Frequency and Severity of Current Account Reversals: An Analysis with a Rational Expectations Regime Switching DSGE Model*

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Abstract

We employ a small open economy model with debt-deflation, where agents form expectations regarding sudden stops—typically characterized by a combination of current account reversals and sharp output declines. To this end, we construct a rational expectations regime switching DSGE model with occasionally binding collateral constraints. In environments with frequent sudden stops, agents anticipate future occurrences more strongly. Heightened expectations of losing access to international financial markets prompt collateral-constrained households to increase precautionary savings. These additional savings help sustain consumption and support collateral prices during turbulent periods, counteracting capital flight. However, as sudden stops become more frequent, the welfare loss due to pecuniary externalities intensifies, necessitating stronger macroprudential capital control measures. We provide empirical evidence from emerging economies that aligns with our theoretical findings.

Keywords: Small open economy; capital flows; regime switching
JEL Classification: F41, F44, E44, G01

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1 Introduction

Sudden stops, typically characterized by current account reversals and deep contractions in output often triggered by a rise in the country risk premium, are widely recognized phenomena, especially for emerging economies.

Figure 1 presents data on sudden stops for 50 emerging economies over the past 60 years. In the figure, blue dots indicate periods included in our sample based on data availability, while red dots represent periods of current account reversals. We define current account reversals as consecutive periods when the year-on-year increase in the current account-to-GDP ratio exceeds 1.5 standard deviations above its mean.[1] With this definition, our sample contains 122 current account reversal episodes.[2]

It is noticed that sudden stops are often concentrated in specific periods, indicating global characteristics: the highest number of reversals occurred in 2009 (18 episodes), followed by 1983 (8 episodes). These events are also often geographically concentrated, as observed during the Asian financial crisis in the late 1990s and the European sovereign debt crisis in the 2010s[3]

Despite this local and global clustering that may suggest common "global financial cycles" (Miranda-Agrippino and Rey, 2020), the figure highlights significant cross-country heterogeneity in the frequency of sudden stops. Some countries experience these episodes more frequently than others. The country with the highest number of episodes is the Dominican Republic, with six events from 1968 to 2019, while Croatia experienced none from 1993 to 2019. The frequency of current account reversals and its standard deviation in our sample are 5.99 percent and 2.40 percent, respectively.

Given these observations, this paper addresses the following questions: 1) What mechanism underlies the heterogeneity in the frequency of sudden stops? 2) How can we explain it beyond differences in the structural shocks affecting these economies? 3) Is there a distinct pattern in the characteristics of sudden stop episodes that arises from differences in their frequency?

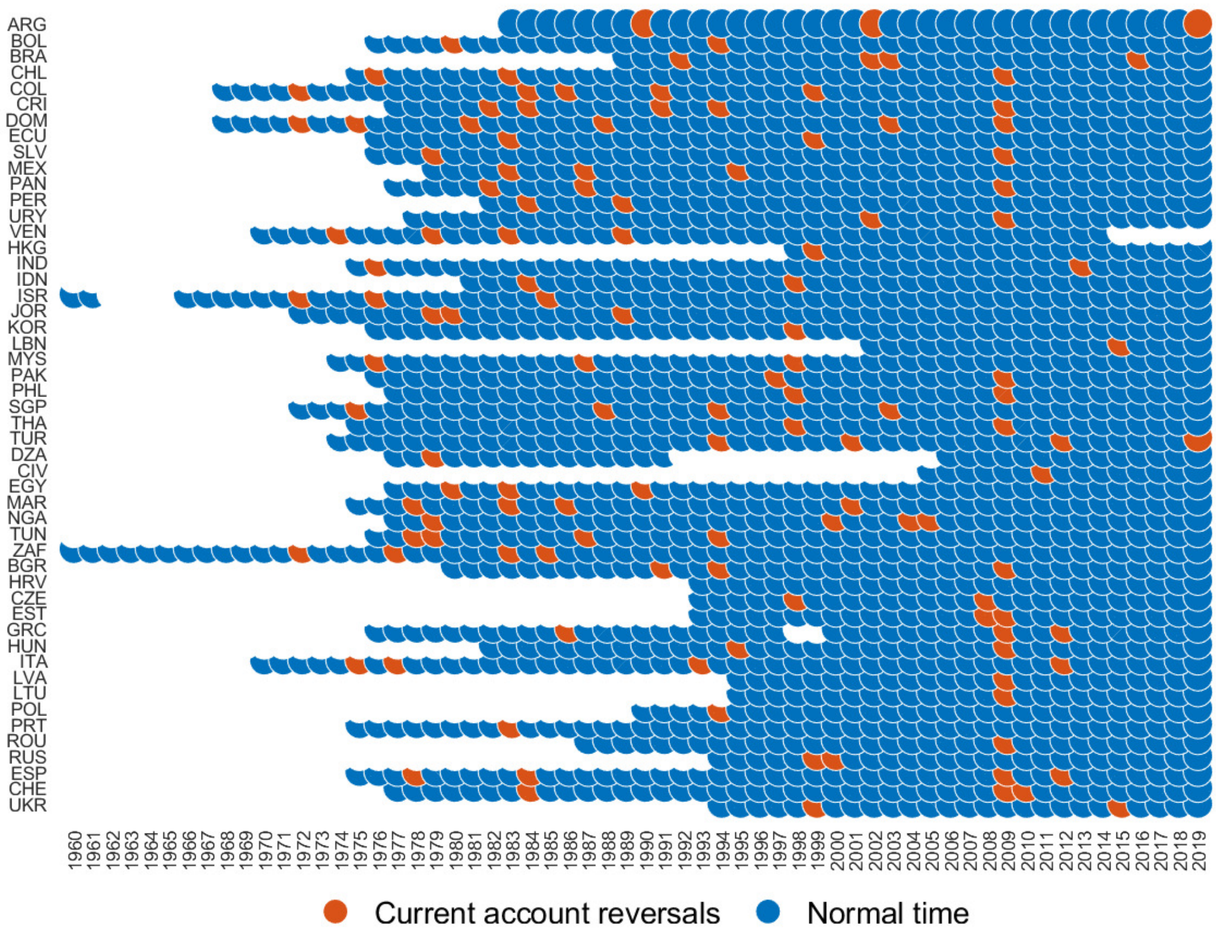
To answer these questions, we build a small open economy model in which sudden stops occur endogenously. In our analysis, households face an occasionally binding collateral constraint—a framework extensively employed in the literature on sudden stop crises (Mendoza, 2002, Mendoza, 2010, and Bianchi, 2011 among others). The model incorporates the amplification mechanism of Fisherian debt-deflation through pecuniary externalities, which is crucial for replicating the dynamics of sudden stops. The binding of the collateral constraint represents a sudden stop, where the country's access to international financial markets becomes restricted, leading to a drying up of capital inflows and potentially triggering a severe domestic recession

[1]The resulting average probability of current account reversals is 5.99 percent per year, which is similar to the estimate reported in Eichengreen, Gupta, and Mody (2006) (5.5 percent per year).

[2]Our dataset includes countries examined in previous research, such as Calvo, Izquierdo, and Talvi (2006) and Liu (2022). Table 5 in Appendix C provides detailed data along with summary statistics.

[3]See also Figure 8 in Appendix C, which shows the number of current account reversals occurring each year and across different regions.

Figure 1: Current Account Reversals in Emerging Economies



Note: Blue dots represent the sample periods, while red dots indicate periods of current account reversals. Current account reversals are defined as consecutive periods when the year-on-year increase in the current account-to-GDP ratio exceeds 1.5 standard deviations from its mean. Our sample consists of 50 emerging countries, including Argentina (ARG), Bolivia (BOL), Brazil (BRA), Chile (CHL), Colombia (COL), Costa Rica (CRI), the Dominican Republic (DOM), Ecuador (ECU), El Salvador (SLV), Mexico (MEX), Panama (PAN), Peru (PER), Uruguay (URY), Venezuela (VEN) from Latin America, Hong Kong (HKG), India (IND), Indonesia (IDN), Israel (ISR), Jordan (JOR), South Korea (KOR), Lebanon (LBN), Malaysia (MYS), Pakistan (PAK), the Philippines (PHL), Singapore (SGP), Thailand (THA), Türkiye (TUR) from Asia, Algeria (DZA), Cote d'Ivoire (CIV), Egypt (EGY), Morocco (MAR), Nigeria (NGA), Tunisia (TUN), South Africa (ZAF) from Africa, Bulgaria (BGR), Croatia (HRV), Czechia (CZE), Estonia (EST), Greece (GRC), Hungary (HUN), Italy (ITA), Latvia (LVA), Lithuania (LTU), Poland (POL), Portugal (PRT), Romania (ROU), Russian Federation (RUS), Spain (ESP), Switzerland (CHE), Ukraine (UKR) from Europe.

through debt-deflation.

We analytically show that when households expect future sudden stops to be more likely, they increase precautionary savings today. These precautionary savings directly reduce the likelihood of sudden stops since the probability of a sudden stop is endogenous and depends on the current level of external debt. Furthermore, when the constraint binds and a sudden stop actually occurs, the additional income from precautionary savings mitigates debt deflation by appreciating the collateral price. This paper demonstrates that a trade-off can emerge between the frequency of sudden stops and the severity of current account reversals.

We then calibrate the theoretical model using data from emerging economies and numerically illustrate the above mechanism. Specifically, we model sudden stops as a regime switching problem between a non-binding regime and a binding (sudden stop) regime, solving the model using the perturbation method suggested by Maih (2015).

Using regime-specific impulse response functions, we show that the transition probability from the non-binding to the binding regime plays a critical role in shaping expectations about future sudden stops and their associated economic disruptions. Specifically, in the non-binding regime, when precautionary motives dominate standard consumption-smoothing motives, households reduce external debt following recessionary income shocks instead of increasing it. Furthermore, through simulations of the theoretical model, we show that the severity of sudden stops is lower when the frequency of such episodes is higher. This is due to the precautionary measures taken by households, which reduce the contraction of output when the binding constraint is triggered.

Finally, we analyze the Ramey optimal policy and quantify the welfare losses associated with sudden stops of varying frequencies. We find that welfare losses are higher when the frequency of sudden stops increases, as debt deflation driven by pecuniary externalities becomes more significant with each episode.

Through the lens of our analysis, we offer several policy recommendations. It is crucial to inform private agents if they fail to accurately assess the likelihood of future sudden stops, as such policies would encourage more precautionary savings, helping to mitigate crises both ex-ante and ex-post, as suggested by our theoretical model. We also highlight the importance of macroprudential policies, such as capital controls, to attenuate debt deflation arising from pecuniary externalities. We find that optimal capital controls are more desirable in economies with a high frequency of sudden stops.

Lastly, we provide supportive evidence from actual data. In our sample of 50 emerging economies, we show that current account improvements are less severe in countries that have experienced more frequent sudden stops, confirming the existence of a frequency-severity trade-off.

The paper is related to the large body of literature that explains the dynamics of sudden stop crises and investigates effective policy interventions using models with credit frictions. In addition to those listed above, the preceding literature includes Benigno et al. (2013), Benigno et al. (2016), Schmitt-Grohé and Uribe (2017), Bianchi and Mendoza (2018), Devereux, Young, and Yu (2019), Ma (2020), Ottonello (2021), Chi, Schmitt-Grohé, and Uribe (2021), Coulibaly (2023), Benigno et al. (2023), and Davis, Devereux, and Yu (2023), among many others. To our knowledge, this paper is the first to point out the trade-off between the frequency and severity of sudden stops by focusing on the role of agents' expectations for such crises.

Additionally, the paper is related to the literature on agents' expectations regarding economic regimes within a regime switching framework. Bianchi (2013) demonstrate how counterfactual beliefs about monetary policy stances can change macroeconomic dynamics. Bianchi and Ilut (2017) extend this discussion to the monetary and fiscal policy mix. We contribute to this body of literature by modeling sudden stops of capital inflows as a distinct economic regime and showing how expectations for the sudden stop regime affect business cycles.

The paper also builds on existing work that models occasionally binding constraints as a regime switching problem within rational expectation DSGE models. Binning and Maih (2017) demonstrate how to model various types of occasionally binding constraints using regime switching and how to solve the resulting regime switching DSGE models. Benigno et al. (2020) estimate a small open economy model of sudden stops—similar to Mendoza (2010)—using Bayesian techniques by modeling the occasionally binding collateral constraint as a regime switching problem and solving it with the perturbation method proposed by Foerster et al. (2016). While most of the literature on sudden stops relies on global solution methods for these models, our paper belongs to the category of studies that apply the perturbation method, which offers significant computational advantages and greater flexibility.

The remainder of the paper is organized as follows. Section 2 introduces the model environment. The intuition behind the theoretical model is developed in Section 3. Section 4 discusses the solution method and calibration, and Section 5 presents the results of the numerical analysis. Section 6 discusses the Ramsey optimal capital control tax and provides a welfare analysis. Section 7 summarizes the empirical observations, and Section 8 concludes.

2 The Model

The small open economy model is adopted from Bianchi (2011). The representative household maximizes lifetime expected utility,

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma} - 1}{1 - \sigma}$$

where c_t represents consumption in period t. The parameters $0 < \beta < 1$ and $\sigma > 0$ determine the discount factor and the inverse of the intertemporal elasticity of substitution, respectively. The consumption basket consists of tradable and nontradable goods consumption and is aggregated using a CES (constant elasticity of substitution) function:

$$c_t = \left[a\left(c_t^T\right)^{1-\frac{1}{\xi}} + (1-a)\left(c_t^N\right)^{1-\frac{1}{\xi}}\right]^{\frac{1}{1-\frac{1}{\xi}}}$$

where c_t^T and c_t^N denote the tradable and the nontradable goods consumption in period t. The parameter $0 < a < 1$ determines the weight of tradable goods consumption in the consumption basket, while $\xi > 0$ represents the intratemporal elasticity of substitution between tradable and nontradable goods.

In each period t, the household receives endowments of tradable and nontradable goods, denoted by y_t^T and y_t^N. Both endowments are exogenously given. The individual household is allowed to borrow from the rest of the world at the net interest rate r through one-period, non-state-contingent debt denominated in units of tradable goods. Specifically, the budget constraint in period t is given by

$$c_t^T + p_t c_t^N + d_t + \frac{\phi}{2}\left(d_{t+1} - d\right)^2 = y_t^T + p_t y_t^N + \frac{d_{t+1}}{1+r},$$

where d_{t+1} denotes the amount of borrowing in period t, and p_t is the relative price of nontradable goods in terms of tradable goods. The parameter ϕ governs the size of the portfolio adjustment cost, and d is the steady-state level of borrowing.[4]

Access to the international financial market is constrained. In every period, the individual household is allowed to borrow only up to a fraction of their current income. Put differently, the household faces the occasionally binding collateral constraint:

$$d_{t+1} \leq \kappa\left(y_t^T + p_t y_t^N\right),$$

where $\kappa > 0$ determines the tightness of the constraint. The collateral constraint amplifies recessionary shocks through debt-deflation when it binds, playing a central role in explaining sudden-stop dynamics, as explored by Mendoza (2010) and others. When the constraint binds following adverse income shocks, the level of borrowing, and hence consumption, falls below the desired level. While the price of tradables is tied to the international market, the relative price of nontradables, p_t, adjusts downward. As a result, the real value of collateral, which endogenously determines the level of borrowing, declines. This feedback loop, known as debt-deflation, amplifies the recession.

The optimal decisions of the individual household are summarized by the following optimality conditions:

$$c_t^{\frac{1}{\xi}-\sigma} a\left(c_t^T\right)^{-\frac{1}{\xi}} = \lambda_t, \tag{1}$$

[4] The adjustment cost is introduced solely to induce stationarity in the small open economy model (Schmitt-Grohe and Uribe, 2003). In the original model of Bianchi (2011), stationarity is ensured through the calibration $\beta < \frac{1}{1+r}$ using global solution methods.

$$p_t = \frac{1-a}{a}\left(\frac{c_t^T}{c_t^N}\right)^{\frac{1}{\xi}}, \tag{2}$$

$$\lambda_t\left\{\frac{1}{1+r} - \phi\left(d_{t+1} - d\right)\right\} - \mu_t = \beta E_t \lambda_{t+1}, \tag{3}$$

$$\mu_t\left\{\kappa\left(y_t^T + p_t y_t^N\right) - d_{t+1}\right\} = 0, \tag{4}$$

and

$$\mu_t \geq 0,$$

where λ_t denotes the Lagrange multiplier on the budget constraint, and μ_t is the Lagrange multiplier on the collateral constraint.

In this environment, a pecuniary externality arises because each individual household does not consider how the relative price of nontradables, p_t, varies with domestic absorption. As a result, private individuals accumulate less precautionary savings, and the level of debt exceeds the socially optimal level.[5]

The market-clearing conditions for nontradable and tradable goods are, respectively,

$$c_t^N = y_t^N, \tag{5}$$

and

$$c_t^T + d_t + \frac{\phi}{2}\left(d_{t+1} - d\right)^2 = y_t^T + \frac{d_{t+1}}{1+r}. \tag{6}$$

In the model, the current account in period t is given by $CA_t \equiv d_t - d_{t+1}$. Additionally, GDP is given by $y_t \equiv y_t^T + p_t y_t^N$.

Finally, the exogenous endowments follow a bivariate AR(1) process as follows:

$$\begin{bmatrix} \ln y_t^T \\ \ln y_t^N \end{bmatrix} = \begin{bmatrix} 0.901 & -0.453 \\ 0.495 & 0.225 \end{bmatrix} \begin{bmatrix} \ln y_{t-1}^T \\ \ln y_{t-1}^N \end{bmatrix} + \varepsilon_t,$$

where $\varepsilon_t \sim N\left(\emptyset, \Sigma\right)$ and $\Sigma = \begin{bmatrix} 0.00219 & 0.00162 \\ 0.00162 & 0.00167 \end{bmatrix}$. The parameter values are taken from Bianchi (2011).

[5]Some examples of underborrowing can be found in Benigno et al. (2013), Schmitt-Grohé and Uribe (2021), Chi, Schmitt-Grohé, and Uribe (2021), and Davis, Devereux, and Yu (2023).

2.1 Occasionally Binding Collateral Constraint with Regime-Switching

To explicitly handle households' expectations regarding the loss of access to the international financial market, we model sudden stops in capital inflows as a distinct regime of the economy. Following Binning and Maih (2017), we reformulate the slackness condition (4) within a regime-switching framework. We introduce a two-state Markov chain, where one state represents a non-binding collateral constraint and the other represents a binding collateral constraint. In the binding state, the level of borrowing is lower than the desired level, capturing the situation where access to the international financial market is restricted, i.e., a sudden stop. The first state is defined as the non-binding state ($\mathcal{N}$), and the second state is defined as the binding state ($\mathcal{B}$).[6] We then introduce the regime-dependent parameter $\boldsymbol{o}(s_t)$, where $s_t = \mathcal{N}, \mathcal{B}$, which takes the value 0 or 1 according to the Markov chain. We assume that $\boldsymbol{o}(\mathcal{N}) = 1$ and $\boldsymbol{o}(\mathcal{B}) = 0$. In this environment, the slackness condition (4) is rewritten as

$$\boldsymbol{o}(s_t)\,\mu_t + (1 - \boldsymbol{o}(s_t))\left\{\kappa\left(y_t^T + p_t y_t^N\right) - d_{t+1}\right\} = 0. \tag{7}$$

In the non-binding state, this equation simplifies to $\mu_t = 0$ with $\boldsymbol{o}(\mathcal{N}) = 1$. In the binding state, it reduces to $\kappa\left(y_t^T + p_t y_t^N\right) = d_{t+1}$ with $\boldsymbol{o}(\mathcal{B}) = 0$.

The economy transitions across two states depending on the following transition probability matrix of the Markov chain,

$$P_t = \begin{bmatrix} 1 - P_t^{\mathcal{NB}} & P_t^{\mathcal{NB}} \\ P_t^{\mathcal{BN}} & 1 - P_t^{\mathcal{BN}} \end{bmatrix},$$

where $P_t^{\mathcal{NB}}$ is the transition probability of switching from the non-binding state ($\mathcal{N}$) to the binding state ($\mathcal{B}$) from period t to $t+1$, and $P_t^{\mathcal{BN}}$ is the probability of switching from the binding state ($\mathcal{B}$) to the non-binding state ($\mathcal{N}$) from period t to $t+1$. The probabilities of remaining in the non-binding and binding states are given by $1 - P_t^{\mathcal{NB}}$ and $1 - P_t^{\mathcal{BN}}$, respectively. In this environment, as $P_t^{\mathcal{NB}}$ increases and $P_t^{\mathcal{BN}}$ decreases, the economy becomes more likely to be in the binding regime. Importantly, people form rational expectations about future economic regimes based on these transition probabilities.

We assume that the probability of switching from the non-binding state to the binding state varies over time depending on the slackness of the collateral constraint and impose the following functional form:

$$P_t^{\mathcal{NB}} = \frac{1}{1 + \left(\frac{1}{\varphi} - 1\right)\exp\left\{g\left(d_{t+1}^* - d^*\right)\right\}}, \tag{8}$$

where $d_{t+1}^* = \kappa\left(y_t^T + p_t y_t^N\right) - d_{t+1}$ represents the slackness of the collateral constraint, and d^* is

[6] Since there is only one Markov chain, we use the terms "state" and "regime" interchangeably.

its steady-state value.[7] The parameter $g > 0$ governs the steepness of the function. At the steady state, the transition probability is equal to a parameter $0 < \varphi \leq 1$.[8]

The probability of switching from the binding state to the non-binding state is assumed to be constant over time for simplicity, given by $P_t^{\mathcal{BN}} = P^{\mathcal{BN}}$.

3 Precautionary Saving and Debt-Deflation in Sudden Stops

How do expectations of the binding constraint, and thus the probability of it binding, matter? We show that: 1) A higher expectation of the collateral constraint binding induces greater precautionary saving ex-ante. 2) Greater precautionary saving reduces the probability of the constraint binding. 3) Greater precautionary saving unintentionally mitigates the effect of debt-deflation once the constraint binds.

The first point is best described by examining the Euler equation. When the constraint is not binding in period t but is expected to bind in period $t+1$, iterating forward the Euler equation yields:

$$\frac{\lambda_t}{1+r} = \beta^2(1+r)E_t\lambda_{t+2} + \beta(1+r)E_t\mu_{t+1},$$

where, for simplicity, we ignore the debt-adjustment cost. Note that households save more (i.e., a higher value of λ_t, indicating a higher marginal utility of consumption, other things being equal) when the collateral constraint is expected to bind ($E_t\mu_{t+1} > 0$) in future periods than they would in an environment where the constraint is not expected to bind. This occurs because the possibility of a binding constraint provides an additional marginal value of saving, captured by the discounted expected shadow value of the collateral constraint, $\beta(1+r)E_t\mu_{t+1}$. Thus, the stronger the expectation that the collateral constraint will bind in future periods, the greater the incentive for precautionary saving. Observe that $E_t\mu_{t+1} > 0$, resulting from the expected binding constraint, is qualitatively similar to a surge in the country risk premium in a future period.

A higher expectation of the binding constraint $E_t\mu_{t+1}$ depends on the transition probability from the non-binding to the binding regime, $P_t^{\mathcal{NB}}$. Since $P_t^{\mathcal{NB}}$ is a function of d_{t+1} as shown in equation (8), households choose their debt level with the understanding that precautionary saving lowers the probability of a sudden stop. Specifically, given a positive value of $g > 0$, increased precautionary saving in the non-binding regime, which corresponds to a lower level of debt d_{t+1}, makes the binding constraint more slack ($d_{t+1}^* - d^*$). Consequently, the probability of a sudden stop decreases, leading to our second point: precautionary saving mitigates sudden

[7] We assume that the transition probability depends on the deviation of the constraint from its steady-state value, $d_{t+1}^* - d^*$, rather than on d_{t+1}^* itself. This specification is necessary because the solution method employed requires that variables influencing transition probabilities have unique steady state values that do not depend on the regime. See Maih (2015) for details.

[8] Households take the transition probability into account when forming rational expectations. They recognize that precautionary saving, which lowers the value of d_{t+1}, directly reduces the transition probability from the non-binding to the binding state. However, they do not fully internalize its impact on the collateral price p_t, as previously discussed. Consequently, the parameter g governs the extent of this feedback.

stops by directly reducing their likelihood.

Note that a lower transition probability to the sudden stop regime also reduces the incentive for precautionary saving, creating a feedback loop depending on the value of φ and g as well as the functional form of $P_t^{\mathcal{NB}}$. However, within this feedback loop, households fail to recognize that precautionary saving raises the collateral price p_t through pecuniary externalities, a point we will elaborate on further.

The aforementioned higher precautionary saving ex-ante allows for a higher level of borrowing when the constraint actually binds. This occurs *unintentionally*, as households fail to recognize the impact of precautionary saving on the collateral price. To see this, suppose that in period t, the collateral constraint is slack, but in period $t+1$, it binds. In such a case, the level of borrowing from period $t+1$ into $t+2$ is determined by:

$$d_{t+2} = \kappa \left(y_{t+1}^T + p_{t+1} y_{t+1}^N \right).$$

The price of collateral is expressed as[9]

$$p_{t+1} = \frac{1-a}{a} \left(\frac{y_{t+1}^T + \frac{d_{t+2}}{1+r} - d_{t+1}}{y_{t+1}^N} \right)^{\frac{1}{\xi}}.$$

Thus, given any realization of exogenous endowments, higher ex-ante precautionary saving (i.e., lower d_{t+1}) results in a higher price of collateral p_{t+1} and a higher level of borrowing d_{t+2} under the binding collateral constraint. Therefore, as households more strongly expect future bindings of the collateral constraint, the decline in capital inflows due to the binding constraint becomes smaller, leading to a milder sudden stop.

Put differently, lower borrowing today for tradable goods due to precautionary behavior—driven by the expected surge in borrowing costs—leaves more income available in future periods. Since the price of tradables cannot decline because of the law of one price (LOP), the price of non-tradables increases as higher income leads to greater demand. This, in turn, raises the collateral value (GDP).[10]

[9] We replace tradable consumption c_t^T in equation (2) using the resource constraint (6).

[10] The lower borrowing in period t may tighten the collateral constraint in period t, rather than relaxing it, if the value of collateral declines by more than one-for-one with the decrease in borrowing. As Schmitt-Grohé and Uribe (2021) document, in such a case, a self-fulfilling binding of the collateral constraint can occur. However, we adopt a parameterization that excludes this possibility throughout the paper.

4 Solution Method and Calibration

We solve the model relying on the perturbation approach developed by Maih (2015) and approximate the model around the regime-specific steady state accurately up to the first order.[11] In our calibration, the subjective discount factor and capital adjustment costs are regime-specific. Using the switching parameter $\boldsymbol{o}(s_t)$, the subjective discount factor is given by $\beta = \boldsymbol{o}(s_t)\,\beta_{\mathcal{N}} + (1-\boldsymbol{o}(s_t))\,\beta_{\mathcal{B}}$. Specifically, we set $\beta_{\mathcal{N}} = \frac{1}{1+r}$ in the non-binding regime, while we set $\beta_{\mathcal{B}} < \frac{1}{1+r}$ in the binding regime to ensure a positive shadow value of the constraint, $\mu > 0$, at the steady state.[12]

Additionally, we assume that the portfolio adjustment cost exists only in the non-binding regime. This is because the role of this cost as a stationarity-inducing device is valid only in the non-binding regime, where the level of borrowing is determined by the Euler equation. In the binding regime, the amount of borrowing is determined by the value of collateral, and hence the debt adjustment cost no longer ensures the stationarity of borrowing. Using the switching parameter $\boldsymbol{o}(s_t)$, the parameter ϕ is thus given as $\phi = \boldsymbol{o}(s_t)\,\phi_{\mathcal{N}} + (1-\boldsymbol{o}(s_t))\,\phi_{\mathcal{B}}$, where $\phi_{\mathcal{B}} = 0$.

The parameter for the tradable share a, the discount factor in the binding regime $\beta_{\mathcal{B}}$, the portfolio adjustment cost in the non-binding regime $\phi_{\mathcal{N}}$, and the fraction of income that can be pledged as collateral κ are set by minimizing the distance between the data moments and those implied by the simulation of the theoretical model. Specifically, we target four moments with equal weight: a debt-to-GDP ratio of 29 percent, the share of tradable production in total production at 32 percent, the probability of sudden stop crises at 5.5 percent, and the standard deviation of the current account-to-GDP ratio of 2.8 percent. These moments are typical for emerging economies prone to sudden stop episodes.[13] Following the literature, we define sudden stop crises as events where the collateral constraint binds and the current account is at least one standard deviation above its mean. The resulting parameter values are $\beta_{\mathcal{B}} = 0.9051$, $a = 0.3013$, $\kappa = 0.3120$, and $\phi_{\mathcal{N}} = 29.3235$.[14]

We calibrate the transition probability of switching from the non-binding to the binding

[11] All numerical analyses in this paper are conducted using the RISE toolbox (Maih, 2015). The solution method allows for multiple steady states and endogenous transition probabilities, in contrast to the perturbation method proposed by Foerster et al. (2016), which perturbs the model around a unique steady state evaluated at the ergodic mean of switching parameters and only accounts for a time-invariant transition probability matrix. Appendix A summarizes the regime-specific steady state.

[12] Assuming a lower subjective discount factor than the pecuniary discount factor, $\beta_{\mathcal{N}} < \frac{1}{1+r}$, is common to induce stationarity. However, with this calibration, the shadow value of the collateral constraint is not zero in the steady state of the non-binding regime. We set $\beta_{\mathcal{N}} = \frac{1}{1+r}$ to ensure $\mu = 0$ in the steady state of the non-binding regime in equation (3).

[13] As in Bianchi (2011), a debt-to-GDP ratio is a net foreign asset position-to-GDP ratio obtained from Lane and Milesi-Ferretti (2001), and the probability of sudden stop crises is the value reported by Eichengreen, Gupta, and Mody (2006) with 24 emerging market countries for the period 1980 to 2003. The share of tradable production is the average value in Argentina for the period 1980 to 2022 in the World Development Indicators data. The standard deviation of the current account-to-GDP ratio is the value reported in Bianchi (2011).

[14] The resulting moments are as follows: a debt-to-GDP ratio of 28.67 percent, the share of tradable production in total production at 31.16 percent, the probability of sudden stop crises at 5.44 percent, and the standard deviation of the current account-to-GDP ratio of 2.67 percent.

Table 1: Calibration

	Parameter	Value
σ	Inverse of intertemporal elasticity of substitution	2
ξ	Intratemporal elasticity of substitution	0.83
r	Real interest rate	0.04
a	Weight of tradable goods	0.3013
κ	Collateral	0.3120
$\beta_{\mathcal{N}}$, $\beta_{\mathcal{B}}$	Subjective discount factor	0.9615, 0.9051
$\phi_{\mathcal{N}}$, $\phi_{\mathcal{B}}$	Debt adjustment cost	29.3235, 0
φ	$P_t^{\mathcal{NB}}$ in the steady state	0.08
g	Steepness of $P_t^{\mathcal{NB}}$	10
$P^{\mathcal{BN}}$	Probability of switching from binding to non-binding	0.99

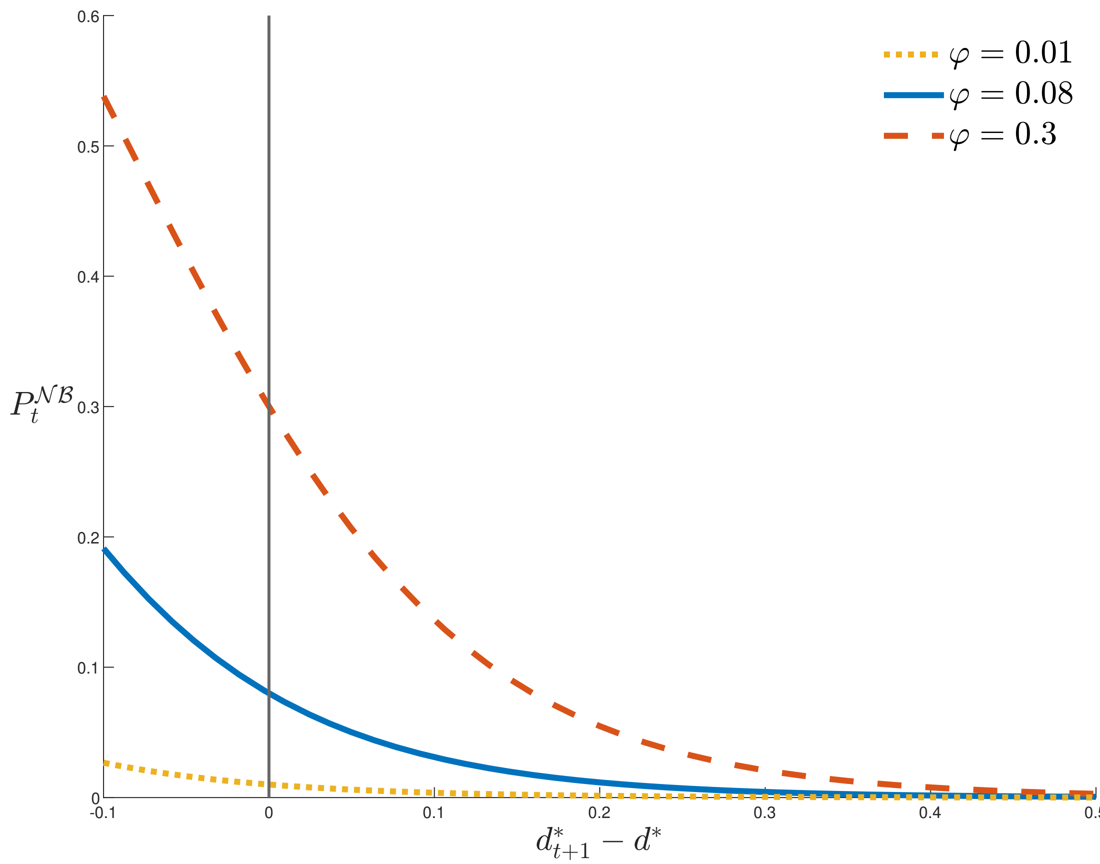
regime so that the probability decreases (increases) as the collateral constraint becomes more (less) slack. We set $\varphi = 0.08$, which yields an average duration of the non-binding regime of 12.5 years if d^*_{t+1} remains at the steady-state level of the non-binding regime. This is consistent with the findings of Schmitt-Grohé and Uribe (2017), who report that the collateral constraint binds once every 12 years in their numerical analyses. The parameter g controls the sensitivity from the slackness of the constraint into the transition probability from the non-binding to the binding regime. Since we do not have a strong justification for choosing this parameter value, we set $g = 10$ arbitrarily while performing a sensitivity analysis with different parameter values.[15] Figure 2 plots the transition probability from the non-binding to the binding regime, $P_t^{\mathcal{NB}}$, with the benchmark case of $\varphi = 0.08$ shown with solid line. To illustrate the impact of this parameter value, we also show the cases of hypothetically lower and higher values of φ, represented by dotted and dashed lines, respectively. With $\varphi = 0.3$, the probability of moving from the non-binding to the binding regime is higher than in the other two cases at any level of slackness in the collateral constraint. On the other hand, with $\varphi = 0.01$, the probability of switching to the binding regime is lower than in the other two cases at any level of slackness in the constraint. We set the transition probability from the binding to the non-binding as $P^{\mathcal{BN}} = 0.99$, which yields an average duration of about one year for the binding regime.[16]

Finally, following Bianchi (2011), the values for the inverse of the intertemporal elasticity of substitution, the intratemporal elasticity of substitution between tradable and nontradable consumption, and the real interest rate are set as $\sigma = 2$, $\xi = 0.83$, and $r = 0.04$, respectively. Table 1 summarizes the parameter values.

[15]The impact of this feedback parameter on the transition probability and macroeconomic dynamics is qualitatively similar to that implied by φ, which determines the steady-state value of the transition probability. See Section 5.1.2.

[16]Eichengreen and Gupta (2016) reports the average duration of sudden stop episodes of four quarters.

Figure 2: Transition Probabilities



Note: The figure shows the transition probabilities, $P_t^{\mathcal{NB}}$, under different values of φ. The dotted, solid and dashed line represents the transition probabilities with $\varphi = 0.01,\ 0.08,$ and 0.3, respectively. Each intersection with the vertical solid line indicates the value of the probability in the steady state.

5 Quantitative Analysis of Sudden Stops and Economic Adjustments

In this section, we quantitatively explore the mechanism described in Section 3. First, we show that as the frequency of binding increases, precautionary savings in the non-binding regime also increase. Using impulse response functions, we characterize the dynamics of adjustments following recessionary income shocks. Second, through model simulations, we show that when the constraint actually binds and thus a sudden stop takes place, an economy with a higher frequency of bindings experiences a milder debt-deflation and recession, thanks to the precautionary behavior of private agents before the crisis.

5.1 Possible Future Sudden Stops and Precautionary Saving

To demonstrate how expectations of sudden stops in capital inflows affect household behavior, we present the regime-specific impulse response function. Specifically, we focus on the impulse response functions to a recessionary decline in endowment income in the regime where the collateral constraint is not binding. We analyze behavior in the non-binding regime because expectations of the binding regime influence household behavior only in the non-binding regime.[17]

Furthermore, to clarify the mechanism, we isolate the impact of the steady-state transition probability φ from the feedback effect controlled by g in the determination of the transition probability $P_t^{\mathcal{N}\mathcal{B}}$, as shown in equation (8).

5.1.1 Impact of Steady State Transition Probability: φ

Figure 3 presents the regime-specific impulse response functions in the non-binding regime to a one-standard-deviation decrease in tradable endowment income.[18] In the figure, we show the IRFs for two alternative parameterizations of φ compared to the benchmark case of $\varphi = 0.08$. As already shown in Figure 2, with $\varphi = 0.3$, the collateral constraint binds most frequently at any level of slackness in the constraint, and people's expectations of the binding regime are the highest. On the other hand, with $\varphi = 0.01$, the binding regime occurs the least frequently, and expectations are the lowest. To isolate the impact of steady-state transition probability from endogenous feedback effects, we assume that the transition probability $P_t^{\mathcal{N}\mathcal{B}}$ does not respond to financial conditions by setting $g = 0$ in the current exercise. As a result, the transition probabilities become constant and equal to the value of φ in each IRFs.[19]

[17] Note that when the constraint is binding, the level of borrowing is not determined in a forward-looking manner through the Euler equation. Instead, it is determined by the value of collateral. Thus, expectations of the future regime do not affect household behavior in the binding regime.

[18] Note that with only the tradable endowment shock, nontradable endowment also changes because 1) the shocks are correlated, and 2) there is a spillover from tradable to nontradable endowments in the AR(1) process.

[19] Note that the probability of switching from the binding to the non-binding regime, $P^{\mathcal{B}\mathcal{N}}$, does not generate any divergence in the formation of household expectations while they are in the non-binding regime across these three parameterizations.

The adjustment dynamics to the recessionary shock when people believe the economy will switch to the binding regime with relatively low probabilities is consistent with what the intertemporal theory of the current account suggests (the cases with $\varphi = 0.01$ and $\varphi = 0.08$, shown with dotted and solid lines, respectively). The temporary fall in income is absorbed by an increase in borrowing and a deterioration of the current account. Consumption of tradable goods falls on impact; however, international borrowing mitigates the decline in consumption and boosts the price of nontradable goods in subsequent periods. In short, households use the current account to smooth consumption, as standard theory suggests.

However, the adjustment dynamics become very different when the probability of the binding regime is much higher, such as in the case of $\varphi = 0.3$, shown with dashed lines in the figure. In response to the same recessionary income shock, borrowing falls and the current account improves on impact. With a sufficiently high probability of switching to the binding regime, the precautionary saving motive dominates the consumption-smoothing motive. In subsequent periods, borrowing begins to increase and the current account deteriorates, as the motive for consumption smoothing takes over, given the persistence of the recessionary shock.

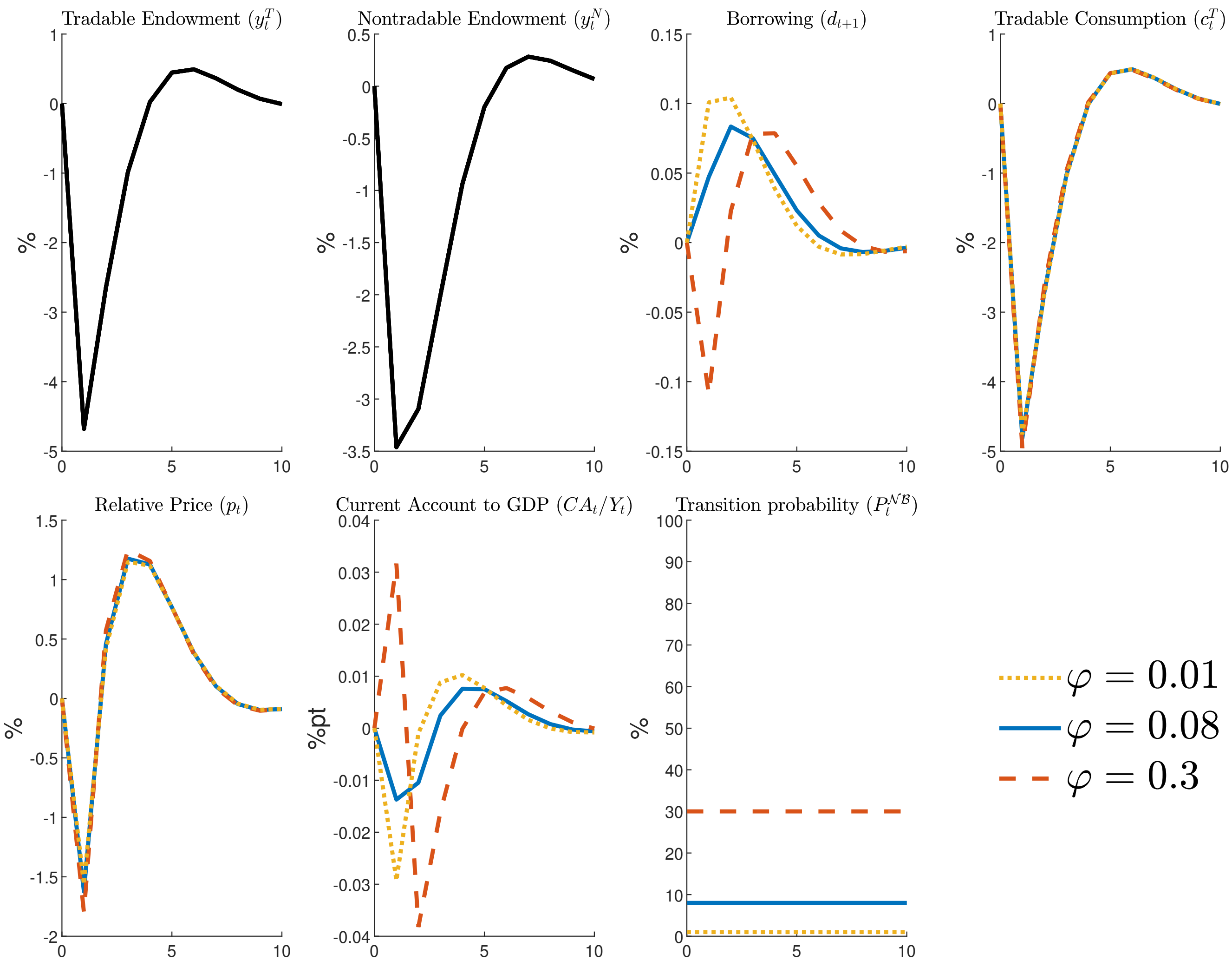
The dynamics of tradable consumption and the relative price of nontradable goods are quantitatively similar across all three parameterizations. Consumption of tradables falls more on impact as the precautionary motive increases due to a higher probability of binding, because households find it optimal to cut consumption today when the likelihood of a future sudden stop increases. Accordingly, the price of nontradables falls more on impact as the probability of binding increases, since the contraction in income requires a sharper adjustment in relative prices.

5.1.2 Feedback Effects through Endogenous Transition Probability: g

Recalling equation (8), the steepness of $P_t^{\mathcal{NB}}$ with respect to financial conditions is controlled by the parameter g. It thus determines the degree of endogenous feedback in the transition probability $P_t^{\mathcal{NB}}$. As discussed, when households reduce debt, the likelihood of a sudden stop $P_t^{\mathcal{NB}}$ decreases. On the other hand, a declining $P_t^{\mathcal{NB}}$ discourages households from accumulating precautionary savings and motivates them to borrow more, thereby creating a feedback loop. Figure 4 verifies this point. The figure shows the regime-specific IRFs in the non-binding regime in response to a one-standard-deviation decrease in tradable endowment income under alternative values for g. Specifically, we consider the cases with $g = 250$ and $g = 1500$, shown with solid and dashed lines, respectively, in addition to the baseline case of $g = 10$ shown with dotted line.

With relatively lower values of g (e.g., $g = 10$ and $g = 250$), the adjustments are qualitatively similar and consistent with what we expect from the standard intertemporal theory of current account: households use the current account to smooth their consumption. Nonetheless, an increase in borrowing and a deterioration of the current account are smaller with a higher g, indicating variations in the feedback effect through changes in the transition probability.

Figure 3: IRFs to Recessionary Endowment Shock: Alternative φ



Note: The figure displays regime-specific impulse response functions in the non-binding regime following a one-standard-deviation decline in the tradable endowment. Each IRF is expressed as a percentage deviation from the steady state of the non-binding regime, except for the current account-to-GDP ratio, which is expressed as a percentage point deviation from the steady state. The dotted, solid, and dashed lines represent IRFs with $\varphi = 0.01$, 0.08, and 0.3, respectively. The transition probability $P_t^{\mathcal{NB}}$ remains constant at its steady-state level when $g = 0$.

Furthermore, the dynamics of adjustment differ significantly when the transition probability is much more sensitive to financial conditions, such as when $g = 1500$, shown with dashed lines. Since the transition probability rises with an increase in debt, households are more motivated to save, resulting in an initial decline in borrowing and an increase in the current account in response to the recessionary income shock. The resulting reduction in borrowing translates into a significant drop in the probability of a sudden stop in subsequent periods, as shown in the figure, confirming the feedback effect.

Summing up, a high expectation of the binding regime motivates collateral-constrained households to save more in a precautionary manner. When the precautionary saving motive dominates the consumption-smoothing motive, we observe different dynamics in the current account adjustment compared to those explained in the standard model without the possibility of binding. As demonstrated, the impact of a higher g is qualitatively similar in motivating the precautionary saving to that of a higher value of φ, which controls the steady-state transition probability.

5.2 Sudden Stops and Debt Deflation

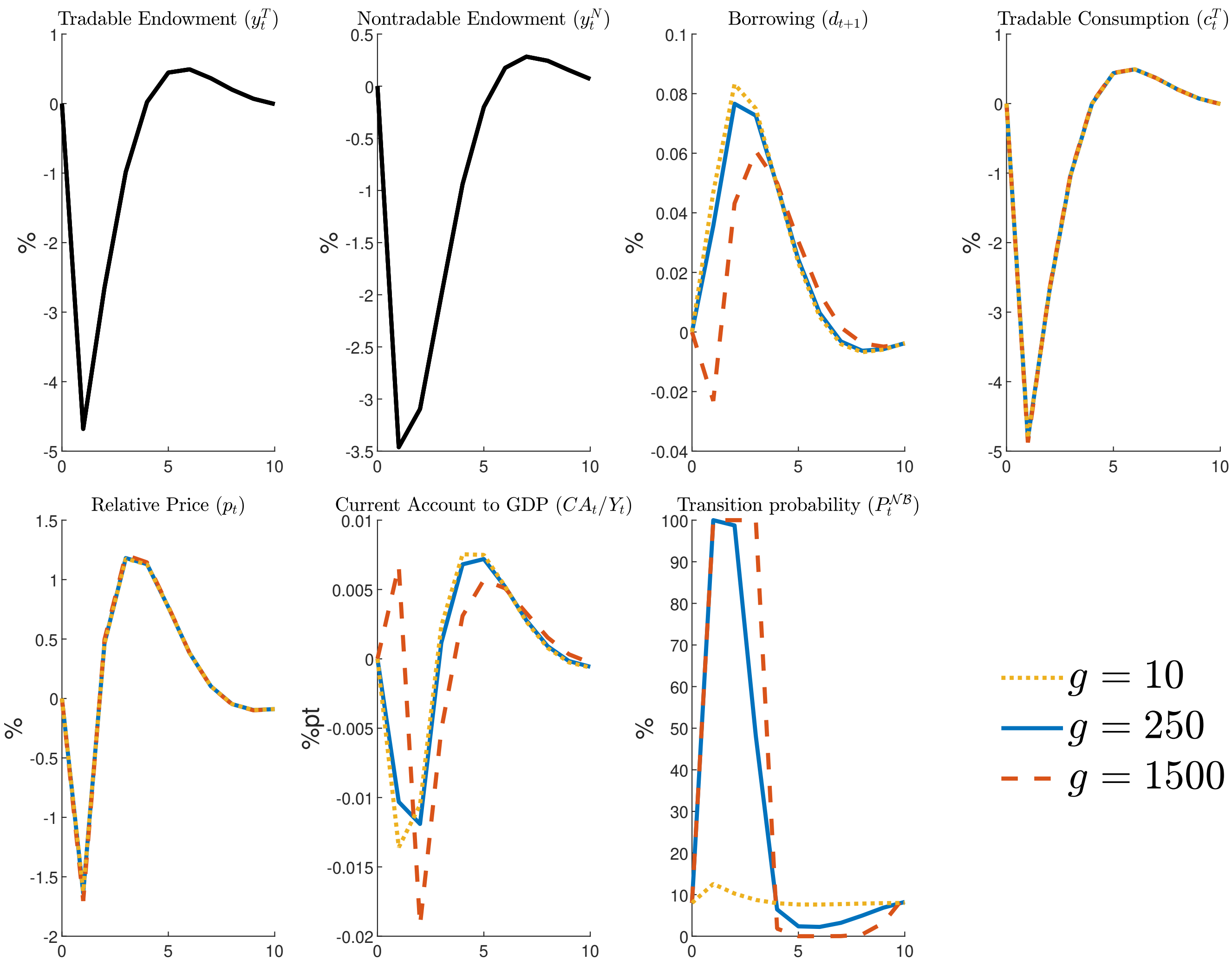
We now demonstrate quantitatively that a higher frequency of sudden stops leads to smaller declines in external debt when a crisis actually occurs, resulting in a less severe recession. To do so, we simulate the model for $20,000$ periods under different values of $\varphi = 0.01, 0.08$, and 0.3, using the same realization of exogenous disturbances across these parameterizations.

First, we show the dynamics of sudden stop crises implied by the theoretical model. We simulate the model with the baseline calibration of $\varphi = 0.08$ for $20,000$ periods and extract 7-year windows surrounding periods when the economy is in the sudden stop with the binding constraint. Figure 5 shows the average dynamics across all identified windows. In period zero, the economy is in the binding regime. As we observe, borrowing falls, and the current account-to-GDP ratio increases in period zero. Furthermore, tradable consumption and the relative price of nontradables fall, setting the debt-deflation mechanism in motion.

Similarly, having simulated series implied by the theoretical model under different transition probabilities, we identify the periods in which the collateral constraint binds in each series. For each binding episode, we then calculate the cumulative changes in the current account-to-GDP ratio, debt, consumption, the relative price of nontradables, and GDP from their levels one period before binding, while the constraint remains binding. Since there are many binding episodes within the 20,000-period simulation, we average these changes for each variable. Table 2 presents the average changes under different frequencies of the binding constraint.

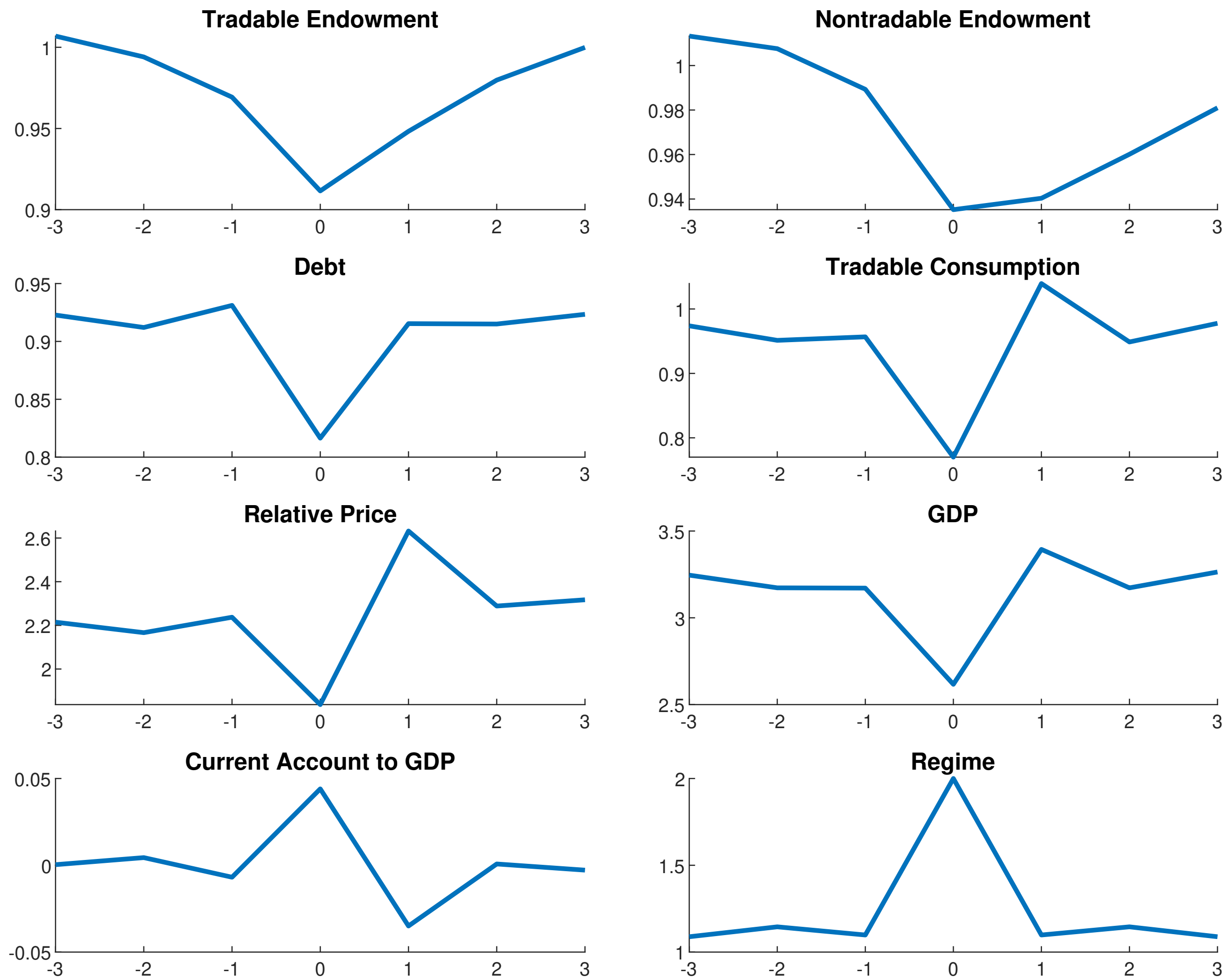
The change in the level of borrowing is -13.93%, -13.67%, and -13.14% under $\varphi = 0.01$, $\varphi = 0.08$, and $\varphi = 0.3$, respectively. This implies that capital inflows decline less when bindings are more frequent. As a result, current account reversals are smaller (larger) with a higher (lower) frequency of binding episodes. On average, across binding events, the current account-to-GDP ratio improves by 5.78%, 5.65%, and 5.53% under $\varphi = 0.01$, $\varphi = 0.08$, and $\varphi = 0.3$, respectively.

Figure 4: IRFs to Recessionary Endowment Shock: Alternative g



Note: The figure displays regime-specific impulse response functions in the non-binding regime following a one-standard-deviation decline in the tradable endowment. Each IRF is expressed as a percentage deviation from the steady state of the non-binding regime, except for the current account-to-GDP ratio, which is expressed as a percentage point deviation from the steady state. The response of the transition probability from the non-binding to the binding regime, $P_t^{\mathcal{NB}}$, is calculated by substituting the response of the slackness of the borrowing constraint, d_{t+1}^*, into equation (8). The dotted, solid, and dashed lines represent IRFs with $g = 10,\ 250,$ and 1500, respectively. The steady-state level of $P_t^{\mathcal{NB}}$ is set to the baseline value, namely $\varphi = 0.08$, across all three cases.

Figure 5: Dynamics of Sudden Stops



Note: The figure shows the average dynamics of sudden stop crises under the baseline calibration of $\varphi = 0.08$. Each dynamic is expressed in levels. The collateral constraint binds in period 0. "Regime" taking the value of 2 implies that the economy is in the binding regime, while taking the value of 1 means it is in the non-binding regime.

Table 2: Frequency and Severity of Sudden Stops

	Low ($\varphi = 0.01$)	Baseline ($\varphi = 0.08$)	High ($\varphi = 0.3$)
Changes during bindings			
Current account to GDP	5.78	5.65	5.53
Debt	−13.93	−13.67	−13.14
Consumption	−11.22	−11.12	−10.99
Relative price	−19.42	−18.99	−18.48
GDP	−19.40	−19.11	−18.79
Before bindings			
Current account to GDP	−0.88	−0.82	−0.78
Debt	1.24	1.17	1.01
Consumption	−0.56	−0.58	−0.63

Note: The table shows the average change in each variable during events of the binding of the collateral constraint relative to one period before these events for different frequency of bindings. Changes are in percentage deviation from the value one period before binding events except for the current account to GDP ratio which is in percentage point deviation. The table also presents the value of each variable in periods before binding events in percentage deviation from respective simulated average. The current account GDP ratio is in percentage point deviation from its mean.

The smaller decline in capital inflows translates into a smaller decline in consumption, as shown in the table. The relative price of nontradable goods also falls less with a higher frequency of binding episodes because the decline in the relative demand for tradable goods is milder. Consequently, GDP declines less.

The fact that precautionary saving is higher with the higher possibility of binding can be seen in Table 2, which shows the level of borrowing one period before sudden stop events with respect to the average borrowing in the entire simulation under different binding probabilities. These are 1.24%, 1.17%, and 1.01% under $\varphi = 0.01$, $\varphi = 0.08$, and $\varphi = 0.3$, respectively. The consumption booms and the current account deficits before crises are more subdued under higher frequency of bindings. As also shown in the table, the current account deficits are 0.88, 0.82, and 0.78 percentage points, and consumption is 0.56%, 0.58%, and 0.63% below their averages under $\varphi = 0.01$, $\varphi = 0.08$, and $\varphi = 0.3$, respectively. The results are consistent with the IRFs under non-binding regimes in Section 3.

In summary, the economic downturns are less (more) severe when the loss of international financial market access is more (less) frequent. As pointed out in the previous section, this result is driven by people's precautionary behaviors and the resulting mitigation of debt-deflation when the constraint binds.

6 Optimal Capital Control and Welfare

We have demonstrated that the severity of current account adjustments depends on their frequency: they are less (more) severe when they occur more (less) frequently due to the precautionary behavior of private agents and the resulting mitigation of debt-deflation. One obvious policy recommendation from our analysis would be to inform private agents when they fail to recognize or correctly assess the future risk of a sudden stop.

However, the welfare loss arising from the pecuniary externality cannot be addressed solely through precautionary behavior, as households fail to internalize variations in collateral value. Several studies consider capital controls as a macroprudential policy to internalize the pecuniary externality.

6.1 Ramsey Optimal Policy

To illustrate the above point, we introduce the capital control tax, denoted by τ_t. With the capital control tax in period t, the households' budget constraint is modified as

$$c_t^T + p_t c_t^N + d_t + \frac{\phi}{2}\left(d_{t+1} - d\right)^2 = y_t^T + p_t y_t^N + \left(1 - \tau_t\right)\frac{d_{t+1}}{1+r} + T_t,$$

where T_t is the lump-sum transfer with which the government rebates all tax revenue to households. The Euler equation of households under the capital control tax is

$$c_t^{\frac{1}{\xi}-\sigma} a \left(c_t^T\right)^{-\frac{1}{\xi}} \left(\frac{1-\tau_t}{1+r} - \phi\left(d_{t+1} - \bar{d}\right)\right) - \mu_t = \beta E_t \left[c_{t+1}^{\frac{1}{\xi}-\sigma} a \left(c_{t+1}^T\right)^{-\frac{1}{\xi}}\right].$$

Other equilibrium conditions remain the same.

The problem of the Ramsey government is to choose τ_t, c_t^T, d_{t+1}, c_t, and μ_t to maximize

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma} - 1}{1-\sigma}, \tag{9}$$

subject to the following constraints:

$$c_t = \left[a \left(c_t^T \right)^{1-\frac{1}{\xi}} + (1-a) \left(y_t^N \right)^{1-\frac{1}{\xi}} \right]^{\frac{1}{1-\frac{1}{\xi}}},$$

$$d_{t+1} \leq \kappa \left(y_t^T + \frac{1-a}{a} \left(\frac{c_t^T}{y_t^N} \right)^{\frac{1}{\xi}} y_t^N \right), \tag{10}$$

$$c_t^{\frac{1}{\xi}-\sigma} a \left(c_t^T \right)^{-\frac{1}{\xi}} \left(\frac{1-\tau_t}{1+r} - \phi \left(d_{t+1} - \bar{d} \right) \right) - \mu_t = \beta E_t \left[c_{t+1}^{\frac{1}{\xi}-\sigma} a \left(c_{t+1}^T \right)^{-\frac{1}{\xi}} \right], \tag{11}$$

$$c_t^T + d_t + \frac{\phi}{2} \left(d_{t+1} - d \right)^2 = y_t^T + \frac{d_{t+1}}{1+r}, \tag{12}$$

$$\mu_t \left\{ \kappa \left(y_t^T + \frac{1-a}{a} \left(\frac{c_t^T}{y_t^N} \right)^{\frac{1}{\xi}} y_t^N \right) - d_{t+1} \right\} = 0,$$

$$\mu_t \geq 0,$$

given the exogenous realization of y_t^T and y_t^N. Importantly, the Ramsey government internalizes the pecuniary externality.

Values of c_t^T and d_{t+1} satisfying (10) and (12) with $\mu_t = 0$ satisfy all other constraints.[20] Then the problem can be reduced to maximizing (9) subject to (10) and (12). Given quantity, the optimal capital control tax is chosen so that the Euler equation of households (11) holds as

$$\tau_t = 1 - (1+r_t) \left[\frac{\beta E_t \left[c_{t+1}^{\frac{1}{\xi}-\sigma} a \left(c_{t+1}^T \right)^{-\frac{1}{\xi}} \right]}{c_t^{\frac{1}{\xi}-\sigma} a \left(c_t^T \right)^{-\frac{1}{\xi}}} + \phi \left(d_{t+1} - \bar{d} \right) \right].$$

As described by Bianchi (2011), the existence of the pecuniary externality leads to an inefficiently high level of borrowing by private households. The government's marginal value of wealth is given by

$$\lambda_t^R = c_t^{\frac{1}{\xi}-\sigma} a \left(c_t^T \right)^{-\frac{1}{\xi}} + \mu_t^R \frac{\partial p_t}{\partial c_t^T},$$

where λ_t^R and μ_t^R are the marginal value of wealth and shadow value of the collateral constraint for the government, respectively, whereas the households' marginal value of wealth is given by (1).

When the collateral constraint is not binding in period t, the Euler equation of households without the capital control tax is given by

$$c_t^{-\sigma+\frac{1}{\xi}} a \left(c_t^T \right)^{-\frac{1}{\xi}} \left\{ \frac{1}{1+r_t} - \phi \left(d_{t+1} - d \right) \right\} = \beta E_t \left[c_{t+1}^{\frac{1}{\xi}-\sigma} a \left(c_{t+1}^T \right)^{-\frac{1}{\xi}} \right],$$

[20] See Schmitt-Grohé and Uribe (2017) for the proof.

Table 3: Welfare Loss of Pecuniary Externality

	Low ($\varphi = 0.01$)	Baseline ($\varphi = 0.08$)	High ($\varphi = 0.3$)
Non-binding ($s_0 = \mathcal{N}$, %)	0.009	0.377	0.472
Binding ($s_0 = \mathcal{B}$, %)	0.021	0.853	1.021

Note: The table summarizes the welfare loss due to pecuniary externality conditional on the initial state being in regime s_0 and the steady state in regime s_0.

and the Euler equation of the Ramsey government is

$$c_t^{-\sigma+\frac{1}{\xi}} a \left(c_t^T\right)^{-\frac{1}{\xi}} \left\{\frac{1}{1+r_t} - \phi\left(d_{t+1} - d\right)\right\} = \beta E_t \left[c_{t+1}^{\frac{1}{\xi}-\sigma} a \left(c_{t+1}^T\right)^{-\frac{1}{\xi}} + \mu_{t+1}^R \frac{\partial p_{t+1}}{\partial c_{t+1}^T}\right].$$

This implies that the Ramsey government has a higher marginal value of saving by the amount of the uninternalized marginal value of saving represented by $\beta E_t \left[\mu_{t+1}^R \frac{\partial p_{t+1}}{\partial c_{t+1}^T}\right]$. Since this expected value of relaxing the collateral constraint with an additional unit of tradable consumption when the constraint binds becomes larger as the expectation for binding increases, the welfare loss due to the pecuniary externality should increase as the binding becomes more frequent.

6.2 Consumption Equivalent Welfare Loss

We now quantitatively measure the welfare loss associated with pecuniary externalities. It is defined as the required percentage change in permanent consumption in the competitive equilibrium without a capital control tax needed to achieve the same level of welfare as in the Ramsey equilibrium.[21] Table 3 summarizes the results.[22]

Regardless of the initial regime, welfare losses due to pecuniary externalities increase as the collateral constraint binds more frequently. Since the welfare loss in the binding regime is, by construction, higher than in the non-binding regime, starting in the binding regime results in a greater welfare loss under any frequency of binding compared to starting in the non-binding regime.

6.3 Optimal Capital Control and Frequency of Sudden Stops

Consistent with the above findings, a higher optimal capital control tax is required as the frequency of the binding of the collateral constraint rises. Figure 6 presents the impulse response function of the optimal capital control tax in the non-binding regime following a one-standard-deviation fall in the tradable endowment under different frequencies of the binding

[21] We follow the procedure described by Schmitt-Grohé and Uribe (2006). Appendix B presents the detailed derivation of the conditional welfare implication.

[22] In the binding regime, the optimal tax and the household's shadow value of the collateral constraint are indeterminate. We set the optimal capital control tax to zero in the binding regime without loss of generality.

($\varphi = 0.01,\ 0.08$, and 0.3).

The negative income shock triggers a rise in the capital control tax under any frequency of the binding of the collateral constraint to prevent households from accumulating excessive borrowing. As documented in previous sections, the incentive to borrow is lower under a higher frequency of bindings of the collateral constraint and unexpectedly mitigates debt-deflation once the constraint binds. However, this reduction in borrowing cannot neutralize pecuniary externalities and the associated debt-deflation. Formally speaking, a higher frequency of the binding amplifies the uninternalized marginal value of saving: $\beta E_t \left[\mu_{t+1}^R \frac{\partial p_{t+1}}{\partial c_{t+1}^T} \right]$, thus, overborrowing and the problem of debt-deflation become more severe when the constraint actually binds. This explains why a larger increase in the optimal tax is required under more frequent bindings as shown in Figure 6.

The call for an optimal macroprudential tax policy becomes more significant as the frequency of bindings increases. The results indicate the detrimental nature of pecuniary externalities, which manifest as overborrowing and subsequently lead to severe debt-deflation once a sudden stop occurs.

7 Empirical Evidence

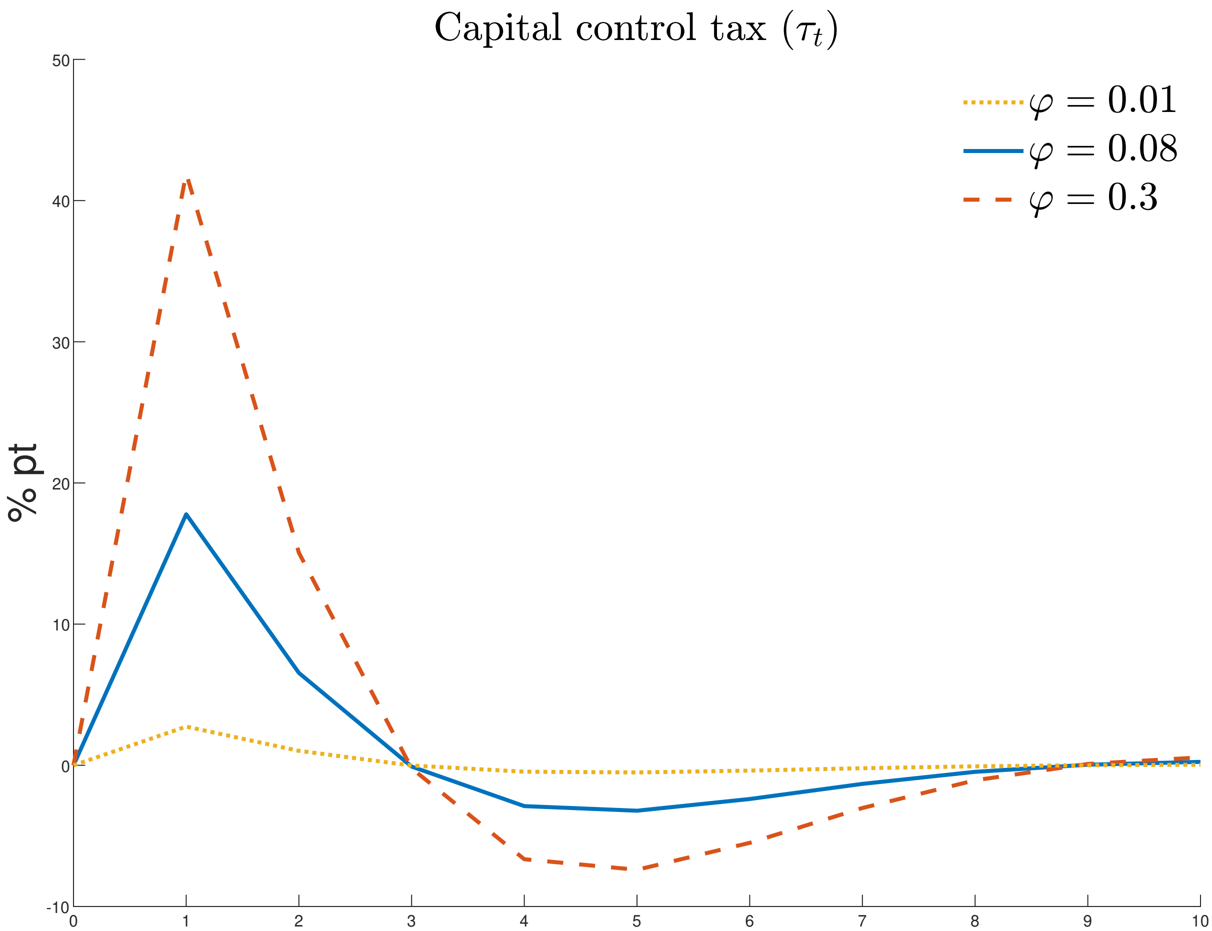
We have demonstrated that highly frequent sudden stops lead to less severe crises due to the precautionary behavior of private agents based on rational expectations, which mitigates debt deflation when access to the international capital market is limited. Does the actual data support this mechanism? The task is challenging because sudden stop episodes are historically rare.

The left panel of Figure 7 illustrates the average size of current account reversals against their frequency for countries that experienced such reversals in our sample.[23] We calculate the average size and frequency of reversals for each country. The size of a current account reversal is defined as the cumulative increase in the current account-to-GDP ratio during each identified event. The frequency of current account reversals is calculated by dividing the number of reversal events by the total sample periods. The fitted line exhibits a downward-sloping pattern, suggesting that current account reversals are less severe in countries with a higher frequency of such events.

The middle and right panels of Figure 7 plot the average change in GDP and consumption during current account reversals against their frequency. We calculate the average change in GDP and consumption for each country. The change in GDP and consumption is defined as the cumulative change in HP-filtered logged GDP per capita and logged consumption per capita during each identified current account reversal. The fitted line displays an upward-sloping pattern, indicating that the decline in GDP and consumption during current account reversals is smaller in countries with a higher frequency of these events.

[23] Appendix C provides the data source.

Figure 6: Optimal Capital Control Tax



Note: The figure displays regime-specific impulse response functions of the optimal capital control tax in the non-binding regime following a one standard deviation fall in the tradable and non-tradable endowment. The IRF is expressed in a percentage point deviation from the steady state of the non-binding regime. The dotted, solid, and dashed lines represent IRF with $\varphi = 0.01,\ 0.08$ and 0.3, respectively.

In summary, the figure shows that a higher frequency of current account reversals is associated with lower magnitudes of capital outflows and smaller declines in GDP and consumption. While our empirical investigation is constrained by a limited number of observations, the findings are broadly consistent with the mechanism suggested by the theoretical model.

8 Conclusion

This paper demonstrates the trade-off between the frequency and severity of current account reversals when agents' expectations for their occurrence depend on their frequency. Using a small open economy model with occasionally binding constraints—where the binding represents sudden stops, restricting the country's access to international financial markets and causing current account reversals—we show that more frequent bindings are associated with smaller current account reversals and less severe macroeconomic recessions.

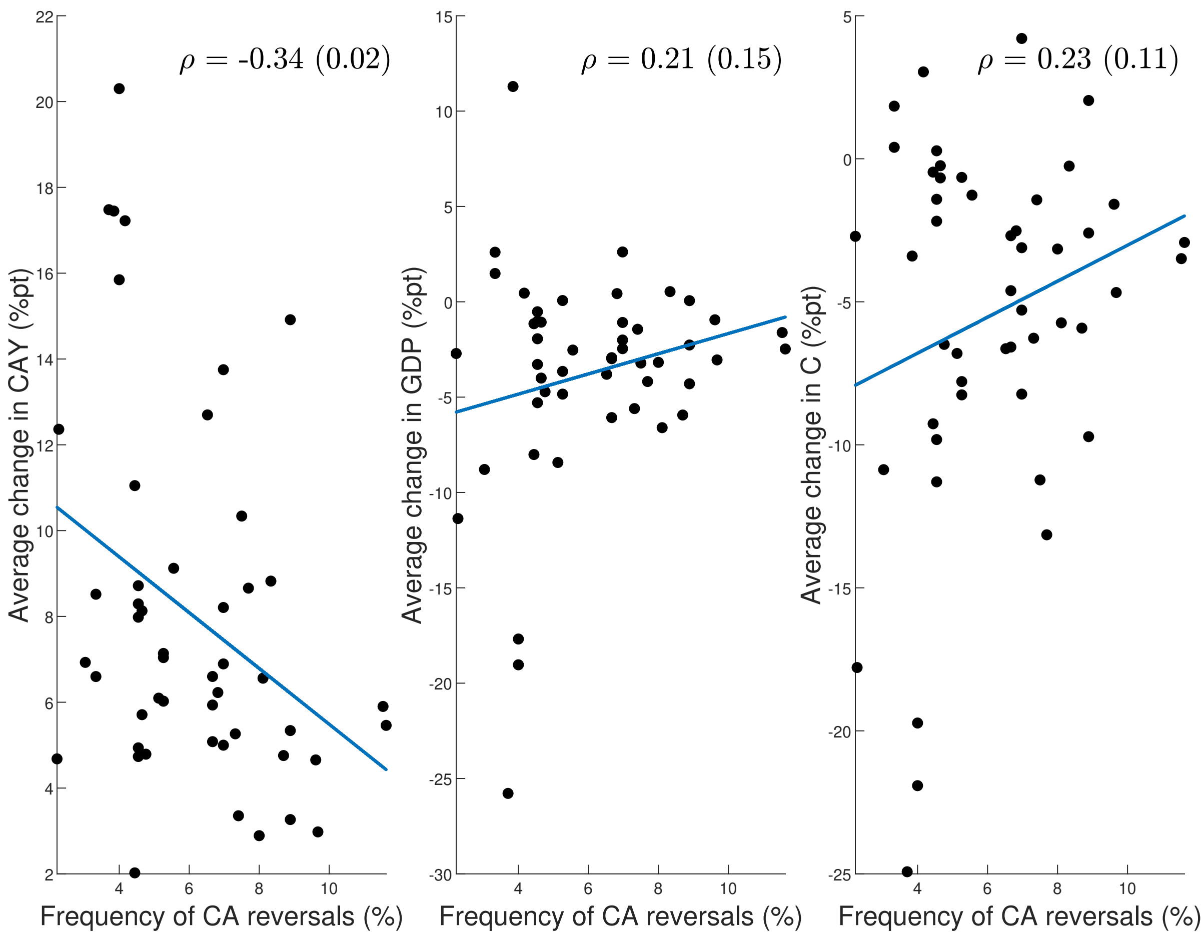
The trade-off arises from the precautionary behavior of collateral-constrained households, who accumulate more precautionary savings when they expect future bindings of the borrowing constraint to be more likely. Employing a rational expectation regime-switching framework that models distinct states of normal times and financial crises, we find that households have stronger incentives to save as bindings of the constraint become more frequent—not only because it is prudent for future financial difficulties but also because it directly reduces the probability of sudden stops by lowering the level of external debt. Since higher precautionary savings unexpectedly prop up collateral values for private agents, they also mitigate the debt-deflation effect once the constraint binds, reducing the magnitude of capital outflows and the resulting economic deterioration.

Furthermore, the welfare analysis reveals that the welfare loss due to pecuniary externalities is more severe with more frequent bindings, necessitating stronger policy interventions. Empirical evidence from emerging economies is consistent with our theoretical findings, supporting the existence of this trade-off between frequency and severity.

By embedding the regime-switching DSGE framework and solving it using perturbation methods, our theoretical model offers several avenues for extension. It would be relatively straightforward to incorporate nominal rigidities and analyze the impact of monetary policy. The use of Bayesian methods for parameter estimation would also be feasible, offering a significant advantage over other solution techniques.

An important aspect that we abstract from in this paper is the possibility of self-fulfilling bindings of the collateral constraint. Schmitt-Grohé and Uribe (2021) demonstrate how agents' pessimistic views can lead to self-fulfilling financial crises. It is possible that high precautionary savings driven by strong expectations of binding constraints could deflate collateral prices and endogenously tighten the constraint in our framework. In our numerical analyses, we exclude the possibility of self-fulfilling financial crises through parameterization to avoid multiple equilibria.

Figure 7: Observed Frequency and Severity of Current Account Reversals, and Economic Downturns



Note: Each panel plots the average change in the current account-to-GDP ratio (CAY), per capita GDP (GDP), and per capita consumption (C) during events of current account reversals against the frequency of current account reversal events in each country. Changes during events are expressed in the percentage point change from their levels one period before each identified event. p-value is in the parenthesis. Appendix C provides detailed information on the dataset.

Relaxing this assumption is left for future research.

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Table 4: Regime-Specific Steady State

	Non-binding regime	Binding regime
$\kappa\left(y^T + py^N\right) - d$	0.0707	0
μ	0	0.0180
d	0.9335	1.0019
c^T	0.9641	0.9615
p	2.2188	2.2115

A Regime-Specific Steady State

We derive the regime-specific steady state of each variable. A variable with the subscript $\mathcal{N}$ or $\mathcal{B}$, instead of a time subscript, denotes its steady-state value in the non-binding and binding regimes, respectively.

First, we derive the steady state in the non-binding regime. By construction, $\boldsymbol{o}(\mathcal{N}) = 1$. From (7), we have $\mu_{\mathcal{N}} = 0$. In this regime, we target a debt-to-GDP ratio of 29 percent, following Bianchi (2011). The debt-to-GDP ratio in the model, $\frac{d}{y}$, is given by

$$\frac{d}{y} = \frac{d_{\mathcal{N}}}{y^T + p_{\mathcal{N}} y^N}.$$

By combining (2), (5), and (6), we can rewrite the debt-to-GDP ratio as

$$\frac{d}{y} = \frac{d_{\mathcal{N}}}{y^T + \frac{1-a}{a}\left(\frac{y^T - \frac{r}{1+r} d_{\mathcal{N}}}{y^N}\right)^{\frac{1}{\xi}} y^N}.$$

Solving this equation for $d_{\mathcal{N}}$ gives us the steady-state value of borrowing in the non-binding regime. The steady-state values of the remaining variables can then be derived straightforwardly.

Next, we derive the steady state in the binding regime. By construction, $\boldsymbol{o}(\mathcal{B}) = 0$. From (7), we have

$$d_{\mathcal{B}} = \kappa\left(y^T + p_{\mathcal{B}} y^N\right).$$

By combining (2), (5), and (6), we obtain

$$d_{\mathcal{B}} = \kappa\left(y^T + \frac{1-a}{a}\left(\frac{y^T - \frac{r}{1+r} d_{\mathcal{B}}}{y^N}\right)^{\frac{1}{\xi}} y^N\right).$$

Solving for $d_{\mathcal{B}}$ yields the steady-state value of borrowing in the binding regime. The steady-state values of the remaining variables can then be derived straightforwardly. Table 4 presents the regime-specific steady-state values of key variables.

B Derivation of the Welfare Implication

We define the welfare associated with the competitive equilibrium and the Ramsey equilibrium conditional on a particular state as

$$V_0 = E_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma}}{1-\sigma}$$

and

$$V_0^R = E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left(c_t^R\right)^{1-\sigma}}{1-\sigma},$$

respectively, where c_t^R is the consumption in the Ramsey equilibrium. The required change in permanent consumption in the competitive equilibrium without a capital control tax needed to achieve the same level of welfare as in the Ramsey equilibrium, denoted by γ, is implicitly defined as

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left[c_t \left(1+\gamma\right)\right]^{1-\sigma}}{1-\sigma} = V_0^R.$$

Solving for γ yields

$$\gamma = \left[\frac{\left(1-\sigma\right) V_0^R + \left(1-\beta\right)^{-1}}{\left(1-\sigma\right) V_0 + \left(1-\beta\right)^{-1}}\right]^{\frac{1}{1-\sigma}} - 1.$$

We characterize γ conditional on the initial regime being regime s_0 and the initial state being a particular state in regime s_0. Writing conditional welfare as $V_0 = V\left(x_0, \sigma_\varepsilon, s_0\right)$ and $V_0^R = V^R\left(x_0, \sigma_\varepsilon, s_0\right)$, the welfare implication conditional on the initial regime being regime s_0 and the initial state being a particular state x_0 is expressed as

$$\gamma = \left[\frac{\left(1-\sigma\right) V_0^R\left(x_0, \sigma_\varepsilon, s_0\right) + \left(1-\beta\right)^{-1}}{\left(1-\sigma\right) V_0\left(x_0, \sigma_\varepsilon, s_0\right) + \left(1-\beta\right)^{-1}}\right]^{\frac{1}{1-\sigma}} - 1.$$

We write the conditional welfare implication as $\gamma = \Gamma\left(x_0, \sigma_\varepsilon, s_0\right)$.

We now characterize the welfare implication conditional on the initial regime being regime s_0 and the initial state being the steady state in regime s_0, denoted by x^s. Specifically, we consider the second-order approximation of $\Gamma\left(x_0, \sigma_\varepsilon, s_0\right)$ around the point where $\left(x_0, \sigma_\varepsilon, s_0\right) = \left(x^s, 0, s_0\right)$. Because we take an approximation around the regime-specific steady state x^s, terms involving derivatives with respect to x^s are ignored. The steady-state level of welfare is equivalent across the competitive equilibrium and the Ramsey equilibrium, thus $\Gamma\left(x^s, 0, s_0\right) = 0$.

Additionally, the first derivatives of policy functions with respect to σ_ε evaluated at $\left(x_0, \sigma_\varepsilon, s_0\right) = \left(x^s, 0, s_0\right)$ are zero, namely, $V_{\sigma_\varepsilon}^R\left(x^s, 0, s_0\right) = V_{\sigma_\varepsilon}\left(x^s, 0, s_0\right) = 0$, and thus, $\Gamma_{\sigma_\varepsilon}\left(x^s, 0, s_0\right) = 0$, because, at the first order, certainty equivalence holds in our environment.[24] Thus, the second-order approximation of $\gamma = \Gamma(x_0, \sigma_\varepsilon, s_0)$ around $(x^s, 0, s_0)$ is given by

$$\gamma \approx \frac{1}{2}\Gamma_{\sigma_\varepsilon\sigma_\varepsilon}(x^s, 0, s_0)\,\sigma_\varepsilon^2.$$

The second-order derivative of $\Gamma(x_0^s, \sigma_\varepsilon, s_0)$ with respect to σ_ε evaluated at $(x^s, 0, s_0)$ is derived as

$$\Gamma_{\sigma_\varepsilon\sigma_\varepsilon}(x^s, 0, s_0) = \frac{V^R_{\sigma_\varepsilon\sigma_\varepsilon}(x^s, 0, s_0) - V_{\sigma_\varepsilon\sigma_\varepsilon}(x^s, 0, s_0)}{(1-\sigma)\,V^R(x^s, 0, s_0) + (1-\beta)^{-1}},$$

where $V^R_{\sigma_\varepsilon\sigma_\varepsilon}(x^s, 0, s_0)$ and $V_{\sigma_\varepsilon\sigma_\varepsilon}(x^s, 0, s_0)$ are the second-order derivatives of the regime-specific policy functions $V^R(x_0, \sigma_\varepsilon, s_0)$ and $V(x_0, \sigma_\varepsilon, s_0)$ with respect to σ_ε, evaluated at $(x_0^s, \sigma_\varepsilon, s_0) = (x^s, 0, s_0)$.

Then, the second-order approximation of γ around $(x^s, 0, s_0)$ is given by

$$\gamma \approx \frac{V^R_{\sigma_\varepsilon\sigma_\varepsilon}(x^s, 0, s_0) - V_{\sigma_\varepsilon\sigma_\varepsilon}(x^s, 0, s_0)}{(1-\sigma)\,V^R(x^s, 0, s_0) + (1-\beta)^{-1}}\frac{\sigma_\varepsilon^2}{2}.$$

The model is solved accurately up to the second order using the perturbation method of Maih (2015).

C Data

Table 5 provides detailed data used in Figure 1. Real GDP and real consumption per capita are calculated by dividing real GDP and real consumption by population data obtained from PWT 10.01 (Feenstra, Inklaar, and Timmer (2015)). Data on the current account balance as a percentage of GDP is sourced from the World Development Indicators. All data is collected on an annual basis. Figure 8 presents the number of current account reversals occurring each year and across different regions.

Table 5: Details of Data

Country	**Sample Periods**	**Current Account Reversal Events**	**# of Events**	**Frequency (%)**
Algeria	1977 – 1991 2005 – 2019	1979	1	3.33
Argentina	1983 – 2019	1990, 2002, 2019	3	8.11
Bolivia	1976 – 2019	1980, 1994	2	4.55

Continued on next page

[24] As shown by Maih (2015), certainty equivalence does not necessarily hold at the first order in a regime-switching model.

Country	Sample Periods	Current Account Reversal Events	# of Events	Frequency (%)
Brazil	1989 – 2019	1992, 2002 – 2003, 2016	3	9.68
Bulgaria	1980 – 2019	1991, 1994, 2009	3	7.50
Chile	1975 – 2019	1976, 1983, 2009	3	6.67
Colombia	1968 – 2019	1972, 1984, 1986, 1991, 1999	5	9.62
Costa Rica	1977 – 2019	1982, 1984, 1991, 1994, 2009	5	11.63
Cote d'Ivoire	2005 – 2019	2011	1	6.67
Croatia	1993 – 2019		0	0
Czechia	1993 – 2019	1998, 2008	2	7.41
Dominican Republic	1968 – 2019	1972, 1975, 1981, 1988, 2003, 2009	6	11.54
Ecuador	1976 – 2019	1983, 1999	2	4.55
Egypt	1977 – 2019	1980, 1983, 1990	3	6.98
El Salvador	1976 – 2019	1979, 2009	2	4.55
Estonia	1993 – 2019	2008 – 2009	1	3.79
Greece	1976 – 1997 1999 – 2019	1986, 2009, 2012	3	6.98
Hong Kong	1998 – 2019	1999	1	4.55
Hungary	1982 – 2019	1995, 2009	2	5.26
India	1975 – 2019	1976, 2013	2	4.44
Indonesia	1981 – 2019	1984, 1998	2	5.13
Israel	1960 – 1961 1965 – 2019	1972, 1976, 1985	3	5.26
Italy	1970 – 2019	1975, 1977, 1993, 2012	4	8.00
Jordan	1972 – 2019	1979, 1980, 1989	2	4.17
South Korea	1976 – 2019	1998	1	2.27
Latvia	1995 – 2019	2009	1	4.00
Lebanon	2002 – 2019	2015	1	5.56
Lithuania	1995 – 2019	2009	1	4.00
Malaysia	1974 – 2019	1976, 1987, 1998	3	6.52
Mexico	1979 – 2019	1983, 1987, 1995	3	7.32
Morocco	1975 – 2019	1978, 1983, 1986, 2001	4	8.89
Nigeria	1977 – 2019	1979, 2000, 2004 – 2005	3	6.98
Pakistan	1976 – 2019	1997, 2009	2	4.55

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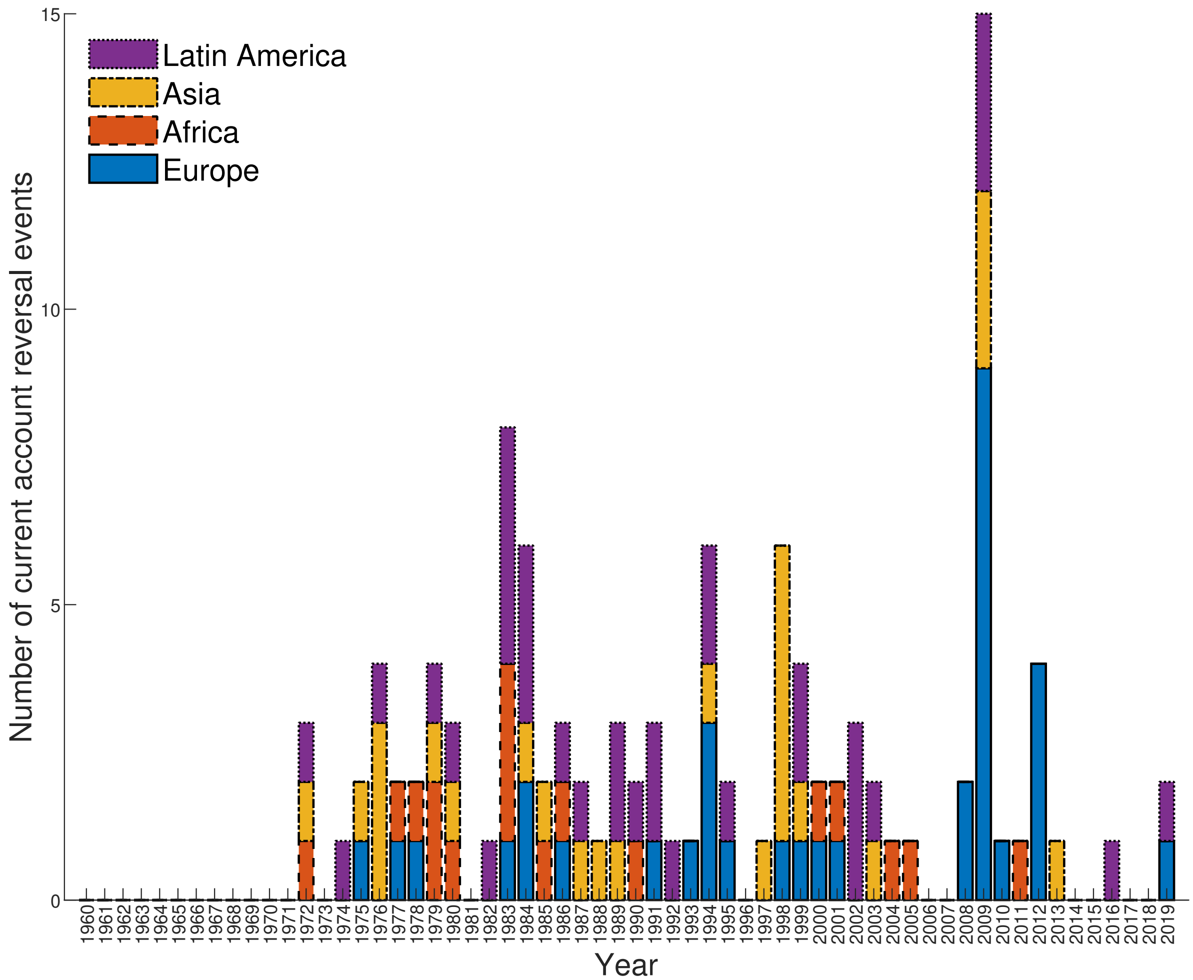
Country	Sample Periods	Current Account Reversal Events	# of Events	Frequency (%)
Panama	1977 – 2019	1982, 1987, 2009	3	6.98
Peru	1982 – 2019	1984, 1989	2	5.26
the Philippines	1977 – 2019	1998, 2009	2	4.65
Poland	1990 – 2019	1994	1	3.33
Portugal	1975 – 2019	1983	1	2.22
Romania	1987 – 2019	2009	1	3.03
Russian Federation	1994 – 2019	1999 – 2000	1	3.85
Singapore	1972 – 2019	1975, 1988, 1994, 2003	4	8.33
South Africa	1960 – 2019	1972, 1977, 1983, 1985	4	4.65
Spain	1975 – 2019	1978, 1984, 2009, 2012	4	8.89
Switzerland	1977 – 2019	1984, 2009 – 2010	2	4.65
Thailand	1975 – 2019	1998, 2009	2	2.44
Tunisia	1976 – 2019	1978 – 1979, 1987, 1994	3	6.82
Türkiye	1974 – 2019	1994, 2001, 2012, 2019	4	8.70
Ukraine	1978 – 2019	1999, 2015	2	7.69
Uruguay	1994 – 2019	2002, 2009	2	4.76
Venezuela	1970 – 2014	1974, 1979, 1983, 1989	4	8.89
Summary Statistics				
Min			0	0
Max			6	11.63
Mean			2.44	5.99
Median			2	5.41
Mode			2	4.55
Standard Deviation			1.28	2.40

Note: The table summarizes details of our dataset and identified events of current account reversals. The frequency of current account reversal events in each country is calculated by dividing the number of identified events by the total number of sample periods in each country. The summary statistics (Min, Max, Mean, Median, Mode, and Standard Deviation) are calculated across all countries.

Figure 8: Number of Current Account Reversals over Time and across Regions



Note: The figure show the number of current account reversals over time and across regions. The dataset consists of 50 emerging countries, including Argentina (ARG), Bolivia (BOL), Brazil (BRA), Chile (CHL), Colombia (COL), Costa Rica (CRI), the Dominican Republic (DOM), Ecuador (ECU), El Salvador (SLV), Mexico (MEX), Panama (PAN), Peru (PER), Uruguay (URY), Venezuela (VEN) from Latin America, Hong Kong (HKG), India (IND), Indonesia (IDN), Israel (ISR), Jordan (JOR), South Korea (KOR), Lebanon (LBN), Malaysia (MYS), Pakistan (PAK), the Philippines (PHL), Singapore (SGP), Thailand (THA), Türkiye (TUR) from Asia, Algeria (DZA), Cote d'Ivoire (CIV), Egypt (EGY), Morocco (MAR), Nigeria (NGA), Tunisia (TUN), South Africa (ZAF) from Africa, Bulgaria (BGR), Croatia (HRV), Czechia (CZE), Estonia (EST), Greece (GRC), Hungary (HUN), Italy (ITA), Latvia (LVA), Lithuania (LTU), Poland (POL), Portugal (PRT), Romania (ROU), Russian Federation (RUS), Spain (ESP), Switzerland (CHE), Ukraine (UKR) from Europe.