

Sticky Capital Controls

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ABSTRACT

There is much ongoing debate on the merits of capital controls as effective policy instruments. The differing perspectives are due in part to a lack of empirical studies that look at the *intensive* margin of controls, which in turn has prevented a quantitative assessment of optimal capital control models against the data. We contribute to this debate by addressing both positive and normative features of capital controls. On the positive side, we build a new dataset using textual analysis, from which we document a set of stylized facts of capital controls along their intensive and extensive margins for 21 emerging markets. We document that capital controls are “sticky”; that is, changes to capital controls do not occur frequently, and when they do, they remain in place for a long time. Overall, they have not been used systematically across countries or time, and there has been considerable heterogeneity across countries in terms of the intensity with which they have been used. On the normative side, we extend a model of capital controls relying on pecuniary externalities augmented by inclusion of an (S, s) cost of implementing such policies. We illustrate how this friction goes a long way toward bringing the model closer to the data. When the extended model is calibrated for each of the countries in the new dataset, we find that the size of these (S, s) costs is large, thus substantially reducing the welfare-enhancing effects of capital controls compared with the frictionless Ramsey benchmark. We conclude with a discussion of the structural interpretations of such (S, s) costs, which calls for a richer set of policy constraints when considering the use of capital controls in models of pecuniary externalities.

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JEL codes: Capital controls, Macroprudential policies, Stickiness, Intensive, (S, s) costs.

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1 Introduction

Following the Global Financial Crisis of 2007–2008, a body of research has taken a closer look at the use of unconventional policy tools—namely, macroprudential instruments—aimed at curbing potential imbalances that can trigger financial crises and sudden stops in cross-border capital flows. Capital controls (or capital flow management policies) are arguably among the instruments that have drawn the most attention.²

The case for capital controls rests primarily on the volatility of foreign capital inflows. As macroprudential measures, they are designed to mitigate systemic crises.³ Recent normative analysis of these policies has argued that their cyclical use can have nontrivial welfare implications by reducing the probability of financial crises. However, much debate remains on both the positive and normative aspects of capital controls.

On the positive side, an element that has prevented the shedding of new light on the use of these policy instruments is a lack of cross-country measures of the *intensive* margin of capital controls (i.e., rates) over time. Although there has been important progress in documenting the *extensive* margin of capital controls (i.e., whether controls are in place or not), no analysis has yet documented the behavior of the intensive margin of this policy instrument, its cyclical properties across countries, and its interaction with other instruments in the macroprudential toolbox.

Related to this shortcoming is a disconnect between the normative implications of models of optimal capital controls and the data. The normative prescriptions of most of these models rely heavily on the use of controls along the *intensive* margin. The optimal policy tends to involve not just the imposition of controls in certain states of nature (*extensive* margin) but, more importantly, an active cyclical use of them (*intensive* margin); hence the lack of data on the intensive margin has made it difficult to bring models of optimal capital controls closer to the data.

²Another set of instruments that has received considerable interest is that aimed at curbing imbalances in domestic financial systems: LTV ratios, dynamic provisions, countercyclical buffers, etc. (see [Jiménez et al. 2017](#); [Galati and Moessner 2018](#); and [Lubis et al. \(2019\)](#), among others). While our work mostly focuses on capital controls, later we will study the relationships between capital controls and these other instruments.

³In addition, controls can have a protectionist or mercantilist motive related to affecting the value of the currency ([Magud et al. 2018](#), [Alfaro et al. 2017](#)).

Our work makes several contributions to this debate that relate to the aforementioned shortcomings. First, using textual analysis of official regulations from multilateral and national sources, we build a novel quarterly dataset on de jure capital controls along their extensive and, importantly, *intensive* margins. To our knowledge, this is the first cross-country panel dataset on the extensive and intensive margins of capital controls. The dataset covers a panel of 21 well-established emerging market economies (EMEs) for the period 1995–2014.⁴

We focus on two types of quantitative capital controls: unremunerated reserve requirement (URRs) rates applicable to cross-border flows, and tax rates applicable to cross-border inflows and outflows. When distinguishing the extensive from the intensive margins, we differentiate controls of a quantitative nature (as the two that we focus on) from those of a qualitative nature (e.g., authorizations and other kinds of regulations that do not directly target market prices or volumes). We label the latter type of measures as non-price-based capital controls. We further complement the dataset with information on other macroprudential instruments from earlier work by [Cerutti et al. \(2017\)](#), as well as that in [Federico et al. \(2014\)](#), which we also extend.

We uncover six stylized facts from the new dataset that taken together point to a large degree of “stickiness” of capital controls. First, the intensive margin of both controls (taxes and URRs) has not been systematically used either across countries or time. Second, when they have been used, controls display considerable heterogeneity across countries in terms of the intensity with which they have been used. Third, changes to capital controls do not occur frequently, and when they do occur, they remain in place for a long time (i.e., longer than a typical business cycle). As a result, these instruments display very high serial autocorrelation. Fourth, the cyclicity of capital controls differs sharply across instruments, with URRs having been used countercyclically during episodes of large economic booms, and taxes on both inflows and outflows having been used in the contractionary phase of the GDP cycle. Fifth, analysis of the joint dynamics of capital controls and other macroprudential policies reveals little evidence of complementarity. If anything, they appear to have been substitutes. Sixth, while extensive measures of capital controls capture more non-price-based

⁴During our period of analysis, most developed nations limited their use of capital controls (see [Fernández et al. 2016](#)).

policy measures, they also display a considerable degree of persistence.

We then turn to a normative analysis. Our starting point—which we label our baseline model—is a small open economy with collateral constraints of the kind introduced by [Mendoza \(2002\)](#). Subsequent works have documented extensively how such types of borrowing constraints give rise to pecuniary externalities that in turn are widely viewed as a benchmark theory for rationalizing the use of capital controls in an dynamic stochastic environment, implemented as taxes on cross-border flows (see [Mendoza and Smith 2006](#), [Uribe 2006](#), [Lorenzoni 2008](#), [Bianchi 2011](#), [Farhi and Werning 2014](#), [Benigno et al. 2011](#), [Korinek 2018](#), [Bianchi and Mendoza 2010](#), [Schmitt-Grohé and Uribe 2017](#), and [Schmitt-Grohé and Uribe 2020](#), among others).⁵

The baseline model allows us to build an unregulated economy with no taxes and where agents do not internalize such externalities, as well as the optimal capital control derived from the Ramsey planner, who can internalize the pecuniary externality. We argue that such optimal policy is not designed to account for the stickiness documented in the data but rather suggests a highly active and cyclical use of these instruments. We then extend this setup to improve the baseline model along this dimension.

Of course, there are many reasons why positive and normative implications may differ.⁶ Our exercise attempts to understand if additional considerations or frictions might be incorporated into the benchmark model, albeit in reduced form, to better account for the stylized facts that we uncover. In particular, we consider the stickiness of controls documented in the empirical part of our work. We naturally turn to (S, s) costs, which have served as a quintessential device for economists seeking to generate inaction regions in models where consumers and firms make decisions, and which have successfully generated stickiness in variables ranging from prices to investment ([Caplin and Leahy, 2010](#)). Our work extends this concept to a policy variable, namely capital controls.

We modify the baseline model by introducing a fixed cost (of policymaking) in the tradition of (S, s) models, whereby policymakers equate their policy instrument to its optimal value only when the benefit of doing so surpasses its (S, s) cost. Otherwise the (policy) cost

⁵The setup of pecuniary externalities can also be used to rationalize the use of *domestic* macroprudential tools. We do not consider this case.

⁶In the last section of the paper, we discuss possible explanations.

is large enough to deter policymakers from adjusting the policy instrument, staying in an inaction region, and inducing stickiness.⁷

Our analysis of this extended model begins with a simple illustration of the quantitative effects of varying levels of (S, s) costs on the equilibrium dynamics in an economy calibrated as in the aforementioned literature, hence taking no stance on the size of such costs. We document that (S, s) costs allow us to bring the model closer to the data along four dimensions that characterize the stickiness in capital controls. First, the extended model has the ability to reduce the share of time during which the tax is active, with higher (S, s) costs further reducing this share—unlike in the baseline case, where controls are counterfactually always active. Second, the presence of (S, s) costs is shown to reduce the frequency of changes in capital controls with values that are more aligned to those observed in the data. Third, (S, s) costs also generate episodes when capital controls are used in a highly non-linear way, where taxes remain inactive for a long time, then jump to high levels with a considerable persistence. Hence, such costs can generate the high serial autocorrelation of capital controls documented in the data, the fourth dimension that characterizes stickiness in these policy instruments.

Our work then considers a formal calibration of the (S, s) costs for each of the 21 EMEs in the dataset. The calibration strategy that we follow is country-specific in the two endowment processes for tradable and non-tradable incomes that constitute the driving forces of the model, the parameters that govern the strength of the collateral constraint, and, importantly, the (S, s) cost that generates the stickiness in capital controls. For the two endowments processes, we build empirical counterparts that we use to parameterize the two driving forces in the model. For the latter two parameters, we select values such that the distance between model and data is minimized along two key moments: the frequency of adjustment in the intensive margin of capital controls—taken from the new dataset—and the frequency of occurrence of financial crises in each of these countries (taken from [Reinhart 2010](#)).

The average value for (S, s) costs calibrated is large and allows the extended model to

⁷While the use of (S, s) costs is intuitive, we do consider other types of (convex and concave) costs. In the Appendix, we document how, when compared with (S, s) costs, such alternative cost specifications do not help the baseline model in a meaningful way to better replicate the data.

account for the low frequency of changes in capital controls in the data. In the data, controls are changed 1.4 times for every 20 years; the extended model matches that quite closely by generating, on average, 1.6 changes for every 20 years simulated. In contrast, the calibrated baseline model with no (S, s) costs predicts, on average, 13.8 changes in capital controls for every 20 years. Importantly, other non-targeted moments are also much more in line with the data, such as the share of time that controls are predicted to be active; the value of the tax used; the non-mean reversion observed in episodes when controls have been used; and their serial autocorrelation.

Calibrated (S, s) costs are also large when we assess their impact on welfare. Using the Ramsey planner who implements controls at no cost as benchmark, imposing capital controls bring about welfare gains for agents in the unregulated economy. However, such gains for agents in a model with (S, s) costs are about 4/5 of those in the unregulated economy. This implies that the magnitude of (S, s) costs calibrated is large enough to eliminate most—though not all—of the welfare gains obtained after imposing controls.

There are several reasons why models of optimal capital controls may be at odds with the data, and the reduced form specification with which we try to capture several of these reasons through an (S, s) cost is, at best, a crude approximation for them. We view the enhanced performance of the modified model as a call for including a richer set of policy constraints when considering the optimal use of capital controls in the presence of pecuniary externalities. In the last section of the paper, we discuss some of these potential policy constraints based on previous studies. We discuss at least three alternative deeper causes for the (S, s) costs. First, such costs may be capturing a more complex cost-benefit analysis made by policymakers, incorporating negative effects and/or unintended consequences of capital controls not picked up by standard models. A second explanation may more generally relate to political economy considerations driving policymaking, which can also link to credibility and signaling issues related to the use of these tools that end up shaping policy choices over these instruments in a highly nonlinear form. Third, model robustness and (perceptions of) lack of ineffectiveness of capital controls may also play a role in policymakers' cautious use of these instruments, unless extreme conditions warrant their use.

This paper relates to several strands of the literature. On the empirical front, seminal

empirical works that have measured capital controls and their use include [Quinn \(1997\)](#), [Chinn and Ito \(2006\)](#), [Schindler \(2009\)](#), [Pasricha \(2012\)](#), [Klein \(2012\)](#), [Aizenman and Pasricha \(2013\)](#), [Ahmed and Zlate \(2014\)](#), [Eichengreen and Rose \(2014\)](#), [Fernández et al. \(2015\)](#), [Fernández et al. \(2016\)](#), [Jahan and Wang \(2017\)](#), and [Pasricha et al. \(2018\)](#), among others. [Klein \(2012\)](#) casts doubts the use of episodic controls on capital inflows and concludes that, with a few exceptions, there is little evidence of the efficacy of capital controls. [Glick et al. \(2006\)](#) find that countries with liberalized capital accounts experience a lower likelihood of currency crises. [Fernández et al. \(2013\)](#) do not find evidence of capital controls implemented as macroprudential tools in the period 1995–2011. We build on these empirical works and complement them by adding an intensive dimension of capital controls to the analysis.

As mentioned above, a growing theoretical macro literature posits pecuniary externalities to motivate the use of capital controls. The lack of data on the intensive margin has precluded evaluating the performance of these models empirically, to which we contribute in this paper. Our work further complements these theoretical frameworks by adding a friction—in the form of an (S, s) cost—which is shown to improve the performance of models relying on these types of externalities. Structural interpretations of the kind of (S, s) costs that we put forth can be viewed as a call for future theoretical work to include a richer set of policy constraints when considering the use of capital controls in models of pecuniary externalities.

The paper proceeds as follows. Section 2 presents the new dataset, while Section 3 documents the stylized facts. Section 4 presents the baseline model of capital controls, postulates the extension including (S, s) costs, and discusses the solution method used. Section 5 presents the quantitative analysis by first illustrating the effects of varying (S, s) costs on the equilibrium dynamics, then calibrating the (S, s) costs for the countries in the dataset and computing welfare gains. Section 6 discusses possible avenues to rationalize the (S, s) costs. The last section concludes.

2 A New Dataset

We build a novel cross-country panel dataset of *de jure* measures on capital controls with both the extensive margin—when controls are active or not—and also, importantly, the intensive margin (i.e., the rates at which capital controls are set when they are active). The frequency of observations is quarterly and covers 21 EMEs over the period 1995–2014. We complement our data with other macroprudential instruments from alternative data sources. In this section, we describe the set of controls documented in our dataset, the methodology used to build it, and its coverage. For further details, we refer the reader to the online dataset’s Technical Appendix.

2.1 Definitions and Instruments

In a country’s balance of payments, international purchases and sales of financial assets are recorded in the financial account. A capital control is a policy designed to limit or redirect transactions on a country’s financial account. In terms of *de jure* capital controls, the International Monetary Fund (IMF) distinguishes between market-based and administrative restrictions. Market-based controls include price-based measures such as taxes on cross-border capital movements, unremunerated requirements on cross-border flows, and dual exchange-rate systems. Administrative controls include, for example, required prior approvals for certain capital account transactions.

In our analysis, we focus on two *de jure* price-based measures of capital controls that capture the intensive margin of these instruments: taxes and unremunerated reserve requirements on cross-border flows. In addition to these quantitative measures, we add information documenting quantitative restrictions and prohibitions as well as qualitative (or non-price-based) administrative measures.⁸

⁸Another way to classify capital controls is according to their direction. Chile, for example, regulated capital inflows during the 1990s, as did Malaysia in 1994. Controls on capital outflows, in contrast, are advocated to manage crises as they occur. Thailand imposed controls on capital outflows in 1997 as a response to the Asian financial crisis, as did Malaysia in 1998. Of course, it is often difficult for policymakers to separate neatly the effects of controls on inflows and outflows. Restrictions on outflows may deter inflows as well, since investors are generally less willing to put their money into countries that restrict their exit. We also explore the direction of flow in the dataset.

2.1.1 Capital Controls: Quantitative and Qualitative Measures

Quantitative Measures. Within the quantitative measures, we focus on two *price-based* capital controls.

1. *Unremunerated reserve requirements* (URRs). These are recorded as rates applicable to cross-border inflows. They are requirements to constitute a compulsory deposit of a non-zero fraction of the intended transaction for a legally mandated period. For this measure, we also calculate the tax equivalent cost of the URR as in [De Gregorio et al. \(2000\)](#).
2. *Tax rates* on cross-border inflows and outflows. These are compulsory contributions that are levied on transactions that imply cross-border flows and are payable to the national tax authorities. We collect this information across various types of assets, including bonds and stocks.⁹

For completeness, we include in the analysis *restrictions*. These measures account for any limit or restrictions on quantities, maturity or percentages that affect cross-border flows. We also consider *prohibitions* when there is an explicit allusion that indicates that a certain activity was not allowed at all.

Qualitative Measures. We consider two types of qualitative measures or controls. *Authorizations* are special permits that are required to perform certain flows. We also include an *Others* residual category that includes specific cases for each particular country, as detailed in the Appendix.

2.1.2 Complementing the Data: Macroprudential Measures

We complement our dataset with macroprudential measures, defined as measures directed to the domestic financial system. We expand on work by [Federico et al. \(2014\)](#) on reserve requirements to include additional countries needed to complete those in our dataset, and we include information about reserve requirements on foreign exchange deposits.

⁹This comes at a cost. Since we do not have the balance of payments data of each asset class, our analysis is silent about volumes of flows.

For additional macroprudential measures, we use the dataset in [Cerutti et al. \(2017\)](#) covering changes across several other macroprudential instruments such as capital buffer requirements of banks, concentration limits, interbank exposure, and loan-to-value caps. Note that these are considered macroprudential measures and not capital controls. Section II of the online dataset’s Technical Appendix describes in detail the list of variables studied with their respective definitions and acronyms.

2.2 Methodology

In building the dataset, we followed these steps:

1. *Textual analysis.* We implemented textual analysis on the IMF’s Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). Specifically, for URRs (which have two specific sections on the AREAER), we systematically focused on the words “*unremunerated*”, “*nonremunerated*”, “*URR*” or “*reserve*”. For taxes, the words we systematically identified were “*tax*” or “*taxable*”.
2. *Manual sorting.* From the policy measures identified in 1, we cleared any regulation that was not specific to capital controls or did not provide a quantitative measure of the intensive margin.¹⁰
3. *National sources.* For each country, We analyze legal documentation on capital control regulations (e.g., decrees and any other country-specific economic legislation) to confirm, complement, or correct information found in 1. and 2. Whenever we found discrepancies across sources, we made a case-by-case analysis. We recorded each of those cases in the online dataset’s Technical Appendix.
4. *Cross-validation.* We cross-validated the data using two previous academic works on capital controls ([Magud et al. 2018](#) and [Ghosh et al. 2018](#)). Additionally, we consulted with each of the central banks of the EMEs considered in our sample for them to

¹⁰Trade measures (e.g., tariffs) were a recurrent example of a regulation that was included in 1 but excluded in 2.

validate the policy measures recorded in the dataset.¹¹¹²

2.2.1 Coverage

We cover 21 conventional emerging market countries. Importantly, these were *not* chosen by any criteria of ex ante use of capital controls (or other macroprudential instruments). They are conventional in the sense that they have been classified as emerging economies by multilateral organizations and rating agencies (IMF, WB, MSCI, JP Morgan) or have been included in the most recent peer-reviewed studies of EMEs' business cycles (see [Caballero et al. 2019](#)).

Those countries, grouped by region, are:

- **Latin America (7)**: Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, and Peru.
- **East Asia & Pacific (7)**: China, India, Indonesia, Republic of Korea, Malaysia, Philippines, and Thailand.
- **Eastern Europe and Central Asia (5)**: Czech Republic, Hungary, Poland, Russia, and Turkey.
- **Other Regions (2)**: South Africa and Israel.

The four-step methodology described above is applied to form an unbalanced panel dataset with quarterly frequency from 1995 to 2014.¹³ It begins in 1995, as this is the year when the IMF's AREAERs first introduced detailed information about policy measures on cross-border flows, disaggregated by direction of flows and type of assets, among other characteristics. To avoid truncation, whenever a policy measure is in place at the beginning or the end of the dataset, we use national sources to extend the time series coverage so as to

¹¹More than half of the central banks we contacted responded to our inquiries. None objected to the dataset we had found. In a few cases, they complemented it with additional regulations. For [Magud et al. \(2018\)](#) and [Ghosh et al. \(2018\)](#), we made a systematic comparison and found a nearly perfect overlap of 95% of the policy measures in our dataset, conditional on the same countries, years, and types of controls.

¹²Section III in the online dataset's Technical Appendix explains in detail the general rules and criteria used for each instrument; Section IV shows how we calculated the tax equivalent of URR; Section V shows the consistency check with other dataset; and Section VI documents the cases where we found discrepancies between multilateral and national sources.

¹³Daily frequency is also partially available on some policy measures. Our analysis, however, is conducted at the quarterly frequency unless otherwise specified.

document the enactment of the control or its repeal, hence the unbalanced structure of the dataset.

There are a total of 1,712 quarterly observations recorded for URRs and 1,680 for taxes on capital flows across the 21 EMEs during the years covered. From these, 286 observations (17%) had an active capital control in the form of a URR; 378 (22.5%) had it as a tax on inflows; and 445 (26.4%) had it in the form of a tax on outflows. The online dataset’s Technical Appendix presents further descriptive statistics on the coverage of the dataset (Section VI of this document presents details regarding each country).

3 Stylized Facts

In this section, we document six stylized facts on the properties of the intensive margin of capital controls from the new dataset: (1) *use* of these instruments across countries and time; (2) *intensity* with which they have been used; (3) *frequency of adjustment*; (4) *cyclical-ity* with other macro variables; (5) *complementarity* with other macroprudential instruments; and (6) *consistency* with measures of the extensive margin of capital controls.

Fact 1. *The **use** of capital controls (price-based) has not been systematic across countries or time*

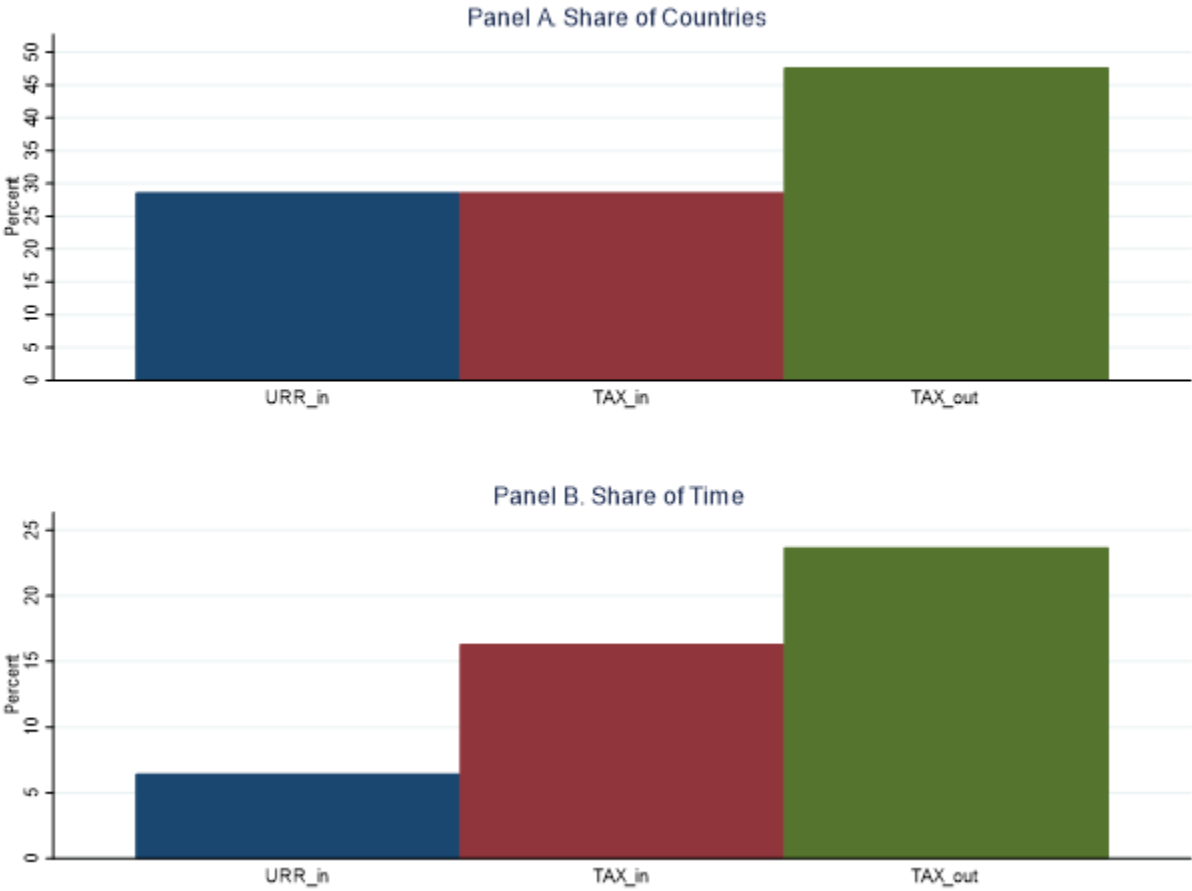
The top panel of [Figure 1](#) shows, for each instrument (horizontal axis), the share of countries that have used the two *price-based* capital controls in our dataset; that is, rates have been strictly positive (vertical axis). Out of the 21 EMEs considered in the dataset, only six countries (29%) used URRs or taxes on inflows at some point during the period covered, while ten (48%) used controls on outflows.

The bottom panel of [Figure 1](#) shows the cross-country average share of time during which each instrument was active. Their use has been limited to a small fraction of the period covered by the dataset: taxes on inflows (outflows) were above zero in less than 20% (25%) of the quarterly time series of the dataset, and URRs in less than 10%.

Additional results in the Appendix contrast these findings with the use of other macroprudential instruments such as reserve requirements in domestic and foreign currency de-

posits. More than 90% of the countries have imposed reserve requirements on accounts in domestic currency, 80% on accounts in foreign currency, and have been used 75% and 95% of the time, respectively. Marginal reserve requirements are much less pervasive, being used by 13% of the countries and less than 5% of the time.

Figure 1: Use of Capital Controls



Notes: In Panel A, the bars depict the share of countries that have used capital controls (i.e. value of the instrument is not 0), at least during one quarter of our sample. In panel B, the bars depict the share of periods in which an instrument was used. The sample was taken from 1995q1 to 2014q4; the maximum total of quarters is 80 (100%).

Fact 2. *The **intensity** with which price-based capital controls have been used displays considerable heterogeneity across countries*

The top two panels in [Figure 2](#) document the mean intensities of URRs and their tax equivalent for each country in the sample. Countries with no bars are those for which no use of capital controls was found along the intensive margin. The bottom two panels document the same information for taxes on inflows and taxes on outflows, respectively. Among the countries that did implement capital controls, there is considerable dispersion of the intensity with which capital controls were used. While URRs have ranged between 10% and 43%, with an equivalent tax rate between 0.2% to 8%, taxes on inflows have ranged between 0.3% and 20% and those on outflows have been used across more countries and more intensively, with the average tax variation ranging from 0.3% to 55%.

Other macroprudential tools, documented in the Appendix, have been employed more homogeneously across countries. For instance, reserve requirements in domestic and foreign currency deposits display variations between 5%-10% and 4%-10%, respectively.

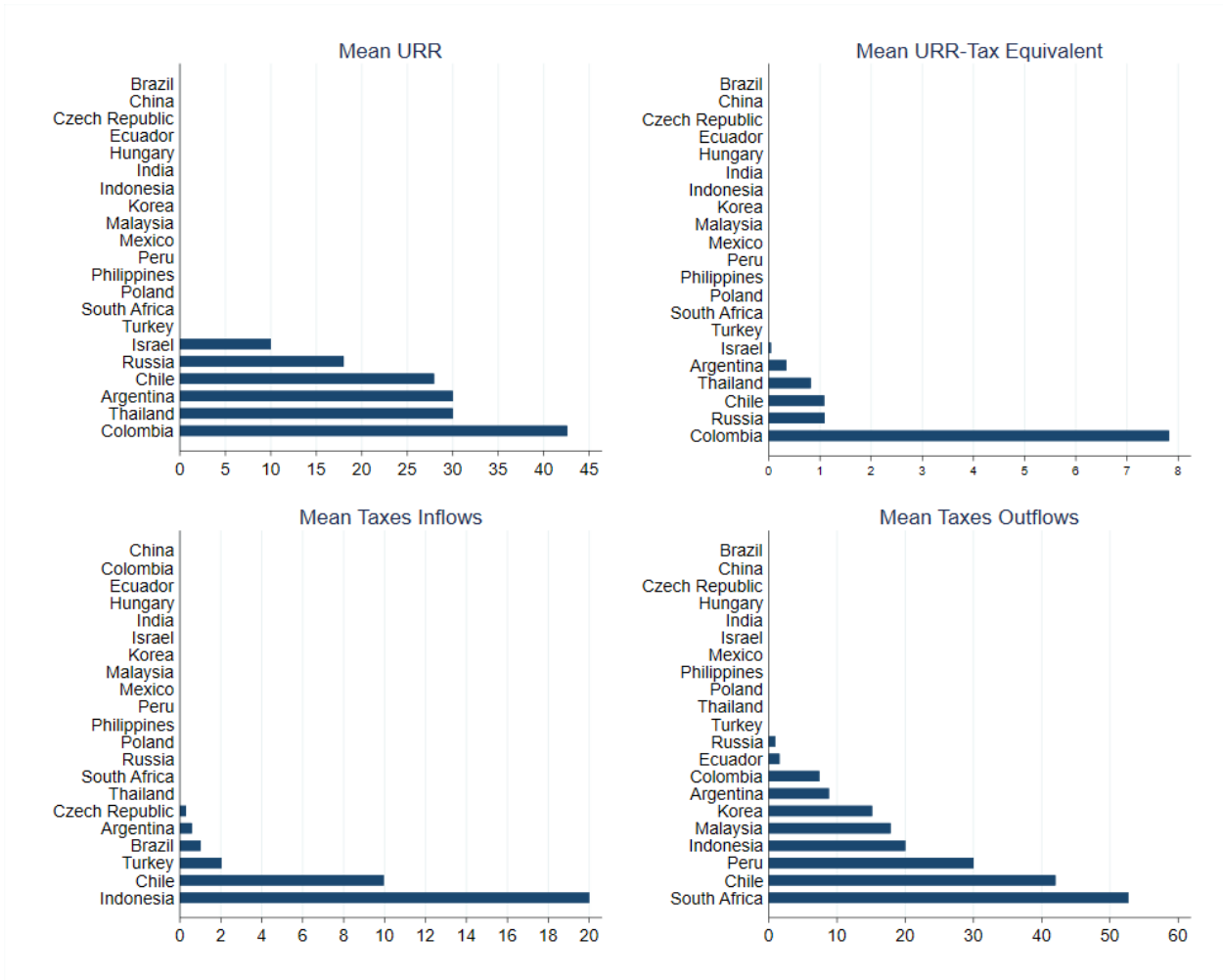
Fact 3. ***Changes** to capital controls occur infrequently; and when they do, they remain in place for long*

[Figure 3](#) presents the frequency of changes across the three instruments of capital controls in the dataset (URRs and taxes on capital inflows and outflows).¹⁴ For the three instruments, the bulk of the distribution is skewed toward the origin, implying that changes to capital controls occur infrequently, if at all. Conditional on their use, the average number of changes to capital controls (in the quarterly frequency) is small: between 4 for URRs, and 6 (4) for taxes on inflows (outflows) during the 20 years covered by our dataset.

[Figure 4](#) further documents the time series behavior of capital controls in episodes when these instruments have been forcefully used, which we define as cases when they display an increase of more than 10% from one quarter to the next, or when they are activated. The figure presents the simple averages across all episodes, denoting time index “*t*” as the moment this condition is met in each episode. The first panel shows the behavior of the three

¹⁴A change here is simply any instance when the value recorded for an instrument changes from one quarter to the next.

Figure 2: The Intensive Margin of Capital Controls

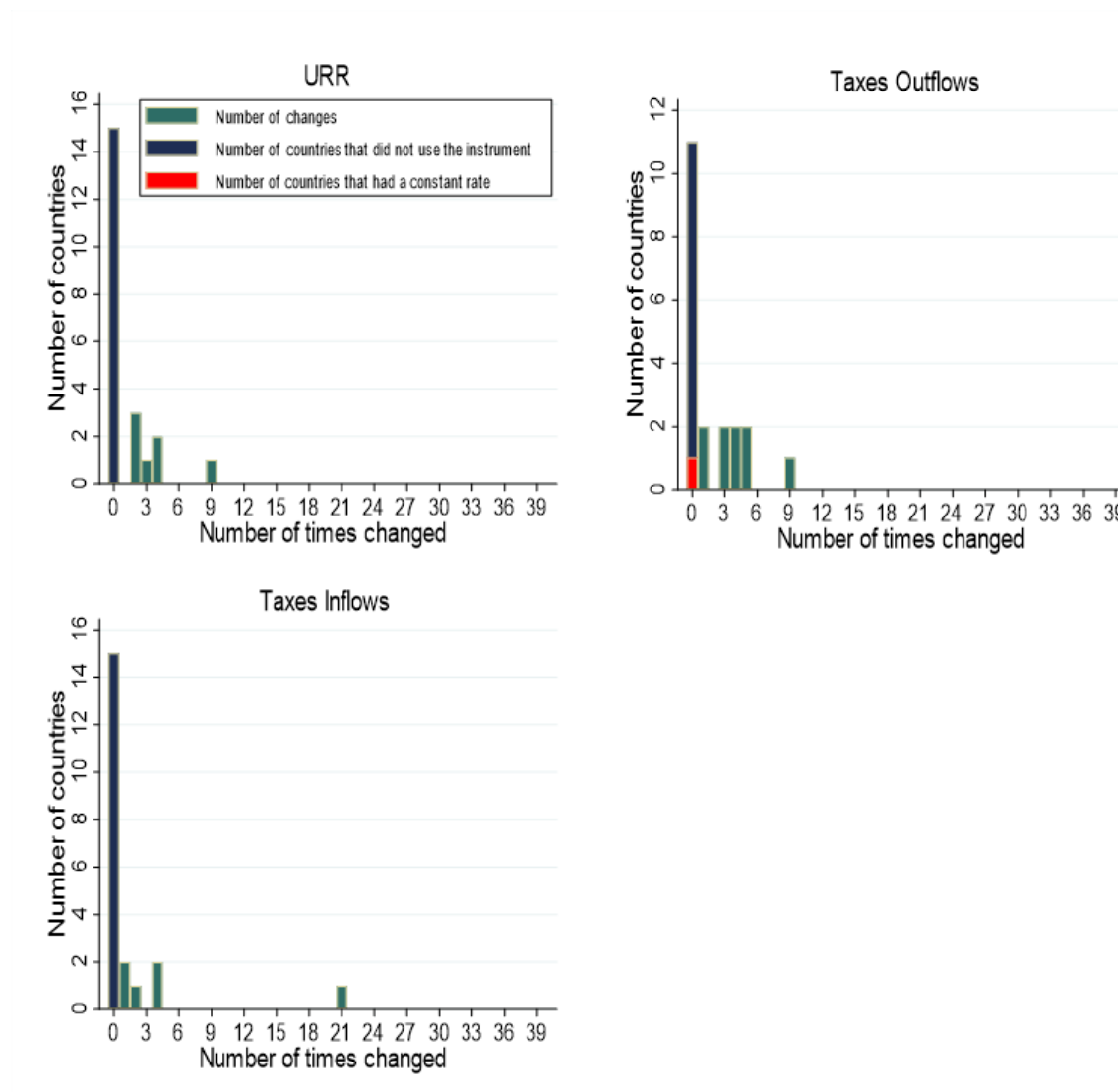


Notes: Each panel corresponds to a different instrument (URR, URR-Tax Equivalent, Taxes on Inflows, and Taxes on Outflows). The bars represent the value of the instrument in each country. Only the periods in which the instrument was active were considered. Countries with no bars are those for which the corresponding instrument was never used in the period considered.

instruments at a quarterly frequency, while the second panel shows it at an annual frequency. The evidence points to a large degree of persistence following these large movements in capital controls: episodes identified in taxes on inflows (outflows) display large increases, on average from 1% to 3% (0% to 25%); and 12 quarters later, they continue to exhibit values above 2.5% (20%). In fact, the annual frequency plot shows that, on average, these measures remain high after 7 to 8 years following the episode identified. As a result, capital controls

display very high serial autocorrelation, as documented in [Figure 5](#).¹⁵

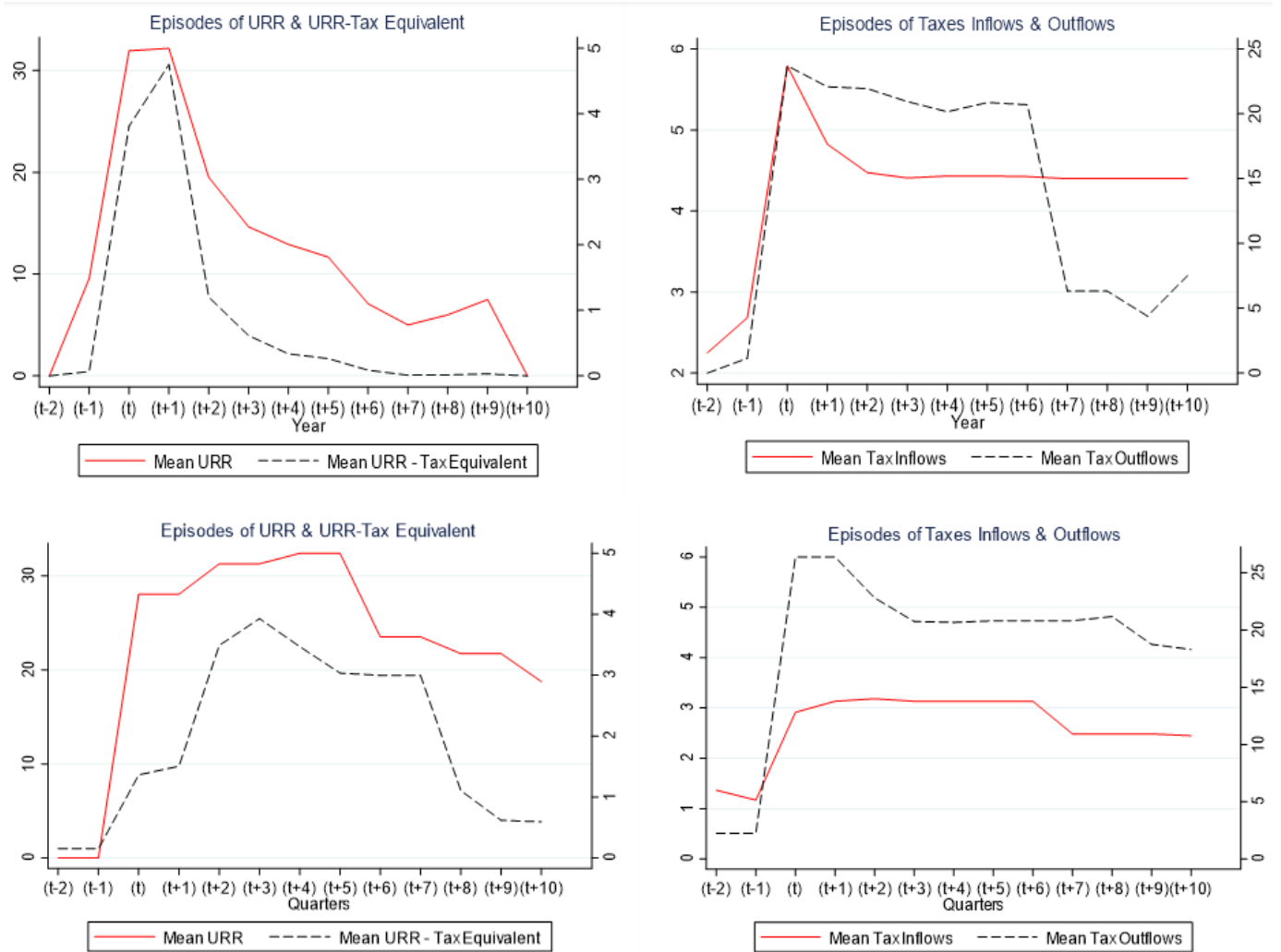
Figure 3: Frequency of Changes in Capital Controls



Notes: A change occurs when the value of an instrument in t was different than in $t - 1$. The countries that at the beginning of the sample, 1995-Q1, had the instrument turned on and did not make any changes until the end of the 2014-Q4 sample are coded in red. The countries that did not use the instrument at any time in the sample are shown in blue.

¹⁵In the Appendix, we document how the results in terms of the persistence of changes in capital controls are robust across different exchange rate regimes.

Figure 4: Episodes of Capital Controls

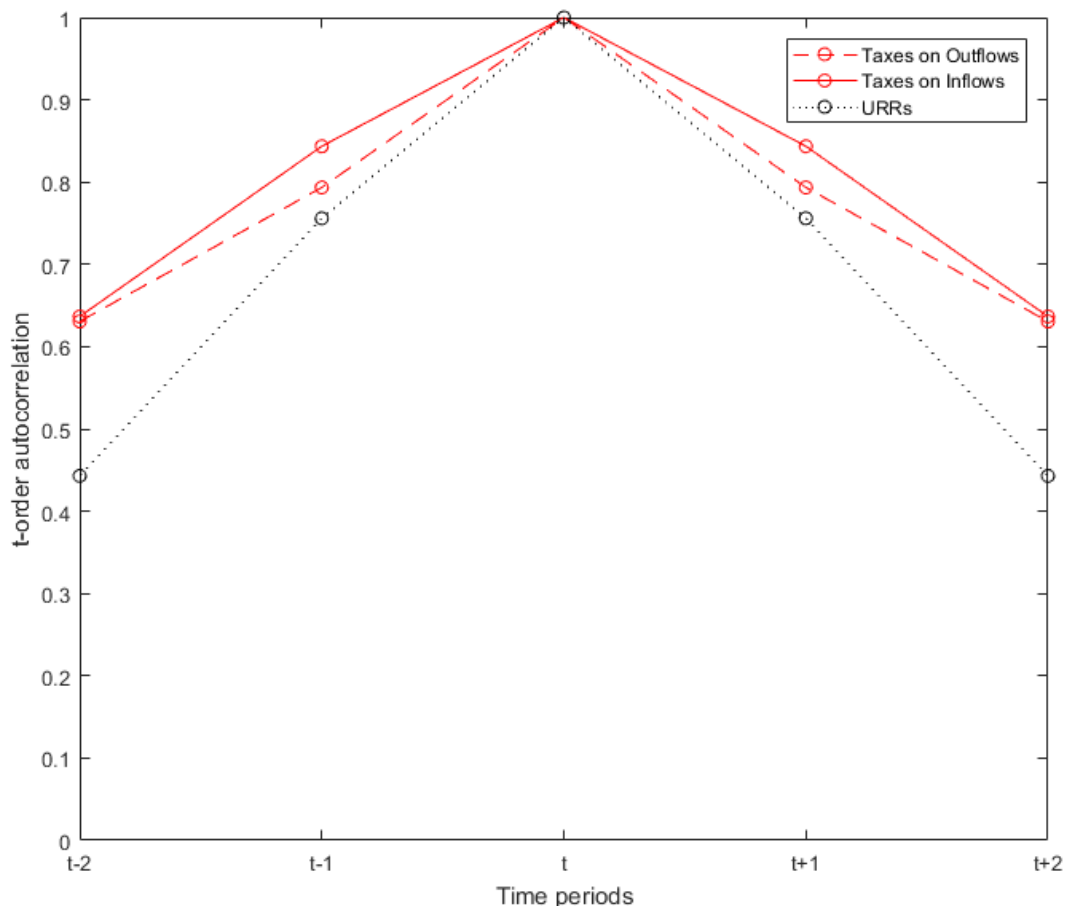


Notes: The beginning of an episode was defined when for a given policy instrument at period t , x_t , we have that: $x_t > 1.1x_{t-1}$. Then the values of each episode were averaged from $t - 2$ to $t + 10$. The first row shows episodes of activation in the controls at a quarterly frequency, and the second row shows such episodes at a yearly frequency. There are six episodes for URRs, five for taxes on inflows, and eight for taxes on outflows.

Fact 4. *The cyclicity of capital controls differs sharply across instrument*

Figure 6 documents the (demeaned) average deviation of GDP growth (right axis) around the episodes of capital controls presented in Figure 4. While URRs have been used countercyclically during episodes of large economic booms, taxes on both inflows and outflows

Figure 5: Serial Correlation of Capital Controls



Notes: The solid line represents the yearly cross-country mean autocorrelation of order $t - j$ of taxes on inflows. The dashed line represents the same variables on taxes on outflows. The dotted line corresponds to URRs.

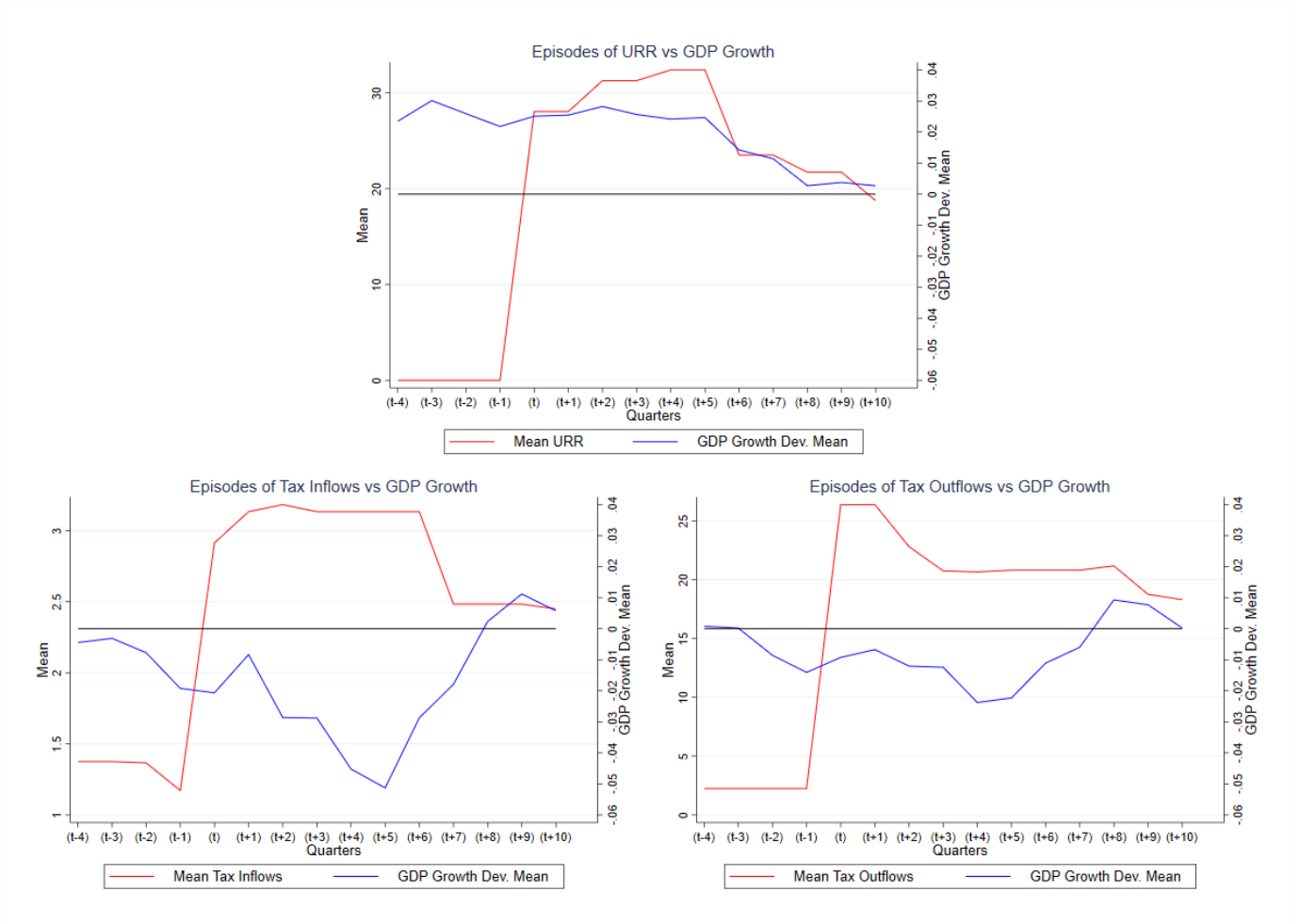
have been implemented in the contractionary phase of the GDP cycle.¹⁶

Fact 5. Complementarity in the use of capital controls and other macroprudential tools has been negligible; if anything, the two type of instruments tend to be substitutes

Figure 7 compares the evolution of domestic macroprudential instruments (right axis) around the same episodes of capital controls in Figure 4 (left axis). The index of macropru-

¹⁶The Appendix extends the results with the current account and real exchange rates instead of the GDP cycle.

Figure 6: Episodes of Capital Controls and the Business Cycle



Notes: It shows the episodes described in Figure 4 along with the cross-country mean deviation from the average GDP growth.

dential instruments that we use comes from [Cerutti et al. \(2017\)](#).¹⁷ As can be seen, capital controls do not move in tandem with the other macroprudential instruments, implying no complementarity between the two types of instruments. In fact, as the intensity in capital controls falls, the use of macroprudential instruments intensifies, signaling that, if anything, the two have been substitutes.¹⁸

¹⁷The index covers the changes across several macroprudential instruments: capital buffer requirements of banks lending mortgages and others types of loans; concentration limits; interbank exposure; loan-to-value caps; and reserve requirements in foreign and domestic currency.

¹⁸Indeed, the correlation between macroprudential indices and our measures of capital controls is relatively low: -0.05 for URRs; 0.03 for controls on inflows; and 0.45 for controls on outflows.

More formal evidence is gathered in the Appendix, where we break down the cyclical-ity in macroprudential tools between those countries that have used capital controls and those that have not (identified in Fact 2). The evidence indicates that the cyclical-ity of macroprudential instruments has been stronger in the latter group of countries relative to that in the former group, reinforcing the substitutability between the two types of instruments.

Fact 6. *Extensive measures of capital controls, which capture more non-price policy measures relative to price-based ones, display a considerable degree of stickiness*

We now explore the overlap between the intensive margin captured in the new dataset and standing measures of the extensive margin. For that purpose, we employed the dataset in [Fernández et al. \(2016\)](#), which measures the evolution of the extensive margin for several countries along a much wider array of assets, and reclassified all policy measures accounted in their dataset in terms of price-based, akin to those in our dataset, and non-priced-based, such as authorization requirements and other bureaucratic measures that do not directly affect the relative cost of cross-border flows.

[Table 1](#) summarizes the results. It documents that priced-based measures, including URR and taxes (and prohibitions, which implicitly is a tax of 100%) represent on average less than half (36%) of all instruments. Regarding the remaining 64% of measures that are non-price-based, a little less than half of those (28%) are authorization requirements and the rest are classified as other bureaucratic red tape that hinders the cross-border flow of capital.

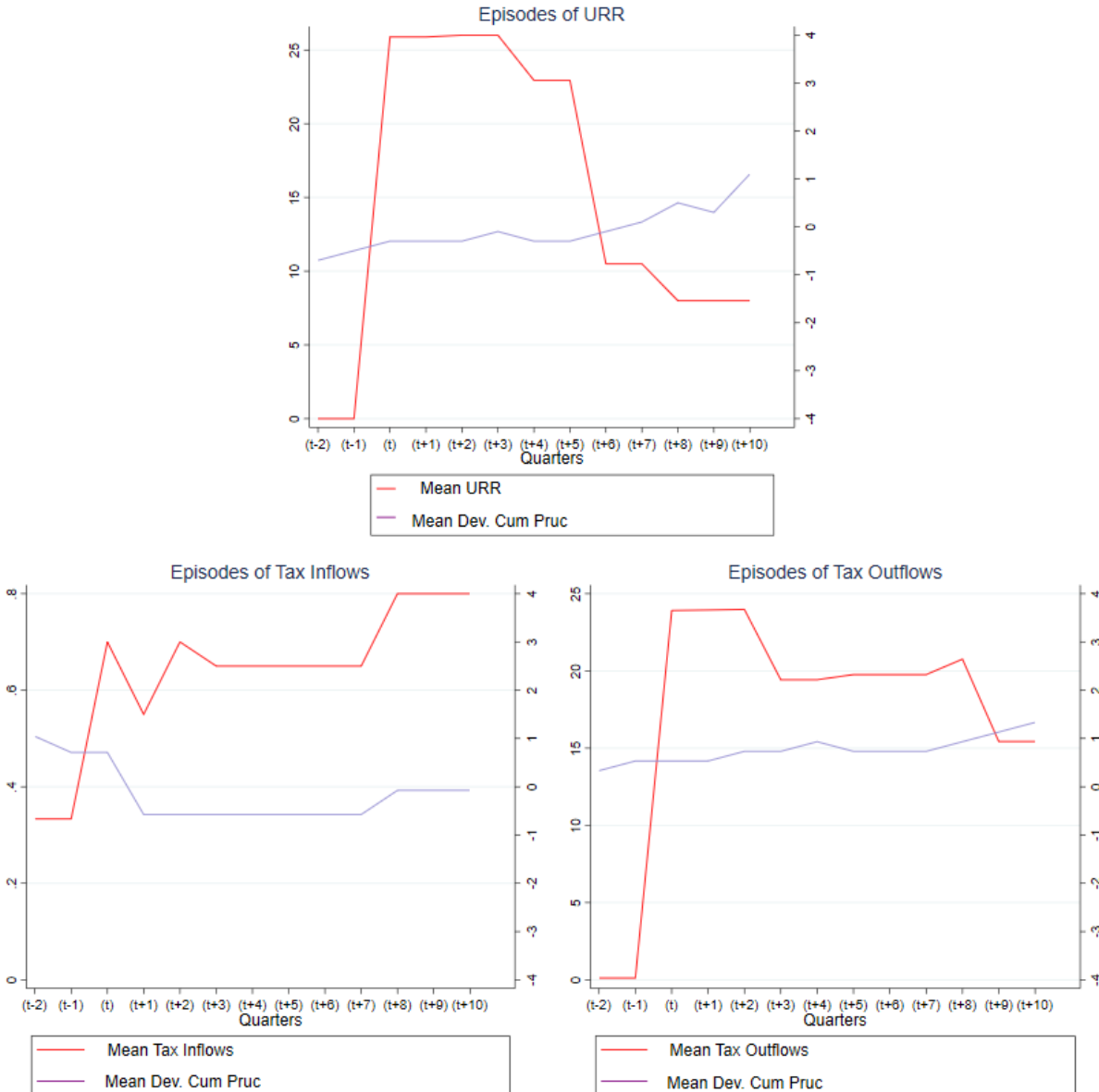
Table 1: Price-Based and Non-Price-Based Capital Controls

	Price-Based		Non-Price-Based	
	URRs - Taxes - Quant	Prohibitions	Authorizations	Others
Avg	27.7 %	8.3 %	28.4 %	35.6 %

Notes: The table shows the cross-country average of the share of the use of each instrument over the total. The first two columns of instruments correspond to price-based capital controls, and the last two to non-price-based capital controls.

A natural question is thus whether the previous stylized facts documented on the intensive margin are robust to a broader set of regulations captured in the extensive margin

Figure 7: Episodes of Capital Controls & Broader Macro Prudential Instruments

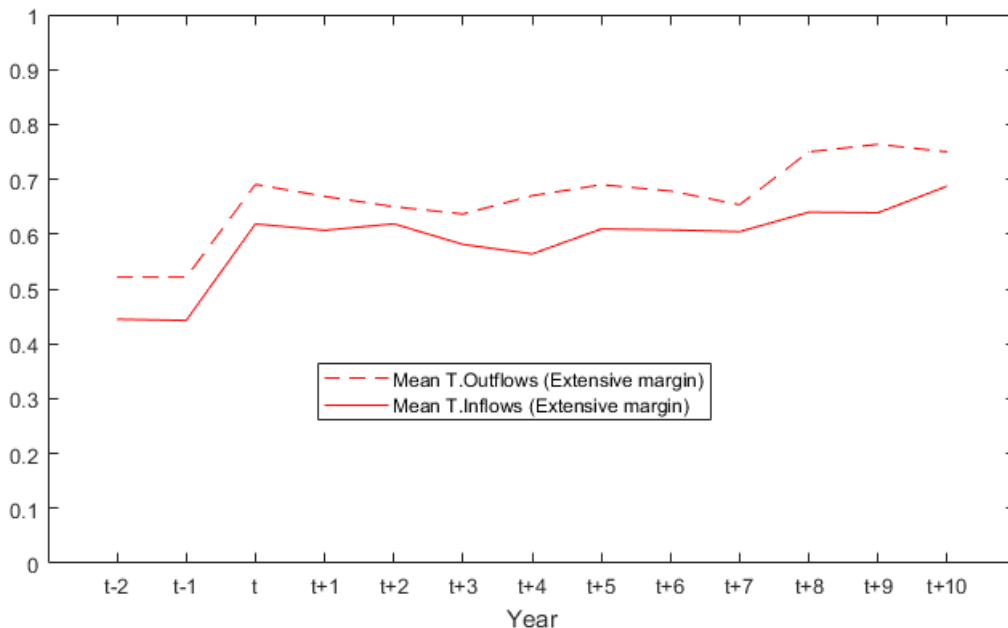


Notes: The beginning of an episode (episodes are depicted by red lines) was defined when for a given policy instrument at quarter t , x_t , we have that $x_t > 1.1x_{t-1}$. The values of each episode were then averaged from $t - 2$ to $t + 10$. The sample of episodes was restricted from 2000q1 to 2014q4 to match the time periods in the data of Cerutti et al. (2017). Deviations were plotted against the average of the accumulated Index of Macroprudential Instruments from the database of Cerutti et al. (2017). This index (purple line) includes the nine instruments on that database.

of capital controls, most of which account for non-price-based measures. Figure 8 reproduces the methodology in Figure 4 by identifying episodes of large increases in the indices of inflow

and outflow controls in [Fernández et al. \(2016\)](#) and reporting the average time series dynamics around them. Since now we are analyzing the extensive margin, the vertical axis is not a rate, as in [Figure 4](#), but rather a scale that goes from 0 (when no controls exist in either of the asset categories) and 1 (where controls exist in all categories). Results are quite robust. Indeed, neither of the two indices displays any mean reversion, and the level of controls is still higher several years after the initial increase in year “ t .”

Figure 8: Episodes of Capital Controls: The Extensive Margin



Notes: Here we use the data for the extensive margin of capital controls in [Fernandez et al. \(2016\)](#). The beginning of an episode was defined when for a given policy instrument at year t , x_t , we have that: $x_t > (1 + stdev(x_{t-1}))$. The values of each episode were then averaged from $t - 2$ to $t + 10$.

Taken together, the stylized facts presented in this section point to a large degree of “stickiness” in capital controls, which materializes in countries not relying on these tools systematically along the business cycle. When countries have relied on these instruments, we observe that such policy tools have displayed little mean reversion and, hence, high persistence over time. This is consistent with broader definitions of capital controls that include more qualitative/administrative controls in measures of the extensive margin of these policy tools. Lastly, such stickiness also appears to manifest in these tools being substitutes

with alternative macroprudential measures. It is thus pertinent to explore whether current state-of-the-art models of optimal capital controls can account for this stickiness, which we undertake in the next section.

4 Models of Capital Controls

4.1 Baseline Model

In this section, we present our baseline model of optimal capital controls. Our starting point is a small open economy with collateral constraints posited in [Mendoza \(2002\)](#), which gives rise to pecuniary externalities that, in turn, are widely viewed as a benchmark theory for rationalizing the use of capital controls. Our setup is cast in an infinite dynamic stochastic environment as in [Mendoza and Smith \(2006\)](#), [Uribe \(2006\)](#), [Bianchi \(2011\)](#), [Benigno et al. \(2011\)](#), [Korinek \(2018\)](#), [Bianchi and Mendoza \(2018\)](#), [Schmitt-Grohé and Uribe \(2017\)](#), and [Schmitt-Grohé and Uribe \(2020\)](#), among others.

We briefly present the unregulated economy case, the Ramsey problem and the optimal capital control derived from it. We further describe that this optimal policy is not designed to account for the stickiness documented in the data. The next section presents an extension to this setup, which improves the baseline model along this dimension.

4.1.1 The Unregulated Economy

The economy has a continuum of identical, infinitely lived households of mass one, with time-separable preferences of the form:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(c_t) \tag{1}$$

The utility function has a standard CRRA form: $U(c_t) = \frac{c_t^{1-\sigma}-1}{1-\sigma}$, where $\sigma > 0$ is the constant risk aversion parameter, $\beta \in (0, 1)$ denotes the subjective discount factor, and \mathbb{E}_0 is the expectations operator at period $t = 0$.

Each period's aggregate consumption, c_t , is a composite of tradable (c_t^T) and non-tradable goods (c_t^N): $c_t = A(c_t^T, c_t^N)$, $\forall t \in [0, \infty)$. The aggregator follows an Armington-type

CES form: $A(c_t^T, c_t^N) = [a(c_t^T)^{1-1/\zeta} + (1-a)(c_t^N)^{1-1/\zeta}]^{1/(1-1/\zeta)}$, where parameters a and ζ are, respectively, the weight of tradables in the CES aggregator and the intratemporal elasticity of substitution between tradable and non-tradable goods.

Households have access to a one-period, internationally traded bond, denominated in terms of tradable goods. The return of these bonds between periods t and $t + 1$ is the exogenous risk-free rate r_t . The households' sequential budget constraint is:

$$c_t^T + p_t c_t^N + d_t = y_t^T + p_t y_t^N + \frac{d_{t+1}}{1 + r_t} \quad (2)$$

where d_{t+1} represents the amount of debt incurred in period t and due in period $t + 1$ and p_t is the relative price of non-tradables in terms of tradables. Variables y_t^T and y_t^N represent the exogenous endowments processes for tradable and non-tradable goods, respectively, and are the only source of uncertainty. Notice that debt is equivalent to negative holdings of the aforementioned internationally traded bond.

The (flow) collateral constraint is given by:

$$d_{t+1} \leq \kappa(y_t^T + p_t y_t^N) \quad (3)$$

with $\kappa > 0$ being the fraction of income that can be pledged as collateral, which determines the upper bound of debt that households can take on during the current period and (completely) pay in the next one. This constraint is the key to the pecuniary externality: Due to the atomistic nature of households, they take p_t as given, although it is endogenously determined in equilibrium. In other words, households do not internalize that their collective absorption of tradables may increase the value of collateral through increases in the relative price of non-tradables. This leads households to borrow more than they would have had they internalized this externality. The literature refers to this as overborrowing.¹⁹

Households choose a set of processes $\{c_t^T, c_t^N, c_t, d_{t+1}\}_{t=0}^{\infty}$ to maximize (1) subject to (2)

¹⁹Schmitt-Grohé and Uribe (2020) show that, under certain parametrizations, multiple equilibrium could lead to self-fulfilling financial crisis and underborrowing. As we will explain in the Calibration section, we abstract from this scenario by following to a large extent the calibration in Bianchi (2011), which does not exhibit underborrowing. We leave for future research the study of the interaction between (S, s) costs in this work with the possibility of underborrowing-type dynamics.

and (3) given the initial debt position d_0 ²⁰.

4.1.2 The Ramsey Planner

The Ramsey planner internalizes the effects that households' decisions have over the relative price, p_t . Thus, by replacing p_t from the first-order conditions of the unregulated economy (see Appendix), the recursive planner's problem in this economy is to choose c^T and d' such that²¹:

$$v(y^T, r, d) = \max\{U(A(c_t^T, c_t^N)) + \beta E[v(y^{T'}, r', d)']\} \quad (4)$$

Subject to:

$$c^T + d' = y^T + \frac{d'}{1+r} \quad (5)$$

$$d' \leq \kappa \left[y^T + \frac{1-a}{a} \left(\frac{c^T}{y^N} \right)^{1/\zeta} y^N \right] \quad (6)$$

Since the planner internalizes the effect that current borrowing has over the collateral constraint in future periods, she borrows on average less than the household, leading to a lower frequency of financial crises—defined here as episodes where the constraint binds—and higher welfare. As an application of the second welfare theorem, there exists a capital control tax (i.e., a tax on debt) that makes households as well off as those living under the Ramsey planner, to which we turn next.

4.1.3 Optimal Capital Control Tax

With the introduction of a capital control tax, τ , the new budget constraints on households and the government become, in recursive format, respectively:

$$\tau \frac{d'}{1+r} = l \quad (7)$$

²⁰The Appendix contains a full derivation of the equilibrium in this economy.

²¹Henceforth, we use a recursive notation where prime variables denote the next period and the rest the current period.

and

$$c^T + pc^N + d = y^T + py^N + (1 - \tau) \frac{d'}{1 + r} + l, \quad (8)$$

where l is a lump-sum transfer from the government to the household.

As derived in [Bianchi \(2011\)](#), combining the equilibrium conditions of the unregulated and Ramsey economies yields the optimal capital control tax:

$$\tau^* = 1 - \frac{E_t \lambda^{R'}}{E_t \lambda^{R'} (1 - \mu^{R'} \Psi')}, \quad (9)$$

where $\mu^{R'}$ is the Lagrange multiplier associated with the collateral constraint and $\Psi = \kappa \frac{1-a}{a} \frac{1}{\zeta} \left(\frac{c^T}{y^N} \right)^{1/\zeta - 1}$.²²

The optimal tax depicted in [Equation 9](#) provides important insights as to the use of this instrument within this setup. As can be seen, as long as the probability of a crisis is not zero, the optimal policy will call for a capital control. Moreover, any change in the probability, be it small or large, will trigger a change in the intensity with which this instrument is deployed, implying that controls will actively be called upon along the business cycle. We therefore conjecture that the baseline model is not designed to properly account for the stickiness in the data documented above—which we will verify in the quantitative analysis below. This disconnect between the baseline model and the stylized facts regarding the dynamic behavior of capital controls suggests that a friction is needed in the ability with which this instrument is employed. We next postulate an extension to the baseline model that incorporates such a friction.

4.2 Extended Model with (S, s) Costs

This section extends the baseline setup by introducing a friction that, we conjecture, has the ability to bring the model closer to the data. The friction that we postulate is a cost of imposing and further adjusting capital controls along the intensive margin. This cost has an (S, s) structure, which has the ability to induce an inaction region that resembles that observed in the data.

²²In the Appendix, we provide the first-order conditions in the Ramsey economy, as well as the derivation of the optimal capital control's tax.

There is a long tradition in economics using (S, s) -type costs to explain inertia in durable goods consumption, investment, and money demand and, perhaps most notably, in providing a rationale for price stickiness (Caplin and Leahy, 2010). We therefore borrow this rationalization of stickiness in economic decision-making and extend it to the choice of imposing capital controls, hence the title of our work.

In general terms, with an (S, s) -type framework, agents remain in an inaction region until their losses generated by this choice surpass a particular threshold, which then triggers an adjustment to a latent optimal value for their state. The environment that we postulate is similar but adapted to the Ramsey planner, who internalizes a (reduced-form) cost in terms of utility when capital controls are adjusted. The planner is thus confronted at every moment with the choice between setting the level of capital controls to their optimal level and hence paying the cost, or not adjusting the instrument and not incurring such cost.

In the next section, we explore the validity of our conjecture by calibrating the model, including the size of the (S, s) cost, and assess the quantitative performance of the extended model.

While reduced form, we believe the (S, s) cost structure captures deeper trade-offs that policymakers face when confronted by the choice of using capital controls that are absent in the baseline model. In the final section, we discuss the possible deep causes that could give rise to such costs and relate them to the literature.²³

4.2.1 Setup

The inclusion of an (S, s) cost into the Ramsey planner problem implies that she now has to choose between two value functions, one associated with adjusting the value of the capital control tax and the other associated with not adjusting it. Formally, the recursive formulation of the planner's problem in this environment becomes:

²³It is natural to ask how other cost structures different from the (S, s) form would perform. We explore this possibility in the Appendix by assuming that, instead of an (S, s) structure, there is a continuous convex or concave cost of adjustment $C(\tau_t)$ paid by the government in terms of tradable goods. Neither of the two costs features the highly non-linear feature of the (S, s) structure. Our main takeaway from this exercise is that hardly any other type of reduced-form cost structure different than an (S, s) setup is able to provide a rationale that explains the observed stickiness in capital controls.

$$V(y^T, r, d, \tau) = \text{Max}(V^A(y^T, r, d, \tau), V^{NA}(y^T, r, d, \tau)) \quad (10)$$

subject to:

$$c^T + d = y^T + \frac{d'}{1+r}, \quad (11)$$

$$d' \leq \kappa \left[y^T + \frac{1-a}{a} \left(\frac{c^T}{y^N} \right)^{1/\zeta} y^N \right], \quad (12)$$

where we define V^A as the value of adjusting the capital control tax from its initial value to the one that is optimal in the absence of (S, s) costs, τ^* . This adjustment carries out a fixed (utility) cost K :

$$V^A(y^T, r, d, \tau) = [U(c^T(\tau^*)) - K] + \beta E[\text{Max}(V^A(y'^T, r', d', \tau'), V^{NA}(y'^T, r', d', \tau'))], \quad (13)$$

and V^{NA} captures the value of not adjusting the instrument and hence not incurring the cost K :

$$V^{NA}(y^T, r, d, \tau) = U(c^T(\tau)) + \beta E[\text{Max}(V^A(y'^T, r', d', \tau'), V^{NA}(y'^T, r', d', \tau'))] \quad (14)$$

Note that, under this new environment, the previous period's capital control tax becomes a state variable. An inaction region for this instrument exists for states when $V^{NA} > V^A$, therefore giving the model a better chance to account for the stickiness observed in the empirical counterparts of capital controls.

Note also that the extended model encompasses, as two extreme cases, the unregulated economy and the Ramsey planner cases described in the previous section. On one hand, the case when $K = 0$ is equivalent to the Ramsey planner's world in the baseline model and yields the largest gains in terms of welfare. On the other hand, [Equation 13](#) implies that there exists a sufficiently large K such that the planner never adjusts τ . This case is equivalent to the decentralized economy in the baseline model and yields the lowest possible welfare.

As a result, welfare in the extended model is bounded between the decentralized case in the baseline model and the Ramsey planner without (S, s) costs.

4.2.2 Solution

The lack of a closed-form solution in both baseline and extended models requires us to solve the models using global methods in order to conduct a quantitative analysis of them. In the unregulated economy of the baseline model, we use policy function iteration procedures; in the Ramsey planner version, since there is no pecuniary externality, we use standard value function iteration procedures. These methods allow us to derive numerically the policy functions that map states—the two endowment processes and debt—into decision variables with which we later conduct simulations in the quantitative analysis presented in the next section (see also the online database’s Technical Appendix for further details of the models).

The solution method of the (S, s) model first requires us to solve for the baseline Ramsey economy to obtain the policy functions of the control variables, including τ^* . Then, given the stochastic process of endowments, we simulate 1 million periods and obtain τ_t^* for each period t (recall that each period corresponds to a state of the pair $\{y_t^T, y_t^N\}$ and d_t). Using the same simulated endowments, we simulate the decentralized (but regulated) economy for all of the (1 million) values of τ_t^* obtained in the previous step. By doing this, we obtain all possible combinations of policy functions, given a simulated process for the endowments, for each state of the economy and for each different τ^* and its correspondent indirect utility at each period. This process facilitates the solution of the Ramsey planner problem with (S, s) costs. Once this is done, in the (S, s) model we need to keep track of the state (τ_{t-1}) and, without loss of generality, assume that the initial value of the tax is 0 ($\tau_0 = 0$). Then for each period in the simulation, given a calibrated value of K , we obtain V_t^A and V_t^{NA} . In case the former is greater than the latter, we set $\tau_t = \tau_t^*$, otherwise $\tau_t = \tau_{t-1}$.

5 Quantitative Analysis

In this section, we run a quantitative analysis of the extended model presented above. We begin with a simple illustration of the effects that varying levels of (S, s) costs have on the equilibrium dynamics of the extended model using a standard calibration from the literature. Next we undertake a formal, more comprehensive exercise where we calibrate the extended model for each of the 21 EMEs in the dataset and assess the performance of the model in matching the stylized facts from Section 3.

5.1 Illustrating the Effects of (S, s) Costs

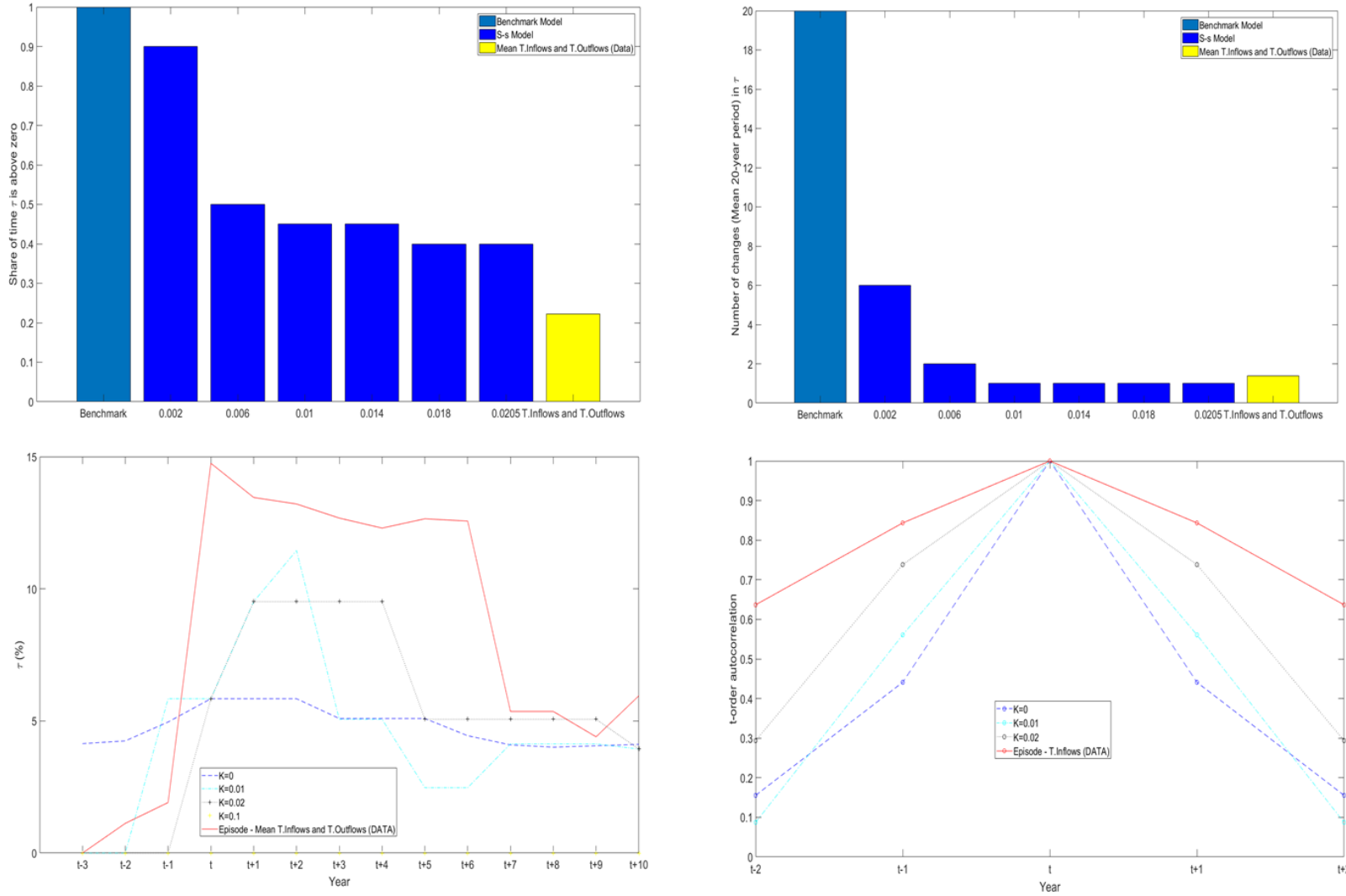
To illustrate the effects of varying levels of (S, s) costs in the extended model, we use the same calibration as in [Bianchi \(2011\)](#) and [Schmitt-Grohé and Uribe \(2017\)](#) and document the results with alternative values for K . When assessing the results, we pay particular attention to the dimensions directly linked to the stickiness in capital controls uncovered in the stylized facts in Section 3.

Employing the policy functions obtained in the solution of the models, we simulate the model for 1 million periods (years in the calibration) and report the results of the simulation in [Figure 9](#).²⁴ The upper left panel shows the average share of time during which the optimal tax is greater than zero. The first bar (light blue) corresponds to the Ramsey economy in the baseline model ($K = 0$); the last bar (yellow) corresponds to the average share of time with activated taxes on inflows and outflows in the data ([Figure 1](#)). The bars in between (dark blue) show the results in the extended model for arbitrarily different values of K . While the baseline model implies that capital controls ought to be active in every period, even relatively small values of (S, s) costs give the extended model the ability to reduce the share of time in which the tax is active, with higher (S, s) costs further reducing this share, bringing it more in line with the data.

The upper right plot in [Figure 9](#) documents the effects of K over the average frequency of changes in the tax for every (nonconsecutive) 20 years in the simulation, the same duration

²⁴More precisely, conditional on an initial debt level and simulated series for the two endowment processes, we use the policy functions obtained in the solution to derive time series for the choice variables in the model (consumption, next-period debt) for the range of years considered in the simulation.

Figure 9: (S, s) Costs in Capital Controls: A Quantitative Illustration



Notes: The figure shows the effects of higher (S, s) costs over the relevant moments regarding stickiness in capital controls. The first two figures in the upper row show in the blue bars for different values of K , respectively, the share of time with a positive capital control tax and the number of changes in it. The yellow bars correspond to the cross-country average between the tax on inflows and the tax on outflows. The two figures in the lower row show for different values of K , respectively, the episodes of activation in the controls and their serial autocorrelation. The red lines correspond to the cross-country averages for the mean between taxes on inflows and outflows.

we observe in the data. While the baseline model predicts a very active use of the policy instrument (i.e., 20 changes in each of the 20 years), thereby validating our earlier conjecture that the baseline model would fail in generating stickiness in capital controls, the extended model features a much lower frequency of changes, ranging from 6 to 1, as the (S, s) costs

increase, which is more in line with the empirical moment documented earlier. In other words, (S, s) costs go a long way toward giving the model the chance to reproduce the stickiness in the data of capital controls.

The lower left panel reproduces episodes of a forceful use of capital controls in the simulated data, akin to those found in the dataset and presented in [Figure 4](#). The results of the simulation document a strong non-linearity in the behavior of capital controls in the (S, s) model as K increases. For values of K lower than a certain threshold, episodes of activation of this tool resemble those in the data: the tax begins the episode at 0% (or close to that value) and forcefully increases above 10%. However, for values of K above that threshold, (S, s) costs are so high that capital controls do not activate, which is also reminiscent of the stylized facts presented above in that capital controls have not been used by several of the countries considered.

Lastly, the lower right panel documents the effects of varying levels of (S, s) costs on the serial autocorrelation of capital controls of one and two years. It illustrates how higher levels of K help increase the autocorrelations of the tax, bringing the simulated moments closer to the high values in the data.

5.2 Calibration

While the results in the previous section are useful for illustrating the quantitative effects of alternative (S, s) costs, a more formal calibration of these costs is needed in order to assess their empirical relevance. We now undertake this task by calibrating the extended model to each of the 21 EMEs in the dataset.

Our calibration strategy is summarized in [Table 2](#). It involves fixing a subset of the parameters equally across countries and then having a country-specific calibration for the remaining subset. When setting the first subset of parameters equally across countries, we follow the literature once more: (1) the inverse of the elasticity of substitution (σ) is set equal to 2; (2) the discount factor (β) is set to 0.91; (3) the annual real interest rate (r) is set to 4%; (4) the intratemporal elasticity of substitution (ζ) is calibrated to 0.83; and (5) the share of tradables in the CES aggregator (a) is set at 0.31.

The second subset of parameters that we calibrate on a country-by-country basis com-

Table 2: Baseline Calibration

Parameter	Value	Description
Mean κ baseline	0.3131	Parameter of collateral constraint
Mean K baseline	0	S-s cost of policymaking
Mean κ S-s	0.3257	Parameter of collateral constraint
Mean K S-s	0.0102	S-s cost of policymaking
σ	2	Inverse of intertemporal elast. of subst.
β	0.91	Subjective discount factor
r	0.04	Annual interest rate
ζ	0.83	Intratemporal elast. of subst.
a	0.31	Weight on tradables in CES aggregator
Targeted Moments		
	Frequency of Crisis	Number of Changes in τ
Data	18.8	1.4
Baseline Model (Mean)	18.36	13.88
S-s Model (Mean)	19.62	1.64

Notes: The second and third rows in the upper panel of the table show, respectively, the cross-country mean values of κ and K calibrated in the baseline model (the latter is zero by definition). The third and fourth rows show, respectively, the same two cross-country mean parameters calibrated in the (S, s) model. The rest of the parameters are the same as in [Bianchi \(2011\)](#). The lower panel of the table shows in the row for Data the two targeted moments used to calibrated κ and K in the (S, s) model. The last two rows show the cross-country means for two two moments generated by both the baseline model and the (S, s) model.

prises the two endowment processes for tradable and non-tradable income $\{y^T ; y^N\}$ that constitute the driving forces of the model and the parameters that govern the strength of the collateral constraint (κ) and the stickiness in capital controls (K). Regarding $\{y^T ; y^N\}$, we build tradable and non-tradable time series for each country from World Development Indicators.²⁵ As [Schmitt-Grohé and Uribe \(2017\)](#), we estimate a 2-variable vector autoregression for both variables, and discretize the process into a 4-state Markov chain.

Our calibration strategy for κ and K selects values for these two parameters such that the distance between model and data along two key moments is minimized: the frequency of adjustment in the intensive margin of capital controls from the new dataset, and the frequency of occurrence of financial crises. The rationale for this strategy is as follows. On the one hand, as we illustrated in the previous section, the frequency of changes in capital controls can be informative about the extent to which (S, s) costs (K) are relevant.

²⁵We followed [Schmitt-Grohé and Uribe \(2017\)](#) and defined y^T as the sum of manufacturing and agriculture, while y^N was the residual from subtracting y^T from total GDP.

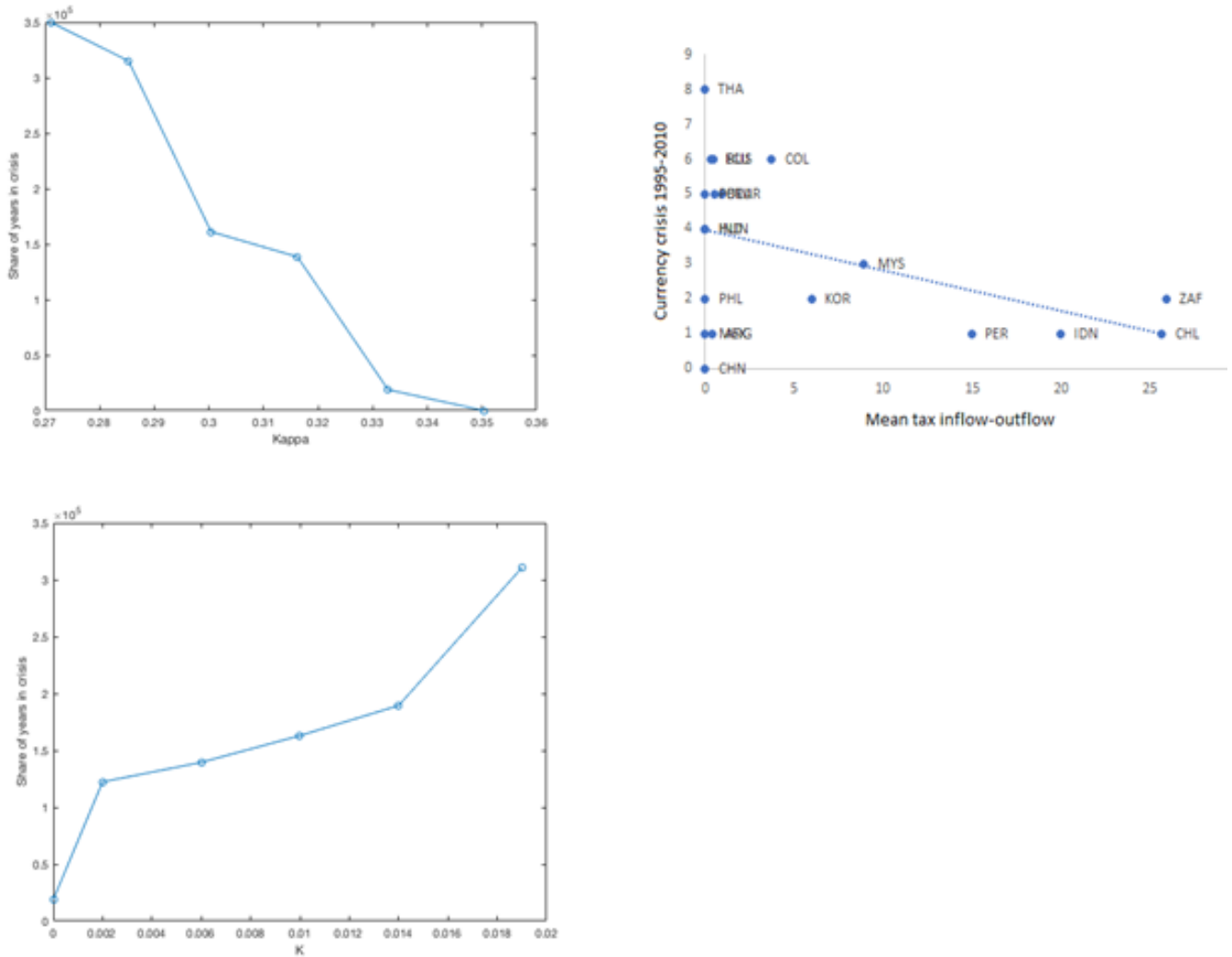
This is akin to the way in which the literature on price stickiness has pinned down the strength of menu costs (a form of (S, s) costs) by using the frequency of price adjustments in the data (Golosov and Lucas 2007; Midrigan 2010). On the other hand, the frequency of financial crises in the data can provide information regarding κ . Indeed, higher values of this parameter will imply, *ceteris paribus*, a less restrictive collateral constraint and therefore fewer states where the constraint binds (a financial crisis in the model). For instance, Bianchi (2011) pinned down κ in his calibrated model for Argentina in order to match the frequency of crises in this country.²⁶

Figure 10 further validates our calibration strategy for these two parameters. The panels document how, in the model, both κ and K relate to the frequency of crisis, defined as the share of time that the constraint binds in our simulations. Other things being equal, a higher κ yields a lower frequency of crisis (upper left panel). Likewise, lower values of K yield a lower share of years in crisis as capital controls can be deployed with more flexibility, thereby allowing the economy to be more insulated against crises (lower left panel). This warrants our choice of the two moments to jointly pin down both parameters.

The upper right panel in Figure 10 presents the relationship between our estimates of intensity in capital controls from the new dataset and the empirical estimates for the incidence of financial crises that we use in our calibration taken from Reinhart (2010). While this work provides estimates for the incidence of a variety of crises on a panel of countries, we focus on their measure of currency crisis (i.e., large depreciations), which we believe is closest to the kind of financial crises in the extended model, since episodes when the financial constraint binds are accompanied by large movements in the relative price of non-tradables. There are two things worth noting in the scatter plot. First, there is a negative and statistically significant correlation between the intensity of controls and the incidence of crises. Second, and perhaps more important for the relevance of (S, s) costs, virtually all countries that did not make use of the intensive margin of capital controls (i.e., those on top of the vertical axis of the plot) still exhibit a relatively high incidence of currency

²⁶Schmitt-Grohé and Uribe (2020) make a case for multiple equilibrium in this class of models, where instead of overborrowing, the decentralized economy could display underborrowing (i.e., the central planner borrows more than private agents). Specifically, for $d = d_0 = \bar{d}$, they show that there is multiple equilibrium with underborrowing when $S(\bar{d}; \bar{d}) \equiv \kappa \left(\frac{1-a}{a}\right) \frac{1}{1+r} \frac{1}{\zeta} (y^T + \frac{\bar{d}}{1+r} - \bar{d})^{1/\zeta-1} > 1$. This condition is not met in the calibration of any of our countries.

Figure 10: Calibrating (S, s) Costs



Notes: The first figure shows how a higher κ in the collateral constraint leads to, other things being equal, lower frequency of crisis (measured as share of years in crisis on the vertical axis). The second figure (first row) shows the mean capital control taxes on inflows and outflows (horizontal axis) for each country in our sample, compared to the number of currency crisis during the period 1995–2010 taken from Reinhart (2010). The last figure shows how a higher (S, s) cost of policy-making K leads to, other things equal, higher frequency of crisis (measured as share of years in crisis on the vertical axis).

crises. It is therefore plausible to argue that, for those countries, an additional friction may have been present that prevented them from using capital controls despite the occurrence of crises, which would be captured in our (S, s) cost.²⁷

²⁷There are three countries/exceptions to this claim. Two of them—Israel and the Czech Republic, which are included in our dataset—are not in the scatter plot as Reinhart (2010) does not provide data of the incidence of crises in these two countries. The third, China, is the only country that does not have a

Table 2 presents the average values for K and κ across the 21 EMEs in the dataset, as well as the performance of the extended model along the two targeted moments. The Appendix contains the country-by-country results. The table also presents the results of calibrating the baseline model with no (S, s) costs and its performance along the same two moments. In the latter case, the mean value of κ is 0.31 and the frequency of crisis is 18.4%, similar to the empirical counterpart of 18.8%. However, the baseline model predicts a very active use of capital controls by implying that such instruments change, on average, 13.8 times for every 20 years simulated. This is by an order of magnitude at odds with the data, where on average, controls are only changed 1.4 times for every 20 years. In contrast, in the extended model, the average κ is 0.33 and the mean value of (S, s) costs (K) is 0.01. This delivers a much better fit in terms of the number of changes in capital controls delivered by the model (1.6 times every 20 years) without a cost in terms of the performance of the model when accounting for the frequency of crisis (19.6%).

5.3 Results

We assess the performance of the extended model in matching more dimensions in the data that were not directly targeted in the calibration and that relate to the aforementioned stickiness of capital controls. For comparison, we also present the results of the baseline model.²⁸

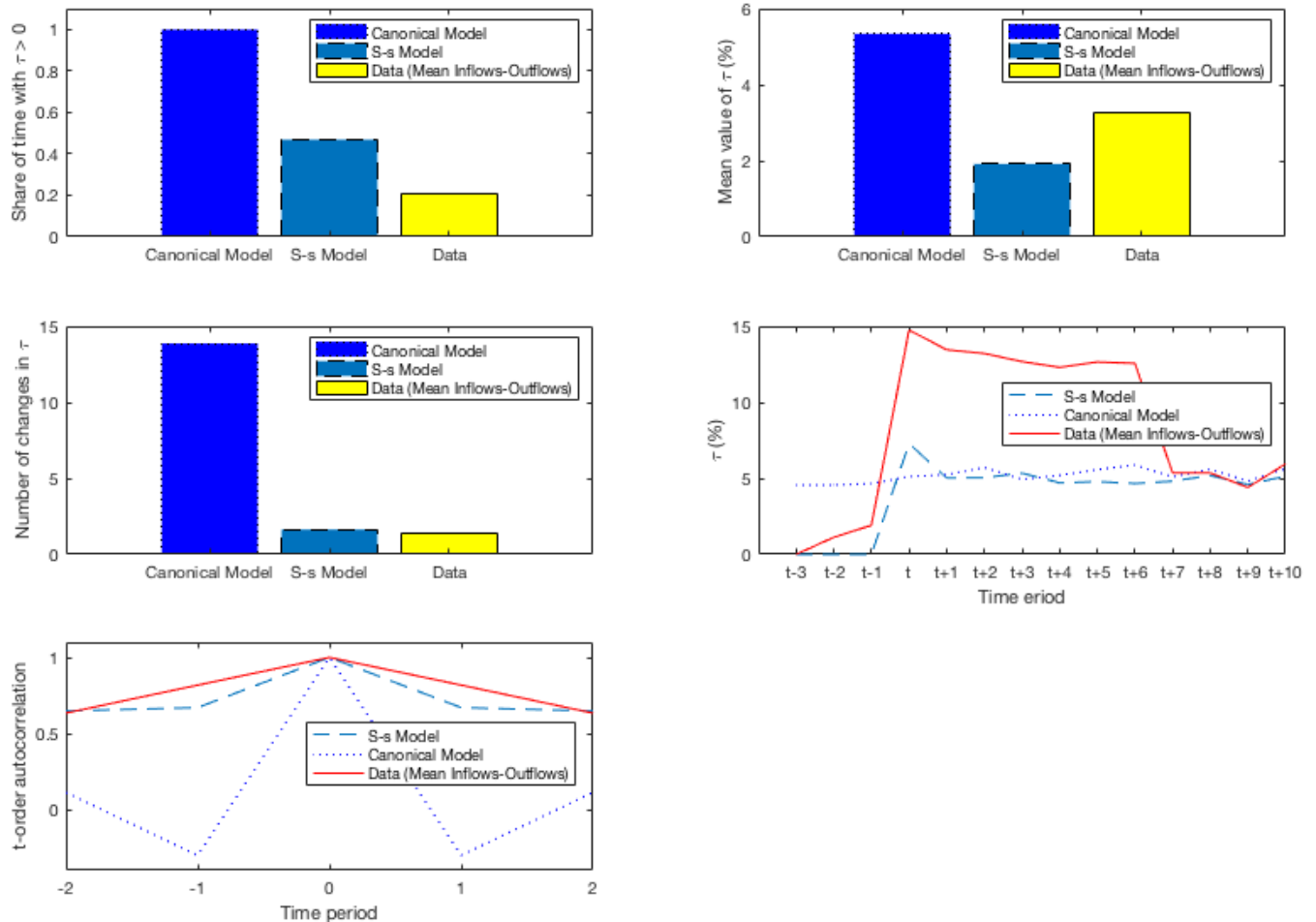
Figure 11 summarizes the results of the various comparisons. Results are averages across the models calibrated for each of the countries in the dataset (the Appendix contains country-by-country results). The panel in the upper left corner documents the share of time that controls are predicted to be active (strictly positive) by each model. It shows how the presence of (S, s) costs brings the model closer to the data: while the baseline

financial crisis, while no use of the intensive margin of capital controls was recorded in our dataset (i.e, it is the only point in the origin of the scatter plot). This can be explained by recalling that, as documented in Section 3, a large fraction of the regulations on capital controls in China are non-price-based, as was further documented in Fernández et al. (2016).

²⁸When comparing model and data, for the latter we use the mean of taxes on inflows and outflows since the model does not distinguish between gross inflows and outflows. However, results are robust if we compare the model with taxes on inflows and outflows separately. This is due to the fact that, in our dataset, controls on inflows and outflows comove—a result that was previously documented by Fernández et al. (2015) using the extensive margin of capital controls over a large panel of countries.

model continues to assume a very active use of controls, being active at every period in the simulation, the extended model predicts controls to be active only above 40% of the time, closer to the 20% in the data.

Figure 11: Quantitative Results



Notes: The first figure compares how the share of time with the capital control's tax is activated in the data (third bar) with respect to the baseline and (S, s) models (first and second bars, respectively). The second figure (first row) does the same than the first one, but for the mean value of the capital control tax. The first figure in the second row shows such comparison for the number of changes in the tax. The second figure in the second row depicts the episodes of activation of capital controls in the data (solid line), the baseline model (dotted line), and the (S, s) model (dashed line). The last figure has the same format of the previous one, and shows the serial autocorrelation of the capital control taxes up to two years. For all figures, the data is the cross-country average of the mean between taxes on inflows and outflows.

The upper right panel presents the results in terms of the mean value of the tax, capturing the intensity with which capital controls were used. The baseline model predicts an average τ of about 5.5%, far above the 3% in the data. The extended model predicts a lower τ of about 2%, closer to the cross-country mean for taxes on inflows and outflows in the data.

The middle left panel represents the number of changes in both the baseline and extended model—which, as mentioned above, was a moment targeted in the calibration. The middle right panel depicts episodes of forceful use of controls identified in the simulated data in the same way that episodes were identified in the new dataset (Figure 4), which we replicate for comparison. Again, results show that (S, s) costs help to account for the stickiness in capital controls: while the baseline model (dotted line) does not yield periods of inaction in the use of controls, which change rather frequently, the extended model with (S, s) costs (dashed line) exhibits initial periods of inactive controls that do not revert to their mean when they become active.

Lastly, the lower left panel further documents the mean reversion properties of the models by reproducing the first and second-order serial autocorrelations implied by both frameworks and comparing them with the one in the data presented earlier (Figure 5). In this dimension, the difference between the baseline model (dotted line) and the extended model (dashed line) is starker. While the former yields a counterfactual negative first-order serial correlation, the latter more closely resembles the relatively high value in the data (solid line).

5.4 Welfare Analysis

We compute the welfare gains of implementing capital controls in the baseline model and contrast them with those in the extended model, given the calibrated values of (S, s) costs presented above. As mentioned before, by construction, welfare gains with (S, s) costs will be lower than those in the frictionless baseline model. It is still relevant to consider by how much gains are lowered when the calibrated (S, s) costs are used. The welfare gains that we compute are consumption-equivalent factors that make households in both the unregulated baseline economy and the (S, s) economy to be as well off as in the Ramsey economy with

frictionless capital controls. Formally, we calculate λ^{UR} and λ^{Ss} such that:

$$\sum_{t=0}^{\infty} \beta^t u [C_t^{UR} (1 + \lambda^{UR})] = \sum_{t=0}^{\infty} \beta^t u [C_t^R] \quad (15)$$

and

$$\sum_{t=0}^{\infty} \beta^t u [C_t^{Ss} (1 + \lambda^{Ss})] = \sum_{t=0}^{\infty} \beta^t u [C_t^R] \quad (16)$$

The cross-country means of λ^{UR} and λ^{Ss} are 0.94% and 0.76%, respectively.²⁹ These results (summarized in table [Table 3](#)) document how on the one hand, there are sizable gains in terms of welfare when implementing capital controls in a frictionless environment. Indeed, consumption by agents in the unregulated economy would have to be close to one percentage point higher for them to be as well off as those living under the Ramsey planner with no (S, s) costs.³⁰ On the other hand, the same consumption equivalent compensation for agents living in the economy with (S, s) costs is also considerable—about 4/5 that of agents living in the unregulated economy. This implies that the magnitude of (S, s) costs calibrated in the previous section is large enough to eliminate most—though not all—of the welfare gains obtained in an environment where capital controls can be used without cost.³¹

Table 3: Welfare Analysis

	Unregulated Economy	S-s Economy
Welfare Gains	$\lambda^{UR} = 0.94\%$	$\lambda^{S-s} = 0.76\%$

Notes: The second column of the table shows the increase in consumption that would be needed for the household in the unregulated economy to have the same welfare as in the Ramsey economy with no (S, s) costs, λ^{UR} . The third column shows the increase in consumption that would be needed for the household in the (S, s) economy to have the same welfare as the Ramsey economy with no S-s costs, λ^{UR} . Both values are cross-country means.

²⁹Country-by-country estimations are reported in the Appendix

³⁰This number goes in the same direction as that calibrated for Argentina in [Bianchi \(2011\)](#). However, our results differ quantitatively, since (1) our results are cross-country means and (2) due to the heavy computational burden of our algorithm, we use have to use a coarser grid for net foreign debt.

³¹An alternative way to measure the welfare implications of (S, s) costs is to derive the consumption equivalent factor (λ^{UR-alt}) that makes households in the unregulated baseline economy to be as well off as in the (S, s) economy: $\sum_{t=0}^{\infty} \beta^t u [C_t^{UR} (1 + \lambda^{UR-alt})] = \sum_{t=0}^{\infty} \beta^t u [C_t^{Ss}]$. In line with the previous result, λ^{UR-alt} is relatively small (0.11%).

6 On the Deeper Causes of (S, s) Costs: A Discussion

The (S, s) costs in the extended model are evidently a reduced form to capture the large set of deeper constraints that policymakers may face when confronted with the choice of using capital controls, absent from the simple environment in the model. While we believe that providing complete microfoundations of (S, s) costs is beyond the scope of this paper, this section offers a discussion of such constraints, relating them to a broader literature on international finance. There are at least three alternative deeper causes for (S, s) costs in the extended model that can be related to the literature. First, such costs may be capturing a more complex cost-benefit analysis that incorporates negative effects and/or unintended consequences of capital controls not picked up by standard models. More generally, a second explanation may be related to political economy considerations driving policymaking, which can be also linked to credibility and signaling from the use of these tools that end up affecting policy choices. Third, model robustness and (perceptions of) ineffectiveness of capital controls may also play a role in policymakers' cautious use of these instruments.

A potential cost of capital controls can be related to the negative effect on the development of deeper financial markets. In light of this possibility, and given that most countries aim to maintain/develop financial markets, they may refrain from imposing capital controls or other draconian measures on the flow of capital, except under episodes of large volatility of these flows. Related to this, research has documented that capital controls may negatively affect liquidity and reduce firms' financing, particularly those that are small ([Forbes 2007](#); [Alfaro et al. 2017](#); [Andreasen et al. 2019](#)).

Policymakers may also worry about the general perception of capital control policies on market participants, as well as more broadly defined political economy considerations. [Bartolini and Drazen \(1997\)](#), for example, argue that countries that lift capital controls can signal "good behavior," while those that impose them could be perceived as following inconsistent policies that would reduce credibility. Research has documented how controls can be linked to corruption insofar as capital controls can be put in place to benefit certain private interests ([Johnston and Tamirisa 1998](#)). There may also be spillovers and interactions across markets ([Cole and Kehoe 1998](#)). Thus, even if policymakers are willing to use

controls as the Ramsey planner would, they may be discouraged from doing so if, given imperfect information, markets view them as signals of possibly inconsistent policies. Under such circumstances, it is plausible to assume that policymakers may be deterred from using these tools except under extreme cases. Another set of explanations as to why countries may opt to impose controls on capital flows centers around the distributive consequences of policies. While an economy as a whole can benefit from opening up to international markets, some groups may lose in the absence of necessary compensating transfers ([Alesina and Tabellini 1989](#); [Rodrik and Van Ypersele 2001](#)). This constraint raises the possibility that the compensatory adjustments in the national tax rates may not be feasible in the absence of coordination among countries ([Alfaro and Kanczuk 2004](#)). Changes in the political equilibria in these environments can thus yield non-linearities in capital controls that are captured through reduced (S, s) costs.

Policymakers may be concerned about issues related to model specification, robustness and effectiveness of capital controls. Indeed, complexities surrounding the transmission mechanism of capital controls that are not well understood and thus hard to capture in standards frameworks may inhibit policymakers from actively using these controls. Regarding model specification, most theoretical frameworks, for example, tend to focus on consumption smoothing benefits with non-contingent assets while abstracting from different interactions and variables: debt/equity financing/hedging and contingent assets, capital accumulation, firm financing, and the development of financial markets. Another concern is that regulations do not properly discriminate between short-term and long-term capital flows. Short-term loans are often rolled over, while long-term assets can be sold in secondary markets.

Related to this, there are also concerns regarding model robustness. Policy prescriptions of models of optimal capital are far from being robust to deviations from the baseline model in terms of calibration, timing of the collateral constraints, or endogenizing production ([Schmitt-Grohé and Uribe 2020](#); [Benigno et al. 2011](#)). Furthermore, optimal rules have been shown to be time-inconsistent, and simpler rules may even be welfare reducing ([Bianchi and Mendoza 2010](#); [Hernandez and Mendoza 2017](#)).

Evidently, concerns about model specification and robustness are amplified in light of the inconclusive evidence regarding effectiveness of capital controls ([Klein 2012](#); [Baba](#)

and Kokenyne 2011; De Gregorio et al. 2000; Goldfajn and Minella 2005; Carvalho and Garcia 2008; etc.), with some exceptions—in particular, draconian cases (e.g., Argentina, Venezuela) or “walls” (China). Hence policymakers may be reluctant to use them unless macro conditions really warrant extreme measures, acting as if there were costs of using them in normal times.

7 Conclusion

One of the legacies of the of the 2007–2008 Global Financial Crisis has been a reassessment of the potential for non-conventional policy tools to curb imbalances that can trigger financial crises and sudden stops. Capital controls have, once again, been seen as a policy tool worth considering in the toolbox. Such a view has been backed by theoretical work that describes environments in which, by reducing the probability of financial crises, cyclical capital controls are desirable for their welfare implications. This view, however, is far from being accepted by the profession, and much debate remains in terms of the effectiveness of these policy instruments.

In this paper, we have aimed to contribute to this debate by addressing both positive and normative features of capital controls. On the positive front, our efforts were devoted to describing the key stylized facts observed from a brand new dataset that we build on the use of de jure controls for a panel of EMEs along the intensive margin so as to get a better picture of how these policy tools have been used. Our view is that any meaningful test for a theory of capital controls needs to be able to account for these stylized facts.

The key empirical finding in our work is that controls display certain statistical properties that makes us label them as “sticky.” Changes to capital controls do not occur frequently, and when they do, they remain in place for a long time. Overall, they have not been used systematically across countries or time, and there has been considerable heterogeneity across countries in terms of the intensity with which they have been used.

On the normative side, we extend a model of capital controls relying on pecuniary externalities augmented to include an (S, s) cost of implementing such policies. We illustrate how this friction goes a long way toward bringing the model closer to the data. When the

extended model is calibrated for each of the countries in the new dataset, we find that the size of these (S, s) costs is large, thus substantially reducing the welfare-enhancing effects of capital controls compared with the frictionless Ramsey benchmark.

Our broad view of this result is *not* that the workhorse model of pecuniary externalities is unsuitable for empirical analysis. Instead, we subscribe to a view that calls for a richer set of policy constraints when considering an optimal use of optimal capital controls in models that rely on such externalities.

Our work has, nonetheless, been silent about the formal microfoundations of such costs and goes only as far as to discuss some of the possible deeper causes. In that regard, an obvious further avenue that comes out of our work is the formal modeling of the primitive frictions that can give rise to the stylized facts documented of capital controls.

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Appendix

A.1 Models' Derivations

A.1.1 Unregulated Economy

Defining λ_t and μ_t as, respectively, the Lagrange multipliers on the sequential budget constraint and the collateral constraint, the Lagrangian is:

$$\mathcal{L} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left\{ U(A(c_t^T, c_t^N)) + \lambda_t [y_t^T + p_t y_t^N + \frac{d_{t+1}}{1+r_t} - c_t^T - p_t c_t^N - d_t] + \lambda_t \mu_t [\kappa(y_t^T + p_t y_t^N) - d_{t+1}] \right\} \quad (17)$$

The first-order conditions are (2), (3), and:

$$[c_t^T] : U'(A(c_t^T, c_t^N)) A_1(c_t^T, c_t^N) = \lambda_t \quad (18)$$

$$[c_t^N] : U'(A(c_t^T, c_t^N)) A_2(c_t^T, c_t^N) = p_t \lambda_t \quad (19)$$

$$[d_{t+1}] : \left(\frac{1}{1+r_t} - \mu_t \right) \lambda_t = \beta E_t \lambda_{t+1} \quad (20)$$

$$\mu_t \geq 0 \quad (21)$$

and

$$\mu_t [d_{t+1} - \kappa(y_t^T + p_t y_t^N)] = 0 \quad (22)$$

Combining (18) with (19) and using the functional forms for the utility function and the consumption aggregator, we obtain:

$$p_t = \frac{1-a}{a} \left(\frac{c_t^T}{c_t^N} \right)^{1-\zeta} \quad (23)$$

The market for non-tradables clears in equilibrium:

$$c_t^N = y_t^N \quad (24)$$

We can use the results from (18) and (23), respectively, into (20) and (3) and the market-clearing condition into all the first-order conditions to define the competitive equilibrium:

Definition 6.1. *Competitive equilibrium - Baseline economy.* Given the exogenous endowments and interest rate: r_t, y_t^T, y_t^N , and the initial debt position d_0 , a competitive equilibrium in the baseline economy is a set of processes $c_t^T, c_t^N, d_{t+1}, \mu_t$, satisfying:

$$\left(\frac{1}{1+r_t} - \mu_t\right)U'(A(c_t^T, y_t^N))A_1(c_t^T, y_t^N) = \beta E_t U'(A(c_{t+1}^T, y_{t+1}^N))A_1(c_{t+1}^T, y_{t+1}^N) \quad (25)$$

$$c_t^T + d_t = y_t^T + \frac{d_{t+1}}{1+r_t} \quad (26)$$

$$d_{t+1} \leq \kappa \left[y_t^T + \frac{1-a}{a} (c_t^T)^{1/\zeta} (y_t^N)^{1-1/\zeta} \right] \quad (27)$$

$$\mu_t \geq 0 \quad (28)$$

and

$$\mu_t \left[\kappa \left(y_t^T + \frac{1-a}{a} (c_t^T)^{1/\zeta} (y_t^N)^{1-1/\zeta} \right) - d_{t+1} \right] = 0 \quad (29)$$

A.2 Baseline Ramsey Planner Economy

For the Ramsey planner, the Lagrangian is:

$$\mathcal{L} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left\{ U(A(c_t^T, c_t^N)) + \lambda_t^R \left[y_t^T + \frac{d_{t+1}}{1+r_t} - c_t^T - d_t \right] + \lambda_t^R \mu_t^R \left[\kappa \left(y_t^T + \frac{1-a}{a} \left(\frac{c_t^T}{y_t^N} \right)^{1/\zeta} y_t^N \right) - d_{t+1} \right] \right\} \quad (30)$$

The first-order conditions are:

$$[c_t^T] : U'(A(c_t^T, y_t^N))A_1(c_t^T, y_t^N) + \lambda_t^R \mu_t^R \kappa \frac{1-a}{a} \frac{1}{\zeta} \left(\frac{c_t^T}{y_t^N}\right)^{1/\zeta-1} = \lambda_t^R \quad (31)$$

$$[d_{t+1}^T] : \left(\frac{1}{1+r_t} - \mu_t^R\right)\lambda_t^R = \beta E_t \lambda_{t+1}^R \quad (32)$$

$$\mu_t^R \kappa [y_t^T + \frac{1-a}{a} \left(\frac{c_t^T}{y_t^N}\right)^{1/\zeta} y_t^N - d_{t+1}] \geq 0 \quad (33)$$

$$\mu_t^R \geq 0 \quad (34)$$

and

$$\kappa [y_t^T + \frac{1-a}{a} \left(\frac{c_t^T}{y_t^N}\right)^{1/\zeta} y_t^N] - d_{t+1} \geq 0 \quad (35)$$

By comparing the first-order conditions of the decentralized economy and the Ramsey planner's economy shown in equations (18) and (31), we get the first remark obtained by [Bianchi \(2011\)](#): When the constraint binds, private agents undervalue wealth (equivalently, when the constraint binds, households overvalue consumption).

The result above emerges from the fact that, as shown by the second term of the left-hand side in equation (31), an additional unit of tradable consumption reduces its marginal utility when the constraint binds, due to the fact that the agent will have to deleverage down to the point where the collateral constraint is not violated (i.e., a binding constraint implies less future consumption of tradable goods). As a result, private agents in the decentralized economy consume more by borrowing from abroad than the Ramsey planner, which leads to the standard result of overborrowing³².

Given the overborrowing result, a direct application of the second welfare theorem is

³²Schmitt-Grohe and Uribe (2016) make a case for multiple equilibrium in this class of models, where instead of overborrowing, the decentralized economy could display underborrowing (i.e., the central planner borrows more than private agents). Specifically, for $d = d_0 = \tilde{d}$, they show that there is multiple equilibrium with underborrowing when $S(\tilde{d}; \tilde{d}) \equiv \kappa \left(\frac{1-a}{a}\right) \frac{1}{1+r} \frac{1}{\zeta} (y^T + \frac{\tilde{d}}{1+r} - \tilde{d})^{1/\zeta-1} > 1$. However, we use the same calibration as in [Bianchi \(2011\)](#), where such condition is not met; hence the economy has a unique equilibrium with overborrowing.

to implement a capital control tax (i.e., a tax on debt) such that the decentralized economy reaches the same allocations of the Ramsey Planner (which dominate in welfare)³³.

A.3 Regulated Economy - Optimal Tax

The optimality conditions (25)- (29) are unchanged except for the debt Euler Equation (25), which now takes the form:

$$\left(\frac{1 - \tau_t}{1 + r} - \mu_t\right)\lambda_t = \beta E_t \lambda_{t+1}$$

Definition 7.1. *Competitive equilibrium - Economy with capital control taxes.* A competitive equilibrium in the economy with capital control taxes is then a set of processes $c_t^T, d_{t+1}, \lambda_t, \mu_t$ and p_t satisfying:

$$c_t^T + d_t = y_t^T + \frac{d_{t+1}}{1 + r_t} \quad (36)$$

$$d_{t+1} \leq \kappa[y_t^T + p_t y_t^N] \quad (37)$$

$$\lambda_t = U'(A(c_t^T, y_t^N))A_1(c_t^T, y_t^N) \quad (38)$$

$$\left(\frac{1 - \tau_t}{1 + r_t} - \mu_t\right)\lambda_t = \beta E_t \lambda_{t+1} \quad (39)$$

$$p_t = \frac{A_2(c_t^T, y_t^N)}{A_1(c_t^T, y_t^N)} \quad (40)$$

$$\mu_t[\kappa(y_t^T + p_t y_t^N) - d_{t+1}] \quad (41)$$

and

³³This capital control tax is designed to reach a constrained first-best allocation in terms of welfare. However, clearly an economy without the financial friction represented by the collateral constraint welfare dominates that of the Ramsey planner.

$$\mu_t \geq 0 \quad (42)$$

Given a policy process τ_t , the exogenous process for endowments y_t^T, y_t^N , interest rate r_t and the initial level of debt d_0 .

The difference between the equilibrium described in definition 3.1 and the one described in 3.2 relies on (39), which is the first-order condition with respect to d_{t+1} and now has τ_t reducing the marginal utility of debt.

A.4 Alternative Costs of Policy Making - First-Order Conditions

The first-order conditions of the Ramsey planner's problem become (now we need to take directly the derivative with respect to τ_t):

$$\begin{aligned} [c_t^T] : & U'(A(c_t^T, y_t^N))A_1(c_t^T, y_t^N) - \\ & \theta_t^R \left(\frac{1 - \tau_t}{1 + r} \right) \left\{ (c_t^T)^{-1/\zeta} \left(\frac{-\sigma + 1/\zeta}{1 - 1/\zeta} \right) [a(c_t^T)^{1/(1-1/\zeta)} + (1-a)(y_t^N)^{1/(1-1/\zeta)}]^{-\frac{\sigma+1/\zeta}{1-1/\zeta}-1} \left(\frac{a}{1-1/\zeta} \right) (c_t^T)^{\frac{1/\zeta}{1-1/\zeta}} \right. \\ & \quad \left. - \frac{1}{\zeta} (c_t^T)^{-1/\zeta-1} [a(c_t^T)^{1/(1-1/\zeta)} + (1-a)(y_t^N)^{1/(1-1/\zeta)}]^{-\frac{\sigma+1/\zeta}{1-1/\zeta}} \right\} \\ & \quad + \lambda_t^R \mu_t^R \kappa \frac{1-a}{a} \frac{1}{\zeta} \left(\frac{c_t^T}{y_t^N} \right)^{1/\zeta-1} = \lambda_t^R \quad (43) \end{aligned}$$

$$[d_{t+1}] : \frac{\lambda_1^R}{1+r} = \beta \lambda_{t+1}^R + \lambda_t^R \mu_t^R \quad (44)$$

$$[\tau_t] : -\lambda_t^R C'(\tau_t) + \frac{\theta_1^R}{1+r} [(c_t^T)^{-1/\zeta} [a(c_t^T)^{\frac{1}{1-1/\zeta}} + (1-a)(y_t^N)^{\frac{1}{1-1/\zeta}}]^{-\frac{\sigma+1/\zeta}{1-1/\zeta}}] = 0 \quad (45)$$

$$\mu_t^R \kappa [y_t^T + \frac{1-a}{a} \left(\frac{c_t^T}{y_t^N} \right)^{1/\zeta} y_t^N - d_{t+1}] \geq 0 \quad (46)$$

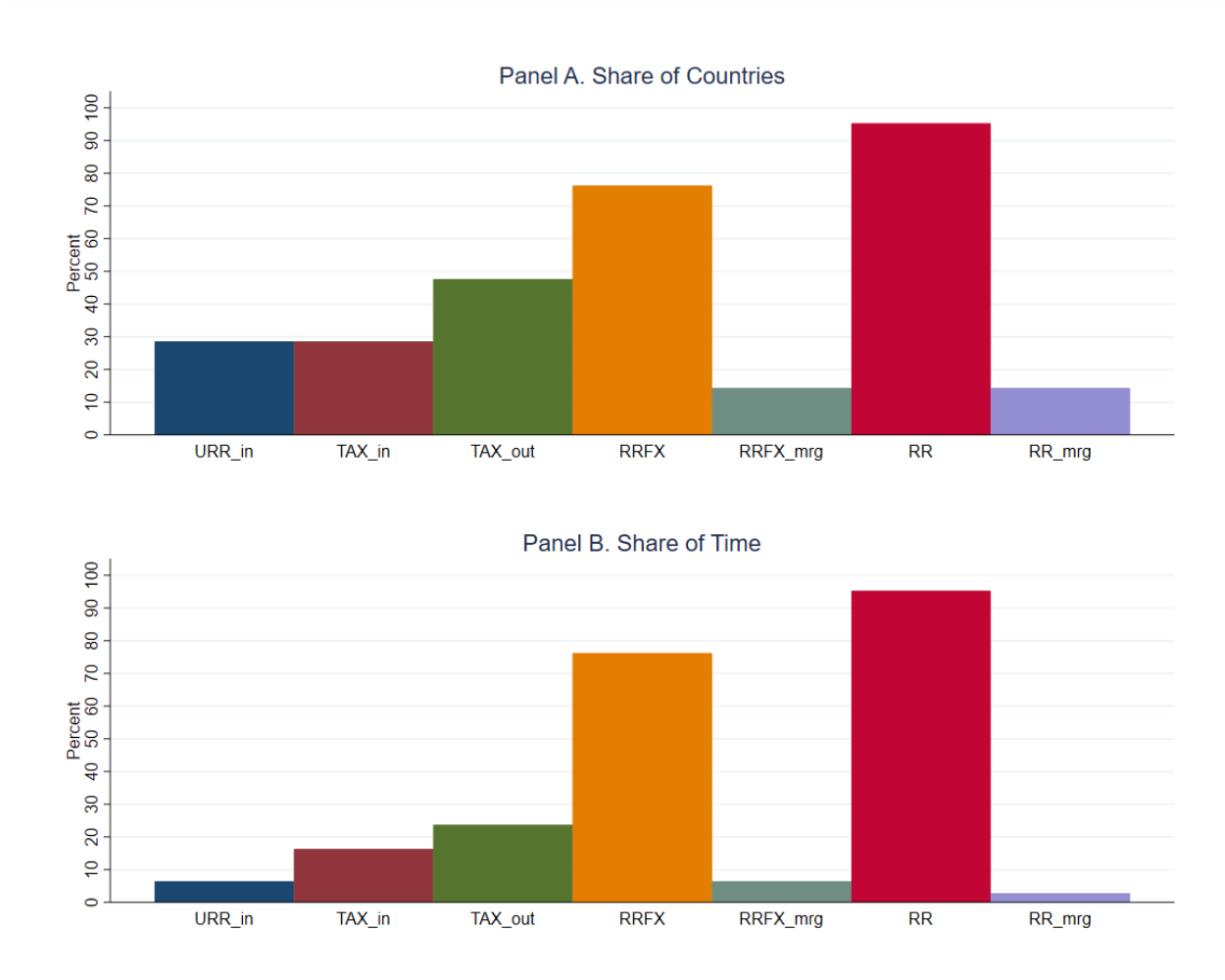
$$\mu_t^R \geq 0 \quad (47)$$

and

$$\kappa[y_t^T + \frac{1-a}{a}(\frac{c_t^T}{y_t^N})^{1/\zeta}y_t^N] - d_{t+1} \geq 0 \quad (48)$$

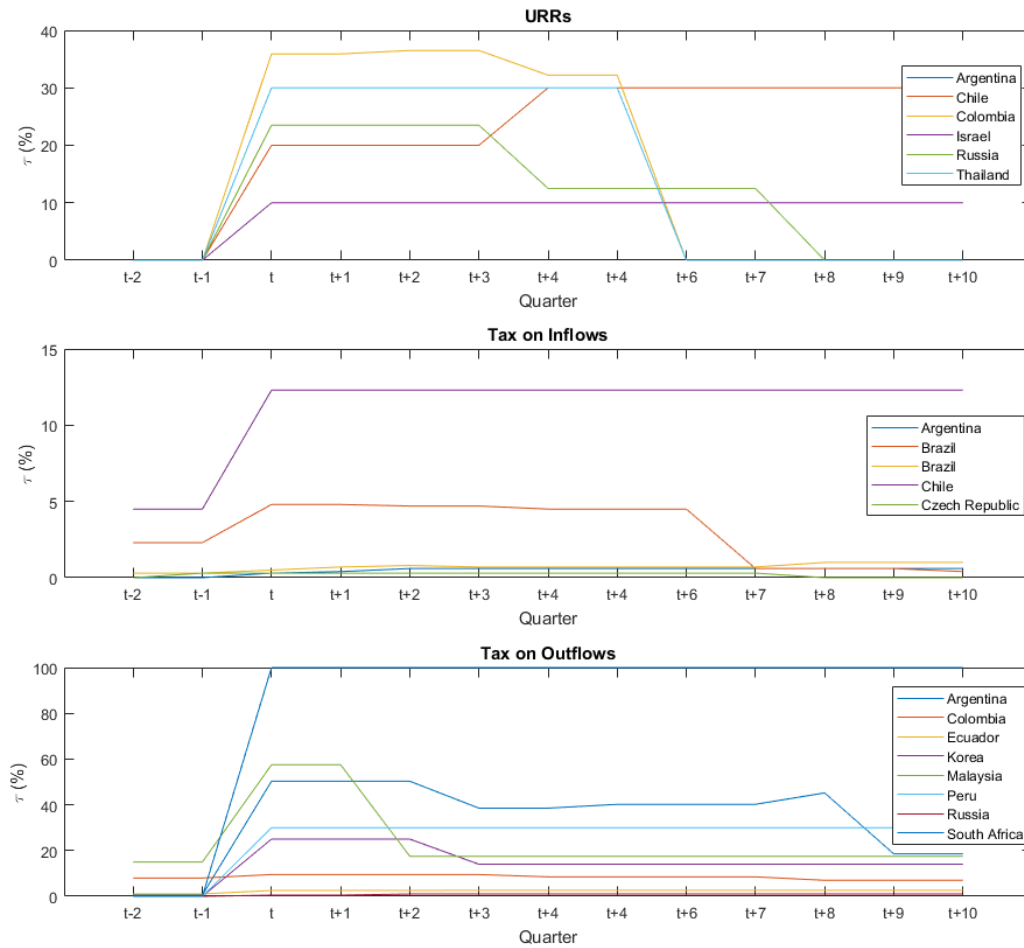
A.5 Additional Figures

Figure 12: Use of Capital Controls: All Instruments



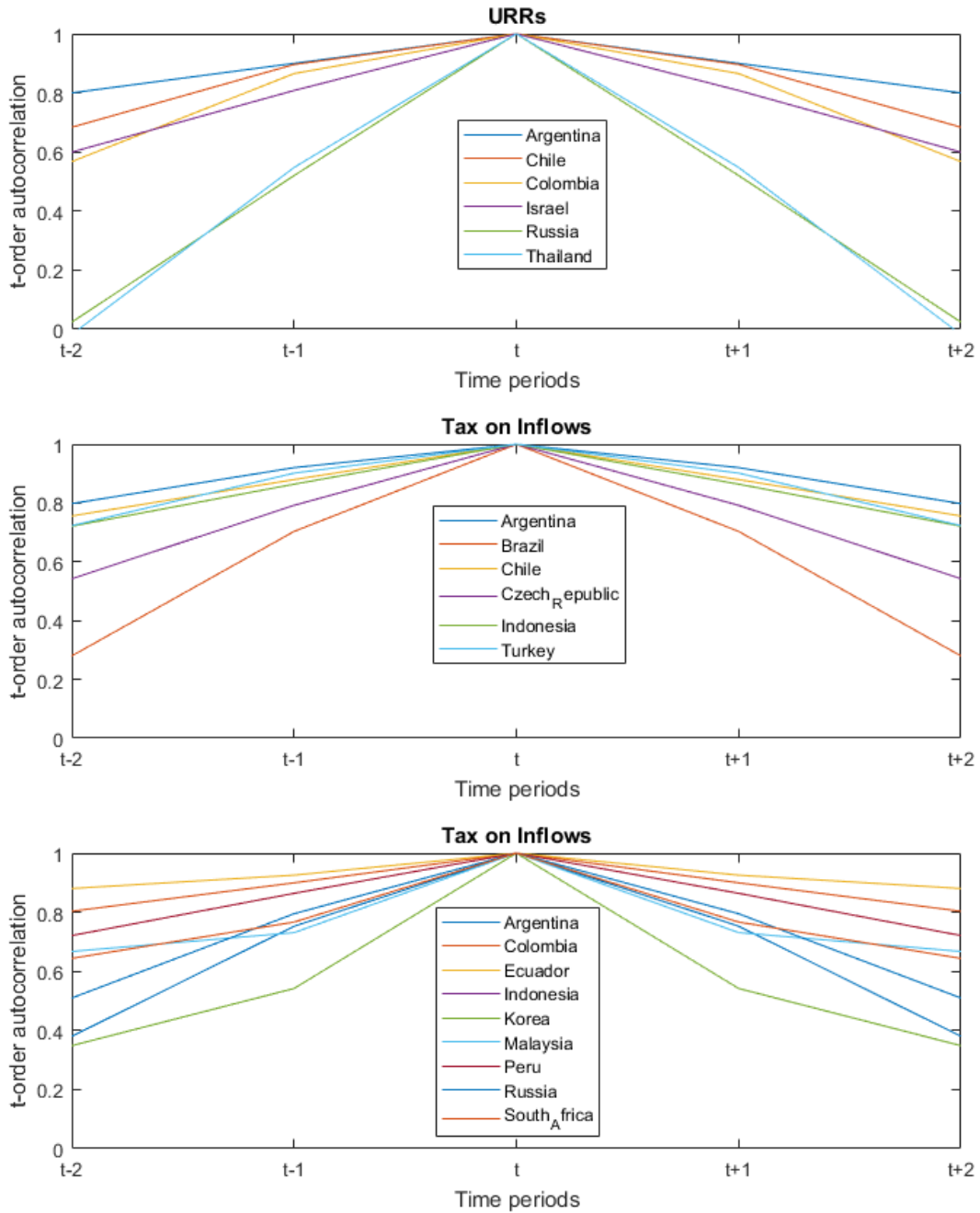
Notes: In Panel A, the bars depict the share of countries that have used (i.e., value of the instrument is not 0), even for a single quarter, any of the instruments out of the 21 countries in the sample. In panel B, the bars depict the share of periods in which an instrument was used. The sample was taken from 1995q1 to 2014q4, the maximum total of quarters is 80 (100%). Here we include capital controls (URRs, Taxes on Inflows, and Taxes on Outflows), and macroprudential instruments (Reserve Requirements and FX Reserve Requirements).

Figure 13: Episodes of Activation in Capital Controls: Country by Country



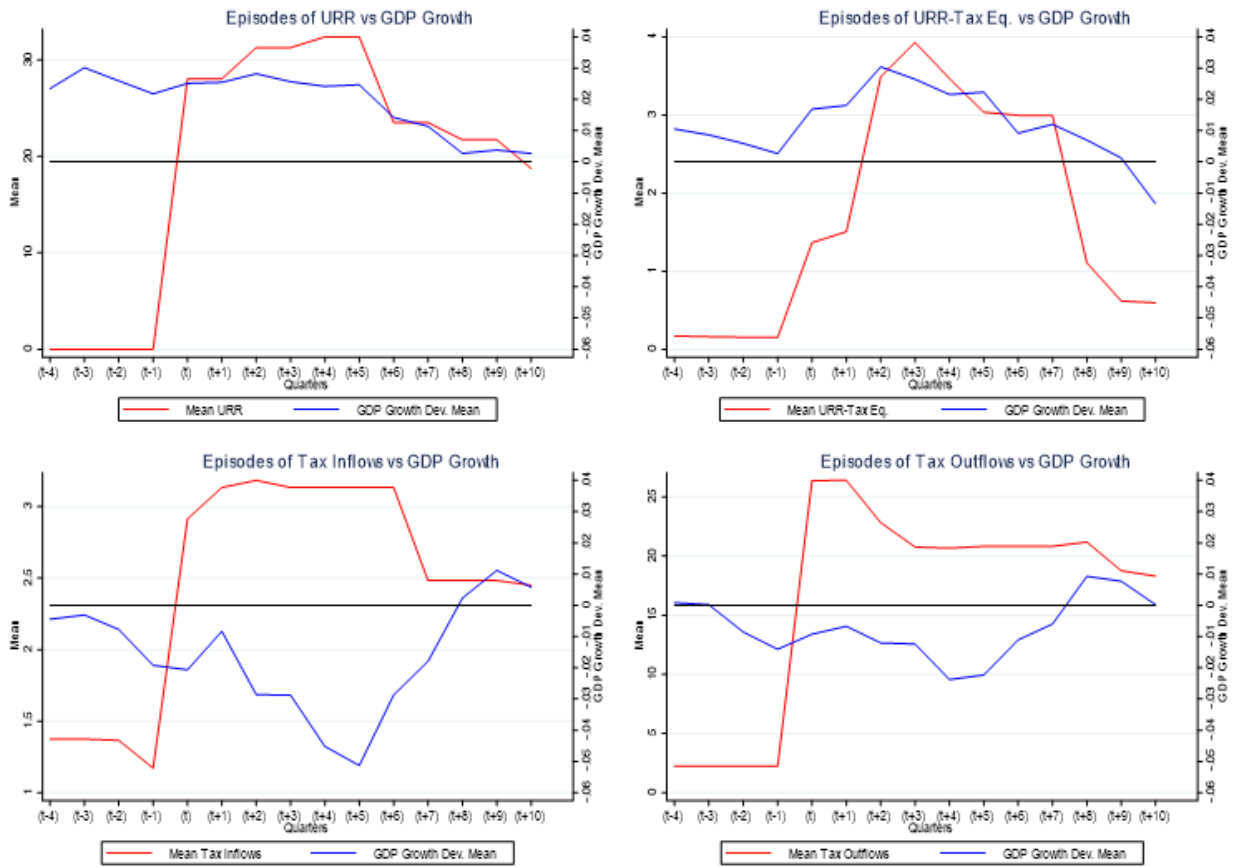
Notes: The beginning of an episode was defined as when, for a given policy instrument at period t , x_t , we have that: $x_t > 1.1x_{t-1}$. Then the values of each episode were averaged from $t - 2$ to $t + 10$. The first row shows episodes of activation in the controls at a quarterly frequency, and the second row shows such episodes at a yearly frequency. Here we show for each capital control instrument—URRs (first row), Taxes on Inflows (second row), and Taxes on Outflows (third row)—the episodes of activation in each country.

Figure 14: Serial Correlation of Capital Controls: Country by Country



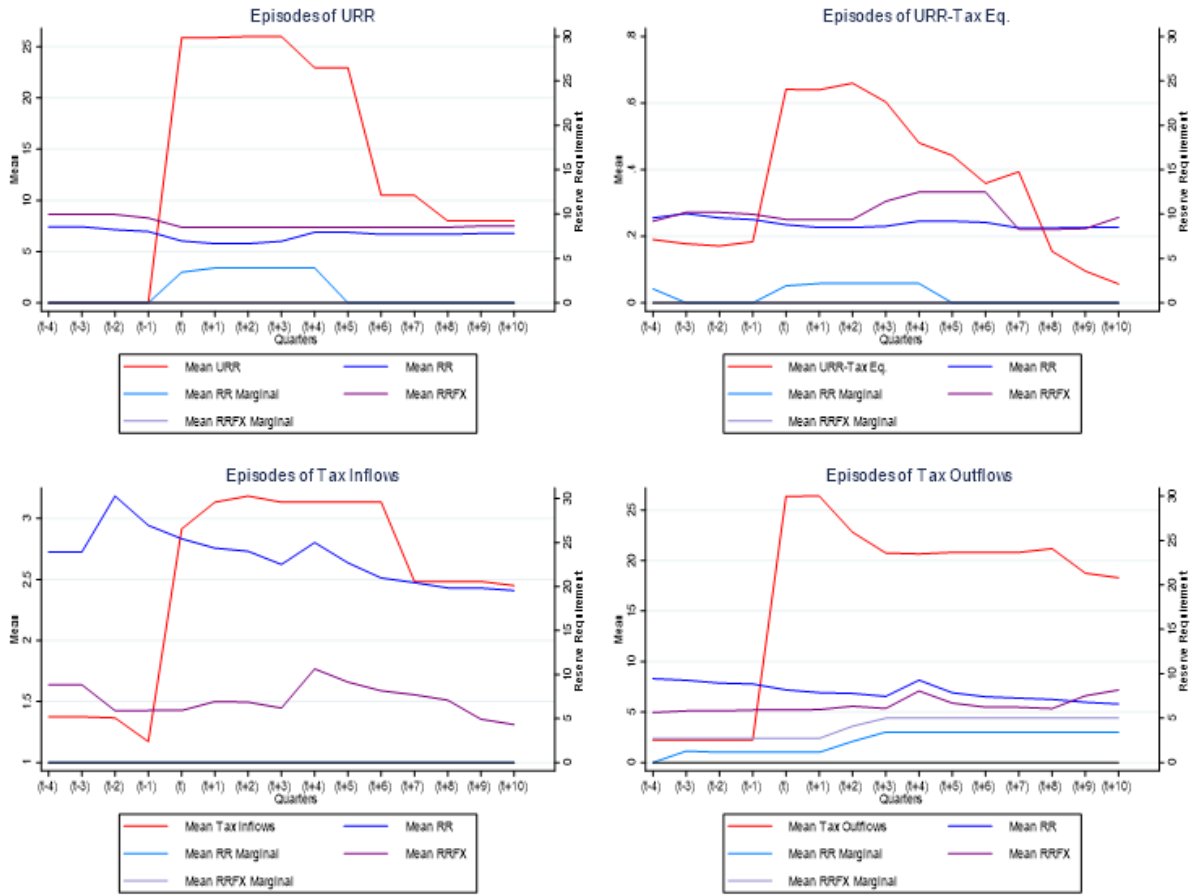
Notes: The figure shows for each capital control instrument—URRs (first row), Taxes on Inflows (second row), and Taxes on Outflows (third row)—the t -order serial autocorrelation for each country.

Figure 15: Episodes of Capital Controls & the Macroeconomy: All Capital Controls



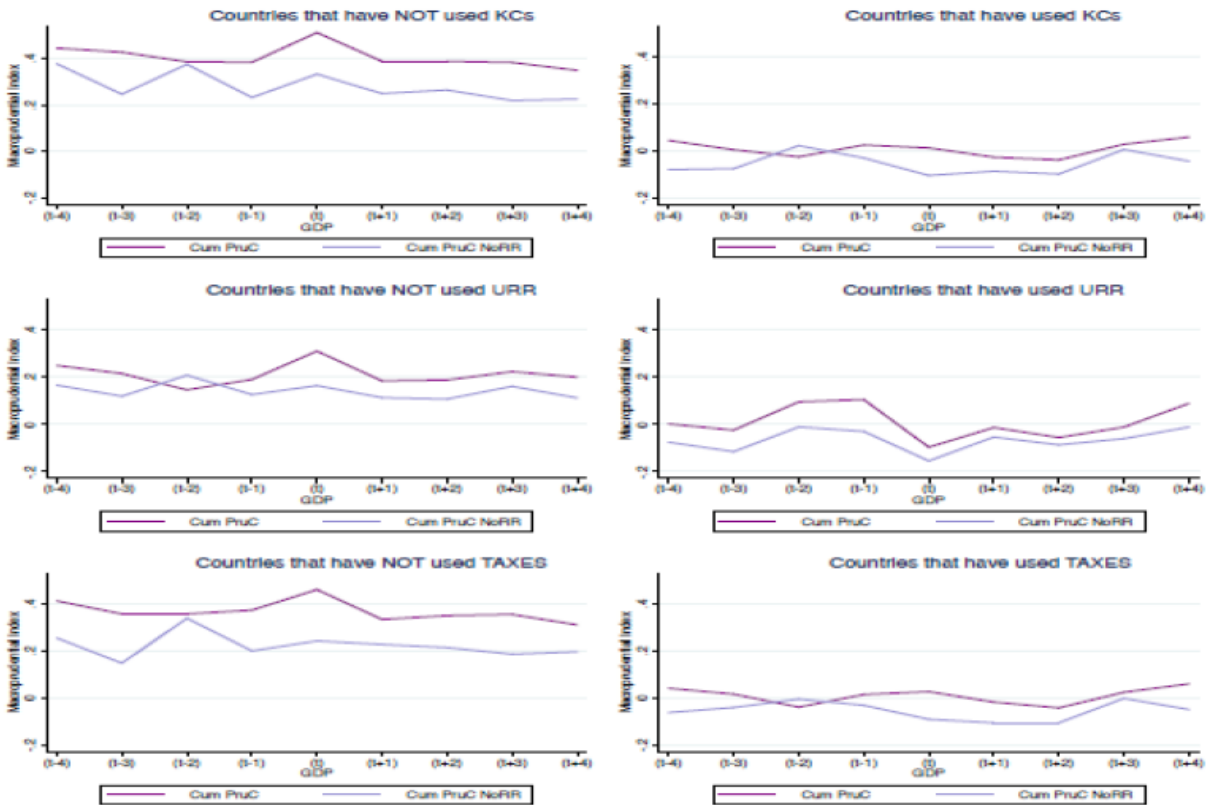
Notes: The figure shows the episodes described in Figure 4 along with the cross-country mean deviation from the average GDP growth. The plots shown the following number of episodes: URRs (7), Taxes on Inflows (6) and Taxes on Outflows (11). We also include the URRs Tax Equivalent (7 episodes).

Figure 16: Episodes of Activation in Capital Controls & Macroprudential Instruments



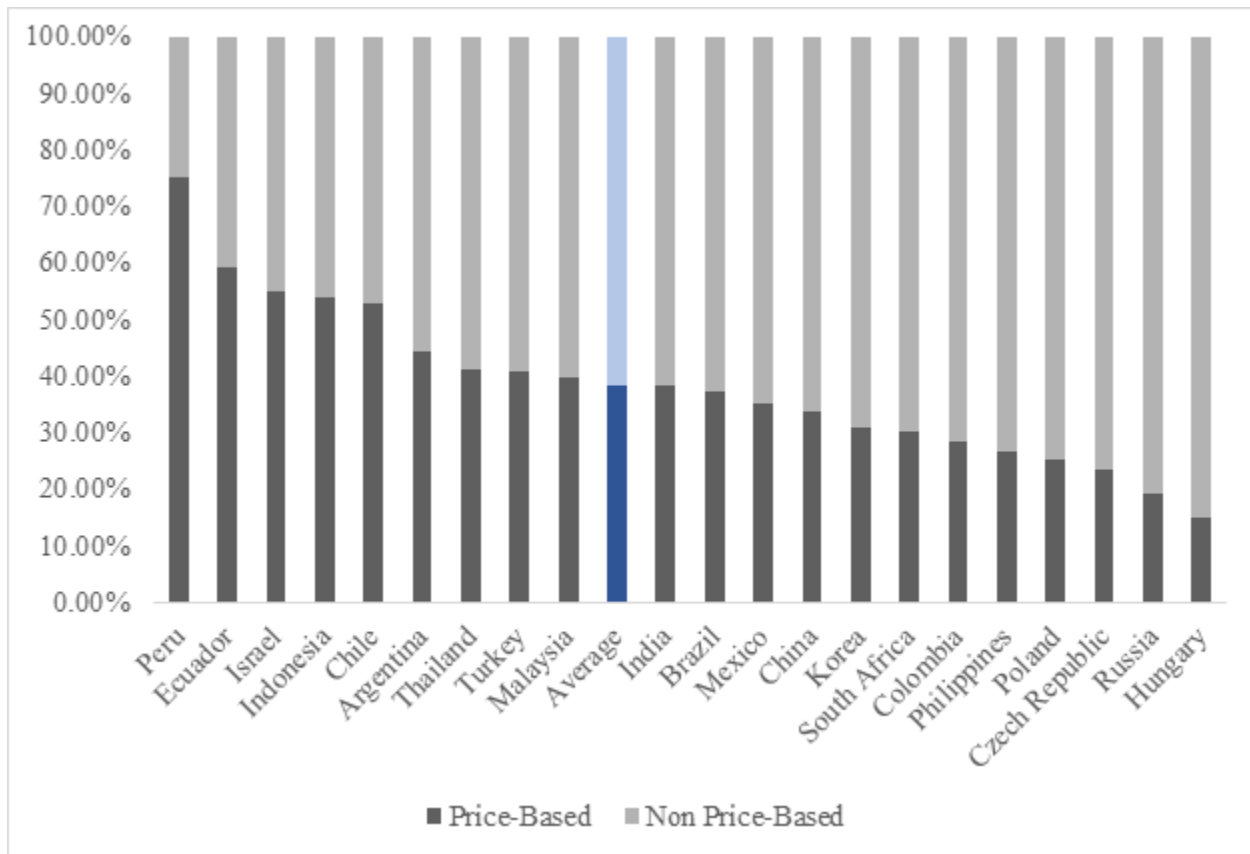
Notes: The beginning of an episode (episodes are depicted by red lines) was defined when for a given policy instrument at quarter t , $x_t > 1.1x_{t-1}$. Then the values of each episode were averaged from $t-2$ to $t+10$. Here we included the macroprudential instruments from our data base: Reserve Requirements (and the Marginal Reserve Requirements) and Reserve Requirements on Foreign Exchange (and the Marginal FX Reserve Requirements).

Figure 17: Capital Controls, Macroprudential Instruments, and the Business Cycle



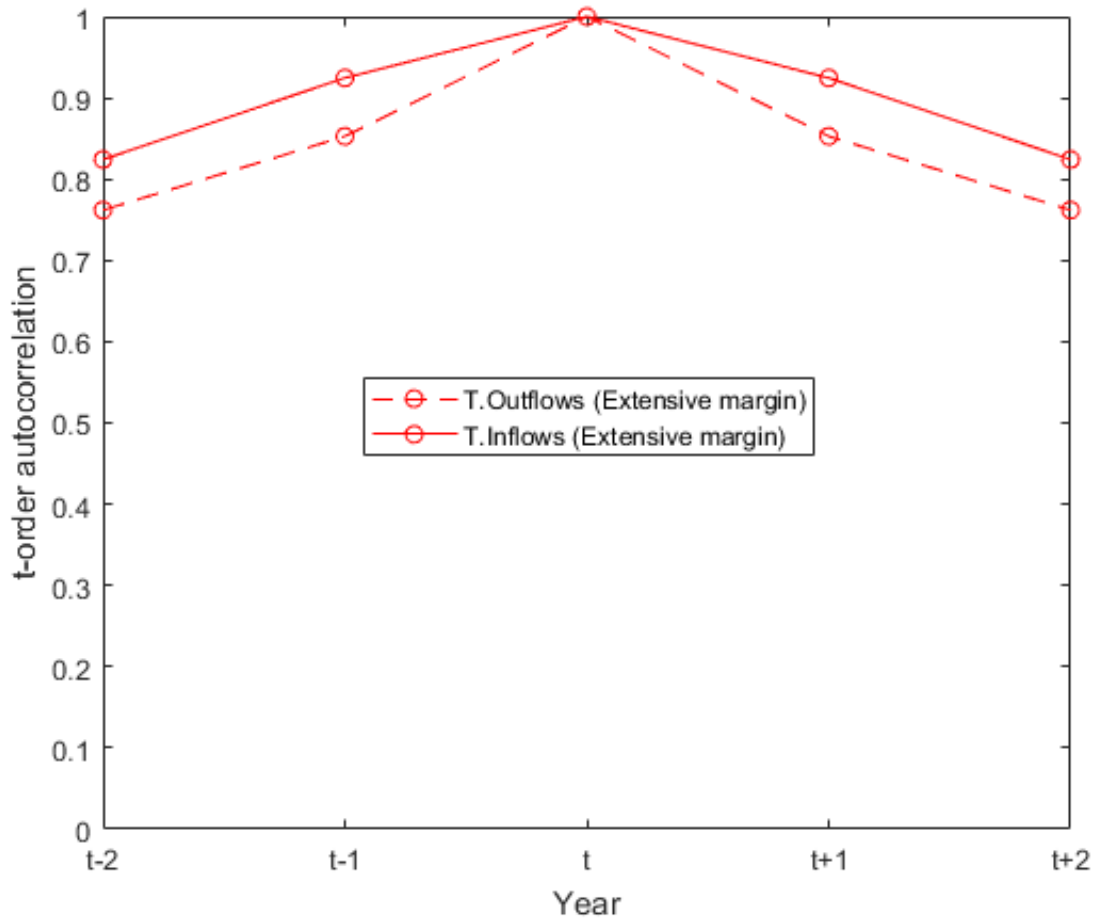
Notes: The figure shows the serial correlation of the Macroprudential Instruments' Indexes and the GDP growth for each category, broken down into countries that have not used the instruments (left column of graph) and countries that have (right column). The episodes of boom and bust correspond to the period from 2000q1 to 2014q4 given the availability of data from macroprudential instruments.

Figure 18: Price-Based and Non-Price-Based Capital Controls



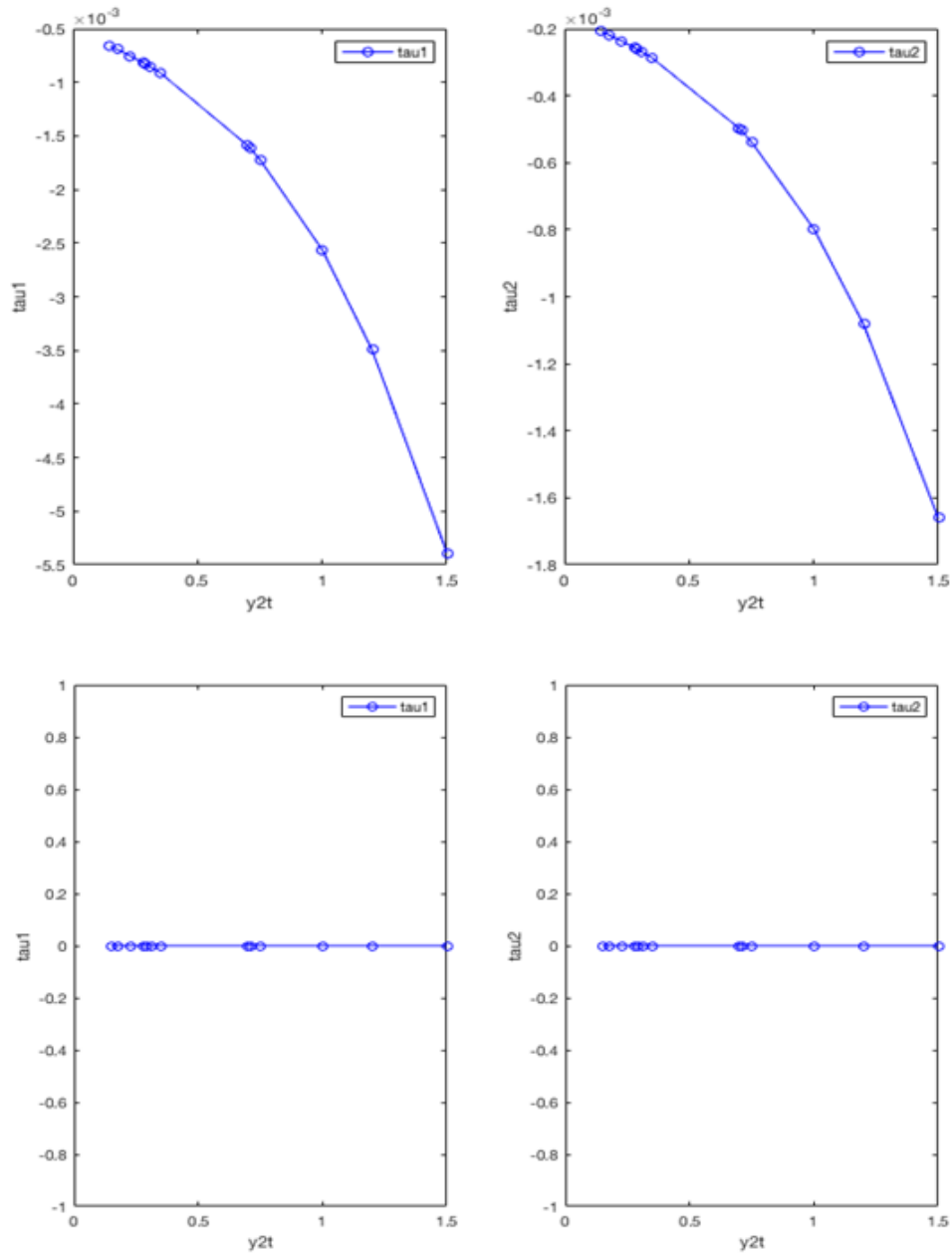
Notes: The bars show what share of instruments corresponds to non-price-based measures (dark shade) and to price-based measures (light shade) for each country. This is based on data for the extensive margin of all instruments.

Figure 19: Serial Correlation of Capital Controls: The Extensive Margin



Notes: The solid line represents the cross-country mean autocorrelation of order $t - j$ of the extensive margin (considering both price-based and non-price-based instruments) of taxes on inflows. The dashed line represents the same variable on taxes on outflows.

Figure 20: Capital Controls with Alternative Cost Functions



Notes: The top row of the figure shows in a three-period framework a recursive simulation of the capital control's tax with convex costs of adjustment in period 1 (left panel) and period 2 (right panel). The horizontal axis displays different values for the endowment of the tradable good in period 2. Periods 1 and 3 are assumed to have a fixed endowment of 1. The bottom row shows in a three-period framework a recursive simulation of the capital control's tax with concave costs of adjustment in period 1 (left panel) and period 2 (right panel). The horizontal axis displays different values for the endowment of the tradable good in period 2. Periods 1 and 3 are assumed to have a fixed endowment of 1. This simulation is constraint to real and non-negative values of the tax.

A.6. Additional Tables

Table 4: Share of Each Capital Control Instrument over the Total Amount of Instruments per Country

Country	Price-Based				Non-Price-Based	
	URR	Taxes	Quantitative	Prohibitions	Authorizations	Others
Argentina	16.40%	0.00%	27.87%	0.00%	28.31%	27.42%
Brazil	0.00%	13.20%	15.40%	8.56%	17.85%	44.99%
Chile	5.68%	8.65%	21.89%	16.49%	32.97%	14.32%
China	0.00%	0.00%	14.40%	19.15%	30.33%	36.12%
Colombia	7.05%	0.00%	18.27%	3.21%	28.53%	42.95%
Czech Republic	0.00%	0.00%	23.63%	0.00%	15.38%	60.99%
Ecuador	0.00%	32.29%	27.08%	0.00%	0.00%	40.63%
Hungary	0.00%	0.00%	15.00%	0.00%	30.00%	55.00%
India	0.00%	0.00%	28.15%	10.18%	28.38%	33.30%
Indonesia	0.00%	0.00%	29.01%	25.00%	4.94%	41.05%
Israel	4.35%	0.00%	36.23%	14.49%	18.84%	26.09%
Korea, Rep.	0.00%	0.00%	27.71%	3.03%	36.36%	32.90%
Malaysia	0.00%	1.41%	34.81%	3.53%	32.86%	27.39%
Mexico	0.00%	0.00%	25.75%	9.51%	18.79%	45.94%
Peru	0.00%	37.50%	37.50%	0.00%	0.00%	25.00%
Philippines	0.00%	0.00%	16.78%	9.80%	30.07%	43.36%
Poland	0.00%	0.00%	21.78%	3.51%	38.41%	36.30%
Russia	0.00%	0.00%	15.65%	3.67%	36.92%	43.77%
South Africa	0.00%	0.00%	28.04%	2.17%	40.43%	29.35%
Thailand	0.00%	0.00%	33.98%	7.04%	36.62%	22.36%
Turkey	0.00%	0.00%	32.88%	7.80%	11.86%	47.46%
All (Average)	1.52%	1.63%	24.45%	8.29%	28.35%	35.77%

Notes: The table corresponds to Stylized Fact 6. It shows for each country the share of each instrument over the total. Thus, for each country, the sum of each row is equal to 1. The first four instruments correspond to price-based capital controls, and the last two to non-price-based controls.

Table 5: Baseline Calibration: Country Results

Country Name	Number of Currency Crisis 1995-2010	TARGETED MOMENTS			CALIBRATED PARAMETERS		SIMULATED MOMENTS		SIMULATED K=0		CALIBRATED PARAMETERS WITH K=0		SIMULATED MOMENTS CALIBRATED κ=0 AND K=0	
		Number of crisis every 100-Y	Frequency of changes in tau (avg Inf-Out)	Sovereign+External Debt Crisis = Number of Changes in 20 Years	κ	K	Simulated Crisis	Simulated Changes	K=0 simulated crisis	K=0 simulated changes	κ	K	Simulated Crisis	Simulated Changes
Argentina	1	6.3	5.0	0.3250000	0.0120000000000000	2.88	4.02	1.87	13.16	0.3200	0.0000	1.90	13.14	
Brazil	5	31.3	7.0	0.3050000	0.0169300000000000	32.92	4.09	18.92	16.30	0.2950	0.0000	30.29	17.12	
Chile	1	6.3	0.5	0.3300000	0.0004000000000000	2.38	0.62	2.38	12.93	0.3100	0.0000	2.48	12.98	
China	0	0.0	0.0	0.3500000	0.0001000000000000	0.00	0.00	0.00	11.77	0.3300	0.0000	0.00	11.77	
Colombia	6	37.5	2.0	0.3250000	0.0095000000000000	28.08	2.38	28.04	16.10	0.3250	0.0000	28.04	16.10	
Czech Republic	0	0.0	0.5	0.3400000	0.0000000000000001	0.00	0.00	0.00	10.27	0.3400	0.0000	0.00	10.27	
Ecuador	6	37.5	2.5	0.3200000	0.0155300000000000	59.52	7.34	32.60	10.59	0.3200	0.0000	32.60	10.59	
Hungary	4	25.0	0.0	0.3270000	0.0190000000000000	1.99	0.00	1.57	10.73	0.3220	0.0000	18.62	14.65	
India	4	25.0	0.0	0.3200000	0.0180000000000000	48.55	0.00	1.59	13.70	0.2950	0.0000	28.89	17.94	
Indonesia	1	6.3	1.0	0.3290000	0.0000000010000000	1.66	2.00E-05	1.66	13.63	0.3270	0.0000	1.97	13.72	
Israel	0	0.0	0.0	0.3400000	0.0000000000000001	0.00	0.00	0.00	9.60	0.3300	0.0000	0.00	9.79	
Korea, Rep.	2	12.5	2.5	0.3240000	0.0156000000000000	3.43	3.21	1.63	12.08	0.2915	0.0000	15.68	12.05	
Malaysia	3	18.8	2.5	0.3150000	0.0156000000000000	48.37	2.64	25.39	12.42	0.3152	0.0000	25.39	12.42	
Mexico	1	6.3	0.0	0.3290000	0.0000000000500000	1.60	0.00	1.60	12.03	0.3281	0.0000	2.70	12.08	
Peru	1	6.3	0.5	0.3250000	0.0140000000000000	25.75	0.71	1.28	11.62	0.3150	0.0000	11.50	14.21	
Philippines	2	12.5	0.0	0.3260000	0.0040000000000000	1.75	0.00	0.09	10.97	0.2950	0.0000	27.80	16.80	
Poland	5	31.3	0.0	0.3240000	0.0150000000000000	21.44	0.00	12.67	13.71	0.3220	0.0000	29.40	16.41	
Russia	6	37.5	1.5	0.3200000	0.0189000000000000	17.39	1.58	16.97	13.39	0.3100	0.0000	29.59	15.41	
South Africa	2	12.5	2.0	0.3260000	0.0051000000000000	47.88	4.67	1.54	13.41	0.3200	0.0000	17.79	16.42	
Thailand	8	50.0	0.0	0.3200000	0.0170000000000000	39.22	0.00	38.78	13.13	0.2500	0.0000	50.09	11.05	
Turkey	5	31.3	1.5	0.3200000	0.0166000000000000	27.35	3.16	27.35	16.50	0.3150	0.0000	30.92	16.49	
Mean	3.0	18.8	1.4	0.3257	0.0102	19.62	1.64	10.28	12.76	0.3131	0.0000	18.36	13.88	

Table 6: Welfare Analysis: Country results

Country	Welfare Des	Welfare Ramsey	Consumption Eq SS to Rams	Welfare S-s	Welfare Ramsey	Consumption Eq S-s to Rams
Argentina	-1.92	-1.718712896	1.53%	-1.88	-1.746985316	1.01%
Brazil	-1.73	-1.574422556	1.24%	-1.81	-1.624850886	1.45%
Chile	-1.84	-1.652840017	1.50%	-1.77	-1.766147372	0.06%
China	-1.76	-1.759292411	0.00%	-1.76	-1.753570251	0.04%
Colombia	-1.83	-1.731663447	0.78%	-1.83	-1.726008275	0.82%
Czech Republic	-1.76	-1.764315351	0.00%	-1.76	-1.758273023	0.05%
Ecuador	-1.88	-1.718662970	1.22%	-1.88	-1.717366716	1.23%
Hungary	-1.92	-1.730591078	1.48%	-1.76	-1.748411373	0.12%
India	-1.71	-1.585714260	0.97%	-1.88	-1.711029946	1.34%
Indonesia	-1.76	-1.747010307	0.11%	-1.76	-1.758236699	0.03%
Israel	-1.76	-1.761844890	0.00%	-1.76	-1.755737458	0.05%
Korea, Rep.	-1.69	-1.558136423	1.08%	-1.90	-1.722211523	1.42%
Malaysia	-1.85	-1.688853810	1.24%	-1.85	-1.692457802	1.21%
Mexico	-1.75	-1.751031894	0.00%	-1.75	-1.746979382	0.02%
Peru	-1.86	-1.663182555	1.53%	-1.85	-1.718132555	1.03%
Philippines	-1.71	-1.585963020	0.98%	-1.78	-1.742702211	0.30%
Poland	-1.91	-1.728568142	1.44%	-1.89	-1.733108336	1.24%
Russia	-1.83	-1.679795452	1.21%	-1.93	-1.729221194	1.53%
South Africa	-1.90	-1.707596649	1.49%	-1.80	-1.736873046	0.47%
Thailand	-1.43	-1.350117202	0.64%	-1.88	-1.721024266	1.23%
Turkey	-1.85	-1.675946863	1.33%	-1.87	-1.706515464	1.27%
Mean	-1.79	-1.67	0.94%	-1.83	-1.73	0.76%