup>5</sup>A recent paper by Ma and McCauley [2014] question the appropriateness of the Chinn-Ito measure in tracking the progress and relative position of China and India on the road to international financial integration. The authors disagree with Chinn-Ito that both countries are stalled on the path to financial integration.



in India's level of openness, i.e., no change in capital controls, for the entire time series from 1970 to 2013. The Schindler [2009] measure appears to do better, by showing some variation in the level of openness, but the observed variation is very minor compared with the changes that have taken place in the regime between 1995 and 2010 that are better reflected in the India-specific indexes constructed by other studies [Hutchison et al., 2012], and the enormous growth of cross-border flows.

Measures based on the AREAER classification table detect a move toward capital account openness only when a sub-category of controls is *dismantled*. In cases of countries like India, the process of capital account liberalisation has gone from complete prohibition to greater access, subject to bureaucratic permissions. The process has generally moved toward greater capital account openness, but without dismantling the structure of controls. This allows authorities to retain their ability to reverse past liberalisations. These complexities are not reflected in AREAER-based measures such as those of Chinn and Ito [2008] and Schindler [2009].

Another constraint with these databases is their frequency: they report one value every year. This prevents analysis of the impact of changes in capital controls within a year. The recent literature shifts focus from the *level* of capital account openness to individual capital control *actions* (CCAs). Although it may be hard to quantify the extent of restrictions present at a point in time, it is more feasible to identify the date of a CCA, and to place it within a classification system. This permits the analysis of *changes* in the system of capital controls.

We hand-construct a new dataset about CCAs in India about one class of capital controls: restrictions on foreign currency borrowing by firms. This has been done by analysing the full text of the legal instruments associated with each CCA. Two examples of this analysis are placed at Appendix B, and illustrate the legal expertise required for this work. This yields unique measurement of CCAs, at the price of focusing on one narrow field: the Indian capital controls against foreign currency borrowing by firms.

Foreign currency borrowing by firms in India is termed 'External Commercial Borrowing' (ECB). This is governed by Foreign Exchange Management (FEM) regulations, which constitute capital controls on foreign borrowing. Appendix A gives a detailed description of the framework of controls on ECB in India. Amendments to these regulations must be tabled by the Reserve Bank of India (RBI) and approved by Parliament. Often, changes to capital controls are published by the RBI in circulars (and are usually made effective) *before* the regulatory amendments are passed. The RBI also issues master circulars that act as a compendium of the notifications/circulars issued in the previous year.

For the purpose of our construction of the CCA dataset, we comprehensively review all legal instruments, cross-verifying the information in these different instruments, verifying that each circular was backed by a notification (regulatory amendment), and verifying the effective dates of each change. Changes in each category of control is counted separately. As an example, changes in quantitative limits on foreign borrowing are counted independently of changes in permissible end-uses of the funds borrowed, even if announced on the same date.

The dataset requires classification of each CCA into ‘easing’ versus ‘tightening’. This is sometimes infeasible when an action has ambiguous impacts, and those records are deleted. Sometimes, legal instruments are issued which portray administrative and procedural changes. We exercise judgment in placing substantive changes into the dataset but deleting records pertaining to minor procedural changes.

Our approach is to count as separate changes all aspects of controls on foreign borrowing (the regulatory sub-categories in Table 9) even if one or more of these are changed on the same date. This approach differs from related work in this field. For example, if one RBI circular eases the eligibility criteria for firms allowed to borrow abroad and also eases the maturity restrictions, Pasricha [2012] classifies this as one event. We classify this as two distinct actions. This allows for the analysis of various classes of CCAs on foreign borrowing.

For our empirical analysis, we drop the dates of mixed events, i.e., dates on which easing and tightening changes were simultaneously introduced. We also drop those changes on controls in foreign borrowing that overlap with other changes in capital controls. This yields a database of changes in capital controls on foreign currency borrowing with no contemporary confounding events in terms of other CCAs.

The resulting database has approximately 76 unambiguous and unconfounded CCAs about ECB between January 2004 to September 2013. Table 1 shows summary statistics on our CCA database. Of a total of 76 events, 68 are easing and 8 are tightening.

Table 2 shows the number of records in the database in each year. The most events occurred in 2012 and 2013, when many CCAs took place to ease controls. However, most tightening events took place in 2007, when net capital inflows to India were surging. Since most of the records pertain to easing, for much of the analysis that follows in this paper, we analyse easing events only.

**Table 1** Tightening and easing events

| Sub-categories                    | Easing | Tightening |
|-----------------------------------|--------|------------|
| Automatic eligible borrowers      | 12     | 1          |
| Automatic amount and maturity     | 8      | 0          |
| Automatic all-in-cost ceilings    | 1      | 1          |
| Automatic end use                 | 6      | 1          |
| Automatic end use not allowed     | 0      | 1          |
| Automatic parking                 | 0      | 1          |
| Automatic prepayment              | 3      | 0          |
| Approval eligible borrowers       | 17     | 0          |
| Approval amount and maturity      | 4      | 0          |
| Approval all-in-cost ceilings     | 2      | 2          |
| Approval end use                  | 9      | 0          |
| Approval parking                  | 0      | 1          |
| Approval prepayment               | 1      | 0          |
| Trade credit amount and maturity  | 2      | 0          |
| Trade credit all-in-cost ceilings | 3      | 0          |
| Total                             | 68     | 8          |

**Table 2** Number of CCAs, by year

| Year  | Easing events | Tightening events |
|-------|---------------|-------------------|
| 2003  | 0             | 1                 |
| 2004  | 2             | 0                 |
| 2005  | 6             | 0                 |
| 2006  | 2             | 0                 |
| 2007  | 1             | 6                 |
| 2008  | 8             | 0                 |
| 2009  | 0             | 0                 |
| 2010  | 8             | 1                 |
| 2011  | 6             | 0                 |
| 2012  | 20            | 0                 |
| 2013  | 15            | 0                 |
| Total | 68            | 8                 |

## 4 Measuring macroeconomic vs. systemic risk objectives

We use the CCA database to address two questions. First, are CCAs undertaken in response to macroeconomic management concerns or systemic risk management concerns? Second, what impact did the CCAs have on macro-economic and financial variables?

In order to address these questions, we need to distinguish between variables that represent macroeconomic management objectives from those that represent systemic risk objectives. A joint report by the Bank for International Settlements (BIS), Financial Stability Board (FSB) and IMF [BIS et al., 2011] makes this distinction. In their analysis, systemic risk regulation pursues the objective of ensuring a stable provision of financial services to the real economy over time. They also recommend that systemic risk policy not be burdened with additional objectives, for example, exchange rate stability or stability of aggregate demand or the current account. This recommendation reflects the emerging consensus view of the best practices in systemic risk regulation at advanced-economy central banks [Bank of England, 2009, Nier et al., 2013].<sup>6</sup> In this framework, capital controls can potentially be a tool for systemic risk regulation.

In this paper, we follow the BIS-FSB-IMF approach and distinguish between macroeconomic objectives (exchange rate pressures) and systemic risk objectives. We use three outcome variables to assess exchange rate objectives:

1. INR/USD returns: This variable is the weekly percentage change in the spot exchange rate of the Indian rupee (INR) against the U.S. dollar (USD).<sup>7</sup>
2. Frankel-Wei residual: EM currencies like the Indian Rupee are intermediate exchange rate regimes. Intermediate currencies demonstrate periods of pegged and floating exchange rate behaviour. Consider the exchange rate regression in Haldane and Hall [1991] that gained prominence after it was used in Frankel and Wei [1994]. An independent currency, such as the Swiss franc (CHF), is chosen as an arbitrary “numeraire,” and the regression model is

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<sup>6</sup>This consensus in advanced-economy and multilateral institutions is in contrast to some of the recent economics literature (and indeed the views of some EME policy-makers) that continues to view exchange rate stabilisation and other macroeconomic management objectives as part of the goals of systemic risk policy. For example, Blanchard [2013] suggests an approach where monetary policy, exchange rate intervention, systemic risk regulation and capital controls are all used to manage the exchange rate, and this is justified in order to prevent large exchange rate changes that are thought to cause disruptions in the real economy and in financial markets.

<sup>7</sup>The exchange rate against the U.S. dollar is the key rate for the Indian economy. The RBI intervenes to mitigate volatility in this rate.

$$d \log \left( \frac{\text{INR}}{\text{CHF}} \right) = \beta_1 + \beta_2 d \log \left( \frac{\text{USD}}{\text{CHF}} \right) + \beta_3 d \log \left( \frac{\text{JPY}}{\text{CHF}} \right) + \beta_4 d \log \left( \frac{\text{DEM}}{\text{CHF}} \right) + \epsilon$$

The  $\epsilon$  of this regression can be interpreted as the India-specific component of fluctuations in the INR/USD exchange rate. This variable is expressed in weekly frequency.

3. Real effective exchange rate (REER): This variable is the trade-weighted average of nominal exchange rates adjusted for the relative price differential between the domestic and foreign countries. REER is expressed at monthly frequency.

All exchange rate variables are defined such that an increase in value corresponds to a depreciation of the Indian rupee, except the REER, in which an increase corresponds to appreciation.

To assess systemic risk objectives, we use the following variables:

1. Foreign borrowing (or external commercial borrowing, ECB): This is the percentage growth in foreign borrowing under the automatic and approval route expressed at monthly frequency.
2. Private bank credit growth: This is the percentage growth of non-food credit extended by the banking sector expressed at weekly frequency.
3. Stock price returns: This is the percentage change in the S&P CNX Nifty closing prices, expressed at weekly frequency.
4. Gross capital inflows: This is the quarter-on-quarter growth in gross flows on the financial account of balance of payments.
5. M3 growth: This is the growth in the money supply expressed at weekly frequency.

## 5 Motivations for CCAs

We approach the question of what motivates the use of CCAs in two ways. The first approach involves using both sets of outcome variables (measuring exchange rate and systemic risk objectives) in a logit model explaining easing of controls.<sup>8</sup> If only exchange rate variables are significant and of the right signs, we may infer that the exchange rate motivations are predominant. The logits are done at a weekly frequency and three lags of each of the outcome variables are used. The weekly frequency puts a constraint on the outcome variables we may use in the logits. We also provide results for logits at a monthly frequency.<sup>9</sup> The results are unchanged. For the exchange rate objective, we use two specifications: (i) the spot returns, and (ii) the predicted portion and the residual from the exchange rate regression used in Frankel and Wei [1994]. To proxy concerns about buildup of financial imbalances, we use growth in the money supply (M3), bank credit growth and the stock market (Nifty) returns.

The second approach is an event study that looks for statistically significant movements in each of the outcome variables in the period leading up to the event date, which is the date of the CCA. On the one hand, if the CCAs are used as a tool for exchange rate policy, then foreign borrowing would be restricted when there is pressure to appreciate, and vice versa. On the other hand, a systemic risk regulator would tighten controls on foreign borrowing in response to evidence of excessive foreign borrowing, excessive currency mismatches or asset price bubbles. The testable hypotheses (expected trends) for each of the outcome variables are summarised in Table 3.

The horizon over which we assess the trends in each variable when assessing motivations for CCAs is, in general, shorter for the exchange rate variables than for the systemic risk variables. The administrative infrastructure for the controls is well established: the RBI has autonomy on foreign exchange management, and it is able to provide notification of changes with immediate effect via circulars and later issue regulatory amendments. Further, RBI actions on capital controls take place quite frequently. Therefore, we assume that the appropriate time horizon for assessing the exchange rate is no more than three months, but potentially shorter. The same holds for market-based variables such as stock prices. For the other variables, such as bank credit, foreign borrowing and gross capital flows which are slower moving we evaluate indicators over a longer horizon before the event, up to six months (for foreign borrowing and bank credit) or two quarters (for gross

<sup>8</sup>There are not enough tightenings in the sample for a robust logit analysis.

<sup>9</sup>The results are not sensitive to the choice of lag. We tried specifications with one to four lags for weekly specification and up to three lags for monthly specification.

capital flows).

For the event study, mean adjustment is used in all cases, where the time series of (cumulative) percentage changes is de-meanned. Cumulation permits the possibility of picking up statistically significant changes over multiple time periods, even if one period changes are not statistically significant in and of themselves. Cumulation also helps address the fact that some of the announcements may be anticipated [Kothari and Warner, 2007].<sup>10</sup>

Inference procedures in traditional event studies were based on classical statistics. However, this involves distributional assumptions, including normality, independence and lack of serial correlation. Further, the asymptotic properties of the test statistics do not apply for small samples. A large literature has shown that bootstrap methods allow more robust inferences for event studies.<sup>11</sup> The bootstrap approach avoids imposing distributional assumptions such as normality, and is also robust against serial correlation—the latter being particularly relevant in the context of macroeconomic variables like exchange rate and foreign inflows. Our inference procedures utilise the bootstrap procedure of Davison et al. [1986], as adapted for event studies by Patnaik et al. [2013], Anand et al. [2014]:

1. Suppose there are  $N$  events.<sup>12</sup> Each event is expressed as a time series of cumulative changes ( $C_t^n, n = 1 \dots N$ ) in event time, within the event window. The overall summary statistic of interest is the  $\bar{C}_t$ , the average over the  $N$  time series.
2. We do sampling with replacement at the level of the events. Each bootstrap sample is constructed by sampling with replacement,  $N$  times, within the data set of  $N$  events. For each draw, the  $C_t^n$  time series corresponding to one event is taken, and  $N$  such draws are made. Averaging over the  $N$  draws, this yields a time-series  $\bar{C}_{1t}$ , which is one draw from the distribution of the statistic.
3. This procedure is repeated 1,000 times in order to obtain the full distribution of  $\bar{C}_t$ . Percentiles of the distribution are shown in the figures reported later in the paper, giving bootstrap confidence intervals for our estimates.

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<sup>10</sup>For all the changes in our sample, the announcement dates were also the effective dates of the changes.

<sup>11</sup>See Kothari and Warner [2007] and references therein.

<sup>12</sup>Note that the event study is done at the level of events, not weeks or months. This means that a week in which there is more than one event is included in the sample as many times as there are events in that week.

**Table 3** Event study for capital controls motivation: Expected trends

| Variable                       | Trend prior to |              |
|--------------------------------|----------------|--------------|
| <b>Exchange rate objective</b> | Easing         | Tightening   |
| INR/USD returns                | Depreciation   | Appreciation |
| Frankel-Wei residuals          | Depreciation   | Appreciation |
| REER                           | Depreciation   | Appreciation |
| <b>Systemic risk objective</b> | Easing         | Tightening   |
| Foreign borrowing (ECB)        | Slowing        | Increasing   |
| Bank credit growth             | Slowing        | Increasing   |
| Gross inflows                  | Slowing        | Increasing   |
| Stock price growth             | Slowing        | Increasing   |

## 5.1 A logit analysis

In order to estimate logit models about the event of easing CCAs, we draw on the literature on the determinants of capital flows and capital controls. First, to control for changes in a country's exchange rate we control for percent changes in the country's nominal exchange rate. Second, to control for increased credit growth we control for the percent change in private credit. We also control for money supply and stock market conditions [Forbes et al., 2015].

The results, in Table 4, show that only exchange rate variables are statistically significant. The table shows estimates of logit models that explain a dummy variable that is 1 in weeks when an easing CCA is present. Model 1 uses the raw INR/USD exchange rate. The only significant regressors are the INR/USD exchange rate with a lag of one week and three weeks. In both cases, depreciation predicts easing. Model 2 shifts from the raw INR/USD returns to two components: the predicted part and the residual from the exchange rate regression used in Frankel and Wei [1994]. At the same two lags (one and three weeks), the residual from the exchange rate regression is statistically significant. Model 3 shows the results of the logit model with variables at monthly frequency. Here we are able to include monthly foreign borrowing flows as one of the explanatory variables.<sup>13</sup> Again, the only regressor that is significant is the INR/USD exchange rate.

This evidence suggests that RBI eases CCAs on foreign borrowing when faced with currency depreciation. We find no evidence that CCAs respond to credit growth, stock market returns or growth in the money supply.

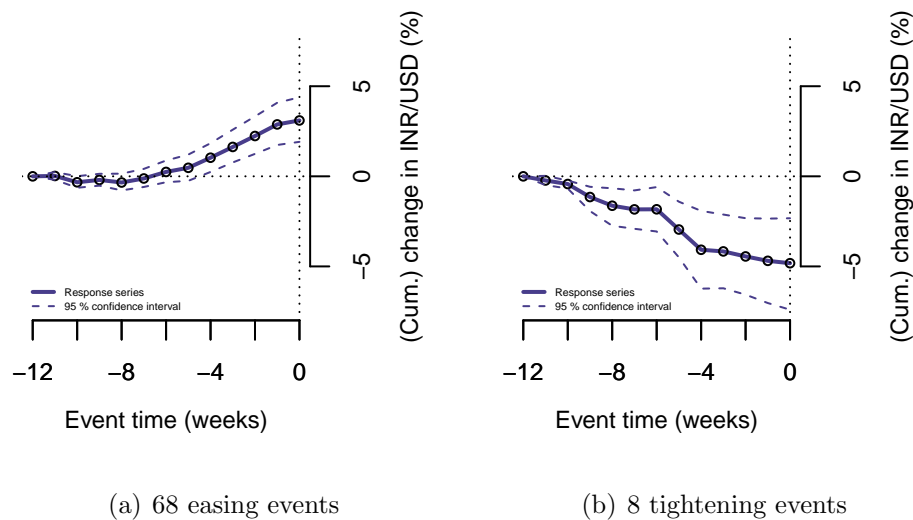
<sup>13</sup>Note that all variables in the monthly logits are measured at a monthly frequency and all variables in weekly logits are measured at a weekly frequency.



**Table 4** Motivations for easing of controls on foreign borrowing: Logit results

|  | Model 1 | Model 2 | Model 3 (Monthly) |
|--|---------|---------|-------------------|
| (Intercept)                            | -3.09*  | -3.32*  | -0.70             |
|  | (0.43)  | (0.27)  | (0.41)            |
| INR/USD returns <sub>t-1</sub>         | 0.60*   |         | 0.29*             |
|  | (0.27)  |         | (0.14)            |
| Foreign borrowing (ECB) <sub>t-1</sub> |         |         | -0.003            |
|  |         |         | (0.004)           |
| Bank credit growth <sub>t-1</sub>      | -0.38   | -0.37   | -0.37             |
|  | (0.37)  | (0.38)  | (0.29)            |
| M3 growth <sub>t-1</sub>               | -0.31   | 0.13    | -0.33             |
|  | (0.54)  | (0.51)  | (0.27)            |
| Nifty returns <sub>t-1</sub>           | -0.05   | -0.05   | 0.00              |
|  | (0.07)  | (0.07)  | (0.04)            |
| INR/USD returns <sub>t-2</sub>         | 0.30    |         |                   |
|  | (0.25)  |         |                   |
| Bank credit growth <sub>t-2</sub>      | -0.02   | -0.03   |                   |
|  | (0.33)  | (0.31)  |                   |
| M3 growth <sub>t-2</sub>               | -0.09   | 0.15    |                   |
|  | (0.48)  | (0.46)  |                   |
| Nifty returns <sub>t-2</sub>           | 0.02    | -0.03   |                   |
|  | (0.07)  | (0.08)  |                   |
| INR/USD returns <sub>t-3</sub>         | 1.21*   |         |                   |
|  | (0.29)  |         |                   |
| Bank credit growth <sub>t-3</sub>      | 0.05    | 0.09    |                   |
|  | (0.30)  | (0.32)  |                   |
| M3 growth <sub>t-3</sub>               | -0.02   | -0.23   |                   |
|  | (0.44)  | (0.48)  |                   |
| Nifty returns <sub>t-3</sub>           | 0.11    | 0.06    |                   |
|  | (0.07)  | (0.08)  |                   |
| FW predicted <sub>t-1</sub>            |         | 0.13    |                   |
|  |         | (0.20)  |                   |
| FW residuals <sub>t-1</sub>            |         | 0.65*   |                   |
|  |         | (0.28)  |                   |
| FW predicted <sub>t-2</sub>            |         | -0.08   |                   |
|  |         | (0.19)  |                   |
| FW residuals <sub>t-2</sub>            |         | 0.29    |                   |
|  |         | (0.30)  |                   |
| FW predicted <sub>t-3</sub>            |         | 0.01    |                   |
|  |         | (0.19)  |                   |
| FW residuals <sub>t-3</sub>            |         | 0.63*   |                   |
|  |         | (0.31)  |                   |
| <i>N</i>                               | 535     | 508     | 85                |
| Akaike information criterion (AIC)     | 209.15  | 203.13  | 104.57            |
| Bayesian information criterion (BIC)   | 431.83  | 473.88  | 119.29            |
| log <i>L</i>                           | -52.58  | -37.57  | -46.28            |

Standard errors in parentheses  
\* indicates significance at  $p < 0.05$

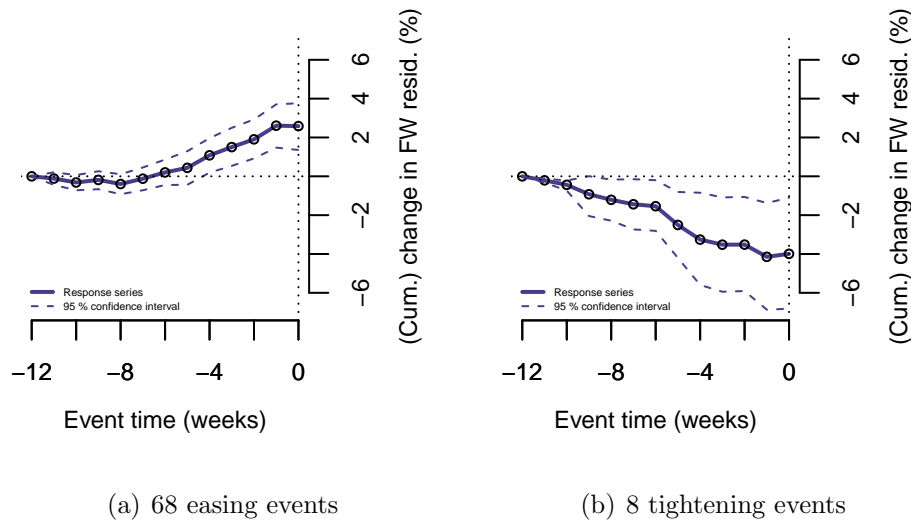
**Figure 2** INR/USD fluctuations prior to dates of CCAs

## 5.2 Event study analysis

The next step in our analysis of motivations for CCAs is to conduct a series of event studies. This permits careful analysis of one time series at a time, in the period leading up to the event date, which is the date of the CCA. We assess the importance of exchange rate versus systemic risk objectives by testing the significance of trends before the CCA dates using three measures of exchange rates (INR/USD spot returns, Frankel-Wei residuals and the real effective exchange rate) and four variables to reflect financial stability risks (growth of foreign borrowing, domestic bank credit growth, gross inflows and stock price returns).

### *Exchange rate objectives*

The mean-adjusted time series of the INR/USD exchange rate returns prior to the CCA dates is shown in Figure 2. The left pane, Figure 2(a), shows the average cumulative return of the INR/USD in the 12 weeks prior to the date on which an easing is announced. There is no significant trend in the exchange rate 12 to 5 weeks before the easing date, but, an average depreciation of 3% is observed in the 4 weeks preceding the easing of controls. The null hypothesis of no change can be rejected at a 95% level of significance. Not only was the average trend prior to easing of inflow controls that of a depreciation of the currency, this also held true for the broad majority of events in sample: 42 out of the 68 instances of easing in our sample were preceded by exchange rate depreciation. For the easing events which were preceded by an appreciation, the extent of the appreciation

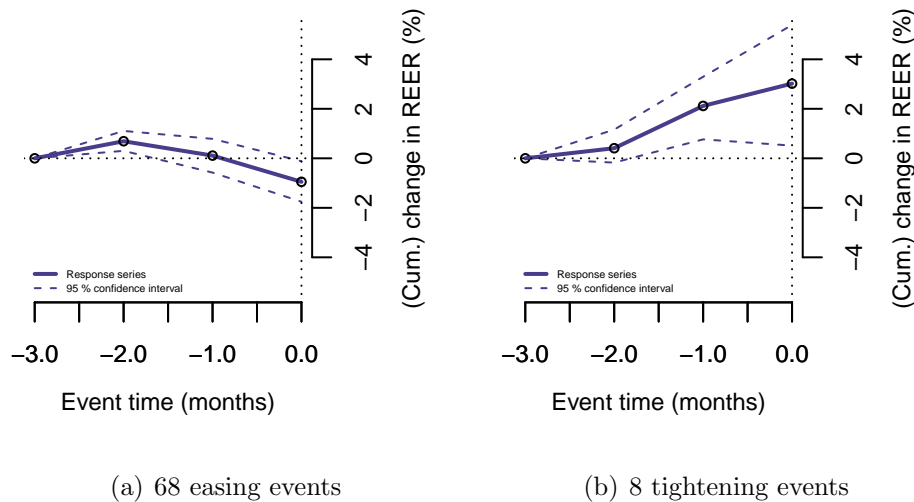
**Figure 3** Frankel-Wei (FW) residual fluctuations prior to dates of CCAs

was small compared to the events preceded by depreciation: the largest 5-week appreciation prior to an easing was 1.3%, compared to 9.2% for depreciation. The average appreciation prior to an easing was only 0.5%, compared to an average depreciation prior to easings of 5%. The right pane in Figure 2(b), applies the same analysis to tightening dates. The data set here is weaker since we observe only eight dates, which results in a wider 95% confidence interval. On average, an exchange rate appreciation of 5% is observed in the 4 weeks preceding the tightening of controls. Here also, the null hypothesis of no change can be rejected at a 95% level of significance. This suggests that CCAs are possibly being used as a tool for exchange rate policy, and is consistent with the logit model of Table 4.

The other two measures of exchange rate motivation for CCAs, shown in Figures 3 and 4, yield similar results. In both cases, there is a significant appreciation trend for the Indian rupee prior to tightening of inflow controls, and a significant depreciation trend prior to easing of inflow controls for Frankel-Wei residuals.

Only for the REER, the depreciation trend prior to easing of inflow controls is not statistically significant at a 95% level of significance for the three-month horizon, but would be significant if a two-month pre-event window is considered. This weakly significant result suggests that the authorities primarily respond to the nominal exchange rate depreciation, and not an REER depreciation, when making a decision to ease capital controls.

On the whole, we can interpret these results as evidence of nominal exchange rate motivation for capital control actions.

**Figure 4** Real effective exchange rate (REER) fluctuations prior to dates of CCAs*Systemic risk objectives*

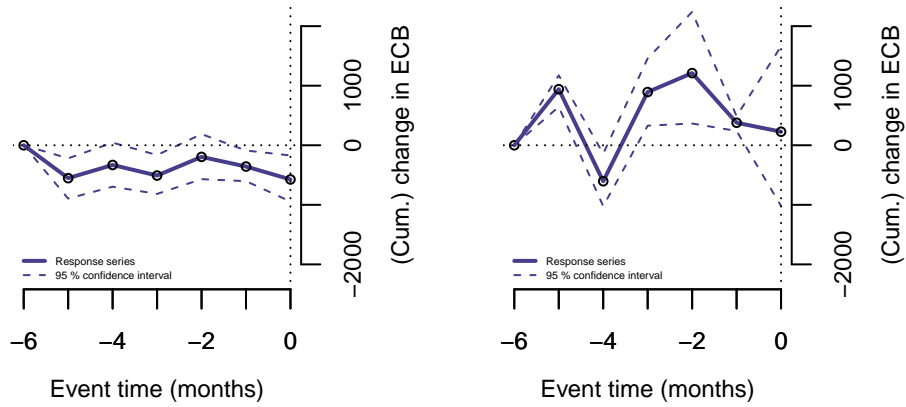
If policy-makers are concerned about the buildup of systemic risk, then there may be a CCA response to foreign borrowing (ECB), private bank credit growth, capital flows and stock prices to lean against the wind. The event study results for each of these series are presented in Figures 5 to 8.

In contrast with the results on exchange rate objectives, the evidence in support of systemic risk objectives is mixed. As far as easing of CCAs is concerned, there are no statistically significant trends in the four variables in the periods leading up to easing of inflow controls. There is evidence of increasing foreign borrowing and gross inflows prior to tightening of controls in the full horizon considered (Figures 5 and 7), but in the last two months before tightening, the foreign borrowing is slowing or flat. Bank credit growth falls prior to tightening of controls, though the trend is not significant. Further, there is no consistent evidence of increasing stock prices prior to tightening of controls.

A striking feature of these results is the lack of inversion in the evolution of these time series before easing vs. tightening events. We interpret these results as providing weak evidence of systemic risk concerns driving CCAs, unlike the evidence for exchange rate objectives.

This conclusion becomes clearer when looking at Table 5, which puts the results for all the variables together, and limits the horizon to one month for the exchange rates and stock prices (since these are faster moving variables), and to three months

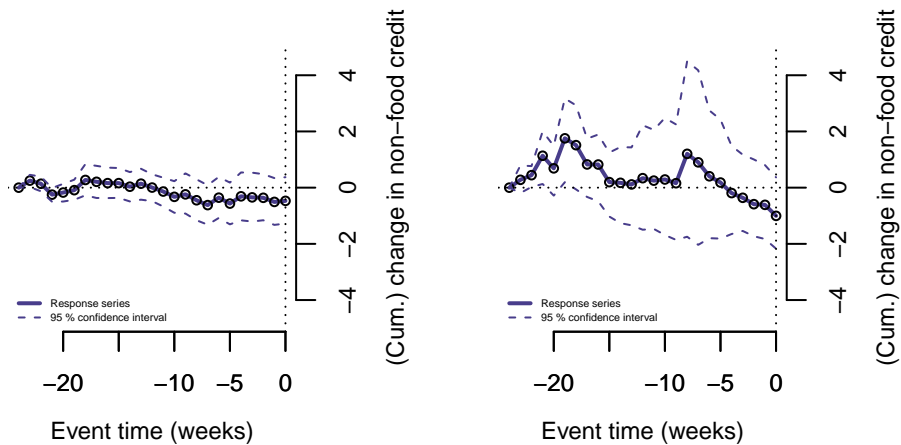
**Figure 5** Fluctuations in foreign borrowings prior to dates of CCAs



(a) 68 easing events

(b) 8 tightening events

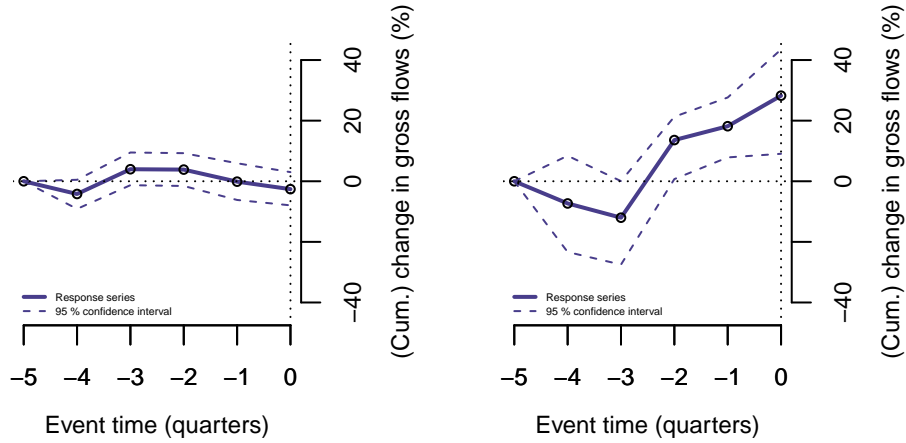
**Figure 6** Fluctuations in bank credit growth prior to dates of CCAs



(a) 68 easing events

(b) 8 tightening events

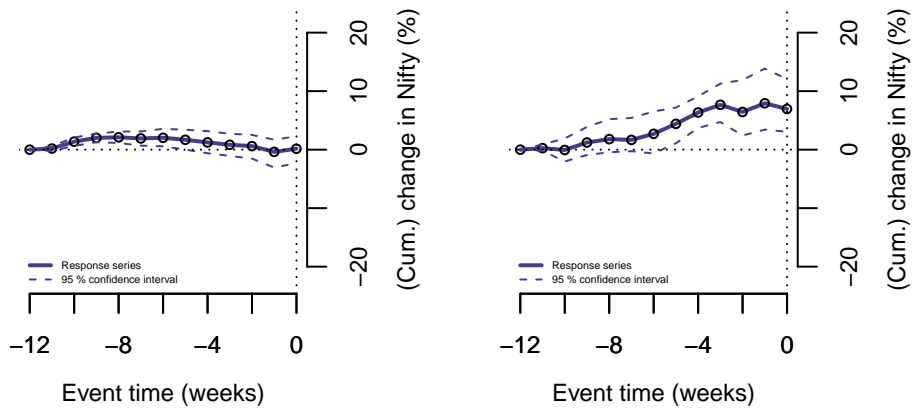
**Figure 7** Fluctuations in capital flows prior to dates of CCAs



(a) 68 easing events

(b) 8 tightening events

**Figure 8** Fluctuations in stock prices prior to dates of CCAs



(a) 68 easing events

(b) 8 tightening events

**Table 5** Event studies for capital controls motivation: a look back at the preceding 1 month / 1 quarter

| Variable                       | Trend prior to: |               |
|--------------------------------|-----------------|---------------|
|                                | Easing          | Tightening    |
| <b>Exchange rate objective</b> | Easing          | Tightening    |
| INR/USD returns                | Depreciation    | Appreciation  |
| Frankel-Wei residuals          | Depreciation    | Appreciation  |
| REER                           | Depreciation*   | Appreciation* |
| <b>Systemic risk objective</b> | Easing          | Tightening    |
| Foreign borrowing (ECB)        | No trend        | No trend      |
| Bank credit growth             | No trend        | No trend*     |
| Gross inflows                  | No trend        | Increasing    |
| Stock prices                   | No trend        | No trend      |

Notes: The table summarises the statistically significant trends (95%) over one month prior to the event for exchange rates and stock prices, and three months (one quarter) prior to the event for the other variables. These horizons are shorter than the ones presented in the figures.

\* The trends in REER are not statistically significant over the one-month horizon, but are statistically significant over a two-month horizon. Foreign borrowing first increases then declines over the three months prior to tightening dates. Bank credit growth falls 6 weeks prior to tightening of controls, though the trend is not significant.

(one quarter) for bank credit, foreign borrowing and gross capital flows.

As a robustness check, we also split the samples into periods before and after the global financial crisis and conduct the event studies separately on these samples. These robustness checks could be conducted only on the easing side, since all tightenings took place in the pre-crisis period. The results for the post-crisis period (2009-13) for easings are broadly the same as those for the full sample. For the pre-crisis period, the results are broadly similar, but there are some interesting differences.

For the January 2004-May 2008 period, there are 10 easings in sample. The results for FW residuals, INR-USD returns and REER are not significant. The wider confidence intervals could be due to the smaller number of observations but also due to more variation in the policy. On the systemic risk side, foreign borrowing, bank credit growth and stock prices continue to show no significant trend in up to two quarters prior to easing. However, gross flows growth shows significant trend one quarter prior to easing but in the opposite direction. These results seem to bolster our finding that capital control actions were not systematically driven by systemic risk motivations.

A careful look at the changes allows us to better understand the findings for the

pre-crisis period. The present ECB regime came into place in 2004, and the changes during 2004-05 seem to be structural changes related to the overall liberalisation of the policy. The changes in this period included new types of borrowers under the approval and automatic routes and expansion of the list of permitted end uses. These changes do not seem to be a response to the prevailing macroeconomic conditions, but rather, they seem to reflect a broader attempt at economic reforms.

If we remove the 2004-05 period, and include the crisis period during which the countercyclicality of policy would have been a priority (January 2006-December 2008), the results are similar to what we obtained for the full sample. As with the full sample, policy seems acyclical with respect to systemic risk variables, with no significant trends in foreign borrowing, bank credit growth, and stock prices. We see a significant declining trend only in gross inflows two quarters prior to easing of controls. For the exchange rate objective, as with the full sample, a depreciation trend is seen in all three variables prior to easing.

On the whole, the robustness check confirms our results of the primacy of the exchange rate objective over the systemic risk objective, both in the high-growth pre-crisis period, during the crisis and in the post-crisis period of less-robust growth.

To summarise, evidence from the logit model and the event studies shows a clear role for exchange rate policy in explaining the use of CCAs. The evidence is less conclusive for variables that may capture systemic risk objectives. These variables are not significant in logit regressions. Further, there are no clear patterns in foreign borrowing or stock price returns prior to changes in controls. There is evidence of tightening of capital controls during periods of increasing gross inflows, but the reverse is not true prior to easings, and moreover, foreign borrowing itself slows in the two months prior to the change. Putting these together, it is hard to conclude that India is using CCAs as a tool for systemic risk reduction. Our results suggest that CCAs may be a tool of exchange rate policy.



## 6 Effectiveness of CCAs

We now turn to measurement of the impact of changes in CCAs. The key problem faced is that of selection bias. Whether policy makers use capital controls for systemic risk regulation, or for exchange rate management purposes, they will be employed in certain situations and not in others. The weeks in which CCAs were implemented will differ from weeks in which CCAs were not implemented. In the regression:

$$Y_t = \alpha + \beta CCA_t + \epsilon_t \quad (1)$$

the dummy variable  $CCA_t$  will be correlated with the error term  $\epsilon_t$ .

### 6.1 Estimation strategy

One way to assess causality is to add other variables  $X_t$  to regression 1, conditional on which the CCA is assumed to be “as good as randomly assigned”. Propensity score matching (PSM) is an alternative strategy where there is an explicit attempt to construct the counterfactual. Instead of trying to model the *outcome* variables, we model the *policy* variable — the use of a CCA — and estimate the conditional probabilities for the use of CCAs. These conditional probabilities, called propensity scores, are used to identify time periods that had similar characteristics to those prior to the date of the CCA but where no CCA was employed (control group). The behaviour of the outcome variables for the control group gives us a counterfactual for how each of these variables would have behaved had the CCA not been employed. We then compare the outcomes in the weeks after the CCA between the treatment and control groups. This comparison can proceed without needing to specify a parametric model that explains the outcome.

Matching techniques, including PSM, are widely used in microeconomic research in settings such as the analysis of households or firms.<sup>14</sup> In recent years, these research ideas have diffused into macroeconomics and international finance.<sup>15</sup> There are several advantages of using PSM rather than multivariate regression in the

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<sup>14</sup>The key methodological paper, Rosenbaum and Rubin [1983], has 15,000 citations in Google Scholar.

<sup>15</sup>Examples of these applications include: Persson [2001], Edwards and Magendzo [2003], Glick et al. [2006], Lin and Ye [2007], Fatum and Hutchison [2010], Angrist and Kuersteiner [2011], Lin and Ye [2013], Jorda and Taylor [2014], Moura et al. [2013], Forbes and Klein [2015], Forbes et al. [2015].

context of this paper. First, macroeconomic variables of interest to us, particularly exchange rates and stock prices, are harder to model or motivate than the policy action (CCA).<sup>16</sup> In the PSM, we do not need to assume a linear relationship between the outcome variable and the regressors, nor do we need to specify the lag length of regressors, for example, in the model for exchange rate.

Second, in computing the average treatment effect on the treated, multivariate regressions put greater weight on observations with equal probability of being treated and untreated. These observations may be very different from observations that belong to the treated group. PSM, on the other hand, puts greater weights on observations that had the highest likelihood of being treated, but were not. That is to say, that PSM put greater weights on the control observations that were most similar to the treated observation, which can reduce bias. Finally, there can be efficiency gains in the finite sample with PSM [Angrist and Hahn, 2004].

Two key decisions shape the research strategy: the model to be used for estimating the propensity scores, and the algorithm to match the treated with the control observations. To estimate the propensity scores, we use the weekly logit model from Section 5.1. The explanatory variables used in the logit model are the same as in model 1 of Table 4: exchange rate changes, credit growth, money supply growth and returns on Nifty.

Once we have the propensity scores, there are several algorithms available in the literature to match treated observations with control observations (i.e., to find control observations that are most “similar” to treated ones). We use the nearest neighbour with a caliper algorithm, which matches each treated observation with the control observation that has the closest propensity score, as long as the distance between the two propensity scores is less than the tolerance level (caliper). We use the tight caliper value of 0.15. We use nearest neighbour matching without replacement, which means that each control week is matched only once with a treatment week.

There are two key assumptions underlying the PSM analysis: the common support condition and the independence assumption (or the balancing test). The common support condition is that the policy is not perfectly predictable, i.e., that there must be both treated and untreated units for each set of observable characteristics. This assumption can be thought of as applying to either the sample or the population. Nearest neighbour matching with a caliper ensures common support

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<sup>16</sup>For an example of the traditional strategy, Chamon and Garcia [2016] assess the effect of the capital controls and related measures on the exchange rate by regressing exchange rate on dummies associated with the imposition of capital controls while controlling for a number of additional explanatory variables like interest rate spread, VIX, commodity prices, foreign exchange intervention etc.

by excluding treated observations for which there is no close enough, untreated neighbour.

The balancing test verifies whether the matching algorithm was able to achieve close proximity in the distributions of relevant variables for the treated and control groups. To check for match balance, we first use the visual approach of plotting the cumulative density functions of the propensity scores for the treated and control groups and the full sample. We also use the Kolmogorov-Smirnov test for the equality of distributions in the treated and control groups for a broad set of outcome variables [Sekhon, 2011].

Ideally, this estimation strategy should yield a quasi-experimental design, where there are certain observations which are controls, and others which are treated, where these two groups of observations have similar characteristics on an array of observables pertinent to the treatment allocation.

PSM originated in the analysis of cross-sectional and panel data where a selection process has identified some units for a treatment. A logit (or probit) regression is utilised to characterise the selection process. Units with a proximate value of the propensity score have a similar probability of being treated, but some are treated and some are not. Untreated units with propensity scores similar to treated units therefore serve as the counterfactual. This strategy has been extended to identifying *time periods* as controls [Angrist and Kuersteiner, 2011, Moura et al., 2013, Aggarwal and Thomas, 2013].

There are 30 weeks in which 68 easing measures are observed. We delete one week in which there was both a tightening and an easing. We force a minimum window of plus or minus four weeks around treatment dates to ensure that treatment and control dates do not overlap. During this window, weeks are dropped from being eligible from being control weeks, even if no CCA was used in those weeks. Nearest neighbour matching with the caliper gives us 22 matched weeks. We then do an event study using only these 22 matched pairs.

## 6.2 Have we achieved match balance?

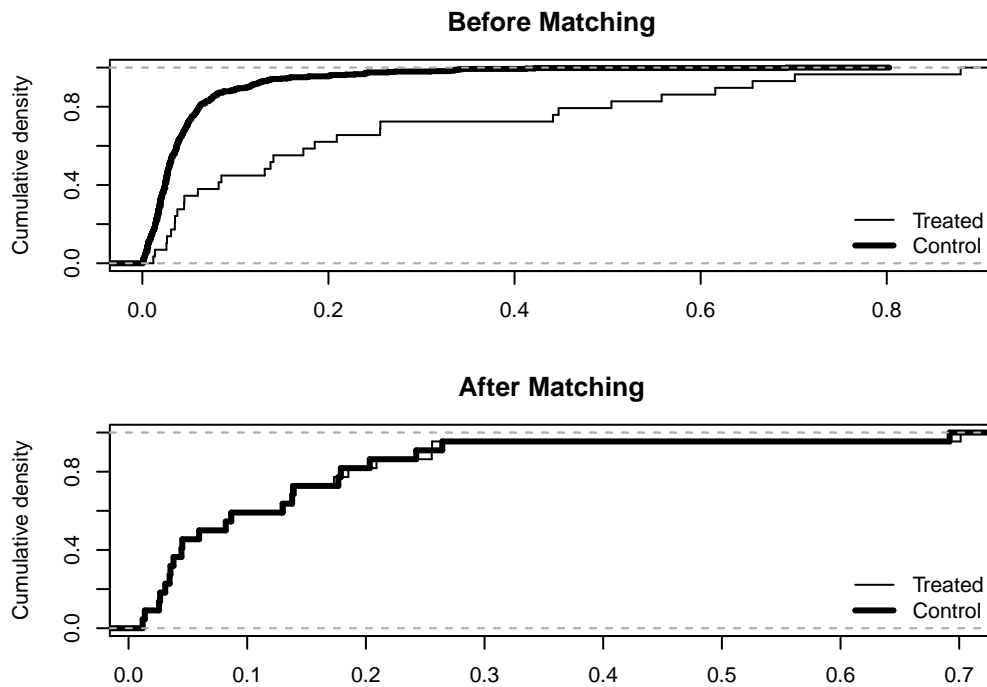
The results of Section 5 show that the RBI utilises a certain selectivity process that determines when a CCA is employed. The time periods prior to the week of a CCA have certain characteristics. We use propensity score matching to identify similar time periods, when no CCA was employed. For each date of a CCA, we identify a control time period where macroeconomic and financial conditions were similar, but no CCA was employed.

**Table 6** Kolmogorov-Smirnov Test

The table shows the Kolmogorov-Smirnov test result for a broad set of variables for the treated and control group before and after matching. The values in parentheses are  $p$ -values. FII refers to foreign institutional investors.

|   | Before Matching | After Matching |
|---|-----------------|----------------|
| Propensity score                                | 0.49<br>(0)     | 0.05<br>(1)    |
| INR/USD returns <sub><math>t-1</math></sub>     | 0.33<br>(0.01)  | 0.27<br>(0.39) |
| Bank credit growth <sub><math>t-1</math></sub>  | 0.11<br>(0.88)  | 0.09<br>(1)    |
| Net foreign inflows <sub><math>t-1</math></sub> | 0.18<br>(0.58)  | 0.39<br>(0.09) |
| Nifty returns <sub><math>t-1</math></sub>       | 0.28<br>(0.03)  | 0.5<br>(0.01)  |
| M3 growth <sub><math>t-1</math></sub>           | 0.11<br>(0.87)  | 0.18<br>(0.86) |
| Reserves growth <sub><math>t-1</math></sub>     | 0.25<br>(0.07)  | 0.27<br>(0.39) |
| Forward rate <sub><math>t-1</math></sub>        | 0.35<br>(0)     | 0.27<br>(0.39) |
| INR/USD returns <sub><math>t-2</math></sub>     | 0.32<br>(0.01)  | 0.23<br>(0.63) |
| Bank credit growth <sub><math>t-2</math></sub>  | 0.06<br>(1)     | 0.14<br>(0.99) |
| Net foreign inflow <sub><math>t-2</math></sub>  | 0.14<br>(0.86)  | 0.3<br>(0.39)  |
| Nifty returns <sub><math>t-2</math></sub>       | 0.22<br>(0.13)  | 0.14<br>(0.99) |
| M3 growth <sub><math>t-2</math></sub>           | 0.13<br>(0.7)   | 0.18<br>(0.86) |
| Reserves growth <sub><math>t-2</math></sub>     | 0.44<br>(0)     | 0.27<br>(0.39) |
| Forward rate <sub><math>t-2</math></sub>        | 0.32<br>(0.01)  | 0.36<br>(0.11) |
| INR/USD returns <sub><math>t-3</math></sub>     | 0.45<br>(0)     | 0.23<br>(0.63) |
| Bank credit growth <sub><math>t-3</math></sub>  | 0.11<br>(0.9)   | 0.14<br>(0.99) |
| Net foreign inflow <sub><math>t-3</math></sub>  | 0.12<br>(0.95)  | 0.33<br>(0.27) |
| Nifty returns <sub><math>t-3</math></sub>       | 0.29<br>(0.02)  | 0.23<br>(0.63) |
| M3 growth <sub><math>t-3</math></sub>           | 0.07<br>(1)     | 0.18<br>(0.86) |
| Reserves growth <sub><math>t-3</math></sub>     | 0.37<br>(0)     | 0.23<br>(0.63) |
| Forward rate <sub><math>t-3</math></sub>        | 0.43<br>(0)     | 0.32<br>(0.22) |

**Figure 9** Cumulative density function of the propensity scores before and after matching



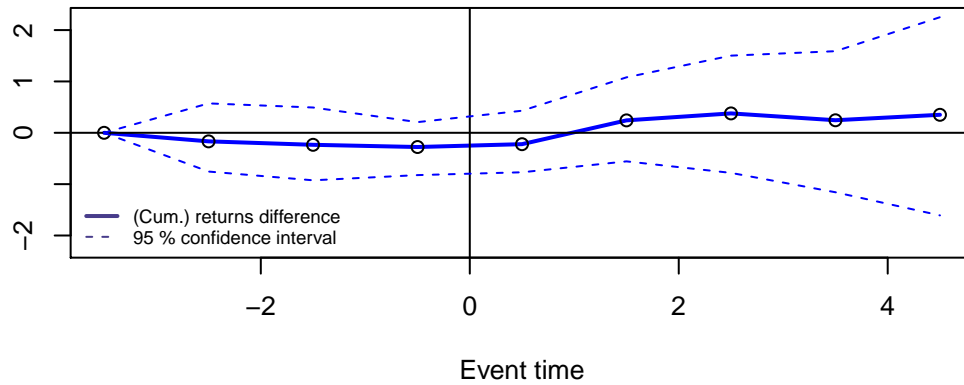
While only a small set of explanatory variables were used in the logit model, the resulting design has sound match balance for a broad set of time-series variables, as shown in Table 6. As an example, we also obtain match balance for reserves growth. This is needed because if policymakers do not tighten controls in periods where they are accumulating reserves faster, using reserves accumulation as a substitute to capital controls tightening, and we do not control for reserves changes, then the error in our estimated probability will be correlated with exchange rate (because faster reserves accumulation dampens exchange rate appreciation). We examine the forward rate of the rupee, to measure expected future depreciation, and find there is match balance here also.

In this table, the null of equality of distributions is always rejected before matching and is broadly not rejected after matching. This suggests that we have succeeded in finding a set of 22 control weeks when macroeconomic conditions were much like the 22 treatment weeks. Figure 9 shows that the cumulative density of the propensity scores is highly unequal before matching, but after the matching, the two distributions are alike, indicating that there is match balance. Match balance is the hallmark of experimental design, and we are able to establish fairly good

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**Figure 10** Causal impact of CCAs upon the INR/USD returns
 

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match balance in our quasi-experimental design.

### 6.3 Results

Using this matched sample of 22 weeks with a CCA and 22 weeks with no CCA, we conduct an event study about returns on the INR/USD exchange rate. This result is shown in Figure 10. The difference in returns between each pair is averaged and cumulated.

We know from Figure 2 that rupee depreciation took place, on average, in the weeks prior to a CCA. Since the control weeks are similar, rupee depreciation also took place in the weeks prior to the similar date with no CCA. Hence, we see no significant difference prior to the event date in the event study. This is as it should be.

Turning to the period after the event date, we see no statistically significant difference between the treatment and control week. This suggests that the CCAs do not seem have an effect on the INR-USD returns at a 4 week horizon.

Table 7 applies such causal analysis to outcome measures connected with exchange rates and systemic risk. In each case, we estimate the OLS model:

$$y_{i,s} - y_{j,s} = \alpha + \epsilon \quad (2)$$

**Table 7** Causal analysis of various outcome variables

For 22 matched pairs, the table shows the test of equality of means between the treated and control weeks at a horizon of 1,2,3 and 4 weeks after the event. \*\* indicates significance at the 5% level and \* indicates significance at the 10% level.

| Credit growth |              |              | FW residuals |              |              |
|---------------|--------------|--------------|--------------|--------------|--------------|
|               | OLS          | Robust       |              | OLS          | Robust       |
| 1             | -0.17 (0.42) | -0.44 (1.7)  | 1            | -0.09 (0.48) | 0.28 (0.5)   |
| 2             | -0.36 (0.45) | -0.36 (0.45) | 2            | -0.07 (0.57) | 0.27 (0.58)  |
| 3             | -0.41 (0.66) | -0.88 (0.73) | 3            | -0.04 (0.71) | 0.16 (0.94)  |
| 4             | -0.36 (0.59) | -0.75 (0.48) | 4            | -0.25 (0.83) | -0.23 (0.92) |

| Stock prices |              |             | Net foreign investment inflows |             |              |
|--------------|--------------|-------------|--------------------------------|-------------|--------------|
|              | OLS          | Robust      |                                | OLS         | Robust       |
| 1            | 0.44 (2.01)  | 0.44 (2.01) | 1                              | 0.03 (0.04) | 0 (0.02)     |
| 2            | 0.24 (2.4)   | 0.13 (3.01) | 2                              | 0.03 (0.04) | -0.01 (0.03) |
| 3            | -0.06 (2.29) | 1.38 (12.8) | 3                              | 0.03 (0.04) | 0 (0.03)     |
| 4            | -0.08 (2.76) | 1.17 (3.55) | 4                              | 0.03 (0.04) | -0.04 (0.03) |

where  $y$  is the outcome variable,  $j$  is the treatment week,  $i$  is the matched control week,  $s$  is the event time 1, 2, 3, 4;. We report the  $\alpha$  and the standard errors in brackets. While the main focus is on the robust regression estimates, OLS estimates are also reported for completeness.

We see no significant impact of CCAs on credit growth at a horizon of one, two and three weeks. There is no significant impact on the residuals of the Frankel-Wei regression, and stock market returns. There is a negative impact on foreign investment flows at a horizon of four weeks. These results are, however not significant.

## 6.4 Robustness checks

The main strategy of the paper has consisted of:

1. A certain specification for the logit model used in the PSM;
2. A certain set of techniques for matching.

We modify both steps in a large number of ways in order to verify that the research strategy is a robust one:

1. In the first stage logit regression, to control for global sentiments that could affect global capital flows, we control for global risk measured by VIX. To control for the reserves behaviour by the Central Bank, we add reserves to the logit regression.

**Table 8** Logit results for robustness checks

|   | Model 1                     | Model 2                     | Model 3            |
|---|-----------------------------|-----------------------------|--------------------|
| Intercept   | -3.43***<br>(0.48)          | -2.70***<br>(0.81)          | -1.83***<br>(0.19) |
| INR/USD Returns <sub>t-1</sub>  | 1.01**<br>(0.36)            | 1.04*<br>(0.41)             | 0.49**<br>(0.18)   |
| Credit Growth <sub>t-1</sub>  | -0.21<br>(0.48)             | -0.06<br>(0.52)             | -0.14<br>(0.21)    |
| Net Foreign Inflow <sub>t-1</sub>   | 5.69<br>(8.46)              | 9.82<br>(8.45)              | 2.99<br>(3.83)     |
| Nifty Return <sub>t-1</sub>   | -0.08<br>(0.09)             | -0.07<br>(0.10)             | -0.03<br>(0.04)    |
| M3 Growth <sub>t-1</sub>  | 0.10<br>(0.65)              | -0.18<br>(0.76)             | 0.00<br>(0.30)     |
| Reserves <sub>t-1</sub>   | 0.19<br>(0.34)              | 0.24<br>(0.36)              |                    |
| INR-USD Returns <sub>t-2</sub>  | 0.10<br>(0.33)              | -0.09<br>(0.37)             | 0.05<br>(0.17)     |
| Credit Growth <sub>t-2</sub>  | -0.47<br>(0.50)             | -0.55<br>(0.56)             | -0.21<br>(0.21)    |
| Net Foreign Inflow <sub>t-2</sub>   | 13.81<br>(9.48)             | 14.70<br>(10.81)            | 6.13<br>(4.40)     |
| Nifty Return <sub>t-2</sub>   | -0.02<br>(0.09)             | -0.04<br>(0.10)             | -0.02<br>(0.04)    |
| M3 Growth <sub>t-2</sub>  | 0.31<br>(0.58)              | -0.41<br>(0.80)             | 0.09<br>(0.27)     |
| Reserves <sub>t-2</sub>   | -0.19<br>(0.33)             | -0.31<br>(0.38)             |                    |
| INR-USD Returns <sub>t-3</sub>  | 0.68 <sup>†</sup><br>(0.40) | 0.89 <sup>†</sup><br>(0.47) | 0.43*<br>(0.19)    |
| Credit Growth <sub>t-3</sub>  | -0.09<br>(0.36)             | 0.13<br>(0.44)              | -0.03<br>(0.18)    |
| Net Foreign Inflow <sub>t-3</sub>   | 14.69<br>(9.57)             | 13.53<br>(10.62)            | 5.88<br>(4.25)     |
| Nifty Return <sub>t-3</sub>   | 0.06<br>(0.09)              | 0.06<br>(0.10)              | 0.02<br>(0.04)     |
| M3 Growth <sub>t-3</sub>  | 0.26<br>(0.51)              | -0.20<br>(0.67)             | 0.04<br>(0.25)     |
| Reserves <sub>t-3</sub>   | -0.61*<br>(0.29)            | -0.44<br>(0.35)             |                    |
| VIX <sub>t-1</sub>  |                             | 0.17 <sup>†</sup><br>(0.09) |                    |
| VIX <sub>t-2</sub>  |                             | -0.18<br>(0.14)             |                    |
| VIX <sub>t-3</sub>  |                             | -0.01<br>(0.11)             |                    |
| <i>N</i>  | 440                         | 395                         | 440                |
| AIC   | 163.23                      | 152.28                      | 162.58             |
| BIC   | 473.83                      | 502.42                      | 424.13             |
| log <i>L</i>  | -5.62                       | 11.86                       | -17.29             |
| Standard errors in parentheses  |                             |                             |                    |
| <sup>†</sup> significant at $p < .10$ ; * $p < .05$ ; ** $p < .01$ ; *** $p < .001$ |                             |                             |                    |



We also perform probit in place of logit analysis. This analysis is performed at weekly frequency as before. The results for these three specifications are reported in Table 8.

2. We modify the logit regression to have fewer lags.
3. We use an exclusion window of 3 weeks.
4. In model 2 in Table 4, we shift from the raw exchange rate to Frankel-Wei residuals.
5. Instead of using PSM with nearest neighbour matching, we use the genetic matching algorithm [Sekhon, 2011] which directly matches the distribution of covariates without using the dimensionality-reduction of the PSM.
6. We modify the nearest neighbour procedure to *not* have a caliper.

The key economic intuition of the results is not changed across all these modifications to the research design. The full details of these results are available from the authors on request.

## 7 Reproducible research

The computer programs used in this research have been placed on the web, so as to enable replication and downstream research.<sup>17</sup> Event study computations were done using the open source R package Anand et al. [2014]. Matching analysis was done using the open source R package Sekhon [2015].

## 8 Conclusion

There is renewed interest in reassessing the potential role for capital controls as a tool for macroeconomic or systemic risk policy. For capital controls to become accepted in the toolkit, an intellectual consensus is required on four questions. First, are capital controls able to deliver the desired objective of systemic risk reduction? Second, are the costs outweighed by the benefits? Third, do real world policy makers utilise capital controls as is envisioned in the ideal world? Fourth, how should real world institutional arrangements be constructed, to utilise these tools appropriately?

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<sup>17</sup> URL: [http://macrofinance.nipfp.org.in/releases/PPPS2016\\_cfm\\_motivations\\_effects.html](http://macrofinance.nipfp.org.in/releases/PPPS2016_cfm_motivations_effects.html)

In many countries, the capital controls system was fully dismantled. In such an environment, it may be particularly easy to evade capital controls through financial engineering and trade misinvoicing. The best opportunity to obtain effectiveness of capital controls may be in countries like China or India, where large bureaucracies manage the capital controls, and the detailed system of specifying rules about every asset class and every economic agent was never dismantled. For this reason, India is an ideal laboratory to study capital controls. If capital controls are found to be useful in India, the case could potentially be made that other EMEs, which dismantled the overall capital controls system, should reverse these reforms.

In this paper, we focus on one class of capital controls in India — on foreign borrowing — where the connection to systemic risk regulation is potentially the strongest. We construct a new dataset about capital control actions, by comprehensively analysing all legal instruments issued over the 2004 to 2013 period.

Our first result concerns the motivations for capital controls. The Indian authorities seem to use CCAs as a tool for exchange rate management, and not systemic risk reduction.

We go on to construct a quasi-experimental research design in order to assess the impact of the capital controls. Our main finding is that there is no discernable treatment effect, either on the exchange rate, or on measures connected with systemic risk.

The Indian authorities seem to be using capital controls as a tool for exchange rate policy and not for systemic risk regulation, and their actions seem to be ineffective. These results are also consistent with many papers in the recent literature which are skeptical about the usefulness of capital controls e.g. Chamon and Garcia [2016], Warnock [2011], Patnaik and Shah [2012], Hutchison et al. [2012], Forbes et al. [2015], Fernandez et al. [2015], Forbes and Klein [2015], Pasricha et al. [2015].

The strength of the research presented here is credible estimates about one locale, India. A fruitful line of inquiry would be to apply such strategies to multiple countries, and build up a literature with careful assessment of country experience, one country at a time, about the ways in which capital controls are used, in the field, and about their treatment effects. A much more expansive strategy would seek to undertake such thorough legal analysis on a multi-country scale in order to construct a consistent database about capital control actions on the scale of all EMEs or the whole world.

Even when capital controls do yield a desired treatment effect, the important question of cost benefit analysis remains. A body of research is required which would assess the costs and the benefits of utilising these tools. On the cost-assessment

side, a wide body of research on capital controls focuses on microeconomic distortions from capital controls [Alfaro et al., 2014, Forbes, 2007]. On the benefits side, the evidence is mixed regarding the extent to which capital controls are able to deliver on the objectives of macroeconomic policy. While capital controls seem to be able to change the composition of flows toward more long-term debt, it is not clear to what extent this represents a mislabelling of flows [Magud et al., 2011, Carvalho and Garcia, 2008]. Pasricha et al. [2015] find that capital control actions were not useful in allowing major emerging markets to change their trilemma configurations and Patnaik and Shah [2012] find that the Indian capital controls are not an effective tool for macroeconomic policy.

Further research is required on the institutional arrangements for capital controls. As an analogy, monetary policy was long viewed as being effective, but it was only in the 1980s that clarity was obtained around the institutional structure of independent central banks with inflation targets and monetary policy committees. In similar fashion, normative research is required in designing institutional arrangements for systemic risk regulation, with mechanism design, akin to a monetary policy committee, and accountability, similar to an inflation target.

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## Appendices

### A Capital controls in India

Capital controls were introduced in India by the British colonial authorities in 1942 as a temporary wartime measure. They gradually evolved into a comprehensive system of restrictions on cross-border capital mobility with the Foreign Exchange Regulation Act (FERA 1973), which criminalised violations. At the time, current account integration was also highly restricted. The conditions associated with a 1991 IMF program required eliminating control of the current account and the capital account. The current account has become open and FERA was replaced by a new law, the Foreign Exchange Management Act (FEMA 1999), under which violations of capital controls were no longer criminal offences, but were civil offences.

All capital account transactions are prohibited unless explicitly permitted. The permissions are granted through a set of legal instruments issued by the Reserve Bank of India (RBI) and the Ministry of Finance. Restrictions differ according to the type of investor, the asset class, the recipient of foreign capital, the intended end-use of the foreign capital, etc.

There are three areas where there are no restrictions on the size of investments: inbound FDI, outbound FDI and foreign investment in the equity market. In all other areas, quantitative restrictions are in place, through which the RBI specifies caps on cross-border activities. For example, there is a cap on the aggregate ownership by all foreign investors of rupee-denominated debt. Similarly, there is a cap on the amount of capital that can be taken out of the country each year by one resident.

Sinha [2010] is a useful description of the capital controls prevalent in 2010. However there is no unified manual or legal document that shows all the capital account restrictions that are in place.

#### A.1 Capital controls against foreign borrowing in India

Foreign borrowing with a maturity of less than three years is termed short-dated borrowing, and is prohibited unless it is trade credit. Trade credit can also have a maturity of more than three years.

The remainder — foreign borrowing with a maturity greater than three years that



**Table 9** Regulatory sub-categories for external commercial borrowing (ECB) and trade credits

| Sub-Category                                     | ECB                              |                                | Trade Credits          |
|--|----------------------------------|--------------------------------|------------------------|
|  | Automatic route                  | Approval route                 | Automatic route        |
| Eligibility criteria to borrow                   | Eligible borrowers               | Eligible borrowers             |                        |
| Controls on eligible lenders                     | Recognized lenders               | Recognized lenders             |                        |
| Quantitative caps and maturity restrictions      | Amount and maturity              | Amount and maturity            | Amount and maturity    |
| Price ceiling                                    | All-in-cost ceiling              | All-in-cost ceiling            | All-in-cost ceiling    |
| Permitted activities with foreign exchange       | End-use                          | End-use                        |                        |
| Special route for spectrum auctions              | Payment for spectrum allocation  | 3G Spectrum allocation         |                        |
| Activities not permitted with foreign exchange   | End-uses not permitted           | End-uses not permitted         |                        |
| Guarantees by financial institutions             | Guarantees                       | Guarantees                     | Guarantees             |
| Nature of security that can be used by borrowers | Security                         | Security                       |                        |
| Remittance of borrowed funds into India          | Parking of ECB proceeds          | Parking of ECB proceeds        |                        |
| Early repayment of ECB                           | Prepayment                       | Prepayment                     |                        |
| Additional ECB for repayment of ECB              | Refinancing of an existing ECB   | Refinancing of an existing ECB |                        |
| Interest payment                                 | Debt servicing                   | Debt servicing                 |                        |
| Legal process                                    | Procedure                        | Procedure                      |                        |
| Route for distressed corporate entities          | Corporations under investigation |                                | Reporting arrangements |
| Committee that decides approval route            |                                  | Empowered committee            |                        |
| Special approval category                        |                                  | ECB for rupee loan repayment   |                        |
| Special approval category                        |                                  | ECB for low cost housing       |                        |

is not trade credit — is termed “external commercial borrowing” (ECB). ECB has, in turn, been broken down into two routes. Some classes of firms are permitted to borrow under certain conditions through an “automatic” window. When these conditions are not satisfied, firms have to apply for “approval” from the RBI.

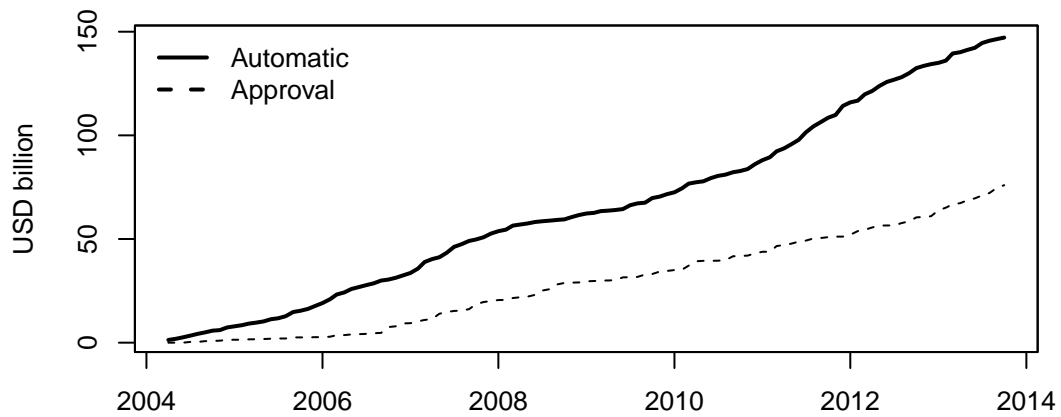
The regulations are extremely detailed, involving prices (e.g., rules about the highest interest rate that can be paid), quantities (e.g., caps on the magnitude that can be borrowed and the maturity), and industrial policy (firms in certain industries are allowed to borrow, while others are prohibited). Table 9 shows 18 sub-categories of controls, and the treatment of these controls under the automatic and approval route of ECB and under trade credits.

India’s restrictions are quite unlike those seen in other EMEs, which have substantially scaled back capital controls as part of the modernisation of their economies. For example, successive AREAERs suggest that Chile has had no restrictions on credit from non-residents to residents since 2000. There have been certain registration requirements and withholding tax on interest on loans in Korea, but only notification requirements for large loans. In Mexico, there have been no restrictions imposed except for some limits on foreign currency borrowing by banks as a percentage of their net worth and on their open foreign exchange positions. In Brazil, there have been no controls other than, for some time, a transparent tax on short-term borrowing. And in Turkey, for part of the past decade, there were restrictions in place on foreign currency and foreign currency-linked consumer and mortgage loans.

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**Figure 11** Cumulative borrowing through ECB

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*Source:* RBI monthly statistics

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## A.2 Foreign borrowing in India

Figure 11 shows the cumulative borrowing that has taken place under ECB (automatic) and ECB (approval) mechanisms over the past decade. The stock of borrowing in March 2013 was 5.4 times that of March 2004. Expressed as a proportion to total external debt, this foreign borrowing rose from 22.9% in March 2004 to 33.4% in March 2013.

## B Construction of the CCA database: Two examples

In this appendix, we present two examples of our methodology for translating CCAs into a consistent database for evaluating the motivation and effectiveness of controls.

1. On 21 May 2007, an RBI circular (<http://rbi.org.in/scripts/NotificationUser.aspx?Id=3544&Mode=0>) reduced the spread on all-in-cost ceilings to 150 basis points for maturities of three to five years and to 250 basis points for maturities of more than five years. The reduced spread was also announced for borrowers under the approval route. End-use requirements governing external borrowings were tightened: proceeds from external commercial borrowing (ECB) could no longer be used for investing in real estate, including integrated townships.

From this circular we get three tightening events:

- (a) The all-in-cost ceilings were reduced for eligible borrowers under the automatic route.
- (b) The all-in-cost ceilings were reduced for eligible borrowers under the approval route.
- (c) The end-use restrictions were tightened.

For this date we get three records in the CCA database, all of which are tightening. Pasricha [2012] classifies these three events introduced on a single day as *two* tightening events: it groups the two price-based measures (cost-ceiling changes) as one event and categorises the end-use restrictions as a quantitative event. These changes may have differential impact on the different types of borrowers (firms under approval and automatic routes). Hence, for the purpose of assessing the impact of controls, they merit independent counting as three tightening events.

The AREAER tracks the changes in foreign borrowing under the head: “Controls on credit operations”. For this date, the AREAER database on India identifies only the first two tightening events. It does not list the restriction on end-use. This comparison highlights the merit in tracking changes by reading legal instruments through primary source.

2. On 29 May 2008, an RBI circular (<http://rbi.org.in/scripts/NotificationUser.aspx?Id=4200&Mode=0>) eased capital controls in three directions:
  - (a) The restrictions on all-in-cost ceilings were eased to 200 basis points from 150 basis points for three- to five-year maturities and from 250 to 350 basis points over six month LIBOR for above-five-year maturities.

- (b) Borrowers that were infrastructure firms were permitted to borrow through ECB with a limit of USD 100 million, for the purpose of rupee expenditure, for permissible end uses, under the approval route.
- (c) For other borrowers, the existing limit of USD 20 million for rupee expenditure for permissible end uses under the approval route was enhanced to USD 50 million.

For this date we get three records in the CCA database, and all three are easing. This circular cannot be read as a standalone legal instrument. The nature of change introduced in this circular is different from the previous example. In this circular, several of the previous tightening events were reversed. This requires tracking all the previous circulars to get an idea of the sequential liberalisation of tightening measures.

From this circular, we get three easing events related to the following aspects of ECB regulation:

- (a) Easing of all-in-cost ceilings.
- (b) Easing of restrictions on eligible borrowers under the approval route.
- (c) Easing of restrictions on permissible amounts.

Pasricha [2012] counts the cost ceilings as one event and groups the other two quantitative changes as one event. In our classification system, these are viewed as three distinct easing events, since the nature of changes introduced through this circular are different and may have differential impact for different borrowers.

The AREAER database on India is not able to track the changes introduced on this date. The list of changes for the year 2008 does not include the changes introduced on 29th May 2008. This shows that the AREAER database misses the finer details of controls on ECB which are key to our analysis.

In this way, we analyse each of the 97 circulars and track changes related to all aspects of ECB regulation. This approach sheds light on the details of changes in capital controls. For example, while Forbes et al. [2015] identifies five events directed toward easing, our approach (that focuses on controls on one category of international capital transactions, i.e., external borrowing) identifies 14 easing events in the period 2009-11. The number is likely to go up if we extend this approach to tracking capital controls on all categories of international transactions.

## C Data sources

**Table 10** Data sources

| Variables                       | Sources   |
|---------------------------------|---|
| Rupee-U.S. dollar exchange rate | Reserve Bank of India   |
| Frankel-Wei residuals           | India-specific component of fluctuations in INR/USD exchange rate based on Frankel and Wei [1994] methodology |
| Real effective exchange rate    | Bank for International Settlements  |
| Foreign borrowing               | Reserve Bank of India   |
| Private bank credit growth      | Reserve Bank of India   |
| Stock price returns             | National Stock Exchange   |
| Gross capital flows             | Reserve Bank of India   |
| Money supply (M3)               | Reserve Bank of India   |
| Reserves                        | Reserve Bank of India   |

## MORE FROM THE AUTHORS

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- Ajay Chhibber (2016), Assessing and Evaluating the Addis Ababa Action Agenda(AAAA), WP 166(March).
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