Capital Flows and Sudden Stops in Small Open Economies*

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Abstract

Balance of payment crises, characterized by Sudden Stops (SS), are not a phenomenon exclusive to emerging economies. In this paper I identify SS episodes for 112 advanced and emerging economies from 1980 to 2016. By decomposing the Financial Account I find that the median net Foreign Direct Investment (FDI) flows in advanced economies is positive (outflows) and in emerging economies is negative (inflows). Then, I develop a two-sector small open economy model with incomplete markets and an endogenous debt constraint that amplify negative shocks. This paper contributes to the literature by incorporating two new elements to the model: i) integration of the economy with global capital markets is through the Portfolio channel and the Direct Investment channel; and, ii) global risk, that I model through the international interest rate, follows a time-varying volatility process. I find that the FDI channel accounts for 44% of the difference between the probability of having a Sudden Stop in an advanced and in an emerging economy. Also, I find that volatility shocks account for 99.6% of the probability of having a Sudden Stop in emerging economies and 82.9% in advanced economies.

Keywords: Sudden Stops, Capital Flows, Foreign Direct Investment.

JEL codes: E21, F21, F32, G01.

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"European stock funds suffered their largest redemptions in nearly six months... Investors pulled $1.4bn from European equity funds in the week ending August 30... It marks the largest redemptions since March..."

Joe Rennison and Eric Platt, The Financial Times, August 31, 2017

"Japan equity funds suffered record outflows in the past week as traders and investors turned defensive..."

Nicole Bullock, The Financial Times, October 20, 2017

"Investors continued to pull money out of US equity funds despite a rebound in share prices... Outflows from US equity funds moderated to $2.4bn for the week ending February 21..., after $6.2bn was withdrawn during the prior week..."

Joe Rennison, The Financial Times, February 23, 2018

1 Motivation

Most of the Sudden Stops (SS) literature has focused on emerging economies[1] neglecting that from 1980 to 2016 there have been 27 SS episodes in advanced economies (see Figure 1). Although, for the past almost four decades advanced economies have been experiencing episodes of capital outflows that have been associated only to emerging and fragile economies, the conditional probability of experiencing a SS for an advanced economy is 3.0 percent while for an emerging economy is 3.5 percent. Is there any difference other than income levels driving these probabilities? This paper contributes to closing the literature gap by studying and contrasting SS episodes in advanced and emerging economies, through the lens of a small open economy framework.

This paper explores the complementaries between Direct Investment (FDI) and Portfolio Investment. The mechanism through which both accounts interact is the following. As FDI enters an economy, the debt capacity of the economy increases because the collateral increases through two channels. First, profits in the tradable sector increase and, second, the stock of capital increases due to the inflow of foreign capital. Both channels increase the collateral available to the economy

[1]The terms emerging and upper-middle income will be used interchangeably, as well as the terms advanced and high income. The income threshold is taken from the World Bank.

since profits serve as collateral as a Debt-to-Income constraint would imply and foreign capital serves as collateral as a Loan-to-Value constraint would imply. The imposed constraint could result from a limited enforcement environment where lender's can not collect more than a fraction of a defaulting debtor's assets and income. This spillover effect from FDI to the borrowing constraint amplifies the negative shocks that hit an economy that is close to the debt limit. The above mechanism, together with a price deflation mechanism similar to the one introduced by Mendoza [2010], will generate crises of the Sudden Stop type.

A SS is defined as an outflow of capital in the Financial Account (FA) of the Balance of Payments Identity (Calvo et al. [2006], Mendoza [2010], among others). At the aggregate Financial Account level, every country that experiences a SS is similar: they all register a large and rare outflow of capital. However, after decomposing the FA there are differences between emerging and advanced economies. Advanced economies have net flows of Foreign Direct Investment (FDI) as percentage of GDP that fluctuate around zero (some years positive and some years negative) while emerging economies tend to have only negative net flows (inflows of capital). In this paper, I will focus on this difference between advanced and emerging economies.

The two main components of the FA are Portfolio Investments and Direct Investment (FDI), which differ in maturity. As noted by Albuquerque [2003], FDI is a long term investment given natural constraints to rapidly withdrawing illiquid investments. On the other hand, Portfolio Investments have shorter maturity, since technological advances provide additional flexibility for the investments to leave an economy faster. Hence, from the perspective of international investors, the current opportunity cost of an investment (i.e. the international interest rate) is not the only affecting investment decisions, but also the current state of international volatility and it's effect on future returns. Therefore, introducing an element of time-varying volatility in the international risk will provide a deeper understanding of the dynamics behind the different capital flows.

A sizable literature, starting 25 years ago with Backus et al. [1992] and Baxter and Crucini [1995], has documented how international financial markets are a transmission mechanism of business cycles among economies. A strand of this literature, closely relate to this paper, has studied business cycles in small open economies (see Heathcote and Perri [2002]). However, the main focus of this paper is considerably narrower: the relationship between different international capital flows characteristic of emerging and advanced economies, and their balance of payments crisis dynamics. For example, in Albuquerque et al. [2005], the authors study how the increase in FDI is related to global factors and to higher integration in capital markets. In that paper, the authors argue that FDI may look similar to equity flows, however, the former does not depend on the existence of developed stock markets. For this reason, it seems more appropriate to use FDI given that liberalization has occurred in different stages of development for each country. They find that global factors have become more relevant and that these factors are able to explain better the dynamics of FDI. Since some local factor risks can be hedged due to the increase in financial liberalization.

The characteristics of FDI on which this paper focuses have been previously documented in the literature. In Albuquerque [2003], the author shows that FDI is less volatile than other financial flows and that non-FDI flows are shorter term investments facing less physical constraints to movement, and thus making it easier to flee a jurisdiction. The author also proposes a model with enforcement constraints where FDI is productive only with intangible assets provided by the source country making FDI less volatile. The model predicts that more financially constraint economies should borrow more relatively through FDI.

Another closely related strand of the literature focuses on the real effect of time-varying volatility of the international interest rate. Justiniano and Primiceri [2008] estimate a large scale DSGE model that allows time variation in the volatility of the structural innovations and conclude that volatility has decreased dramatically in the postwar era having a large effect on investment. In this line of research, Fernández-Villaverde et al. [2011] document how changes in the volatility of the interest rate can have an effect of output, consumption, investment and hours worked even when the interest rate level doesn't change. The present paper contributes to this growing literature by introducing time-varying volatility to a *Fisherian* model with endogenous occasionally binding constraints and document the effect of time-varying volatility on the dynamics during a Sudden Stop.

The effect of changes in domestic volatility has been reviewed in Fogli and Perri [2015]. That paper studies two representative agent economies with incomplete markets and analyzes the effect that changes in GDP variance have on the net foreign position of each country. Trying to explain a similar question, Mendoza et al. [2009] study how two economies with heterogeneous, under different financial development, behave after financial integration.

All the previous works have studied real business cycles. However, it was not until Mendoza [2010] that the debt deflation mechanism was introduced in order to study SS episodes. I follow this set-up to analyze the role of external flows in Sudden Stop crises. As noted above, most of the papers mentioned study the effects of integration; however, they do not explore differences in the way this integration is done and the effect of different capital flows. For this reason, this paper contributes to the understanding of the consequences that different capital flows have on a small open economy.

The rest of the paper is structured as follows. Section 2 describes the panel data base I constructed and shows empirical evidence on the importance of the FDI channel. In Section 3 I propose a small open economy model with incomplete markets that incorporates both types of international capital flows: Portfolio Investment and Direct Investment and, allows for time-varying volatility in the international interest rate given the different forces behind each type of flow. Then, in Section 4 I present the quantitative results from running simulations with calibrated parameters for each type of economy, quantifying how much of the differences in the probability of a Sudden Stop observed in the data can be accounted by the FDI channel. In Section 5 I conclude.

2 Empirical Evidence

The first point this paper aims to make is that Sudden Stop crises happen also in advanced economies. To accomplish this, I construct a panel data base of 37 advanced and 75 emerging economies from 1980 to 2016. The economies were selected according to the classification of the World Bank of high income economies (advanced) and upper-middle income economies (emerging). Following Calvo et al. [2006], I identify a SS episode as a large outflow of capital from an economy. Specifically, a change in the Financial Account as percentage of GDP of 2 standard deviations above the historical mean in a year is a SS episode. Figure 1 shows the number of crises per year for both groups of economies. There have been 27 SS in advanced and 75 SS in emerging. This evidence suggests that SS are not a phenomena exclusive of emerging economies although they are more probable than in advanced economies. Figure 1 also suggests that SS crises do not happen in isolation; there seems to be clustering of episodes during the beginning of the 80's, the late 90's and early 2000's, and during the great recession years.

Fact 1: The probability of a SS for advanced economies is 3.0 percent and for emerging economies is 3.5 percent.

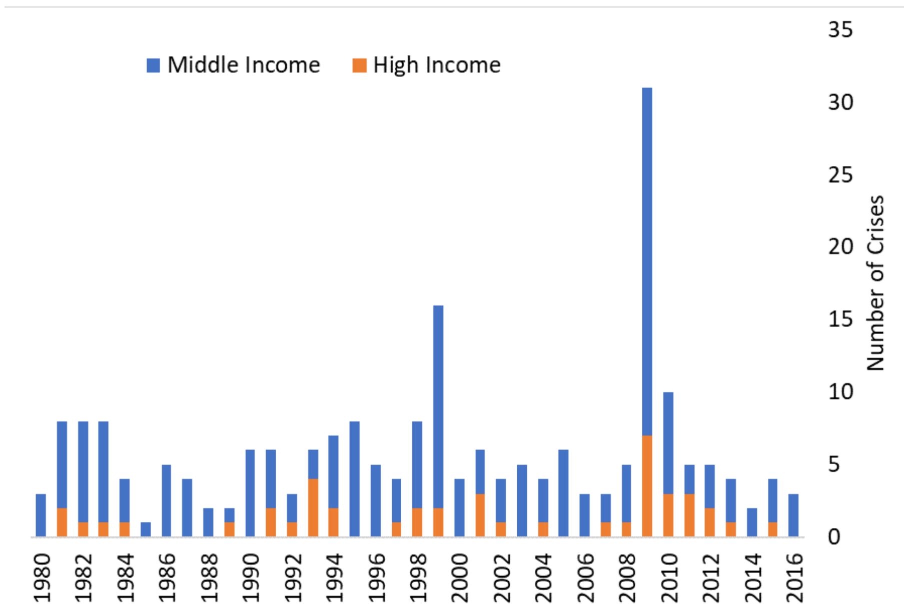


Figure 1: Number of identified Sudden Stops by year and by country.

2.1 Why study the FDI account?

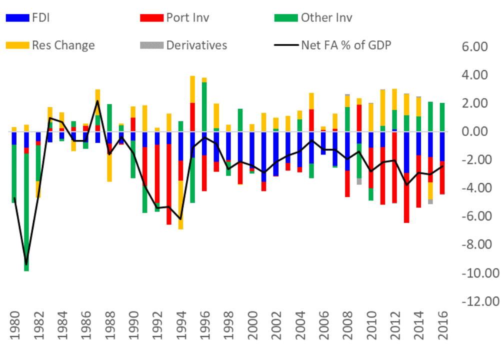
Although at the aggregate level of the Financial Account a crises seems similar between economies, a decomposition of the financial account suggests fundamental differences between both groups of economies. The median[2] net FDI to GDP flow in percentage for emerging economies is -2.73% (inflow) while for advanced economies is 0.35% (outflow), and the median net Inflow FDI to GDP flow in percentage for emerging economies is -3.46% while for advanced economies is -2.64%. These percentages suggest that net FDI and net Inflow FDI are similar in emerging economies while very different in advanced. This means that the net FDI account in the former is mainly an inflow

[2]To obtain the following statistics I average each country across time and then I take the median across countries.

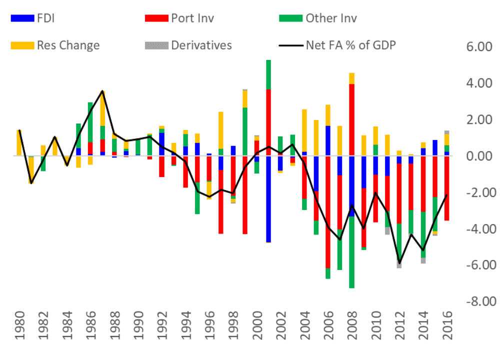
account: capital is flowing into the economy. While for advanced economies, a similar magnitude of inflows and outflows of capital such that the net FDI is around zero and even positive. In this sense, emerging economies only have inflows of capital while advanced economies attract capital and invest abroad approximately in the same magnitudes.

Fact 2: The median net FDI as percentage of GDP flow for emerging economies is -2.73% while for advanced is 0.35%.

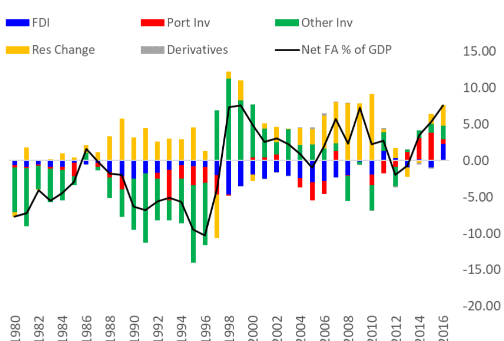
Figure 2 and Figure 3 show the decomposition of the Financial Account for a subsample of 4 economies for each group. Emerging economies (Figure 2) consistently have negative FDI flows. This means that capital from abroad is flowing into the economy.



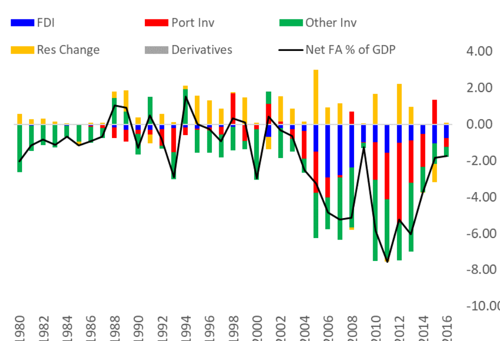
(a) Mexico



(b) South Africa



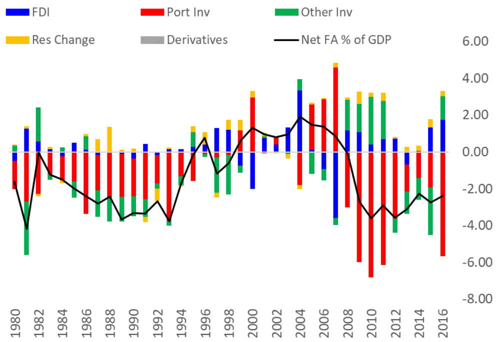
(c) Thailand



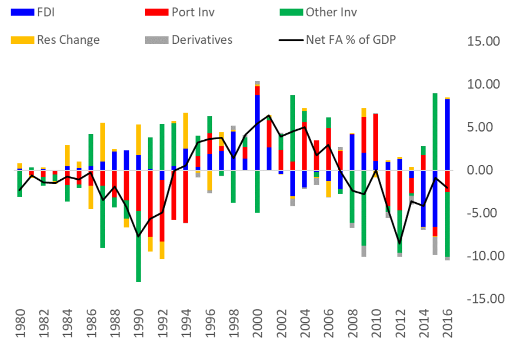
(d) Turkey

Figure 2: Financial Account decomposition for Emerging Economies. Source: World Bank WDI and IMF.

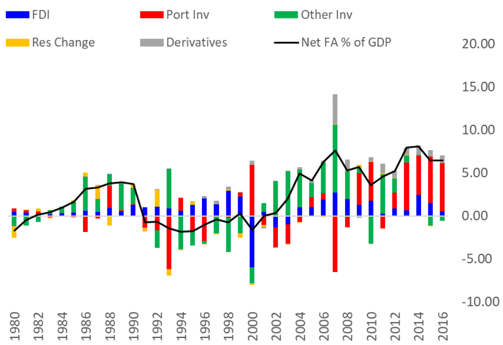
As a global resource constraint would imply, this capital is coming from another economy, which most likely is an advanced economy. As Figure 3 shows, advanced economies have both positive and negative large flows of FDI.



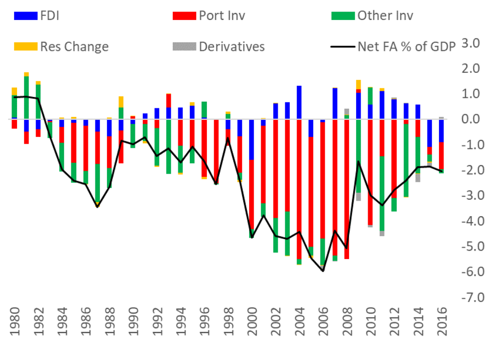
(a) Canada



(b) Finland



(c) Germany



(d) United States

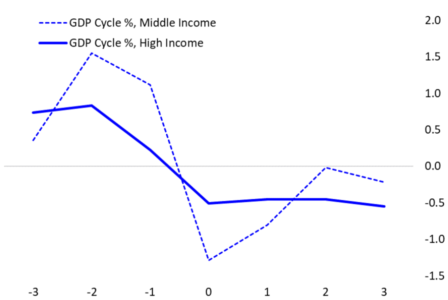
Figure 3: Financial Account decomposition for Advanced Economies. Source: World Bank WDI and IMF.

Another difference is with respect to the capital stock:

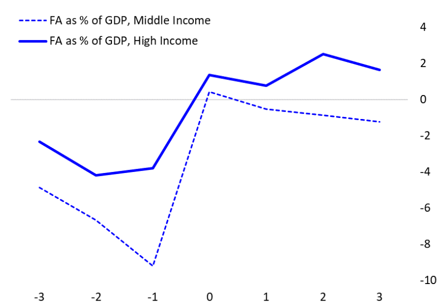
Fact 3: The median capital to GDP ratio in advanced economies is 2.6 and in emerging economies is 2.0.

Fact 2 and Fact 3 can be rationalized as follows: under a national production function with diminishing marginal returns to capital and no domestic investment, emerging economies that have smaller stocks of domestic capital relative to advanced economies will have a greater rate of return on capital and will attract larger amount of international capital inflows.

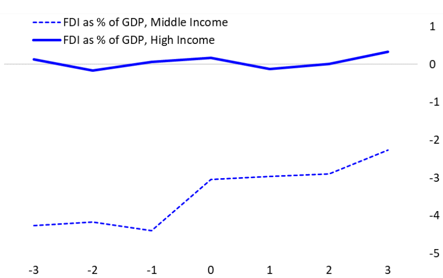
These differences can be seen not only at a business cycle level during the whole sample but also during SS episodes. Figure 4 shows median GDP, FA, FDI and Portfolio plus Other Investments across episodes and economies during a SS. The graphs are centered around period 0 that corresponds to the period identified as a SS. Even when the method to identify a SS does not include directly a drop in the GDP, Figure 4.a shows a drop in the cycle component of the GDP for both groups. In this sense, SS's are accompanied by real recessions in the production that is 1.5 percentage points more severe in emerging economies. We can see in Figure 4.b that at the aggregate level, the FA follows a similar movement in both economies although in the last period before the SS, emerging economies have a more negative position, around 2 percentage points. However, after decomposing into FDI and PI (that also includes Other Investments) we can see a clear difference between groups. FDI flows previous to a SS account for almost half of the FA deficit in emerging economies while for advanced economies the flows are close to zero. Also, emerging economies suffer a large correction in FDI the year of the SS while advanced economies are able to smooth it out. On the Portfolio side, although both groups show similar movements, in the last period before the SS, advanced economies have a more negative position.



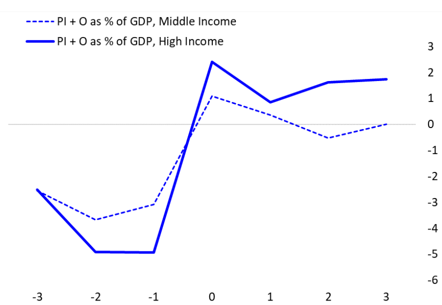
(a) GDP cycle



(b) Financial Account as percentage of GDP



(c) FDI as percentage of GDP



(d) Portfolio and Other Investment as percentage of GDP

Figure 4: Event Analysis of a Sudden Stop.

2.2 Importance of the international volatility

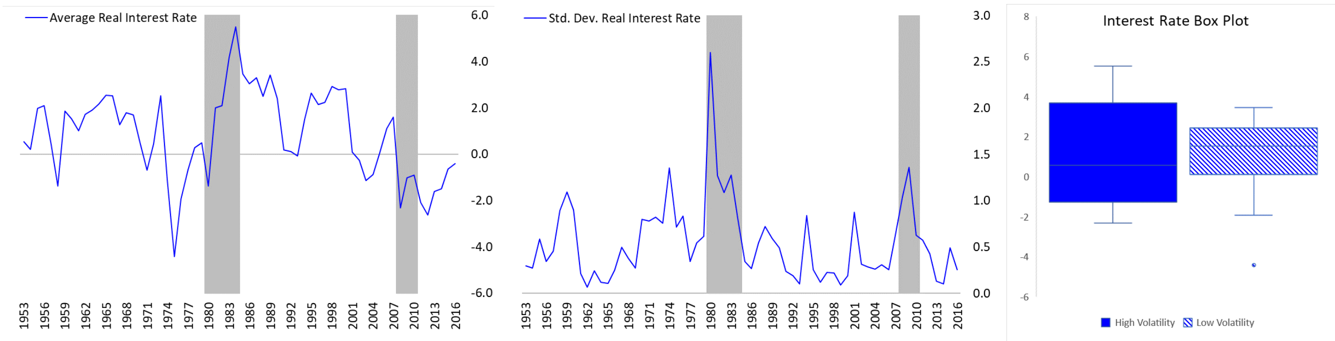
The Financial Account records transactions that involve financial assets and liabilities that take place between residents and non-residents. Its to main components, FDI and Portfolio Investment, are different in nature. According to the International Monetary Fund [2013]:

> *"Direct investment is a category of cross-border investment associated with a resident in one economy having control or a significant degree of influence on the management of an enterprise that is resident in another economy."*

and,

> *"Portfolio investment is defined as cross-border transactions and positions involving debt or equity securities, other than those included in direct investment or reserve assets."*

Hence, these accounts involve transactions of different things. Portfolio investments are the exchanges of financial securities while Direct investments are the exchanges of control (ownership) of enterprises. From the perspective of an international investor (noted earlier by Albuquerque [2003]), FDI is a longer term investment while Portfolio could be short term. Given the different possible maturities of each investment, not only the current interest rate is relevant but also it's volatility. Following the literature on high frequency data I construct a proxy of the volatility of the US interest rate using it's realized volatility. Using average monthly series (intra-period information) I estimate the standard deviation for a year (period length of analysis) and use it as a proxy for international volatility (Figure 5). The 3-Month Treasury Bill rate for the US is used as a proxy for the international interest rate and is converted to a real rate using the past 12 months inflation.



(a) US Real Rate Average (b) US Real Rate Volatility (c) US Real Rate Box Plot

Figure 5: US real interest rate and global volatility. The gray area corresponds to high volatility periods. Source: FRED.

Having documented the importance of the FDI flows and the state of the international volatility to study Sudden Stop episodes, in the next section I will propose a small open economy model that incorporates both elements.

3 Model

3.1 Environment

I propose a representative agent, two-sector small open economy that builds from Durdu et al. [2009] and Bianchi et al. [2016] with two new elements: a FDI channel and time-varying volatility in the international interest rate.

The economy is inhabited by an infinitely lived household with preferences defined over stochastic sequences of aggregate consumption $c(c_t^T, c_t^N)$ for $t = 0, ..., \infty$. The preference specification is:

$$E_0\left[\sum_{t=0}^{\infty}\beta^t u(c(c_t^T, c_t^N))\right], \text{ where } u(c(.)) = \frac{c(.)^{1-\nu}}{1-\nu}, \quad c(c_t^T, c_t^N) = [a(c_t^T)^{-\eta} + (1-a)(c_t^N)^{-\eta}]^{\frac{1}{-\eta}}$$

Tradable goods are produced by a single firm with a decreasing-returns-to-scale production function, that uses capital as its only input and is exposed to a stochastic total factor productivity (TFP) shock, $y_t^T = \exp(\epsilon_t^T)A^T(\bar{k} + k_{f,t})^{\gamma}$. Capital is composed of an exogenously fixed domestic stock, $\bar{k}$, and an endogenous foreign stock (FDI), $k_{f,t}$, which are additive perfect substitutes. The firm, which is owned by the household and who receives it's profits, choses how much foreign capital to rent at the rate, $r_{k,t}$ which the firm takes as given. The non tradable goods are given by a fixed endowment, $y_t^N = A^N$. The TFP shock, ϵ_t^T, follows a first-order Markov process. The international interest rate, r_t, follows a stochastic process with time-varying volatility, σ_t, that follows a regime-switching process. The stochastic process's will be specified at the end of the section.

The representative household has access to a non-state-contingent bond, b_{t+1}, issued in terms of the tradable good with price equal to the inverse international interest rate factor, $q_t = (1 + r_t)^{-1}$. The household will choose sequences of consumption and bond positions to maximize her lifetime expected utility subject to the following period budget constraint:

$$c_t^T + p_t^N c_t^N + q_t b_{t+1} = p_t^N y_t^N + \pi_t^T + b_t$$

The agent income comes from the non tradable endowment, y_t^N, multiplied by the relative price of non tradable with respect to tradable, p_t^N, plus the profits from the tradable firm, π_t^T, plus any bond position coming from the previous period, b_t. On the expenditure side, the agent will buy tradable goods, c_t^T, and non tradable goods in terms of tradables, $p_t^N c_t^N$, plus the next periods bond position, b_{t+1}, multiplied by its price, q_t. However, next period bond position is subject to an endogenous *Fisherian* debt-deflation collateral constraint:

$$q_t b_{t+1} \geq -\kappa[\pi_t^T + p_t^N y_t^N + k_{f,t+1}]$$

The household won't be able to issue more debt (negative bond positions) than a fraction κ of the current flow of income plus (or minus if there are outflows of capital) any foreign capital stock, $k_{f,t+1}$. This constraint introduces a pecuniary externality because agents do not internalize how current borrowing decisions affect the collateral value.

There is an external investor that choses sequences of foreign capital to rent to the firm (note that the rental rate will be such that foreign capital market will clear), $k_{f,t}$ for $t = 1, ..., \infty$, as to maximize the expected present discounted value of profits paid to their global shareholders (as in

Mendoza and Smith [2006]). The objective function is:

$$\sum_{t=0}^{\infty} M_t \left[r_{k,t}k_{f,t} - (k_{f,t+1} - (1-\delta)k_{f,t} + \Phi(k_{f,t+1}, k_{f,t})\right] \quad \text{given } k_{f,0}$$

Where M_t is the discount factor used by the financial institution. I will assume $M_t = q_t = \frac{1}{1+r_t}$. The function $\Phi(k_{f,t+1}, k_{f,t}) = \phi\frac{(k_{f,t+1}-k_{f,t})^2}{\bar{k}+k_{f,t}}$ corresponds to the adjustment costs incurred by the international investor to move capital globally.

As noted above, the exogenous stochastic shocks of the model are the tradable TFP, the interest rate and the international volatility. The interest rate will follow an AR1 process with time-varying volatility:

$$r_t = (1-\rho_{\sigma_r})\bar{r} + \rho_{\sigma_r} r_{t-1} + \sigma_t \epsilon_{r,t} \ , \quad \epsilon_r \sim N(0,1)$$

The volatility, σ_t, will follow a regime-switching process between low and high periods of volatility. Finally, the tradable TFP will follow an AR1 process (independent from the interest rate).

3.2 Recursive Competitive Equilibrium

The state variables are today's bond position b, the foreign owned capital stock in the economy k_f and the exogenous state vector of shocks composed by tradable TFP, the international interest rate and its volatility: $s = (\epsilon^T, r, \sigma)$.

Household's problem:

$$v(b, k_f, s) = \max_{c^T, c^N, b'} u(c(c^T, c^N)) + \beta E[v(b', k_f', s')]$$

$$c^T + p^N c^N + qb' = p^N y^N + \pi^T + b \quad \text{, Budget Constraint}$$

$$qb' \geq -\kappa[\pi^T + p^N y^N + k_f'] \quad \text{, Debt Constraint}$$

$$k_f' = H(k_f, s) \quad \text{, Rational Expectations of the HH regarding External Investors Decision}$$

When λ is the multiplier on the B.C. and μ on the debt constraint, the equilibrium conditions are:

$$\begin{aligned} q u_{c^T} =& \beta E[u_{c'^T}] + \mu q \\ p^N =& \frac{u_{c^T}}{u_{c^N}} = \frac{1-a}{a}\left(\frac{c^T}{c^N}\right)^{1+\eta} \\ qb' + \kappa[\pi^T + p^N y^N + k'_f] \geq& 0 \quad \text{with equality if } \mu > 0 \end{aligned}$$

Tradable firm problem:

$$\pi^T = \max_{k_f \geq -\bar{k}} \ \exp(\epsilon^T) A^T (\bar{k} + k_f)^\gamma - r_k k_f$$

$$\text{if interior solution} \ \Rightarrow \ \text{FOC:}$$

$$r_k = \gamma \epsilon^T A^T (\bar{k} + k_f)^{\gamma - 1}$$

Financial Institution problem:

Given rational expectations on the rate of return of capital r_k, the financial institution will solve:

$$v_f(k_f, s) = \max_{k'_f} \ r_k k_f - (k'_f - (1-\delta)k_f + \Phi(k'_f, k_f)) + ME[v_f(k'_f, s')]$$

$$\Rightarrow \ \text{FOC:}$$

$$1 + \Phi_1(k'_f, k_f) = ME\left[r_{k'} + 1 - \delta - \Phi_2(k''_f, k'_f)\right]$$

Finally, the Recursive Competitive Equilibrium is given by the allocation functions $\{c^T(b, k_f, s), c^N(b, k_f, s), b'(b, k_f, s), k'_f(k_f, s)\}$, the price functions $\{p^N(b, k_f, s), r_k(k_f, s)\}$ and the functions $\{v, v_f, H\}$ such that:

1. Given the prices, the functions $\{c^T(b, k_f, s), c^N(b, k_f, s), b'(b, k_f, s)\}$ solve the household's problem.

2. Given the prices, the tradable firm maximizes profits.

3. Given the prices, the function $k'_f(k_f, s)$ solves the External Investor's problem.

4. The market clearing conditions are satisfied:

$$c^T(b, k_f, s) = \pi^T(b, k_f, s) + b - qb'(b, k_f, s) \quad \text{and} \quad c^N(b, k_f, s) = y^N$$

4 Quantitative Analysis

In this section I report the results obtained after solving the model calibrated to an emerging economy.

4.1 Calibration

Table 2 shows the calibrated parameters.

Table 1: Calibrated Parameters

Parameter		Value	Source or Target
Common to the literature			
ν	Risk aversion	2	From Bianchi et al. [2016]
μ	Determines CES	0.316	From Mendoza and Smith [2014]
a	CES aggregator	0.341	From Durdu et al. [2009]
δ	Depreciation rate	0.088	From Garcıa-Verdú [2005]
ϕ	FDI Adj cost	0.20	From Mendoza and Smith [2014]
Matched moments			
$\bar{k}$	Fix capital stock	2.3	Match FDI/Y% = -2.7 for emerging eco.
γ	Share of capital	0.25	Match K/Y = 2.0 for emerging eco.
A^T	Tradable productivity level	1.0	Match K/Y = 2.0 for emerging eco.
A^N	Non-Tradable productivity level	1.0	Normalization
β	Discount factor	0.91	Match probability of SS of 3.5%
κ	Debt fraction of collateral	0.21	Match probability of SS of 3.5%
Exogenous process			
$\bar{r}$	Mean interest rate	1.06%	Match average real interest rate data
r	Interest rate values	{-1.0, 0.4, 1.7, 3.0}	Discretized using Tauchen-Hussey
ρ_r	Interest rate AR1 coefficient	{0.215,0.618}	Estimated using low and high volatility periods
σ_l	Low volatility variance	0.45%	Match average of low volatility periods
σ_h	High volatility variance	1.30%	Match average full sample volatility
F_{ll}	Transition probability σ_l to σ_l	0.91	Match duration of low volatility periods
F_{hh}	Transition probability σ_h to σ_h	0.41	Match duration of high volatility periods
ρ	TFP autoregressive coefficient	0.58	Common in literature for emerging economies
σ	TFP autoregressive variance	0.0258	Common in literature for emerging economies

The parameters of the utility function were taken from the literature. Risk aversion equal to 2 and the elasticity of substitution between tradable and non tradable consumption ($\frac{1}{1+\eta}$) equal to 0.76 implies a value of $\eta = 0.316$ was taken from Mendoza and Smith [2014] who calibrated it with Mexican data. Given estimates of the sectoral consumption ratios by Durdu et al. [2009], the CES aggregator was set to 0.341. Lastly, the adjustment cost parameter ϕ was set to 0.20 following

Mendoza and Smith [2014] which implies a high price elasticity of 5 for the international investor that is commonly used in the literature.

Regarding the parameters that were calibrated to match specific moments of the data, the fix domestic capital stock for an emerging economy was set to 2.3 to match the median FDI to GDP percentage of -2.73%. The share of capital γ and the tradable TFP coefficient were set to 0.25 and 1.0 respectively to match the median capital to GDP ratio for an emerging economy of 2.04. The discount factor β and the debt to income fraction κ were set to 0.91 and 0.21 to match the probability of a SS for an emerging economy of 3.5%.

With respect to the exogenous process, the 3-Month Treasury Bill for the US was used as a proxy for the international interest rate and was converted to a real rate using the past 12 months inflation. Intra-period data (monthly) was used to construct period (yearly) volatility. Let the volatility process follow a two-state regime switching process. Identified low volatility episodes are from 1953 to 1979 and from 1985 to 2007 the latter know as the Great Moderation era; and high volatility episodes are from 1980 to 1984 which is know as the period of highly active monetary policies made by Federal Reserve Chairman Paul Volcker to control inflation and from 2008 to 2010 which was the years of the Great Recession. The sample used starts at the beginning of a full observed period of low volatility and ends at the end of a full observed period of high volatility. The calibration is set to capture the average duration of low volatility periods to be 25 years and of high volatility periods to be 4 years. The value for the low volatility is set to the average of both low volatility periods: $\sigma_l = 0.45\%$. Given the long-run probabilities implied by the durations of each period, high volatility is set to $\sigma_h = 1.3\%$ to match the full-sample 1953-2010 average volatility of 0.57% with transition probabilities $F_{ll} = 0.91$ and $F_{hh} = 0.41$.

For the interest rate process a Tauchen-Hussey discretization algorithm was used with mean interest rate of 1.06% and autocorrelation coefficient 0.215 for the high volatility process and 0.618 for the low volatility process. The autocorrelation coefficients were estimated using the periods identified above. Finally, the tradable's TFP autoregressive coefficient and variance were set to commonly used values for emerging economies of 0.54 and 0.0258 respectively.

The difference between an advanced and an emerging economy studied in this paper is the different dynamics of the FDI account. For this reason, two parameters will differ between both set of economies. The FDI adjustment cost, ϕ, for an advanced economy will be larger than in an emerging economy. This difference is a reduced form proxy for what has been recently documented in the World Bank [2017]. The World Bank, through the Global Investment Competitiveness group, surveyed executives of multinational corporations with investments in developing countries. They find that over 90 percent of all investors say that legal protections are critically important in the decision process of investing abroad. These guarantees include laws that protect against expropriation, breaches of contracts and arbitrary government conducts. Hence, I will use the adjustment costs as a proxy of the different rule of law development between advanced and emerging economies. A ϕ of 0.60 (three times larger than for emerging) will be used for advanced economies. Larger adjustment costs incentive external investors to react in a smaller amount to both domestic and external shocks. This serves as a proxy of a larger degree of certainty in the domestic economy that the shocks are transitory and the commitment with the contracts is preserved. The other difference will be in the capital output ratio. Advanced economies have a larger ratio and FDI flows closer to zero, hence, a A^T of 0.915 will be used for the advanced economy simulations. Accompanying the smaller A^T, the domestic stock of capital, $\bar{k}$, is increased to 3.28 such that average output is left unchanged in the absence of foreign capital.

4.2 Quantitative results

The solution method is a global time-iteration method due to the high non linearities that occasionally binding models are characterized to show in the policy functions. The description of the algorithm can be found in the Appendix. After solving the model, I simulated 110,000 periods and dropped the first 10,000 points. Table 3 shows the moments of the simulated data for both economies over the full sample and over the identified SS episodes.

Table 2 and Figure 6 show the statistics and simulated dynamics of some variables during a Sudden Stop. The First row of graphs corresponds to the exogenous stochastic process's. We can see that a SS episode is characterized by being preceded by a drop in tradable productivity of normal *business cycles magnitude* and by an increasing international interest rate combined with a sudden drop

Table 2: Simulated Statistics

	Emerging Economy	Advanced Economy	
Business Cycles			
Mean FDI/GDP%	-2.62%	0.44%	Matched
Mean Capital Local/GDP	1.7	2.7	Matched
Sudden Stops			
The long-run probability of SS	3.98%	3.76%	
GDP drop during a SS	-12.81%	-14.33%	
Port. Inv./GDP change	-4.02%	-3.97%	
FDI/GDP change	-6.19%	-2.08%	

in ts volatility. This event study analysis suggests that Sudden Stops in emerging economies are characterized by larger movements in international shocks while in advanced economies, SS's happen when domestic shocks are larger. With respect to the Financial Account, advanced economies have smaller deficits in the FA, while emerging economies show a larger contraction in the FA. This difference is due mainly to the FDI channel since both groups show similar dynamics in the Portfolio flows. The upper part of Table 2 shows the Business Cycle moments matched in the calibration and the bottom part shows the dynamics during a Sudden Stop. Advanced economies have a smaller probability of a Sudden Stop and the contraction in the FDI account is smaller. However, advanced economies experience a larger contraction in the GDP that is not consistent with the data presented in Section 2. This could be due to the fact that in the simulations I am using the same TFP process for both types of economies while in the data, advanced economies could have a less volatile process. The reason I am using the same process is because the aim of this paper is to focus on the differences in the Direct Investment account between economies and its effect on the probability of a Sudden Stop.

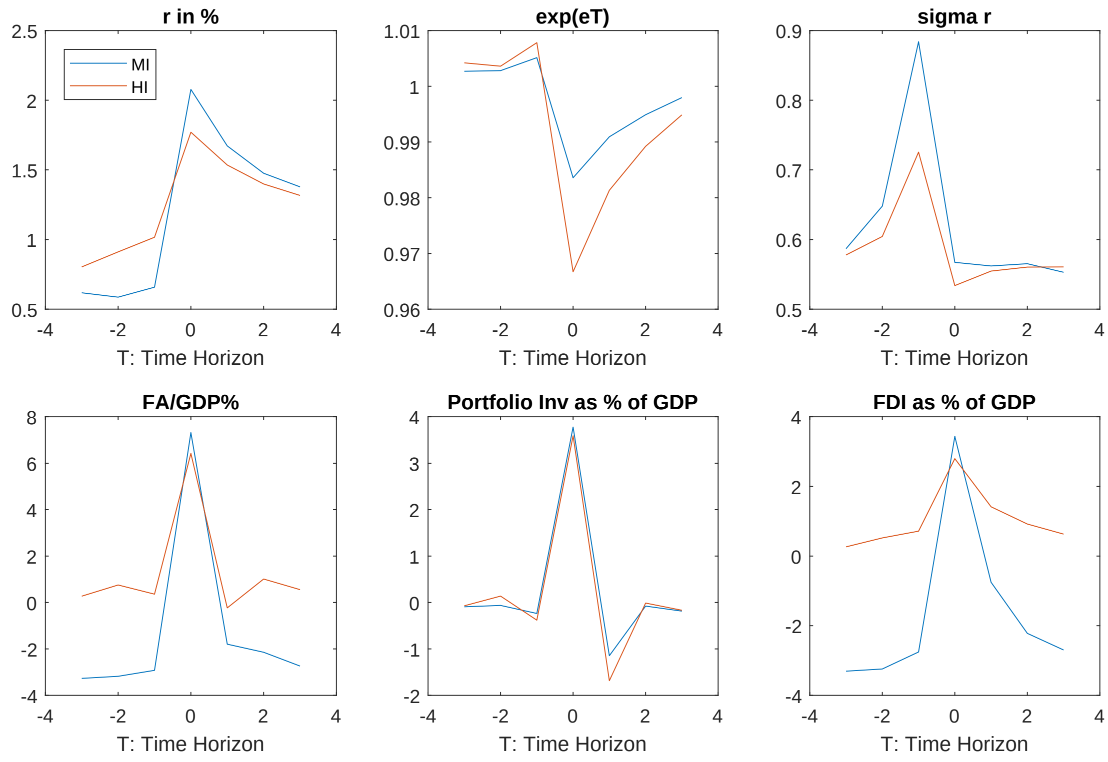


Figure 6: Simulated dynamics during a Sudden Stop. HI refers to high income and MI refers to upper-middle income.

Finally, in Table 3 I compare the results obtained from Probit regressions with simulated data and with observed data. Using the panel structure of the constructed data base I run the following regression: a Probit model where the dependent variable is a binary variable that takes the value of 1 if in the year t and the country i was in a SS episode.

Using real data for emerging economies (column (2)) an increase in the current interest rate decreases the probability of a SS while an increase in the previous period increases the probability of a SS. An interpretation of this is that as international interest rates start increasing, the opportunity cost of investment increases and capital that had previously enter the economy will be reallocated and invested at the international rate. With respect to the volatility, current volatility seems to not have a statistically significant effect on the probability, while previous period volatility has a positive effect on the probability of a SS. As the economies enter high volatility states, SS become more probable in the future. An increase in the current business cycle (measured as the cycle from a HP filter in real data) decreases the probability of a SS. Finally, more FDI inflows as percentage of GDP in the previous period increase the probability of a SS in emerging economies.

In terms of the sign of the coefficients the model does a successful job. However, as expected, in the regression using simulated data, all of the coefficients are over estimated. One possible explanation for this is that the data simulated from the model abstracts from other variables that lie outside the scope of this study.

Table 3: Probit Regressions

Dependent Variable: $DummyCrisis_{t,i}$

	Emerging Economies		Advanced Economies	
	(1) Simulated Data	(2) Real Data	(3) Simulated Data	(4) Real Data
$E(r_{t,US})$	-2.203***	-0.047*	-2.016***	-0.077*
	(0.080)	(0.024)	(0.048)	(0.047)
$E(r_{t-1,US})$	2.394***	0.071***	1.796***	0.040
	(0.082)	(0.022)	(0.044)	(0.040)
$\sigma(r_{t,US})$	0.447***	-0.0007	0.132***	-0.036
	(0.063)	(0.070)	(0.047)	(0.15)
$\sigma(r_{t-1,US})$	0.701***	0.265***	0.343***	0.214*
	(0.047)	(0.067)	(0.035)	(0.129)
$Cycle^a_{t,i}$	-0.150***	-0.051***	-0.193***	-0.071
	(0.007)	(0.014)	(0.005)	(0.047)
$FDI/GDP_{t,i}$	1.450***	0.011	1.910***	-0.013
	(0.027)	(0.007)	(0.028)	(0.018)
$FDI/GDP_{t-1,i}$	-0.493***	-0.007*	-0.923***	-0.007
	(0.015)	(0.004)	(0.021)	(0.017)
Country FE	-	YES	-	YES
Observations	100,000	2,101	100,000	879

Standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

/a For simulated data corresponds the exponential TFP shock $\exp(\epsilon^T)$ and for real data corresponds to te cycle component of the GDP per capital obtained using a HP filter.

4.3 Effect of only time-varying volatility

As documented in Fernández-Villaverde et al. [2011], changes in volatility have an effect in real term variables. I extend their analysis to study how changes in volatility can cause Sudden Stops. In this subsection, I simulate the model fixing the TFP shock to it's mean, $\exp(\epsilon_t^T) = 1$, and the interest rate to it's mean, $r_t = 1.0\%$, and letting only the volatility to fluctuate.

Table 4: Simulated Statistics with only volatility shocks

	Emerging Economy	Advanced Economy
Sudden Stops		
The long-run probability of SS	3.97%	3.11%
GDP drop during a SS	-9.4%	-9.4%
Port. Inv./GDP change	-3.9%	-3.8%
FDI/GDP change	-6.2%	-2.2%

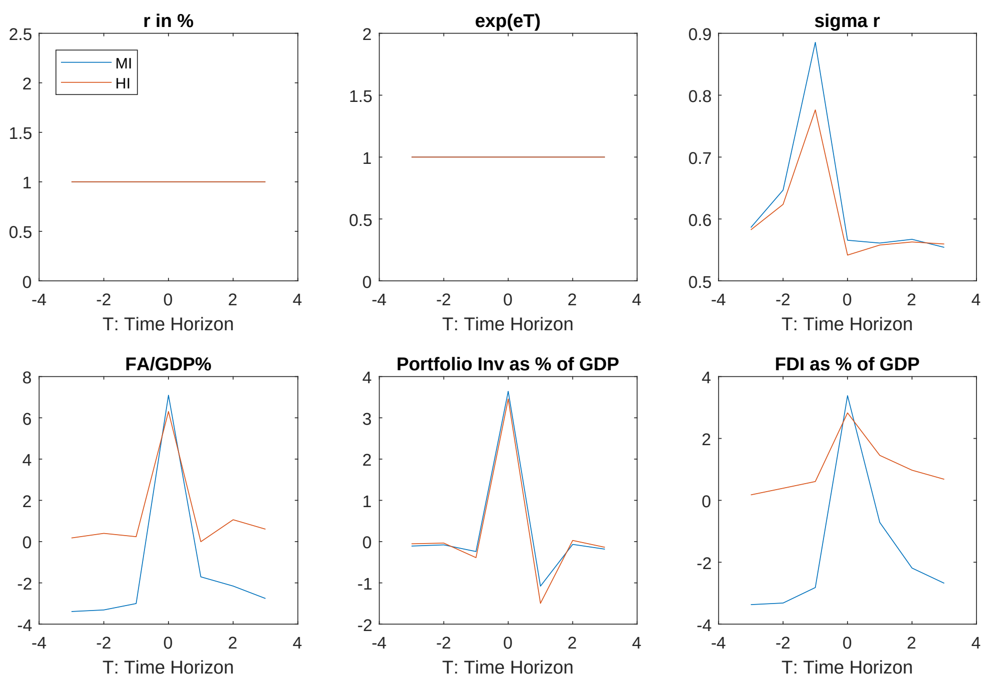


Figure 7: Simulated dynamics during a Sudden Stop. HI refers to high income and MI refers to upper-middle income.

Table 4 and Figure 7 show the results of this experiment. The most striking result is that shocks to volatility can account for 99.6% of the probability of having a Sudden Stop in emerging economies and for 82.9% in advanced economies. Also, volatility shocks can generate Sudden Stops that cause a contraction in the GDP of 9.4% in both groups of economies.

5 Conclusion

Balance of payment crises, characterized by Sudden Stops (SS), are not a phenomenon exclusive to emerging economies. However, the underlying factors are not necessarily the same; these countries have opened their economies to foreign capital in different ways. This evidence motivates the study of the differences between both type of economies in order to better understand why the probability of having a SS in an emerging economy is 0.5 percentage points larger than in advanced economies.

By decomposing the Financial Account I identify important differences between emerging and advanced economies in the Direct Investment (FDI) account. Advanced economies less negative, and even positive, FDI to GDP flows and have in average larger capital to GDP ratios than emerging economies. To account for this, I propose a two-sector small open economy model with incomplete markets and a collateral constraint that contributes to the literature by incorporating two new elements: i) integration of the economy with global capital markets is through the Portfolio channel and the Direct Investment channel; and, ii) global risk, that I model through the international interest rate, follows a time-varying volatility process.

I find that the FDI channel can account for 44% of the difference between the probability of having a Sudden Stop in an advanced and in an emerging economy. Also, I find that volatility shocks account for 99.6% of the probability of having a Sudden Stop in emerging economies and for 82.9% in advanced economies.

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6 Appendix

6.1 Description of the Data

The panel database consists of 37 high income economies and 75 upper-middle income economies according to the World Bank's classification. Data on the Financial Account components comes from the IMF Balance of Payments Statistics, GDP comes from the World Bank National Accounts database, capital stocks come from the IMF Investment and Capital Stock Dataset, debt stocks come from the Joint External Debt Hub, and the US interest rate comes from the FRED. The economies considered are:

Table 5: List of Countries

Name	Classification
Albania	Upper-Middle Income
Algeria	Upper-Middle Income
Angola	Upper-Middle Income
Antigua and Barbuda	Upper-Middle Income
Argentina	Upper-Middle Income
Aruba	High Income
Australia	High Income
Austria	High Income
Azerbaijan, Republic of	Upper-Middle Income
Bahamas, The	High Income
Bahrain, Kingdom of	Upper-Middle Income
Barbados	Upper-Middle Income
Belarus	Upper-Middle Income
Belgium	High Income
Belize	Upper-Middle Income
Bermuda	High Income
Bosnia and Herzegovina	Upper-Middle Income
Botswana	Upper-Middle Income
Brazil	Upper-Middle Income
Brunei Darussalam	High Income
Bulgaria	Upper-Middle Income
Canada	High Income
Chile	Upper-Middle Income
China, P.R.: Mainland	Upper-Middle Income
Colombia	Upper-Middle Income
Costa Rica	Upper-Middle Income
Croatia	Upper-Middle Income
Curacao	High Income
Cyprus	High Income
Czech Republic	Upper-Middle Income
Denmark	High Income
Dominica	Upper-Middle Income
Dominican Republic	Upper-Middle Income
Ecuador	Upper-Middle Income
Equatorial Guinea	Upper-Middle Income
Estonia	Upper-Middle Income
Fiji	Upper-Middle Income

Finland	High Income
France	High Income
French Territories: French Polynesia	High Income
Gabon	Upper-Middle Income
Georgia	Upper-Middle Income
Germany	High Income
Greece	Upper-Middle Income
Grenada	Upper-Middle Income
Guyana	Upper-Middle Income
China, P.R.: Hong Kong	High Income
Hungary	Upper-Middle Income
Iceland	High Income
Iran, Islamic Republic of	Upper-Middle Income
Iraq	Upper-Middle Income
Ireland	High Income
Israel	High Income
Italy	High Income
Jamaica	Upper-Middle Income
Japan	High Income
Jordan	Upper-Middle Income
Kazakhstan	Upper-Middle Income
Korea, Republic of	Upper-Middle Income
Kuwait	High Income
Latvia	Upper-Middle Income
Lebanon	Upper-Middle Income
Libya	Upper-Middle Income
Lithuania	Upper-Middle Income
Luxembourg	High Income
China, P.R.: Macao	High Income
Macedonia, FYR	Upper-Middle Income
Malaysia	Upper-Middle Income
Maldives	Upper-Middle Income
Malta	Upper-Middle Income
Marshall Islands, Republic of	Upper-Middle Income
Mauritius	Upper-Middle Income
Mexico	Upper-Middle Income
Montenegro	Upper-Middle Income
Namibia	Upper-Middle Income
Netherlands	High Income
French Territories: New Caledonia	High Income
New Zealand	High Income
Norway	High Income
Oman	Upper-Middle Income
Palau	Upper-Middle Income
Panama	Upper-Middle Income
Paraguay	Upper-Middle Income
Peru	Upper-Middle Income
Poland	Upper-Middle Income
Portugal	High Income
Qatar	High Income
Romania	Upper-Middle Income
Russian Federation	Upper-Middle Income
Saudi Arabia	Upper-Middle Income
Serbia, Republic of	Upper-Middle Income
Seychelles	Upper-Middle Income
Singapore	High Income
Sint Maarten	High Income
Slovak Republic	Upper-Middle Income

Slovenia	Upper-Middle Income
South Africa	Upper-Middle Income
Spain	High Income
St. Kitts and Nevis	Upper-Middle Income
St. Lucia	Upper-Middle Income
St. Vincent and the Grenadines	Upper-Middle Income
Suriname	Upper-Middle Income
Sweden	High Income
Switzerland	High Income
Thailand	Upper-Middle Income
Trinidad and Tobago	Upper-Middle Income
Turkey	Upper-Middle Income
Tuvalu	Upper-Middle Income
United Kingdom	High Income
United States	High Income
Uruguay	Upper-Middle Income
Venezuela, Republica Bolivariana de	Upper-Middle Income

The list of Sudden Stop episodes identified are:

Table 6: List of Sudden Stops

Name	Classification
Albania	2009
Angola	2010
Antigua and Barbuda	2014
Argentina	2002
Austria	2006
Bahamas, The	2015
Bahrain, Kingdom of	1995
Belgium	2010
Belize	2006
Bosnia and Herzegovina	2009
Botswana	2005
Brazil	2015
Brazil	2016
Brunei Darussalam	2010
Bulgaria	2009
Canada	1982
Chile	2009
China, P.R.: Mainland	2007
Colombia	1999
Colombia	2016
Costa Rica	2009
Croatia	2009
Cyprus	2009
Cyprus	2011
Denmark	2001
Denmark	2011
Dominica	2016
Dominican Republic	2009
Dominican Republic	2015
Ecuador	1983
Estonia	2009
Fiji	2007
Fiji	2015
Finland	2013
France	2010

Georgia	2009
Germany	2013
Greece	2012
Grenada	2004
Grenada	2014
Guyana	1996
Hungary	2009
Iceland	2009
Ireland	2009
Israel	2001
Israel	2009
Israel	2014
Italy	2012
Jamaica	2009
Jamaica	2015
Jordan	2013
Kazakhstan	2010
Korea, Republic of	1998
Latvia	2009
Lebanon	2010
Lithuania	2009
Macedonia, FYR	2009
Malaysia	1998
Malaysia	2011
Malta	2012
Malta	2016
Mauritius	2013
Mexico	1982
Mexico	1983
Mexico	1995
Montenegro	2009
Namibia	2006
Norway	2008
Oman	2010
Palau	2015
Panama	1980
Panama	2009
Paraguay	1996
Paraguay	2013
Poland	1994
Poland	2009
Poland	2012
Portugal	2011
Portugal	2012
Romania	2009
Serbia, Republic of	2009
Seychelles	2009
Seychelles	2013
Singapore	2010
Slovak Republic	2009
Slovak Republic	2012
Slovenia	2009
Spain	2009
Spain	2012
St. Kitts and Nevis	2012
St. Lucia	2009
St. Lucia	2014
Suriname	2016

Sweden	2010
Switzerland	2010
Thailand	1998
Trinidad and Tobago	2006
Trinidad and Tobago	2008
Turkey	2009
United States	2009
Uruguay	1983
Uruguay	2003

6.2 Solution Method

The following algorithm follows the algorithm presented in Bianchi et al. [2016]. To solve the decentralized equilibrium using the time-iteration method I need to solve for the policy functions $c^T(b,k_f,s), p^N(b,k_f,s), b'(b,k_f,s)$ and $k'_f(k_f,s)$ that satisfy:

$$p^N(b,k_f,s) = \frac{u_{c^N}(c^T(b,k_f,s),y^N)}{u_{c^T}(c^T(b,k_f,s),y^N)} \tag{1}$$

$$qu_{c^T}(c^T(b,k_f,s),y^N) \leq \beta E[u_{c^T}(c^T(b'(b,k_f,s),s'),y'^N)] \tag{2}$$

$$qb'(b,k_f,s) \geq -\kappa[\pi^T + p^N y^N] \tag{3}$$

$$c^T(b,k_f,s) + qb'(b,k_f,s) = \pi^T + b \tag{4}$$

$$1 + \Phi_1(k'_f(k_f,s),k_f) = ME\left[r'_k(k'_f(k_f,s),s') + 1 - \delta - \Phi_2(k''_f(k'_f(k_f,s),s'),k'_f(k_f,s))\right] \tag{5}$$

$$r_k(k_f,s) = \gamma\epsilon^T A^T(\bar{k}+k^f)^{\gamma-1} \tag{6}$$

$$y^T(k_f,s) = \epsilon^T A^T(\bar{k}+k^f)^{\gamma} \tag{7}$$

$$\pi^T(k_f,s) = \epsilon^T A^T(\bar{k}+k^f)^{\gamma} - r_k(k_f,s)k^f \tag{8}$$

$$\tag{9}$$

Note that $s = (r,\epsilon^T,\epsilon^N)$.

The algorithm starts by conjecturing $c^T_j(b,k_f,s), p^N_j(b,k_f,s), b'_j(b,k_f,s)$ and with iteration $j=1$, then:

1. Obtain $k'_f(k_f,s)$ from equation (5) and (6).

2. Obtain $b'_{j+1}(b,k_f,s)$ from $qb'_{j+1}(b,k_f,s) = -\kappa[\pi^T + p^N y^N]$ and calculate $c^T_{j+1}(b,k_f,s)$ from 4.

3. Compute $U \equiv q u_{c^T}(c^T_{j+1}(b, k_f, s), y^N) - \beta E[u_{c^T}(c^T_j(b'(b, k_f, s), s'), y'^N)]$

4. If $U > 0$, then the collateral constrain binds ($\mu = 0$) and get $p^N_{j+1}(b, k_f, s) = \frac{u_{c^N}(c^T_{j+1}(b,k_f,s),y^N)}{u_{c^T}(c^T_{j+1}(b,k_f,s),y^N)}$

5. If $U \leq 0$, the collateral constraint does not bind ($\mu > 0$). Discard $b'_{j+1}(b, k_f, s)$ and $c^T_{j+1}(b, k_f, s)$ from step 2 and solve for the recursive function $c^T_{j+1}(b, k_f, s)$ that satisfies equation (2) with equality. Then get $p^N_{j+1}(b, k_f, s)$ from equation (1) and $b'_{j+1}(b, k_f, s)$ from equation (4).

6. Check for convergence between conjectures j and $j + 1$