Currency Risk Under Capital Controls

Xiang Fang, Sining Liu, and Yang Liu*
University of Hong Kong

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Abstract

Currencies of emerging markets with stricter capital controls have lower average returns. These return spreads cannot be explained by traditional currency risk factors. The effect of capital controls is concentrated in debtor countries and is not present in currencies of advanced economies. The high-capital-control currencies depreciate less in times of high global risk, measured by VIX or currency implied volatility. This evidence is consistent with the macroprudential view of capital controls. We propose an equilibrium intermediary-based asset pricing model where a country borrows subject to an occasionally binding credit constraint. Capital controls can reduce the crises probability and mitigate the currency crashes in crisis times. The model quantitatively accounts for the empirical findings. The model quantifies the financial impact of non-pecuniary externality and the effect of capital control policies to restore efficiency.

Key words: Capital control, Currency risk, Risk premia, Sudden stop, Emerging markets

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1 Introduction

Conventional wisdom states that capital account liberalization and financial integration are welfare-improving. Free capital flows can facilitate productive investment and consumption smoothing. This view is challenged by a series of financial crises in the recent three decades, often coupled with large capital flows. Extensive studies have focused on the perils of dramatic capital flows, especially for the emerging market economies. This literature provides theoretical underpinnings for capital controls as a desirable macro-prudential policy that mitigates excessive macroeconomic volatility and financial instability. Particularly, capital controls can reduce the magnitude of financial crises, current account reversal, and asset price crashes.

Understanding the effect of capital control policies on exchange rates and exploring its underlying mechanism is important to guide policy practice. We study this effect from a new perspective: the risk-return tradeoff of currencies. We find that currencies with stricter capital controls have lower average returns in emerging market economies. Capital controls reduce the exposure of currencies to the global systematic risk, and thus the risk premia. Our approach follows an asset pricing view of exchange rates, for example, Lustig et al. (2011) and Verdelhan (2018).

In the empirical analysis, we use the capital control indices constructed by Fernández et al. (2016) that covers a wide range of countries from 1995 onward. The index is between zero and one, as an average of binary indicators of capital controls in various categories, including inflows and outflows of different asset classes. Countries display substantial heterogeneity in their capital control policies in the cross section.

We sort currencies into four portfolios based on the one-year lagged capital control indices. Average currency returns fall from 4.72 percent per year for the lowest-control portfolio to 0.84 percent for the highest-control portfolio. Buying low-control currencies and selling high-control currencies generates an average return of 3.89 percent and a Sharpe Ratio of 0.51. This return spread cannot be explained by exposures to traditional risk factors, such as the dollar and carry factors (Lustig et al., 2011), the value factor (Asness et al., 2013; Menkhoff et al., 2017), and the momentum factor (Menkhoff et al., 2012; Asness et al., 2013). In time-series asset pricing tests, after including these traditional risk factors, the alphas are significant with similar magnitude as the raw average returns. In panel regressions, capital controls negatively predict future currency returns even after controlling for the forward discount.

The existing evidence of the capital control effect on exchange rate dynamics is weak and inconclusive. The literature focuses on examining the contemporaneous correlation between capital controls and the levels of exchange rates. One challenge of this literature is the endogeneity that controls may respond to the current exchange rate. Even if policies are exogenous, currencies with tight controls should be undervalued upon inflow surges and overvalued upon outflow surges, which leads to an ambiguous unconditional relationship. Our approach is not subject to these challenges. As we study the expected currency return instead of the current exchange rate level, the government is unlikely to respond to largely unpredictable return. Furthermore, the capital control effect on risk mitigation is unambiguous and does not depend on the direction of capital flows.

While most emerging markets have imposed variety of capital controls, advanced economies (AE) have little to no controls. When focusing on AEs, we find no significant difference among currency returns of capital-control-sorted portfolios. In fact, this contrasting result is consistent with the view that capital controls are advocated mainly for emerging markets, which are more fragile to capital flows.

We utilize conditional tests to further understand the underlying mechanism. Highly indebted countries are more prone to financial crisis. Based on the findings in the literature, we hypothesize that capital controls in these countries reduce exchange rate risk and expected returns by a larger degree. This is indeed what we find. The effect of capital control on currency return is significantly more negative for debtor countries and is close to zero for creditor countries.

Besides the evidence on expected returns, we provide evidence on how capital controls alter the risk exposures. We take CBOE Volatility Index (VIX) as the measure of global risk. Generally, currencies depreciate against the US dollar when VIX increases. When interacting capital controls with VIX, we find that tighter capital controls reduce the depreciation in times of high global risk. We find the same risk reduction effect when we measure global risk by currency implied volatility.

We present an equilibrium intermediary-based asset pricing model to study the effect of capital control policies on currency risk and returns. In the model, a small open economy borrows from the rest of the world facing an occasionally binding credit constraints .The borrower of the small open economy block is similar with the literature (Bianchi, 2011). The key ingredient of the model is that agents borrow from the rest of the world subject to a credit constraint that is positively related to the level of real exchange rate. If the country is heavily indebted such that the constraint is close to bind, a negative output shock will trigger a financial crises with a large, sudden consumption drop, a current-account reversal, and an exchange rate depreciation. The depreciation further tightens the constraint and depreciates the currency even more. The spiral of exchange rate depreciation exposes global investors to large currency crashes when the constraint is triggered to bind.

Different from the macro literature, we model the lender as risk-averse global intermediaries. The lenders' Euler equation has a wedge, which is interpreted as the cost of balance sheet expansion. The global intermediaries are exposed to two sources of risks, the global macroeconomic risk and the financial risk that drives the Euler equation wedge.These intermediaries require a larger risk premium to hold the local currency bonds if their exchange rates depreciate in bad global macroeconomic states or in states when their Euler equation wedge widens. Capital control policies increase the cost of borrowing and discourage the accumulation of debt, which reduces the probability of a binding constraint and sharp currency depreciations when output is low. Therefore, the global intermediaries require lower risk premia to hold local currency bonds issued by countries with capital control policies. On top of the risk compensation, the existence of the wedge also increases the excess return. The calibrated model can quantitatively match the business cycle moments of the borrowing country, the SDF dynamics of intermediaries, and the currency risk premia for countries with and without capital controls. Furthermore, the model quantifies the financial impact of non-pecuniary externality and the effect of capital control policies to restore efficiency.

The model provides a complementary view of how capital control policies affect capital flows and exchange rates. Consistent with the conventional view, capital control policies restrict capital flows, which reduces exchange rate depreciation (appreciation) when capital flows out (in). In addition, the capital control policies in the model discourage the country from accumulating too much debt and prevent the economy from having a binding constraint and large capital outflows. Through this mechanism, capital controls reduce the currency risk and thus the currency return.

This paper bridges the two growing literature of macro-prudential capital controls in international macroeconomics and currency risk premia in international asset pricing. In particularly, we focus on constrained global intermediaries that determine currency risk premia. The currency risk premia is changed by capital control policies, which has received relatively little attention in the asset pricing literature. We document how capital controls change the systematic risk of currencies and their associated returns. Our finding implies an unintended consequence of capital control policies to lower the local-currency borrowing cost from the international financial market.

We also contribute to the literature that studies emerging market currencies and how they are affected by macroeconomic policies. While most of the asset pricing literature focuses on the AEs or the sample of all countries, we find that EM currencies are exposed to the distinct currency crash risk when the borrowing constraint is triggered to bind. Investors charge a risk premium over bearing such risks. Such risks are reduced by capital control policies. The understanding of such crash risks of EM currencies is particularly useful in the current times when bond investors invest more aggressively into EMs for higher yields.

Literature review. The paper is related to the literature of currency risk premia, for example, Lustig et al. (2011); Menkhoff et al. (2012, 2017); Della Corte et al. (2016, 2021); Colacito et al. (2020); Verdelhan (2018). We uncover a distinct source of emerging market currency risk related to the sharp depreciation in global bad times. The risk is related to currency crash risk (Farhi et al., 2009). Different from Farhi et al. (2009), we focus on a specific source of currency crash faced by emerging market currencies. We follow the intermediary asset pricing literature in international finance (Gabaix and Maggiori, 2015; Du et al., 2018; Fang and Liu, 2021; Du et al., 2019) and consider the global intermediaries with an Euler equation wedge as pricers of the local currency bonds.

A large literature has been discussing the pros and cons of capital account liberalization and capital control policies. Henry (2007) summarizes and critically evaluates the empirical studies before the crisis, arguing that capital liberalization improves the macroeconomic performance. After the financial crisis, there has been more suspicion on the desirability of a completely free capital account. Theoretical studies of Lorenzoni (2008) and Bianchi (2011), show that when the financial market is imperfect, there exists a pecuniary externality and the decentralized equilibrium is not constrained optimal. Mendoza (2010) shows quantitatively that the feature of imperfect financial market is crucial to explain the emerging market business cycles and sudden stops they experience. Built on the theoretical foundation, capital control policies are proposed to improve the welfare of such economies, for example, Korinek and Sandri (2016), Bianchi and Mendoza (2018), Mendoza and Rojas, 2019, Jeanne and Korinek (2020), and Liu et al. (2021). The literature also proposes other sources of inefficiency, for example, aggregate demand externalities that rationalize the optimal use of capital control policies (Farhi and Werning, 2016; Costinot et al., 2014; Schmitt-Grohé and Uribe, 2016).

The evidence on the effect of capital controls has been elusive. Forbes (2007) and Alfaro et al. (2017) find that capital controls increase cost of capital. Ostry et al. (2012) find that countries with capital control in place exhibits growth resilience during the Global Financial Crisis. Forbes et al. (2015) and Bruno et al. (2017) find that capital controls make banks more prudent and reduces financial fragility. Keller (2019) find that banks with capital controls are encouraged to lend in dollars in Peru. Particularly, the literature has established little evidence of the capital control effect on exchange rates (Rebucci and Ma, 2019; Erten et al., 2021). Our paper makes progress on this front by utilizing new data and taking an asset pricing approach, instead of only examining the contemporaneous exchange rate.

The remainder of the paper is structured as follows. Section 2 discusses the data we use and the summary statistics. Section 3 presents the main empirical results. Section 4 lays out the model and its quantitative implications. Section 5 concludes the paper.

2 Data and Summary Statistics

In this section, we briefly describe the data used in this study.

2.1 Capital Controls

A capital control is a policy designed to limit transactions on capital account. It is commonly implemented as taxes, reserve requirements, quantitative limits and restrictions, prohibitions, authorizations. As capital controls have many facets and the practice varies across countries, it is challenging to have a precise measure of capital controls. We use the comprehensive measure proposed by Fernández et al. (2016). In this section, we briefly describe the essential features of the capital control measures that are relevant for our study, and refer the reader to Fernández et al. (2016) for more details.

The information used for measurement is based on IMF's Annual Report on Exchange Rate Arrangements and Restrictions (AREAER). The AREAER describes de jure legal restrictions and regulations for international transactions by asset categories. Fernández et al. (2016) use the narrative description in the AREAER to determine the presence of restrictions on international transactions and interpret the narrative information according to a set of rules. They generate a binary indicator for each transaction and aggregate these indicators to a capital control index that is between 0 and 1. A higher index represents a greater breadth, comprehensiveness and intensity of controls. They also construct indices on inflow, outflow and on 10 asset classes (money market instruments, bonds, equities, collective investments, derivatives, financial credits, commercial credits, guarantees, real estate, direct investments). The indices are at annual frequency and span from 1995 to 2020.

Because of the intrinsic challenge in measuring capital controls, there are several caveats on this measure. First, a higher capital control measure represents the presence of control for broad asset categories, and the measure does not reflect the intensity of the control policy. We assume that the extensive margin of capital control is correlated with its intensive margin, i.e., a country that imposes controls on broader asset categories is more likely to impose more stringent controls.[1] Second, the de jure measure cannot account for the complication in the implementation of the policies in the real world. Because of the variety of forms, there can be a gap between de jure regulation and de facto situation.

Our sample covers 19 EM countries and the G10 countries in AEs. EMs include Brazil, Chile, China, Czech, Egypt, Hungary, India, Indonesia, Israel, Kuwait, Malaysia, Mexico, Philippines, Poland, Russia, South Africa, Thailand, Turkey, Ukraine. AEs include Canada, Denmark, Euro/Germany[2], Japan, New Zealand, Norway, Sweden, Switzerland and United Kingdom.

2.1.1 Summary statistics

Table 1 shows the summary statistics of capital controls in different countries and the average of the EM and AE groups. Capital control policies are widely used in EMs: the average capital control

[1]In a recent study, Acosta-Henao et al. (2020) construct a data set of capital control in the intensive margin using textual analysis for several countries. They find that the pattern of capital controls are similar in both the extensive and intensive margins.

[2]We use the Germany capital control index for Eurozone.

index of EMs is 0.58. They also have relatively large time-series standard deviation of 0.12. There exists large heterogeneity in the cross-section of countries. A few EM countries always keep the controls at the high level, such as China, India, Malaysia, Philippines and Ukraine. The countries with low controls are relatively more developed ones such as Israel. Capital control measures feature a high annual persistence of 0.77, which translates into a monthly persistence of 0.98.

Even though EMs have stricter capital controls than AEs, AEs demonstrate some degrees of departure from free capital mobility: the capital control indices in AEs are zero in only 26% of the sample and have an average of 0.11 and a standard deviation of 0.06. The level of controls vary across countries. While Japan, Netherlands, and the UK are close to perfect capital mobility, capital controls of Australia, Germany, and Switzerland have reached to more than 0.3 in our sample. The contrast between AEs and EMs motivates our separate analysis of these two groups of countries.

2.2 Spot and Forward Rates, and Other Asset Prices

We collect monthly spot rate and one-month forward rate from Reuters and Barclays through Datastream. We exclude the turmoil episodes when data are not reliable following Lustig et al. (2011). The spot and forward rates are defined as US dollar per unit of currency. Thus, an increase in an exchange rate indicates an appreciation of the currency and a depreciation of the dollar.

Currency returns are calculated as the differences between future spot rate and current forward rate as

$$rx_{t+1} = s_{t+1} - f_t,$$

where rx_{t+1} denotes currency returns earned by investors who short the dollar and long foreign currency at time t. s_{t+1} is the next-period log spot exchange rate; f_t is the log forward rate.

We collect the 3-month interbank rate in these countries as short-term risk-free rates, based on which we calculate the deviations from covered interest parity. We also collect bid and ask prices of the spot exchange rates to compute the bid-ask spread.

3 Capital Controls and Currency Returns

3.1 Portfolio Sorting

To assess the relationship between capital controls and currency returns, we sort currencies into four portfolios by their capital control indices. Since capital controls data are only available at the annual frequency, the sorts are done once a year in January using the capital control in the past year.

Table 2 shows average monthly returns for these portfolios sorted by capital controls for EMs. Countries with high capital controls have low currency returns. Average returns fall from 4.72% per year for the lowest-control portfolio to 0.84% for the portfolio with highest control. The average returns decrease monotonically with capital controls. Taking a long position in high-control and a short position in low-control currencies on average produces a -3.89% return, which is statistically significant. This long/short position generates a high Sharpe ratio of 0.51, comparable to carry and other currency strategies. For the least controlled portfolio, the average capital control is 0.16. The most controlled portfolio has a control level of 0.88, which corresponds to comprehensive controls on almost all instruments.The volatility of currency returns decreases with capital controls, albeit non-monotonically.

To what extent do capital controls capture information in other country characteristics that are related to currency returns? Table 3 shows the average of country characteristics of currencies of the four portfolios. High-control countries have lower forward discounts. This result seems to indicate that the return pattern manifests the classic carry trade. In later sections we will show that the return pattern is different from classic carry pattern. There is no clear relation between the net foreign asset position (NFA) of a country and its capital controls. While the literature shows debtor countries often have high currency returns (Della Corte et al., 2016), NFA difference cannot be the explanation for returns associated with controls. Intuitively, the volatility of NFA decreases with capital controls. We notice that high-control countries have high CDS. However, the literature has established that currencies with higher CDS spread earn higher returns (Della Corte et al., 2021), while we find more controlled currencies have lower returns. Therefore, default risk cannot be an explanation to the return pattern we uncover.

The recent international finance literature has paid substantial attention to the role of frictional intermediaries in driving exchange rates (Gabaix and Maggiori, 2015; Du et al., 2018). One salient feature that convincingly validates the friction is the deviation from covered interest rate parity (CIP). The bid-ask spread is another common measure of currency market liquidity. We find that the absolute value of CIP deviations [3] and bid-ask spreads of spot exchange rate do not differ much across the four portfolios. Finally, we find no relationship between capital controls and exchange rate regimes, measured by the indices from Ilzetzki et al. (2019).

3.2 Relation with Standard Currency Risk Factors

After establishing the negative correlation between capital control and currency excess returns for EMs, we investigate whether these excess returns can be explained by existing currency risk factors

[3] The CIP deviations are measures as the dollar interest rate minus the synthetic dollar interest rate, based on Libor rates. Unlike the CIP deviations in AE that are mostly negative, those is EM change signs frequently in the sample. To assess the amount of derivations, we focus the absolute values.

in the literature. A vast literature has proposed various currency risk factors that span the cross-section of currency returns. The candidate factors we consider in this study include dollar and carry (Lustig et al., 2011), value (Asness et al., 2013; Menkhoff et al., 2017), and momentum (Menkhoff et al., 2012; Asness et al., 2013). Table 4 reports the results of time-series asset pricing tests. Panel A reports the alphas of each portfolio after adjusting for exposures to the dollar and carry portfolio. The return spread remains similar and significant. This result shows that the capital-control return spread cannot be explained by exposures to the dollar and carry factor. Controlling for the value and momentum factors also do not reduce the average excess returns, as we show in Panel B and C.

3.3 Panel Regressions

We next examine the relation between currency return and capital controls in a regression setting. Table 5 Panel A displays the panel regression results of currency returns on lag capital controls. For the EMs, capital controls significantly predict future currency returns with a negative sign. This finding is the same as what we find with portfolio sorts, i.e., more controlled currencies have lower currency returns. In terms of the magnitude, if an EM's control index changes from 0 to 1, its average currency return decreases by 4.61 percent per annum. This value is similar to the return spread between the highest- and lowest-control portfolios.

We include the additional control of the lagged forward discount to distinguish the excess return originating from capital controls from the classic carry returns. The coefficient of capital control remains negative after controlling for the lagged forward discount. While forward discount declines with capital controls, this evidence, together with the significant carry factor alpha, suggests that the average return related to capital controls are distinct from the classic carry trade returns.

3.4 Advanced Economies

After establishing the evidence between capital controls and currency returns for EMs, we turn to the analysis of AEs. Panel A of Table 5 shows that the regression coefficient is positive but insignificant (t-stat = 1.22) for AEs. The coefficient remains insignificant when forward discount is controlled. Furthermore, the portfolio sorts confirms this results. We sort the G10 currencies into three portfolios. The returns have a mild increasing pattern, but not strong enough to make a statement statistically. The lack of result in AE is not surprising since most AEs undertake lenient capital control policies. Most studies of capital controls have focused on EMs and the pro-control view largely advocates for controls in EMs but not AEs. The resilience of AEs to free capital flows could be higher than EMs, perhaps because of the development of the domestic financial market and less stringent credit constraints on external borrowing.

3.5 External Positions

In this section, we investigate a conditional relationship that is informative about the underlying economic mechanism. Capital controls are typically imposed to prevent overborrowing or sudden capital inflows in the boom period, which reduces the risk of sudden reversal. Countries that are highly indebted are closer to the sudden reversal and should benefit more from capital control policies. In contrast, creditor countries worry less about capital flows and reversals. Consequently, we hypothesize that capital controls reduce currency returns more for debtor countries. In Panel B of Table 5, we run a panel regression of future currency excess returns onto the capital control index, a dummy indicator of the country indebtedness, and their interaction. First, the coefficient on the indicator is negative, consistent with the intermediary theory of Gabaix and Maggiori (2015) and the evidence in Della Corte et al. (2016) that currencies of debtor countries have higher returns. Second, the coefficient of the interaction term is positive and statistically significant. This positive coefficient suggests that in creditor countries, the association between capital controls and currency average excess returns is weaker. The coefficient of capital controls for indebted countries is -8.40, close to the double of the effect in Panel A for all countries. Summing up the coefficient of capital control and the interaction term, we find no negative relationship in creditor countries. In other words, capital controls do not reduce the average return of a currency if the country has a high level of NFA surplus. These results confirm our hypothesis.

3.6 Global Risk

The previous sections have shown the unconditional relation between capital controls and currency returns. If the average returns associated with capital controls are due to a risk-return tradeoff, capital controls should affect the levels of currency risk. Besides the evidence on expected returns, we further provide evidence on how capital controls alter currencies' risk exposures. We take CBOE Volatility Index (VIX) as the measure of global risk. VIX reflects the market volatility as well as the risk appetite. Panel C of Table 5 shows the panel regressions results of currency returns on the lag capital control, the contemporaneous change of VIX, and their interaction. Generally, currencies depreciate against the US dollar when VIX increases. Through the interaction term, tighter capital controls reduce the depreciation in times of high global risk. Despite of its wide use, VIX is a stock market measure. We further take a more direct measure from the global currency market: the JP Morgan G7 currency implied volatility (VXY). The risk mitigation effect of capital control remains unchanged.

4 Model

The empirical analysis establishes the relation between capital control policies and currency risk and returns. In this section, we present a standard small open economy model with risk-averse global intermediaries that face balance sheet constraint and frictional currency dealers. The small open economy is subject to currency mismatch and occasionally binding collateral constraints, which is a standard setting in the international macroeconomics literature, for example, Mendoza (2010) and Bianchi (2011). The framework can successfully account for business cycles and financial crisis episodes in emerging market economies. Capital control policies reduce the incentive for the small open economy to borrow and stablize net foreign asset adjustment and exchange rate fluctuations. We differ from the macro literature by adding risk-averse global intermediaries subject to constraints as marginal investors, and focus on the currency risk premia effect of capital control policies.

4.1 The Small Open Economy

The small open economy has a continuum of representative households that consume two goods, tradable and nontradable good. The total consumption is a CES aggregation of tradable and nontradable goods as

$$C_t = \left[\omega(C_t^T)^{-\eta} + (1-\omega)(C_t^N)^{-\eta}\right]^{-\frac{1}{\eta}}. \tag{1}$$

ω is the share of tradable consumption in aggregate consumption, and $\frac{1}{1+\eta}$ is the elasticity between tradable and nontradable good consumption. The optimization problem of the representative household is

$$E_0 \sum_{t=0}^{\infty} \beta^t u(C_t), \tag{2}$$

$$s.t.: B_{t+1} + C_t^T + P_t^N C_t^N = B_t R_t + Y_t^T + P_t^N Y_t^N + T_t, \tag{3}$$

$$B_{t+1} \geq -\kappa(P_t^N Y_t^N + Y_t^T). \tag{4}$$

Equation (3) is the budget constraint. Following the convention in the literature, B_{t+1} is the bond holding of the household and a positive number of B_{t+1} indicates saving, and R_t is the cost of borrowing in tradable goods faced by the small open economy, which depends on the global investors' required return and the capital control policies. T_t is the lump-sum transfer of capital control tax proceeds from the global investor to households in the small open economy. Y_t^T and Y_t^N are exogenous endowments of tradable and nontradable goods. For simplicity, we assume $Y_t^N \equiv 1$

and $y_t^T \equiv \log Y_t^T$ follows the following exogenous AR(1) process:

$$y_t^T = \rho_y y_{t-1}^T + \sigma_y \varepsilon_{y,t}. \tag{5}$$

Equation (4) sets the borrowing limit faced by households, which equals a proportion κ of the current income of the households. The income level depends on the price of nontradable good, or the real exchange rate. If the real exchange rate depreciates, it tightens the borrowing limit.

The optimality conditions of this small open economy consists of the following four equations:

$$u_{T,t} = E_t \beta u_{T,t+1} + \mu_t, \tag{6}$$

$$P_t^N = \left(\frac{1-\omega}{\omega}\right)\left(\frac{C_t^T}{C_t^N}\right)^{\eta+1}, \tag{7}$$

$$\mu_t \left[B_{t+1} + \kappa(Y_t^T + P_t^N Y_t^N)\right] = 0, \mu_t \geq 0, B_{t+1} + \kappa(Y_t^T + P_t^N Y_t^N) \geq 0, \tag{8}$$

$$C_t^T = Y_t^T + B_t R_t - B_{t+1}. \tag{9}$$

Equation (6) is the intertemporal Euler equation, in which $u_{T,t}$ is the marginal utility of tradable consumption and μ_t is the Lagrangian multiplier associated with the borrowing constraint. Equation (7) characterizes the relation between the real exchange rate and the consumption of tradable consumption. Equation (8) is the complementary slack condition for the borrowing limit: if the constraint binds, $\mu_t > 0$, otherwise $\mu_t = 0$. In equation (9), we already plug in the market clearing condition for nontradable consumption and consolidate the effect of capital control and the lump-sum rebate.

4.2 Global Intermediary Investors, Currency Dealer, and the Currency Risk Premia

Next, we model the investors of bonds issued by the small open economy.

4.2.1 Global Intermediaries

Different from most papers in the literature, we focus on the risk premia of currencies. In particular, we model a global intermediary as the marginal investor of bonds issued by the small open economy. The global intermediary has stochastic discount factor (SDF) M_{t+1} that follows to be specified.

Motivated by the intermediary asset pricing literature (for example, Gabaix and Maggiori (2015); Fang and Liu (2021); Du et al. (2019)), the global intermediaries's Euler equation for asset i includes an Euler equation wedge Γ_t^i as follows

$$E_t M_{t+1} R_{t+1}^i = 1 + \Gamma_t^i.$$

The wedge Γ_t^i can be understood as the additional cost of intermediaries expanding their balance sheet by holding one more unit of asset i. Γ_t^i may differ across assets.

Define Γ_{t+1} as the Euler equation wedge stemming from the financial constraint for the intermediary as a whole. We specify the SDF of global intermediaries as

$$M_{t+1} = \exp(\mu_{m,t} - \lambda_y y_{t+1}^g - \lambda_\Gamma \log \Gamma_{t+1}), \tag{10}$$

where $\mu_{m,t}$ is the conditional mean of the log SDF. The SDF is exposed to two shocks. y_{t+1}^g represents the global macroeconomic condition and Γ_{t+1} is the intermediary's Euler equation wedge. λ_y and λ_x are the prices of the two sources of risks.

Global intermediaries require compensation for two risks. First, they are exposed to global macroeconomic risks y_{t+1}^g. A positive global macroeconomic shock decreases the marginal value of wealth and represents a good time for the global intermediary. The second source of risk is the fluctuations in the Euler equation wedge Γ_{t+1}. A higher value of Γ_{t+1} indicates that the intermediary's balance sheet cost is higher and the marginal value of intermediary wealth is higher. Du, Hébert, and Huber (2019) provide a model in which such SDF specification can be solved from the optimization problem faced by a constrained intermediary with Epstein-Zin preference. These authors show evidence that the risk of changing constraint tightness is priced in asset returns.

We assume the global macroeconomic conditions and the intermediary's Euler equation wedge are both exogenous and the small open economy assets have negligible impacts on the intermediary. Therefore, we take the SDF as exogenously specified relative to the small open economy. In the subsequent analysis, we consider a risk-free bond denominated in tradable goods (dollar bond) and a risk-free bond denominated in the nontradable good of the small open economy (local currency bond). As we show in Section 4.1, the interest rate paid by a dollar bond is R_t, and analogously, the interest rate paid by the local currency bond is R_t^*.

The capital control policy imposes a tax τ on intermediaries' foreign investments. From the global investors' perspective, the dollar bond return is $R_t(1-\tau)$ and the local currency bond return is $R_t^* P_{t+1}^N / P_t^N (1-\tau)$ after taking the capital control tax into consideration. Therefore, the Euler equations are

$$E_t M_{t+1} R_t (1-\tau) = 1 + \Gamma_t, \tag{11}$$

$$E_t M_{t+1} \frac{R_t^* P_{t+1}^N}{P_t^N}(1-\tau) = 1 + \Gamma_t^{LC}. \quad (12)$$

Moreover, we assume the dollar interest rate in the world capital market is priced exactly by the intermediaries' SDF, i.e.,

$$E_t M_{t+1} R_t^f = 1. \quad (13)$$

Combine equation (12) and (13), we express the expected currency excess return as the sum of three terms. The first term captures the risk premium as the covariance between the intermediaries' SDF and exchange rate change. The second term shows that a higher wedge from the financial constraint results in a higher return. Thirdly, the return increases with capital control tax. Investors require a higher pre-tax return to offset the capital control tax and obtain the same post-tax return.

$$E_t\left(\frac{P_{t+1}^N}{P_t^N}\frac{R_t^*}{R_t^f}\right) = -cov_t\left(M_{t+1}, \frac{P_{t+1}^N R_t^*}{P_t^N}\right) + \frac{1+\Gamma_t^{LC}}{1-\tau}. \quad (14)$$

In our empirical analysis, we measure the currency excess returns from forward contracts as the difference between the future spot rate and the forward rate. The forward trade is often in the offshore market without cross-border investment, so that it is not subject to capital control. Empirically, the literature has mostly used the forward rate to calculate currency excess return, because it is immune to sovereign default risk, illiquidity, and potential capital control issues. To capture the excess return to the forward contract, we specify the determination of the forward rate through the frictional currency dealer.

4.2.2 The Currency Dealer

Currency dealers are the market makers that price the forward contracts. Suppose global intermediaries are buying a forward contract at forward rate F_t, the currency dealer needs to sell the forward contract. To provide the forward contract, the currency dealer borrows dollar at R_t^f, convert to the local currency at rate $P_{N,t}$, earn the local interest rate R_t^*, pay the capital control tax, and convert the proceeds back to dollar at forward rate F_t. The currency dealer requires a compensation for providing forward, which equals its Euler equation wedge Γ_t.The excess return required by the currency dealer to provide the forward contract is

$$1 + \Gamma_t = \frac{F_t R_t^*(1-\tau)}{P_{N,t} R_t^f}. \quad (15)$$

Combine equations (14) and (15), the expected excess return of a forward contract is

$$E_t \frac{P_{N,t+1}}{F_t} - 1 = -\frac{1-\tau}{1+\Gamma_t} cov_t(M_{t+1}, \frac{P_{t+1}^N R_t^*}{P_t^N}) + \frac{\Gamma_t^{LC} - \Gamma_t}{1+\Gamma_t}. \tag{16}$$

The expected excess return to the foreign currency forward has two terms. The first term is the covariance between the SDF and exchange rate movement. If the small open economy's currency depreciates when the SDF of the global intermediary takes large values, the global intermediary requires a positive expected excess return to hold the forward contract. The second term reflects the relative Euler equation wedge for the global intermediary's local currency bond position and that for the currency dealer's forward provision.

We specify the Euler equation wedge of global intermediaries following Fang and Liu (2021) as

$$\log \Gamma_t = \log \theta_0 + \theta_1 z_t.$$

where z_t is a measure of global financial risk. The Euler equation wedge is higher when the global risk is high. θ_0 is a constant and θ_1 is the sensitivity of the wedge relative to the state variable z_t.

The return to the dollar bond and the forward arbitrage do not involve in any risk, so their Euler equation wedge are both Γ_t. For the local currency bond return, the wedge also have an component that increases with the exchange rate volatility, consistent with the Value-at-Risk practice.

$$\log \Gamma_t^i = \log \theta_0 + \theta_1 z_t + \theta_2 \sigma_t(r_{t+1}^i).$$

where θ_2 captures how much exchange rate volatility changes the wedge for the local currency bond.

The global intermediary's Euler equation wedge for the local currency bond is higher than that of the currency dealer because the local currency bond is subject to the exchange rate risk.

4.3 Model Calibration

The small open economy block of the model's calibration follows Bianchi (2011), in which the parameter values are chosen to target the business cycle and financial crisis characteristics of a typical emerging market economy. Table 7 displays the parameters values. Our model has an additional global intermediary and currency dealer block and emphasizes the risk premia effect of capital control policies. Note that only the component of global macroeconomic risk that is correlated with y^T matters in exchange rate determination. For simplicity, we assume $y_t^g = y_t^T$. We have to calibrate the following more parameters: the exogenous process of z_t, the parameters that determine Euler equation wedges, θ_0, θ_1, and θ_2, and the two prices of risk, λ_y and λ_Γ.

The process of z_t is standardized to a standard normal distribution with an autocorrelation of 0.8. θ_0, θ_1 and θ_2 follows the results of the structural estimation in Fang and Liu (2021). θ_0 and θ_1 match the mean and volatility of the CIP deviation. θ_2 is also consistent with the elasticity of the unit VaR and the exchange rate volatility. λ_y has an interpretation of the relative risk aversion coefficient and is set to be 10. λ_Γ are calibrated such that the variance of of $\lambda_\Gamma \Gamma_t$ match their empirical counterparts in Du, Hébert, and Huber (2019). They use multiple asset classes to estimate the risk premium associated with intermediary balance sheet cost measured by forward CIP return which is 0.87% per annum (7.25 bp per month).

We solve the model by a global method of fixed point iteration. The exogenous AR(1) process of y_t^T and z_t are discretized to a Markov chain with 25 states.

4.4 Debt and Consumption

We start our analysis with the decisions rules in an economy without capital controls. Figure 1 reports the decision rules of the next-period debt B_{t+1} and tradable consumption C_t^T as a function of the current-period debt B_t at the average level of tradable endowment and global financial condition.

$B_{t+1}(B_t; y_{t+1}^T, z_{t+1})$ displays non-monotonicity. When the current-period debt level B_t is sufficiently high, the constraint is binding and a higher B_t reduces the current demand of tradable good, which depreciates the price of nontradable good and reduces the debt limit. As a result, B_{t+1} declines with B_t. When B_t is less negative and the constraint becomes slack, households from the small open economy are able to roll over the debt and B_{t+1} increases with B_t. The low debt capacity B_{t+1} in high-debt states force households to cut tradable consumption. The reduced tradable consumption depreciates the domestic currency, or the price of nontradable good, which further tightens the constraint. The feedback loop introduces a strong nonlinearity in B_{t+1} when the constraint binds. When the constraint becomes slack, agents are able to smooth consumption over the life cycle and thus the slope of consumption decision rule becomes flatter. The turning point is when the constraint turns from being binding to being slack.

Figure 2 illustrates the occurrence of a financial crisis, fixing z_t at its average value. The horizontal axis is the debt level B_t which is determined in the last period. The vertical axis plots the next-period debt B_{t+1} and tradable consumption C_t. The red line shows the choice of B_{t+1} and C_t if the current tradable output takes the lowest value, while the blue line shows the choices with medium average tradable output. For both tradable output values, when B_t is sufficiently negative, the constraint binds and households are forced to reduce their borrowing and consumption. The feedback loop between the domestic currency exchange rate and the borrowing limit leads to sharp declines in borrowing and consumption. A lower tradable output shifts the cutoff value of B_t, to the right. When tradable output is low, the constraint is more likely to bind and households consume less. The large reversals in borrowing and consumption, together with domestic currency depreciation, are considered as "financial crisis" in the model context. From this analysis, we identify two factors that lead to a financial crisis: a sufficiently high debt B_t, and a sufficiently low output y_t^T.

4.5 Exchange Rate Dynamics and the Effect of Capital Controls

4.5.1 Exchange Rate Response to Output Shocks

Figure 3 illustrates the response of exchange rate (the price of nontradable good) to changes of the tradable output endowment from its average value for different debt levels with and without capital control policies, holding z_t at its average.

In the left figure, we plot the response of exchange rate to Y_t^T in a low-debt economy ($B_t = -0.8$). The blue line shows the result without capital control policy ($\tau = 0$), and the red line shows the result with capital control policy ($\tau = 0.04$). Overall, a lower tradable output lowers households' tradable consumption and depreciates the domestic currency. From Figure 2, we find that the constraint is not binding even for the lowest level of output. Exchange rate still depreciates more sharply when there is no capital control. The depreciation arises from the concern that the constraint may bind in the future, which is associated with large consumption reduction. With such concerns, households decide to borrow and consume less. The concern for future binding constraint is more severe when y_t^T is low.

The right figure plots the response of exchange rate to Y_t^T in a high-debt economy ($B_t = -0.95$).Similar with the left figure, the blue line is without capital control policy ($\tau = 0$) and the red line is with capital control policy ($\tau = 0.04$). The constraint is triggered to bind when y^T is sufficiently negative. Without capital control, the exchange rate depreciates more sharply in response to the same output shock than with capital control. With capital control, the cost of borrowing is higher and households borrow and consume less when the constraint is slack. The change in consumption and exchange rate is milder when the constraint is triggered to bind.

The exchange rate response to positive output shock is mild and straightforward. Households borrow less in good times for consumption smoothing. Consumption changes only mildly because it is determined by the permanent endowment income, which is not greatly affected by a transitory endowment shock. The exchange rate response to positive output shock holds for economies both with and without capital controls.

Overall, exchange rate depreciates sharply in response to negative output shocks, especially when debt level is high. The appreciation responses to positive shocks due to consumption smoothing motive are mild. Capital control policies alleviate the sharp exchange rate depreciation in response to negative output shocks, both due to smaller depreciation when the constraint binds, and a decrease in concerns of a future binding constraint.

4.5.2 Debt Distribution

The previous section analyzes the asymmetric response of exchange rate to output shocks in high- and low-debt economies with and without capital controls. The analysis is conditioning on the level of debt. Capital control policies also have significant effects on the distribution of debt. Figure 4 displays the distribution of debt with ($\tau = 0.04$) and without ($\tau = 0$) capital control tax.

When there is no capital control at place, the ergodic distribution has a substantial mass on high levels of debt below -1. The mass reduces to 0 when the capital control policy with $\tau = 0.04$ is implemented. Capital control policies shrink the distribution of debt by lowering the standard deviation of debt. The intuition is straightforward: capital control policies make borrowing more expensive, so that households are less active in borrowing to smooth consumption over time.

The reduced volatility of debt has important implications on the probability of financial crisis. Recall in Figure 2 and 3 that the constraint is more likely to bind when debt level is high. Capital control policies reduce the volatility of debt, which makes it less likely to hit the region where the constraint binds and exchange rate depreciates sharply. The effect of capital control policies on debt is mixed: it is less likely for the households to have a large debt, but the likelihood of having moderate levels of debt increases. As we can see from the simulation, the average level of debt does not show a significant difference with and without capital control policies.

4.6 Business Cycle and Currency Risk Premia

The first two columns in Panel A of Table 8 reports the aggregate macro moments in economies with and without capital controls. The economy with no control exhibits similar macro moments with the literature, for example, Bianchi (2011). Capital control reduces the volatility of tradable consumption and real exchange rate . When the economy is far from the region of a binding constraint, capital control policies increase the cost of borrowing and households are less active in intertemporal consumption smoothing, leading to a lower consumption volatility. More importantly, when the economy gets closer to the binding constraint, the higher cost of borrowing discourages households from increasing their debt, which reduces the possibility of a binding constraint in subsequent periods that comes with a sharp consumption reduction and exchange rate depreciation. Both forces make consumption and exchange rate less volatile under capital control.

Capital control policies do not significantly reduce the average debt to GDP ratio.because capital control policies reduce the possibility of extremely high debt levels on the left tail and increase the possibility of medium debt levels. This result can be seen from the ergodic distribution of debt displayed in Figure 4. The volatility of current account is reduced from 2 percent to 1 percent due to the same reasons that explain lower volatility of consumption and exchange rate.The last two rows of Panel A report the frequency of having a binding constraint and the frequency of crises in these economies. The capital control policy reduces the frequency of a binding constraint from 14 percent to 2 percent. Following the literature, we define a "financial crisis" an event in which the constraint binds and capital outflow is two standard deviation above the mean and the frequency of the crisis drops from 4 percent to close to 0.

Panel B of Table 8 reports the the currency return related moments in the simulation with and without capital control policies. As we show in equation (16), the currency excess return is determined by the covariance between the global intermediaires' SDF and exchange rate change, plus the difference of global intermediary and currency dealer's wedge.

Quantitatively, the average currency excess return mainly comes from the covariance term and the wedge difference only contributes a small proportion. Here we focus the discussion on the covariance term. The small open economy's currency depreciates in bad times when the constraint binds or is close to bind, with a particularly strong nonlinear effect. The rate of depreciation can be much larger than the original shock itself, as we show in previous analysis. The bad times for the small open economy coincides with states with high marginal value of wealth for the global intermediaries. Therefore, the global intermediaries require a large, positive average excess return of 5.71 percent per annum to hold these currencies.

Capital control policies discourage households from borrowing adjustment and cumulating a large amount of debt, which reduces the likelihood of a binding constraint and sharp depreciation. If a country has adopted capital control policies, its currency is less volatile and not exposed to the output shock as much. The reduced exchange rate exposure leads to a lower risk premium of 2.68 percent that is charged by the global intermediaries. The spread between the average currency excess returns in these two states is 3 percent, which is close to our empirical counterpart.

We also report the volatilities of currency excess returns in these two economies. The majority of currency return volatility comes from the volatility of exchange rate. Similar with real exchange rate volatility reported in Panel A capital control policies greatly reduce the volatility of currency excess return. Lastly, the average forward discount of the two currencies exhibit similar patterns with the average currency excess returns. Investors require a higher average return to hold the local currency bonds issued by the country without capital control, which pushes up the interest rate R^* and the forward discount.

The benchmark model features three components in the global intermediaries' SDF: the global macroeconomic shock, intermediaries' balance sheet cost shock, and the wedge that is related to the volatility of exchange rate for the local currency bond that is issued by the small open economy.

In Columns 3-6 of Table 8, we evaluate the relative importance of these ingredients in the SDF specification.

The results reported in Column 3-4 are simulated from a version of the model that only has the global macroeconomic risk in the SDF, i.e., $\lambda_\Gamma = 0$, and the global intermediary is not subject to any balance sheet cost. Assuming away balance sheet cost lowers the cost of borrowing for the small open economy, which leads to a slightly more volatile consumption, exchange rate, and current account volatility, and a slightly higher probability of a binding constraint or a crisis. This result holds for both the economy with and without a capital control. For the currency returns, since the global intermediaries are not subject to the balance sheet constraint, the average currency excess returns are lower. Assuming away the presence of financial constraint risk in the SDF does not significantly change the average excess return, which indicates a quantitatively small risk premium sourced from exposure to fluctuations in Γ.

Columns 5-6 simulate results from a version of the model that has global macroeconomic risk and balance sheet cost risk in the SDF, but Γ_t^{LC} does not depend on the exchange rate volatility. All macroeconomic moments in Panel A are mostly unchanged compare to the benchmark results. For currency return moments, the average currency returns are lower because exchange rate volatility does not further tighten the constraint and increases the balance sheet cost, both for economies with and without capital controls.

From the comparison of the three economies, we show that under the calibration, the major source of risk premium comes from exposure to the global macroeconomic risks. Risk premium from balance sheet cost is quantitatively unimportant, and the wedge faced by the global intermediaries has a moderate effect on average currency excess return. Whether the balance sheet cost for the local currency bond depends on exchange rate volatility does not change the result much, either.

4.7 Capital Flows and Exchange Rates: Dynamics in Crisis and Normal Times

The conventional wisdom of capital control considers how capital control affects exchange rates through its impact on capital flows. A currency depreciates (appreciates) if capital flows out of (into) the country. If capital control policies restrict capital inflows and outflows, exchange rates are thus affected. However, under stationary scenarios, inflows and outflows should largely equal each other and the effects capital control policies on exchange rates are averaged out. This explains the elusive evidence on the contemporaneous relation between capital control and exchange rates.

Our model also provides insights into the relation between capital flows and exchange rates, as well as how this relation is interacted with capital control policies. Since the key mechanism of the model focuses on exchange rate fluctuations around a binding constraint, we first conduct an event analysis of capital flows (current account adjustment) and exchange rates for crisis episodes.

Figure 5 displays the result. Time 0 is the crisis period, defined as when capital outflow is two standard deviations higher than the mean and the constraint binds. The figure shows the behavior of capital flows and exchange rates 2 periods before and after the crisis period. Without capital control policies, current account has a strong reversal with a large capital outflow in the period of crisis, and exchange rate depreciates sharply. With capital control policies, both capital outflows and exchange rate depreciations are weaker. The behaviors of capital flow and exchange rate in crisis periods are consistent with the conventional view: currencies depreciate when capital flows out, and capital controls restrict capital outflow to prevent exchange rate depreciation. In the model, capital controls restrict capital outflow not only through imposing a contemporaenous higher cost, but more importantly, through discouraging debt accumulation and preventing the constraint from binding.

Exchange rates and capital flows fluctuate not only in crisis times but also in normal times. Figure 6 extends the event analysis to the full sample of model simulation. We categorize the sample path into periods with capital outflows and capital inflows and define them as "event" of capital outflows and inflows. Similar with crisis dynamics, we plot the behavior of capital flows and exchange rates two periods before and after the event.

By construction, capital flows out in the outflow event period 0, and flows in in the inflow event period 0. Capital control policies reduce the magnitude of capital outflows for reasons analyzed above. The two economies have similar paths of capital inflows as capital inflows are only driven by intertemporal consumption smoothing motive when the economy experiences a good output shock and reduces borrowing. The constraint plays a weaker role when capital flows in.

The exchange rate dynamics display more pronounced difference between the two economies. In the economy without capital control, exchange rate depreciates (appreciates) when capital flows out (in), which has been analyzed in previous sections. For the economy with capital controls, exchange rate movements are largely muted. Therefore, capital control helps prevent exchange rate fluctuating with capital flows. The exchange rate appreciates (depreciates) when capital flows out (in), which is in the opposite direction from the economy without capital control. The reason for the small and opposite exchange rate dynamics is that capital control policies largely insulate the economy from the risk of a binding constraint. Capital flows in this economy is mainly driven by the intertemporal consumption smoothing motive. Capital flows out (in) of the economy when output is high (low) and exchange rate appreciates (depreciates).

The comparison of capital flow and exchange rate dynamics in economies with and without capital controls shows that the conventional wisdom on capital flows and exchange rates does not always hold. When the economy is not subject to capital control and capital flows are driven by the borrowing constraint, the conventional wisdom holds that exchange rate depreciates (appreciates) when capital flows out (in). However, the relation between capital flow and exchange rate is opposite to the conventional wisdom when capital flows are mainly driven by intertemporal consumption smoothing: capital flows out when output is high and the domestic currency appreciates.

Finally, the model provides a different view on how capital controls affect capital flows than the conventional wisdom. The conventional wisdom argues that capital control policies impose a higher cost of borrowing and lending that impede capital flows. In our model, capital control policies reduce capital outflows for an additional reason by preventing the economy from accumulating too much debt and lowering the probability of having a binding constraint and sharp capital outflows.

5 Conclusion

Capital controls are a two-edged sword. It impedes consumption smoothing and the financing of investment opportunities, potentially affecting the capital formation and growth of an economy. Meanwhile, it reduces drastic capital flows and improves financial stability. From an asset pricing perspective, this paper provides evidence and theory that countries under tighter capital controls have lower currency returns. We find that the capital control effect is concentrated in emerging markets and debtors countries, which are more prone to sudden stops and currency crashes. We further show that capital controls indeed reduce the currency exposure to global systemic risk. We propose an equilibrium model that demonstrates the potential "sudden stop risk" in currencies and the beneficial effect of capital controls on mitigating this risk. The model quantitatively matches our empirical findings.

The empirical and theoretical results are largely consistent with the macro-prudential view of capital controls. In fact, the views on capital controls have gradually shifted from being a market friction to a macro-prudential tool. The IMF, who used to be an important advocate for free capital flow, stated in the taxonomy of capital flow management: "There is no presumption that full liberalization is an appropriate goal for all countries at all times." Our evidence lends further support to the use of capital controls especially for countries with low resilience to global shocks.

With the rising adoption of the capital control policy, it becomes an increasingly important determinant of exchange rates. While the effect of capital controls on the macroeconomy has been extensively studied, we bring the insight of this literature to understanding the risk and returns of currencies. The consequential effect of risk premia can feed back into the macroeconomy and have rich implications on capital flow management. Future work can study the optimal policy taking into account the documented effects on currency risk. Potentially, the joint dynamics of capital controls and the exchange rate can serve as a barometer to evaluate the resilience of the economy to capital flows and guide the policy designs.

Table 1: Summary statistics: capital controls

	mean	sd	high	low	ac(1)	cc=0 (%)
EM Average	0.58	0.12	0.79	0.41	0.77	0.02
AE Average	0.11	0.06	0.19	0.04	0.73	0.26
EM:						
Brazil	0.63	0.17	0.88	0.28	0.76	0.00
Chile	0.39	0.27	0.93	0.23	0.94	0.00
China	0.96	0.06	1.00	0.80	0.80	0.00
Czech	0.29	0.14	0.48	0.05	0.68	0.00
Egypt	0.17	0.07	0.25	0.03	0.81	0.00
Hungary	0.24	0.28	0.75	0.00	0.83	0.08
India	0.97	0.02	1.00	0.95	0.86	0.00
Indonesia	0.64	0.06	0.70	0.50	0.65	0.00
Israel	0.13	0.17	0.55	0.00	0.82	0.32
Kuwait	0.35	0.07	0.45	0.11	0.76	0.00
Malaysia	0.81	0.05	0.88	0.72	0.61	0.00
Mexico	0.60	0.08	0.94	0.53	0.17	0.00
Philippines	0.85	0.07	0.98	0.75	0.80	0.00
Poland	0.72	0.15	1.00	0.55	0.81	0.00
Russia	0.61	0.21	1.00	0.20	0.87	0.00
South Africa	0.65	0.05	0.75	0.58	0.90	0.00
Thailand	0.73	0.06	0.83	0.58	0.78	0.00
Turkey	0.46	0.18	0.70	0.23	0.96	0.00
Ukraine	0.80	0.05	0.94	0.75	0.78	0.00
AE:						
Australia	0.27	0.07	0.35	0.13	0.71	0.00
Canada	0.06	0.02	0.10	0.05	0.79	0.00
Germany	0.19	0.14	0.30	0.00	0.91	0.24
Japan	0.00	0.01	0.05	0.00	-0.04	0.96
New Zealand	0.10	0.01	0.13	0.10	0.91	0.00
Norway	0.05	0.03	0.08	0.00	0.87	0.28
Sweden	0.09	0.07	0.23	0.00	0.61	0.12
Switzerland	0.19	0.13	0.35	0.05	0.90	0.00
UK	0.02	0.04	0.13	0.00	0.88	0.72

Note: The table reports the summary statistics of the capital control indices of each country and the cross-country average in EM and AE. Data are annual from 1995 to 2017.

Table 2: Portfolio sort: capital controls

	P1 (low cc)	P2	P3	P4 (high cc)	P4-P1
mean	4.72	1.83	1.35	0.84	-3.89
s.e.	(1.63)	(2.30)	(1.96)	(1.18)	(1.53)
t-stat	(2.90)	(0.80)	(0.69)	(0.71)	(-2.54)
sd	8.14	11.49	9.79	5.88	7.66
SR	0.58	0.16	0.14	0.14	-0.51
cc	0.16	0.45	0.67	0.88	0.72

Note: The table shows the summary statistics of portfolios sorted on capital controls. Means, standard errors, t-statistics, standard deviations, Sharpe ratios, and average capital controls (cc) are reported. Data are monthly from 1996:1 to 2018:12.

Table 3: Portfolio characteristics

	P1 (low cc)	P2	P3	P4 (high cc)	P4-P1
n	3.33	3.81	4.17	4.27	
cc	0.16	0.45	0.67	0.88	0.72
sd(cc)	0.09	0.08	0.03	0.04	0.11
fd	8.29	6.58	6.08	3.88	-4.43
nfa	-0.02	0.26	-0.35	-0.19	-0.18
sd(nfa)	0.62	0.42	0.11	0.12	0.71
CDS	1.35	1.97	1.79	2.28	0.94
bid-ask	0.13	0.22	0.17	0.16	0.02
CIP	120.08	112.25	64.03	108.61	-24.44
regime	2.67	2.77	2.97	2.42	-0.25

Note: The table shows the average of country characteristics in portfolios sorted on capital controls. The characteristics include: the number of currencies (n), the means and standard deviations of capital controls (cc), the forward discount (fd), the means and standard deviations of the net foreign asset (nfa), the CDS spread, the bid-ask spread, the absolute value of CIP deviation, and the currency regime. Data are monthly from 1996:1 to 2018:12.

Table 4: Asset Pricing Test

	P1 (low cc)	P2	P3	P4 (high cc)	P4-P1
A. Dollar and Carry					
α	3.85	-2.71	-2.47	-0.83	-4.69
(t-stat)	(3.58)	(-1.77)	(-2.41)	(-0.94)	(-3.19)
β dollar	1.02	1.06	1.10	0.54	-0.48
(t-stat)	(19.80)	(14.42)	(22.48)	(12.69)	(-6.77)
β carry	0.03	0.55	0.44	0.19	0.16
(t-stat)	(0.71)	(10.19)	(12.25)	(5.96)	(3.10)
B. Value					
α	4.66	1.74	1.34	0.75	-3.91
(t-stat)	(2.85)	(0.75)	(0.68)	(0.64)	(-2.53)
β value	0.03	0.04	0.00	0.04	0.01
(t-stat)	(0.43)	(0.43)	(0.06)	(0.78)	(0.14)
C. Momentum					
α	4.65	2.03	1.48	0.96	-3.69
(t-stat)	(2.85)	(0.88)	(0.76)	(0.82)	(-2.42)
β momentum	0.05	-0.13	-0.09	-0.08	-0.13
(t-stat)	(0.76)	(-1.51)	(-1.16)	(-1.85)	(-2.24)

Note: The table reports the results of asset pricing tests. In Panel A, the factors are the dollar and carry factors from Lustig et al., 2011. In Panel B and C, the factors are the value and momentum factor from Asness et al., 2013. Each panel shows the α and β from the asset pricing test and the associated t-statistics. Data are monthly from 1996:1 to 2018:12.

Table 5: Capital controls: mechanisms

A. Capital control and carry							
	cc	(t-stat)	fd	(t-stat)			R^2
EM	-4.61	(-2.50)					0.08
EM	-3.91	(-2.08)	0.21	(0.65)			0.31
AE	8.53	(1.22)					0.07
AE	6.09	(0.90)	1.36	(2.66)			0.76

B. NFA							
	cc	(t-stat)	creditor	(t-stat)	cc×creditor	(t-stat)	R^2
	-8.40	(-3.25)	-7.71	(-3.04)	11.44	(3.43)	0.22

C. Implied Volatility							
	cc	(t-stat)	ΔIV	(t-stat)	cc$\times\Delta IV$	(t-stat)	R^2
VIX	-4.54	(-2.61)	-3.15	(-5.95)	1.33	(2.91)	7.29
VXY	-4.44	(-2.52)	-12.62	(-5.82)	4.75	(2.59)	6.23

Note: The table reports the panel regression results of currency returns on the lagged capital controls and other variables. Panel A shows the results controlling for the lagged forward discount in EM and AE, respectively. Panel B shows the results on the lagged capital controls, the lagged dummy variable indicating a creditor country, and the interaction. Panel C shows the results on the lagged capital controls, the contemporaneous change in implied volatility, and the interaction. Implied volatility includes CBOE Volatility Index (VIX) and JP Morgan implied volatility in G7 currencies (VXY). The t-statistics are based on standard errors clustered by month. R^2 are in percentage points. Data are monthly from 1996:1 to 2018:12.

Table 6: Portfolio sort: capital controls in AE

	P1 (low cc)	P2	P3 (high cc)	P3-P1
mean	-0.92	-0.48	0.62	1.53
s.e.	(1.38)	(1.91)	(1.85)	(1.24)
t-stat	(-0.66)	(-0.25)	(0.33)	(1.23)
sd	6.92	9.54	9.25	6.22
SR	-0.13	-0.05	0.07	0.25
cc	0.02	0.08	0.23	0.22

Note: The table reports the summary statistics of portfolios sorted on capital controls in AE. Means, standard errors, t-statistics, standard deviations, Sharpe ratios, and average capital controls (cc) are reported. Data are monthly from 1996:1 to 2018:12.

Table 7: Calibration

Variable	Symbol	Value
Risk aversion	γ	2
Elasticity of substitution	η	0.20
Time discount factor	β	0.91
Tradable good share	ω	0.32
Constraint tightness	κ	0.32
Tradable persistence	ρ_y	0.54
Tradable shock vol	σ_y	0.025
Capital control	τ	0, 0.04
Risk-free rate	R	1.04
Price of risk	λ_y	10
Price of risk	λ_Γ	2
Euler equation wedge	θ_0	-4.95
Euler equation wedge	θ_1	0.84
Euler equation wedge	θ_2	4

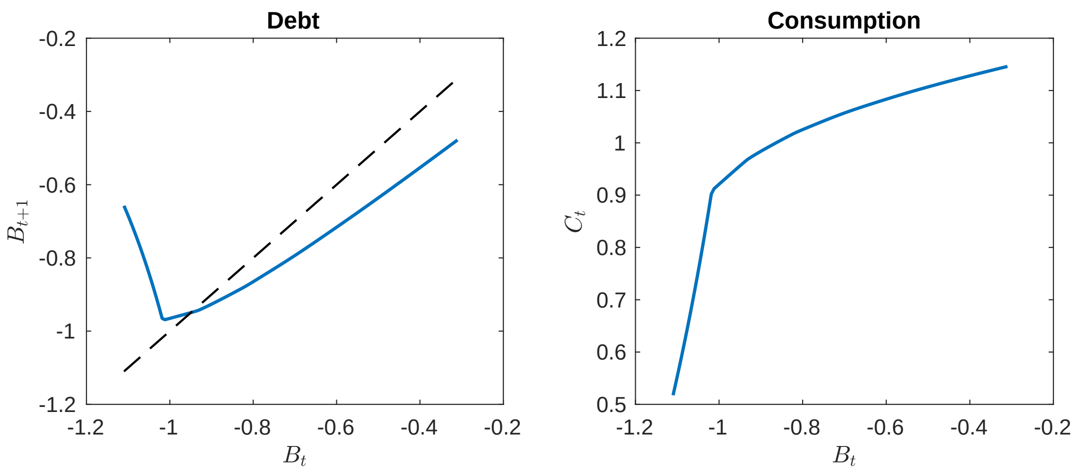
Note: This table reports the calibrated parameter values.

Table 8: Aggregate Moments

	benchmark		macro risk		financial risk	
	no control	w/ control	no control	w/ control	no control	w/ control
A: Macroeconomic moments						
Tradable consumption volatility	0.08	0.04	0.09	0.05	0.08	0.04
Real exchange rate volatility	0.16	0.04	0.17	0.08	0.16	0.04
Average debt to GDP	-0.31	-0.24	-0.30	-0.29	-0.31	-0.24
Current account volatility	0.02	0.01	0.03	0.01	0.02	0.01
Binding frequency	0.14	0.02	0.17	0.04	0.13	0.02
Crisis frequency	0.04	0.00	0.04	0.02	0.04	0.00
B: Currency returns						
Currency excess return	5.71	2.68	4.91	2.39	5.32	2.59
diff w/ and w/o control		-3.03		-2.52		-2.73
Currency excess return vol	10.30	3.56	10.57	5.57	10.16	3.52
Average forward discount	5.81	2.65	5.03	2.36	5.41	2.56

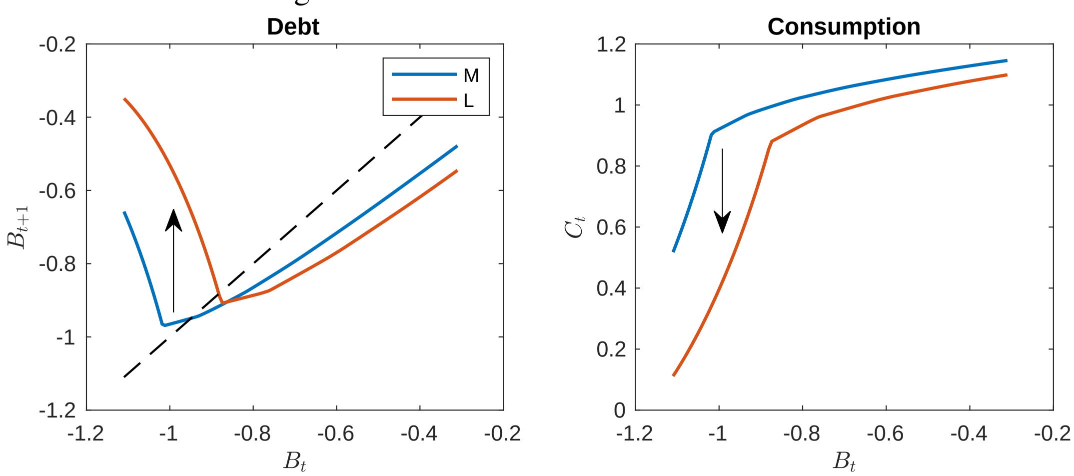
Note: This table reports the aggregate moments from model simulation. Panel A lists the macro moments, and Panel B lists the moments related to currency returns and currency risk premia.

Figure 1: Decision rules: Debt and Consumption



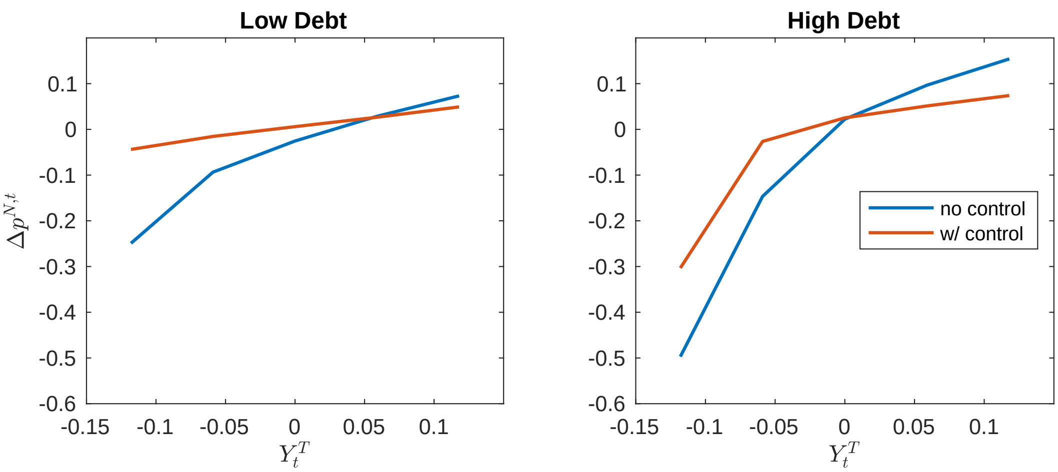
Notes: This figure plots the decision rule of the next period debt B_{t+1} and consumption of tradable good C_t^T as a function of the current level of debt B_t, fixing tradable good endowment and global financial condition at their average levels.

Figure 2: An illustration of a financial crisis



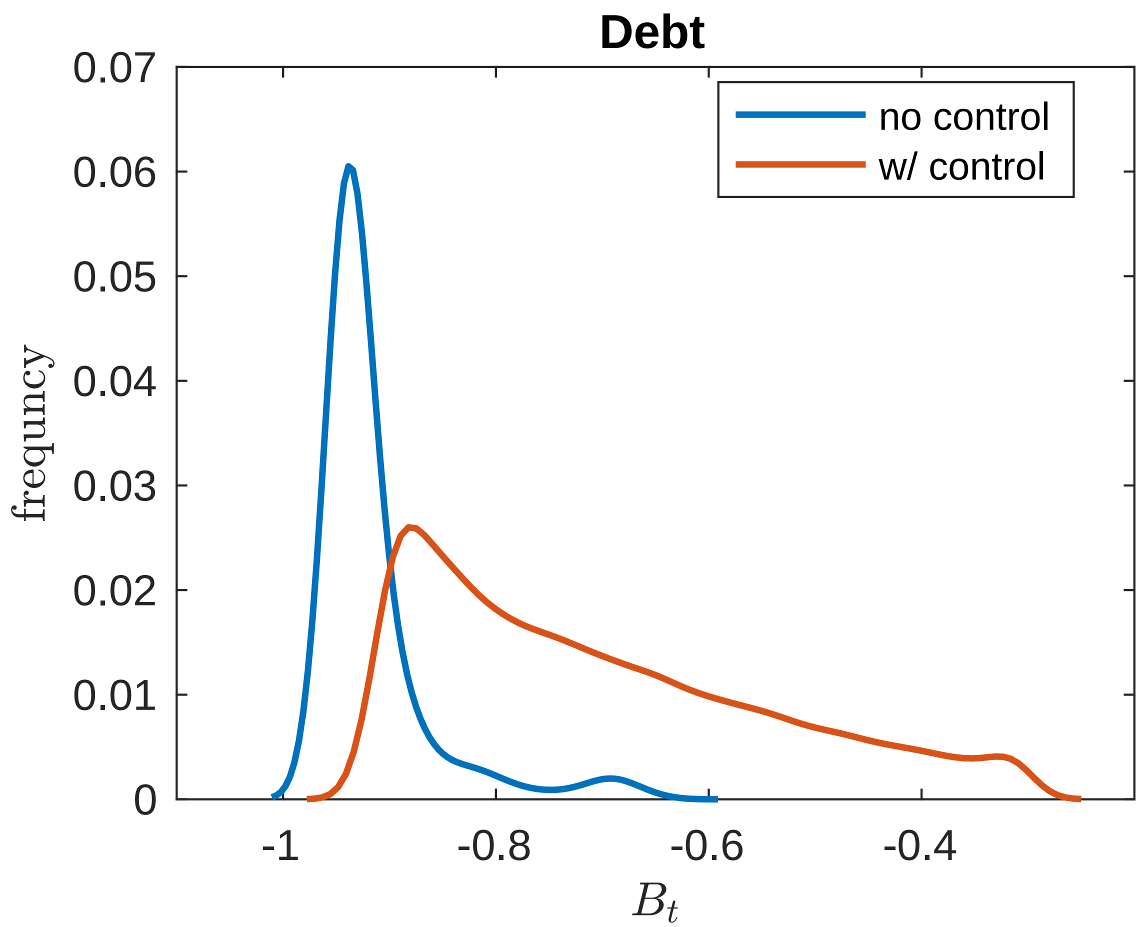
Notes: This figure illustrates the occurrence of a financial crisis using the decision rules of borrowing level B_{t+1} and tradable consumption C_t. The horizontal axis is the current debt level B_t. The red line represents a medium value of y^T , and the blue line represents a low value of y^T. z_t is fixed at its average value.

Figure 3: Exchange Rate Dynamics and Capital Control Policy



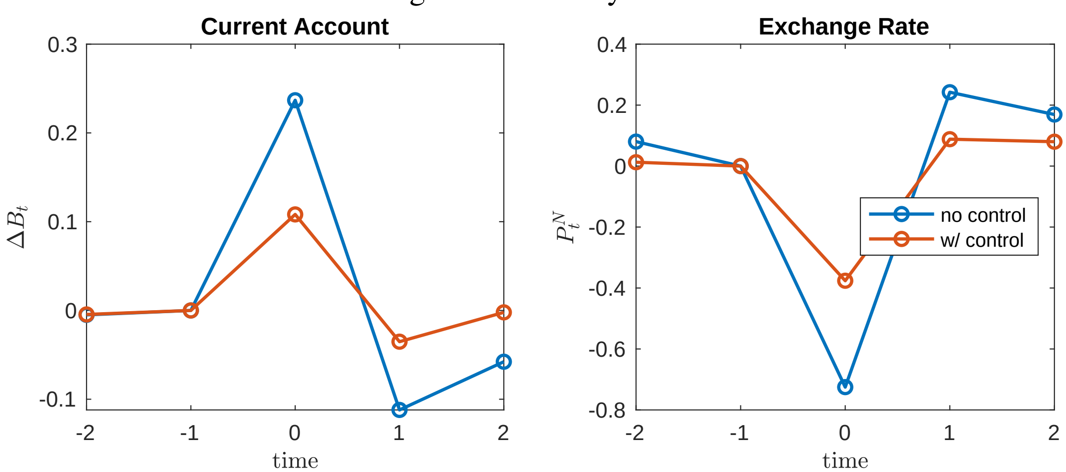
Notes: This figure plots the response of exchange rate when the economy moves from (B_t, Y_t^M, z_t^M) to $(B_{t+1}(B_t, Y_t^M, z_t^M), Y_t, z_t^M)$ for different a low debt level ($B_t = -0.8$) and a high debt level ($B_t = -0.95$). The red line shows the results with capital control $\tau = 0.04$. The blue line is with no capital controls $\tau = 0$.

Figure 4: Debt distribution and capital control policy



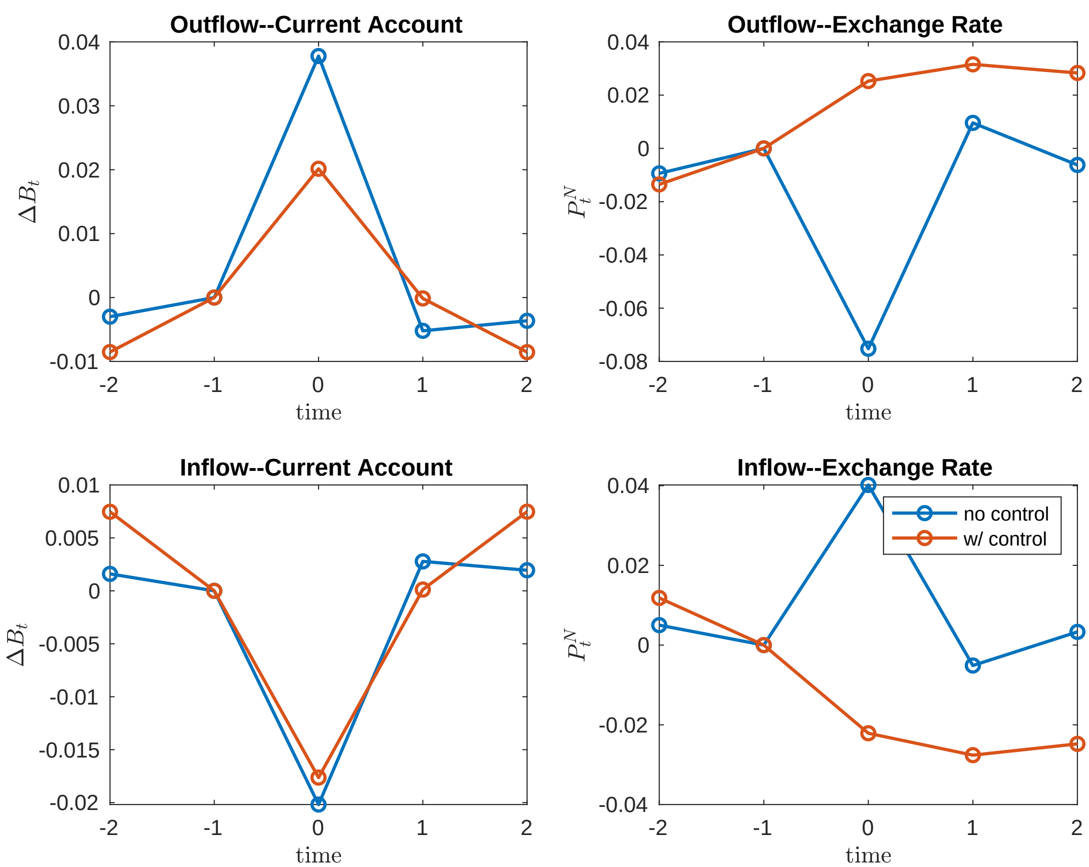
Notes: This figure plots the ergodic distribution of debt B_t in two economies with ($\tau = 0.04$) and without ($\tau = 0$) capital control policies.

Figure 5: Crisis dynamics



Notes: This figure plots the exchange rate and current account dynamics around crisis with different capital control policies. A crisis is defined as (i) the constraint binds; (ii) capital outflow is higher than 2 standard deviation from the mean. The blue solid line plots the pattern in the economy without capital control ($\tau = 0$). The red solid line plots the pattern in the economy with capital control ($\tau = 0.04$). The values in period T-1 are normalized to zero.

Figure 6: Capital flow and exchange rate dynamics



Notes: This figure plots the exchange rate and current account dynamics around crisis with different capital control policies. A crisis is defined as (i) the constraint binds; (ii) capital outflow is higher than 2 standard deviation from the mean. The blue solid line plots the pattern in the economy without capital control ($\tau = 0$). The red solid line plots the pattern in the economy with capital control ($\tau = 0.04$). The values in period T-1 are normalized to zero.

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