Currency Risk Under Capital Controls

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

November 2021

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 low-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. In an equilibrium 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.

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

*Preliminary Draft. Xiang Fang(xiangf@hku.hk), Sining Liu (siningll@connect.hku.hk), and Yang Liu (yangliu5@hku.hk) are at the University of Hong Kong. We are grateful to Yan Ji, Wenhao Li, George Panayotov, and seminar participants at Hong Kong University of Science and Technology, University of Hong Kong, and University of Southern California for helpful comments and suggestions.

1 Introduction

Conventional wisdom has it 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 is important to explore the underlying policy mechanism and 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 of various categories, including inflows and outflows of different asset classes. Countries largely differ in their capital control policies, so there is substantial dispersion in the cross section.

We sort currencies into four portfolios based on the one-year lagged capital control indices. Average 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 understood by 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 risk factors, the alphas are significant with similar economic magnitude as the average return. Furthermore, capital controls negatively predict future currency returns in panel regressions, controlling for the forward discount.

The existing evidence of the capital control effect on exchange rate dynamics is weak and inconclusive. These studies focus 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 be in response 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, implying 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, the government is unlikely to respond to largely unpredictable expected 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 returns in capital-control-sorted portfolios. There is little evidence in panel regressions, either. 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 mechanism. Highly indebted countries are more prone to financial crisis. As the literature has argued that capital controls are more useful for financial stability in debtors countries, we hypothesize that capital controls in these countries reduce exchange rate risk and expected returns by a larger degree. Empirically, 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 show the same risk reduction effect when we measure global risk by currency implied volatility.

We present a canonical two-sector small open economy model with occasionally binding credit constraints to study the effect of capital control policies on currency risk and returns. The key ingredient of the model is that agents borrow from the rest of the world subject to a credit constraint 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 tradable good shock will trigger a "sudden stop": 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 "sudden stop risk" and currency crashes, so that the global investors require a large risk premium to hold these currencies. Capital control policies that increase the cost of foreign debt are useful to reduce the probability of sudden stops. The policy has an important effect on exchange rate dynamics. First, the increased borrowing cost impedes the import of tradable goods and reduces borrowing in good times. Second, the decreased borrowing makes the constraint less likely to bind in the subsequent period and reduces the possibility of sharp exchange rate depreciation. Therefore, capital controls mitigate the exchange rate depreciation with respect to negative shocks. Global investors, whose marginal utilities depend on the global tradable good shock, consider currencies under stricter controls less risky and require lower currency returns.

The purpose of our quantitative model is to study the interaction between capital control policies and currency risk premia and analyze how currency risk premia changes with the capital control policies, modeled as a tax on international investment of global investors. The model quantitatively illustrates the capital control effect on the reduction of currency risk and matches the empirical findings.

This paper bridges the two growing literature of macro-prudential capital controls in international macroeconomics and currency risk premia in international asset pricing. While the importance of capital controls has been extensively studied and fully acknowledged in international macroeconomics, it 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.

In the meantime, we contribute to the international asset pricing literature on currencies by studying the systematic risk of emerging market currencies that is related to macroeconomic policies. While most of the asset pricing literature focuses on the AEs or all countries, we find that EM currencies are exposed to the distinct "sudden stop risk" that can be reduced by capital control policies. The understanding of the "sudden stop risk" of EM currencies is particularly useful in the current time of global low interest rates, when bond investors invest more aggressively into EMs for higher yields.

Literature review. This paper is related to several strands of broad literature.

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 & Sandri (2016), Bianchi & Mendoza (2018), Mendoza & Rojas, 2019, and Jeanne & Korinek (2020). The literature also proposes other sources of inefficiency, for example, aggregate demand externalities that rationalize the optimal use of capital control policies (Farhi & Werning, 2016; Costinot et al., 2014; Schmitt-Grohé & 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 makes 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 & 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 change.

The paper is also related to the large 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. Our paper features an imperfect international financial market, which is along the agenda of international economics that highlights financial market frictions, for example, (Gabaix & Maggiori, 2015; Du et al., 2018; Fang & Liu, 2021).

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 implications. Section 5 concludes the paper.

2 Data and Summary Statistics

In this section, we briefly describes 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 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 according to a set of rules for interpreting the narrative information. They generate binary indicator for each transactions and aggregate it to capital control indices that is between 0 and 1. A higher index is interpreted to represent 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 2017.

Because of the intrinsic challenge in measuring capital controls, there are several caveat on this measure. First, a higher capital control measure represents the presence of control on broader 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. 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, three 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. AE 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 indices of EMs are 0.58. They also have relatively large time-series standard

[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.

deviation of 0.12. There exist large heterogeneity in the cross-section countries. A few EM countries always keep the controls at high level, such as China, India, Malaysia, Philippines and Ukraine. The countries with low controls are relatively developed ones such as Israel. Capital controls features high annual persistence of 0.77, which translates into 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 relatively large 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.

Most theoretical and empirical studies on capital controls focuses on EM. 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 an depreciation of the dollar.

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

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

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 rate; f_t is the log forward rate.

We collect the 3-month interbank rate in these countries as short-term risk-free rates. Deviations from covered interest parity are based on interbank rates. 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 monthly returns on capital control indices into four portfolios. Since capital controls data is only available in 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 sorts on capital controls. Starting from the results of EM, countries that have 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 highest . 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. Capital controls also reduce the volatility of currency returns, albeit non-monotonically. For the least controlled EM portfolio, the average capital control is 0.16, which is already higher than average AE level. The most controlled portfolio has a control level of 0.88, which corresponds to comprehensive controls on almost all instruments.

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 in the four portfolios. High-control countries have lower forward discount and interest rates. This pattern seems consistent with the classic carry trade, and we will differentiate the two strategies further in later sections. There is no clear relation between the net foreign asset position (NFA) of a country and its capital controls. While debtor countries often have high currency returns (Della Corte et al., 2016), NFA cannot be the explanation for returns associated with controls. Intuitively, the volatility of NFA decreases with capital controls. Currency risk is positively related to sovereign default risk, measured by CDS spread (Della Corte et al., 2021). In contrast, high-control countries have high CDS, which should lead to high returns through the channel of sovereign default risk.

The recent international finance literature has paid substantial attention to the role of frictional intermediaries in driving exchange rates (Gabaix & 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

[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

of spot exchange rate do not have 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 opposite pattern of capital control and currency excess returns for AEs and EMs, we investigate whether the excess returns of capital control sorted portfolios can be explained by existing currency risk factors 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.

3.3 Panel Regressions

We next examine whether 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. We focus on EM first. Capital controls significantly predict future currency returns with a negative sign. Same as what we find with portfolio sorts, more controlled EM have lower currency returns. In terms of the magnitude, if an EM's control 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.

The panel also shows the results that include the additional control of the lag forward discount. The coefficient of capital control remains negative after controlling for 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 carry trade.

---

frequently in the sample. To assess the amount of derivations, we focus the absolute values.

3.4 Advanced Economies

After establishing the evidence on EM, 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). 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, not strong enough to make a statement statistically. To some degree, the lack of result in AE is not surprising. Most studies 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 the weaker of credit constraints on external borrowing.

3.5 External Positions

The previous sections display the unconditional relation between capital controls and currency risk and returns. 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 sudden stops. 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 measure, a dummy variable indicating a creditor country, and the interaction term. First, the coefficient on the indicator is negative, consistent with the intermediary theory of Gabaix & Maggiori (2015) that currencies of debtor countries have higher return and the evidence in Della Corte et al. (2016). Second, the coefficient of the interaction term is positive and statistically significant. This positive coefficient suggest that in creditor countries, the association between capital controls and currency average excess returns is weaker. The coefficient of capital controls shows that the effect is -8,40, close to the double of the effect in all countries. Sum 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 "sudden stop risk" of currencies if the country has a high level of NFA surplus. These results confirm our hypothesis.

3.6 Global Risk

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 the 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 B 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 usage, 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 canonical framework for analyzing capital control policies to illustrate and understand the mechanism through which capital control alters the currency risk premia, and quantify the capital control effect. The framework features a small open economy with an occasionally binding collateral constraint, in which the borrowing limit is determined by the real exchange rate dependent current income. The framework has successfully accounted for business cycles and financial crisis episodes in emerging market economies and been used to analyze the welfare consequences of capital control policies from the macroeconomic perspective (see, e.g., Mendoza (2010) and Bianchi (2011)). We differ from the macro literature by focusing on the exchange rate exposures and the risk premia with a risk-averse global investor.

4.1 The Small Open Economy

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

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

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

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

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

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

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 indicates the cost of borrowing in tradable goods faced by the small open economy, which depends on the global risk 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:

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

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

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

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

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 Investors and the Currency Risk Premia

Different from most papers in the literature, we focus on the risk premia of currencies. Therefore, we model a global investor with tradable good denominated stochastic discount factor

$$M_{t+1} = \exp(\mu_m - \lambda(y_{t+1}^T - y_t^T)) \tag{10}$$

where μ_m is a constant pinned down by the world interest rate, and λ is the price of the tradable endowment shock. When specifying the stochastic discount factor of the global investor, we assume that the tradable good shock is a global shock and thus is reflected in the currency risk premia.

We consider a risk-free bond denominated in tradable goods (termed "dollar bond"), which delivers a return of R in tradable good. Moreover, we consider a risk-free bond denominated in the nontradable good of the small open economy (termed "local currency bond"), which delivers a nontradable good denominated risk-free rate of R_t^*.

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

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

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

We define the excess return, in log term, as

$$rx_{t+1} = (\log P_{N,t+1} - \log P_{N,t}) + (\log R_t^* + \log(1-\tau)) - \log R \tag{13}$$

Moreover, we define the interest rate differential, or the forward discount, as

$$idr_t = (\log R_t^* + \log(1-\tau)) - \log R \tag{14}$$

In the last subsection, we establish the equivalence between idr_t with the forward discount measure that we use in our empirical analysis.

4.3 Model Calibration

The model 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 two additional parameters: λ is the price of risk, and τ measures the degree of capital control. We pick three values of $\tau = 0, 0.03, 0.05$, which represent low, medium, and high capital controls. $\tau = 0$ indicates no capital controls, and the tax rate for the highest capital controls is 5 percent. The price of risk λ is set to 25. This parameter can be broadly interpreted as the relative risk aversion coefficient. As the stochastic discount factor only has a small Gaussian shock, we choose a relatively large λ.

We solve the model by a global method of fixed point iteration. The exogenous AR(1) process is discretized to a Markov chain with 5 states.

4.4 Debt, Consumption, and Asymmetric Exchange Rate Dynamics

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.

We notice that $B_{t+1}(B_t; y_{t+1}^T)$ displays non-monotonicity. When the current-period debt level is sufficiently high, the constraint is binding and a higher B_t reduces the current demand of tradable good, 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. Correspondingly, when B_t takes large negative values, households are forced to cut consumption to reduce their borrowing, so that the consumption of tradable goods is very low with a steep slope. 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 sudden stop with the decision rule of debt and consumption for two different values of tradable endowment, its average value (M) and a negative value (L). Suppose the economy starts at the average level of Y^T, and the current debt level is close to the turning point. If the economy experiences a negative shock of tradable good, that is, Y^T next period takes a negative value, the constraint will bind as shown in the blue line. Households are forced to cut consumption and reduce their debt to the maximum debt limit. The key to understanding the occurrence of the crisis is the effect of Y^T on the point when the constraint turns from being binding to slack. The higher Y^T is, the less likely the constraint will bind, and the more negative the turning point is. Therefore, if Y^T takes an average value, the economy is still in a regime with a slack constraint with the initial debt level. But the economy shifts into a regime where the constraint binds if Y^T experiences a negative shock.

Figure 3 illustrates the asymmetry of tradable consumption as a function of the tradable good endowment for different debt levels. We fix debt B_t at a high level of -0.98 for the blue line and a low level of -0.52 for the red line. When the debt level is low, households' tradable consumption declines with tradable good endowment with a flat slope due to the intertemporal smoothing of consumption across time. When the debt level is high and Y_t^T takes large values, the slope of the tradable consumption with respect to tradable endowment is similarly flat with that of low debt level. But when Y_t^T takes small values, tradable consumption drops sharply, because the constraint binds in these states and households are forced to cut consumption to meet the maximum debt limit. The economy exhibits asymmetry for positive and negative news of Y_t^T, as well as for high and low debt levels.

The asymmetry is reflected in the exchange rate dynamics as well. In Figure 4, we plot the change of log exchange rate (nontradable price) from state (B_t, Y_t^M) to $(B_{t+1}(B_t, Y_t^M), Y_{t+1}^H)$ in red line and $(B_{t+1}(B_t, Y_t^M), Y_{t+1}^L)$ in blue line. B_t is on the horizontal axis, and Y_t^M, Y_t^H, Y_t^L correspond to medium, high, and low value of tradable endowments, respectively. Note that $B_{t+1}(B_t, Y_t^M)$ is pinned down at the end of time t.

When the debt level B_t is not so high, the exchange rate change is relatively flat with B_t. Households consume more tradable goods when the endowment is high, which raises the price of nontradable good. When debt level B_t is close to the turning point, for example, to the left of -0.8, we observe strong asymmetry. If the time $t+1$ tradable endowment shock is positive, households consume slightly more due to intertemporal consumption smoothing. If the time $t+1$ tradable endowment shock is negative, households will hit their debt limit as we analyze in Figure 2 and are forced to cut their tradable consumption. In that case, the exchange rate will depreciate sharply, as what we observe in the blue line.

4.5 The Effect of Capital Controls

The previous section analyzes the asymmetric feature of our model economy, in particular, the possibility of a large consumption reduction and real exchange rate depreciation when debt level is high. In this section, we analyze the effect of capital control policies on the dynamics of consumption, debt, and real exchange rate, as well as the currency risk premia.

Basically, capital controls increase the cost of borrowing and discourages consumption when income is low. The reduced borrowing decreases the probability of triggering the constraint to bind in the next period, and thus reduces the sharp exchange rate depreciation in adverse shocks. Compared to the literature, e.g., Bianchi (2011), who discussed the welfare consequences of such policies by correcting the pecuniary externalities of borrowing, our paper takes an alternative asset pricing perspective to explore currency risk premia in such economic environments.

4.5.1 Debt Distribution and Aggregate Moments

We start the analysis of capital controls with the ergodic distribution of debt, B_t. Figure 5 displays the distribution of debt with capital control tax $\tau = 0$ and $\tau = 0.05$.

The contrast illustrates the effect of capital control policies. 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 a capital control policy with $\tau = 0.05$ is implemented. Capital control policies shrink the distribution and debt and induce a mass in moderate levels of debt, because the capital control tax disincentivizes households to borrow. Therefore, it reduces the probability of debt being on the right tail when the constraint binds and households are forced to cut consumption to reduce their debt.

Panel A of Table 8 reports the aggregate moments in these three economies. Tradable consumption and the volatility of real exchange rate change declines with capital control, since capital control policy reduces the likelihood that the economy enters the regime with binding constraint, where exchange rates are particularly volatile due to the strong nonlinearity analyzed in previous sections. Capital control policies do not significantly reduce the average debt to GDP ratio, since it reduces the likelihood of debt level being on both left and right tails. The volatility of current account is reduced from 2 percent with $\tau = 0$ to less than 0.5 percent with $\tau = 0.05$, since the current account sharply reverses when the constraint is triggered to bind. The last two rows of Panel A report the frequency of having a binding constraint and the frequency of crises in these economies. The crisis is defined as an episode with a binding constraint and a capital outflow two standard deviations above the mean. The capital control policy of $\tau = 0.05$ reduces the frequency of having a binding constraint from 23 percent to 10 percent, and the frequency of the crisis from 6 percent to 3 percent.

4.5.2 Real Exchange Rate Dynamics in Different Regimes

In this section, we explore the relation between capital control policy real exchange rate dynamics. Figure 6 plots the dynamics of exchange rate when the economy moves from (B_t, Y_t^M) to $(B_{t+1}(B_t, Y_t^M), Y_t^L)$ for different capital control policies. The red line is with $\tau = 0.05$ and the blue line is with $\tau = 0$. In the previous section, we analyze that when B_t is sufficiently negative, a negative Y_t^T shock will trigger the constraint to bind and lead to a sharp real exchange rate depreciation. Capital control policies can reduce such risk. The turning point of the slope in the figure is shifted to the left by a capital control policy of $\tau = 0.05$. That means with such capital control policy, it is less likely to have a binding constraint, so that there is a smaller chance to observe sharp exchange rate depreciations in these states when the constraint is triggered to bind.

4.5.3 Crises Dynamics: Currency Crash and Current Account Reversal

We next conduct an event study using the simulation from the model. In the simulated data, we define a crisis as a period when the constraint binds and the capital outflow is more than two standard deviations above the average. We collect these crises episodes in the simulation and plot the dynamics of exchange rate and current account 2 periods before and after the crisis with different capital control policies of $\tau = 0$ using the blue line and $\tau = 0.05$ using the red line. When there is no capital control, real exchange rates depreciate sharply in crises when the constraint is triggered to bind, manifested as a currency crash. The reversal of current account, or capital outflow, is very severe when there is no capital control policy. With the capital control policy, even conditional on the crisis event with a binding constraint and a sharp capital outflow, the exchange rate depreciation and current account reversal are much milder.

4.5.4 Currency Risk Premia and Interest Rate Differential

Since capital control policies alleviate sharp exchange rate depreciations in crises, which is triggered by a negative tradable endowment shock into the regime of a binding constraint, such stabilizing effect is reflected in the required expected excess return by the global investor. When the exchange rate depreciates l4ess in global bad times, the currency is considered less risky and the risk premia should be lower. Panel B of Table 8 reports the basic statistics of currency excess returns of the three economies with different values of τ.

When there is no capital control, i.e., $\tau = 0$, the average excess return is 4.92 percent per annum, since global investors require compensation for large currency depreciations when bad tradable good shock triggers the constraint to bind. This is close to what we observe in the data, 4.72 percent per annum. As τ increases, the frequency of sharp depreciations declines and thus the average excess return is smaller. The average spread between the $\tau = 0$ and $\tau = 0.05$ economy is 3.21 percent per annum. The magnitude is more than 80 percent of its empirical counterpart of 3.89 percent per annum. The second row reports the volatility of currency excess return, which also declines with τ. In the third row, we report the average local currency risk-free rate minus the world tradable good denominated interest rate in these three economies, which shares the similar pattern with currency risk premia.

4.6 Forward Contracts and the Intermediary Friction

In the previous sections of the analysis, we compute currency excess return using the interest rate differential and exchange rate change. In the empirical section, we calculate the currency excess return using the outright forward rates and spot only, without the use of money market interest rates. The difference raises two concerns. First, as shown by Du & Schreger (2016) and Du et al. (2018), there has been deviations from the covered interest rate parity even after accounting for default risk, so that there is a discrepancy between the forward discount and the risk-free interest rate differential. Second, and more importantly, forward contracts are settled offshore and there is no need to have actual capital flows into the emerging market economy so that the investor is not necessarily under the capital control policy of the country. In this section, we extend the model to incorporate these complications. The additional block follows Gabaix & Maggiori (2015), which features a constrained intermediary that supplies forward contracts in the market with a premium charge.

Suppose there is a global intermediary that supplies the forward contract. Denote F_t the forward rate of the nontradable good (foreign currency) in terms of the tradable good (dollar). To supply one unit of foreign currency forward contract to the market, the intermediary borrows one unit in dollar, converts it to the foreign currency and gains the foreign currency interest rate. However, when the global intermediary invests in the foreign currency interest rate, it is subject to the capital control policy, so that the excess return the global intermediary earns is

$$rx_{I,t} = \log F_t - \log P_{N,t} + [\log R_t^* + \log(1-\tau)] - \log R \tag{15}$$

Suppose the intermediary charges a premium Γ to this trade, it pins down the outright forward rate as

$$\log F_t = \log P_{N,t} - [\log R_t^* + \log(1-\tau)] + \log R + \Gamma \tag{16}$$

Plug the forward rate into the definition of forward based currency excess return, which uses forward and spot rate only, we have

$$\log P_{N,t+1} - \log F_t = rx_{t+1} - \Gamma \tag{17}$$

The forward discount is

$$\log P_{N,t} - \log F_t = [\log R_t^* + \log(1-\tau)] - \log R - \Gamma \tag{18}$$

We conclude that if there is a frictionless global intermediary supplying forward contracts, i.e., $\Gamma = 0$, the forward based currency return is exactly the same as the excess return we analyze in the previous sections rx_{t+1}. The excess return is affected by the capital control although outright forward contract is settled offshore. The reason is that the global intermediary needs to involve in cross-border transaction to supply the forward. If the global intermediary is frictional, i.e., $\Gamma > 0$, the discrepancy between rx_{t+1} and forward based currency excess return is the premium charged by the global intermediary Γ. In the literature, the intermediary charge for supplying forward contracts can be measured by the deviation from CIP for G-10 default-free advanced economy currencies, which is much smaller than the average currency excess return. Therefore, we conclude this section that the introduction of outright forward supplied by a global intermediary does not change the results of our previous analysis.

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 lowers 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	0.909
Tradable shock vol	σ_y	0.025
Capital control	τ	0, 0.03, 0.05
Risk-free rate	R	1.04
Price of risk	λ	25

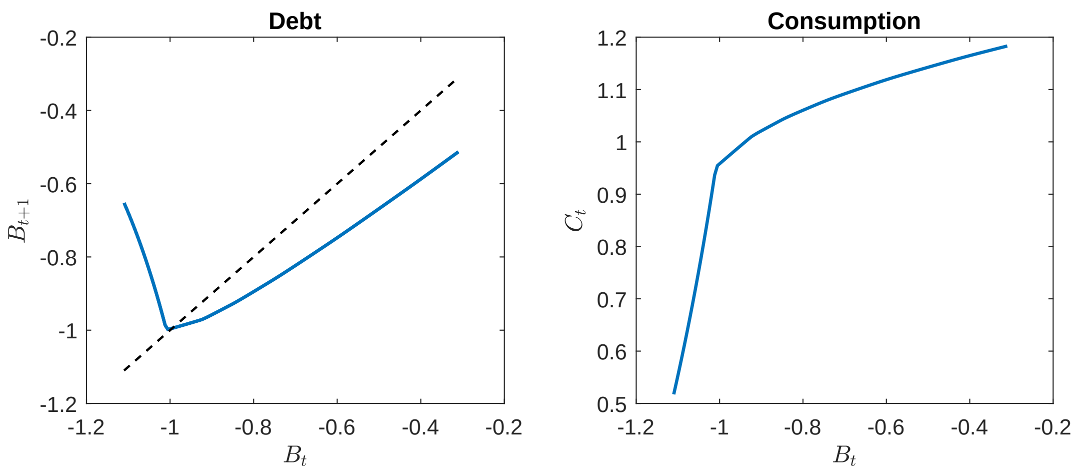
Note: This table reports the calibrated parameter values.

Table 8: Aggregate Moments

	$\tau = 0$	$\tau = 0.03$	$\tau = 0.05$	spread
A: Macroeconomic moments				
Tradable consumption volatility	0.07	0.06	0.04	
Real exchange rate volatility	0.13	0.08	0.03	
Average debt to GDP	-0.32	-0.32	-0.30	
Current account volatility	0.02	0.01	0.00	
Binding frequency	0.23	0.16	0.10	
Crisis frequency	0.06	0.05	0.03	
B: Currency returns				
Average currency return	4.92	3.62	1.71	3.21
currency return vol	8.61	6.30	3.14	
Average interest rate diff	4.28	3.24	1.58	2.70

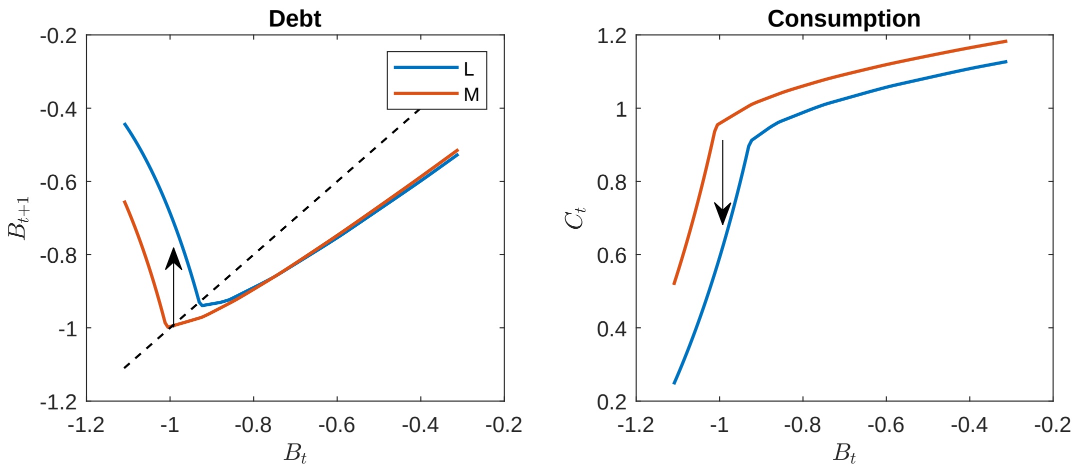
Note: This table reports the aggregate moments from model simulation. Panel A lists the macro moments, and Panel B lists the moments related to currency returns and currency risk premia.

Figure 1: Decision rules: Debt and Consumption



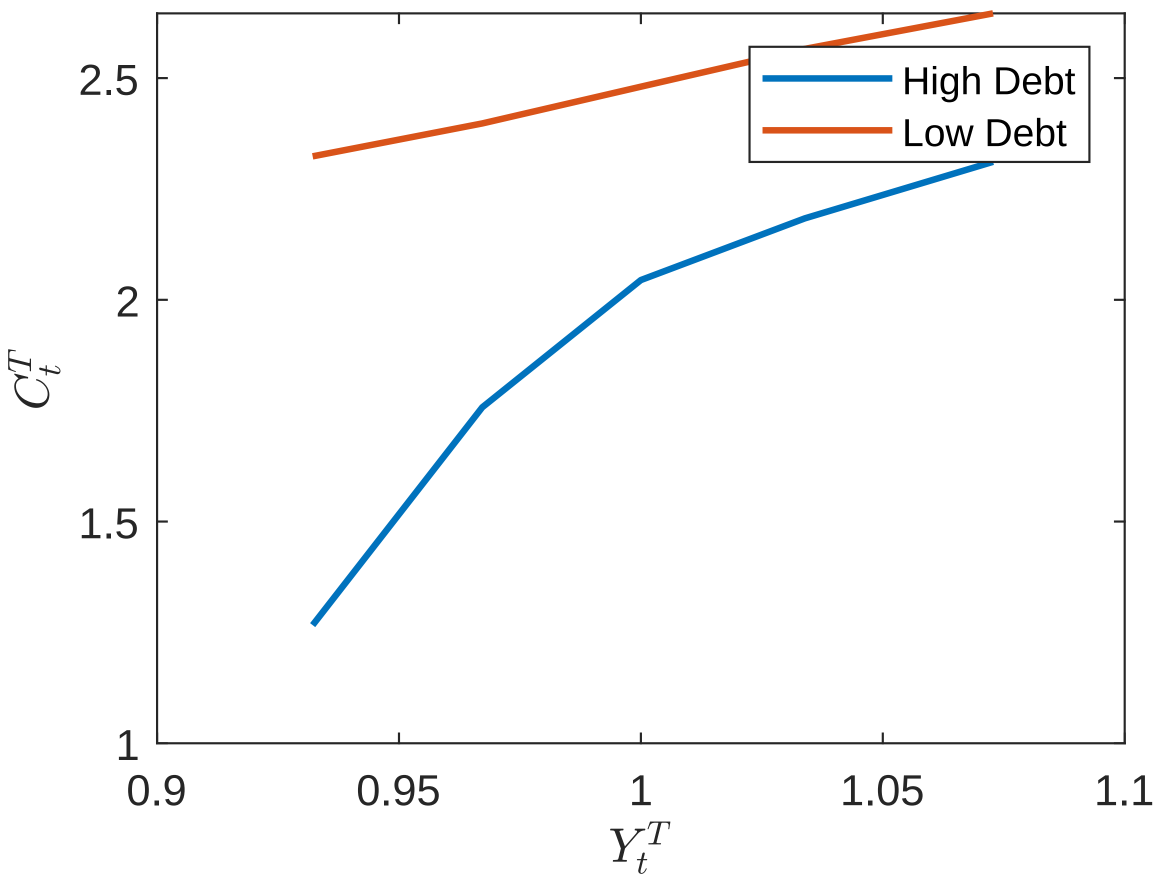
Notes: This figure plots the decision rule of the next period debt B_{t+1} and consumption of tradable good C_t^T as a function of the current level of debt B_t, fixing tradable good endowment at its average level.

Figure 2: An illustration of a financial crisis



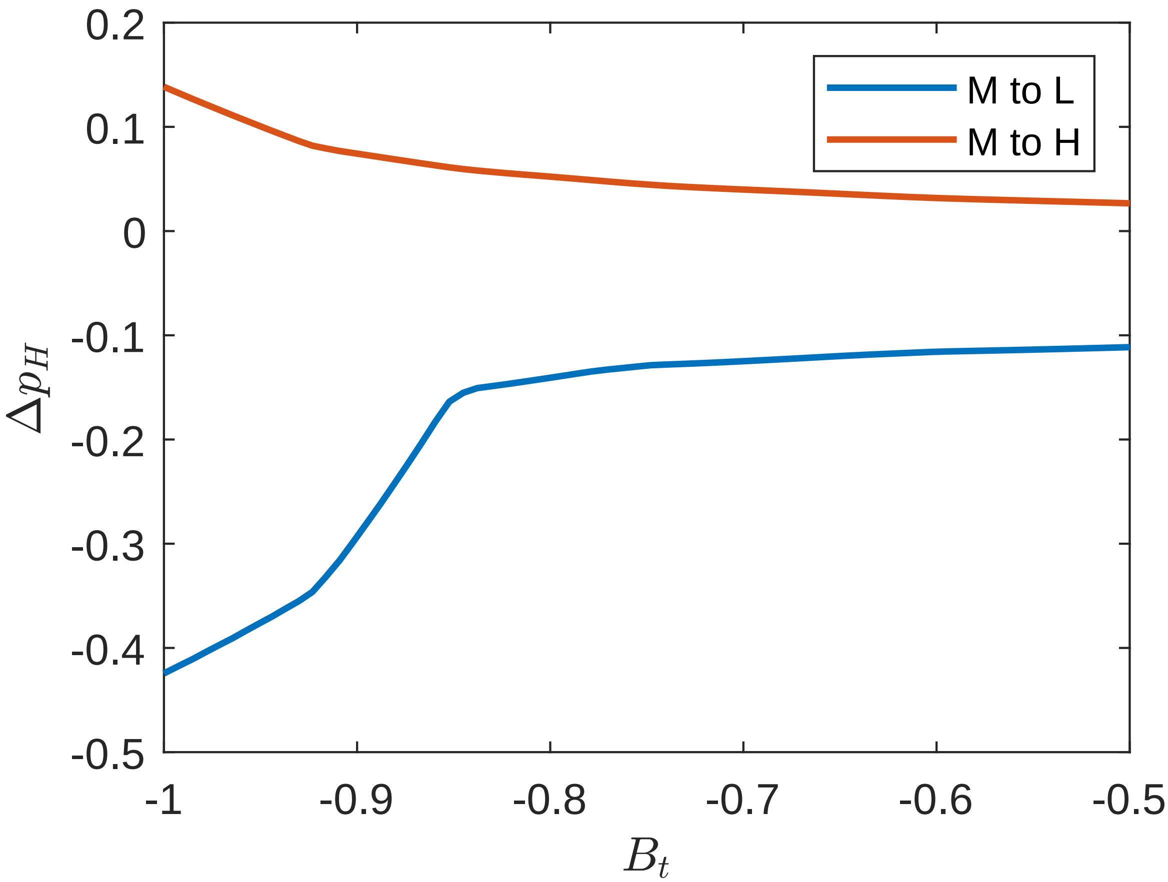
Notes: This figure illustrates the occurrence of a financial crisis when the current-period tradable endowment is at its average level and the current-period debt is close to the turning point, and the economy experiences a negative tradable endowment shock. The red line represents the decision rule when y^T takes an average value, and the blue line represents the decision rule when y^T takes a low, negative value.

Figure 3: Asymmetric consumption policy



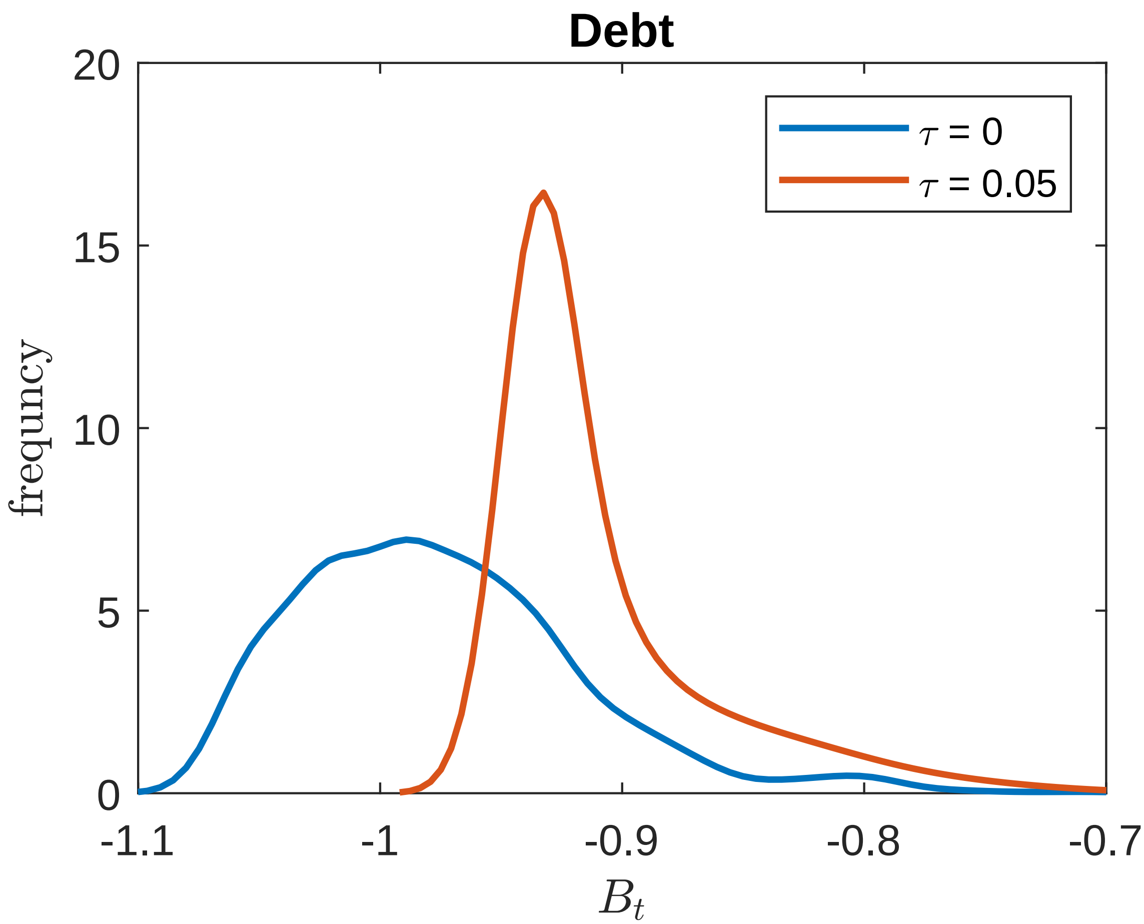
Notes: This figure plots the tradable consumption decision rule C_t^T against the realization of tradable endowment Y_t^T for different values of current-period debt. The red line corresponds to a low level of debt, with $B_t = -0.52$. The blue line corresponds to a high level of debt, with $B_t = -0.98$.

Figure 4: Asymmetric exchange rate change



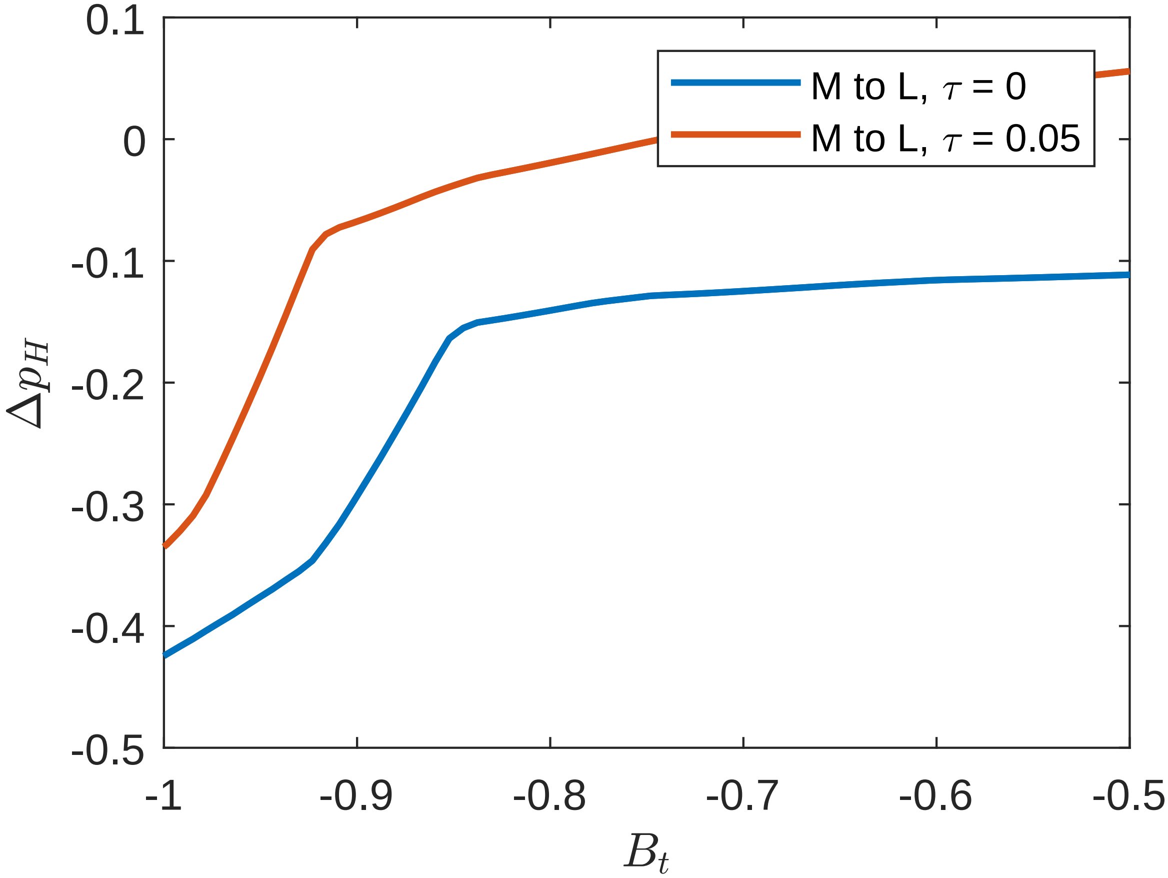
Notes: This figure plots the change of the exchange rate (nontradable price) Δp_H from state (B_t, Y_t^M) to $(B_{t+1}(B_t, Y_t^M), Y_{t+1}^H)$ in red line and $(B_{t+1}(B_t, Y_t^M), Y_{t+1}^L)$ in blue line. B_t is on the horizontal axis, and Y_t^M, Y_t^H, Y_t^L correspond to medium, high, and low value of tradable endowments, respectively.

Figure 5: Debt distribution and capital control policy



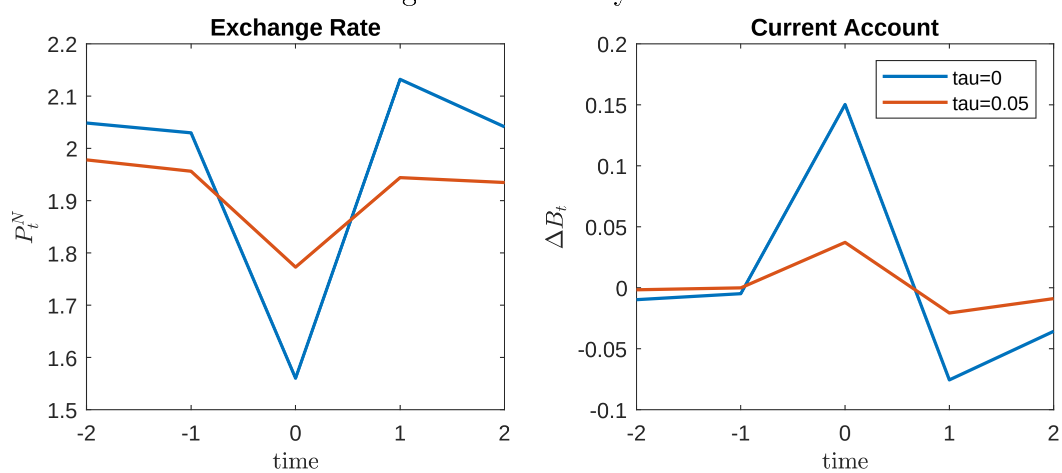
Notes: This figure plots the ergodic distribution of debt B_t in two economies with $\tau = 0$ (in blue) and $\tau = 0.05$ (in red).

Figure 6: Exchange Rate Dynamics and Capital Control Policy



Notes: This figure plots the dynamics of exchange rate when the economy moves from (B_t, Y_t^M) to $(B_{t+1}(B_t, Y_t^M), Y_t^L)$ for different capital control policies. The red line is with $\tau = 0.05$ and the blue line is with $\tau = 0$

Figure 7: 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 with $\tau = 0$. The red solid line plots the pattern in the economy with $\tau = 0.05$.

References

Acosta-Henao, M., Alfaro, L., & Fernández, A. (2020). *Sticky capital controls*. Technical Report National Bureau of Economic Research.

Alfaro, L., Chari, A., & Kanczuk, F. (2017). The real effects of capital controls: Firm-level evidence from a policy experiment. *Journal of International Economics*, *108*, 191–210.

Asness, C. S., Moskowitz, T. J., & Pedersen, L. H. (2013). Value and momentum everywhere. *The Journal of Finance*, *68*, 929–985.

Bianchi, J. (2011). Overborrowing and systemic externalities in the business cycle. *American Economic Review*, *101*, 3400–3426.

Bianchi, J., & Mendoza, E. G. (2018). Optimal time-consistent macroprudential policy. *Journal of Political Economy*, *126*, 588–634.

Bruno, V., Shim, I., & Shin, H. S. (2017). Comparative assessment of macroprudential policies. *Journal of Financial Stability*, *28*, 183–202.

Colacito, R., Riddiough, S. J., & Sarno, L. (2020). Business cycles and currency returns. *Journal of Financial Economics*, *137*, 659–678.

Costinot, A., Lorenzoni, G., & Werning, I. (2014). A theory of capital controls as dynamic terms-of-trade manipulation. *Journal of Political Economy*, *122*, 77–128.

Della Corte, P., Riddiough, S. J., & Sarno, L. (2016). Currency premia and global imbalances. *The Review of Financial Studies*, *29*, 2161–2193.

Della Corte, P., Sarno, L., Schmeling, M., & Wagner, C. (2021). Exchange rates and sovereign risk, .

Du, W., & Schreger, J. (2016). Local currency sovereign risk. *The Journal of Finance*, *71*, 1027–1070.

Du, W., Tepper, A., & Verdelhan, A. (2018). Deviations from covered interest rate parity. *The Journal of Finance*, *73*, 915–957.

Erten, B., Korinek, A., & Ocampo, J. A. (2021). Capital controls: Theory and evidence. *Journal of Economic Literature*, *59*, 45–89.

Fang, X., & Liu, Y. (2021). Volatility, intermediaries, and exchange rates. *Journal of Financial Economics*, .

Farhi, E., Fraiberger, S. P., Gabaix, X., Ranciere, R., & Verdelhan, A. (2009). *Crash risk in currency markets*. Technical Report National Bureau of Economic Research.

Farhi, E., & Werning, I. (2016). A theory of macroprudential policies in the presence of nominal rigidities. *Econometrica*, *84*, 1645–1704.

Fernández, A., Klein, M. W., Rebucci, A., Schindler, M., & Uribe, M. (2016). Capital control measures: A new dataset. *IMF Economic Review*, *64*, 548–574.

Forbes, K., Fratzscher, M., & Straub, R. (2015). Capital-flow management measures: What are they good for? *Journal of International Economics*, *96*, S76–S97.

Forbes, K. J. (2007). One cost of the chilean capital controls: increased financial constraints for smaller traded firms. *Journal of International Economics*, *71*, 294–323.

Gabaix, X., & Maggiori, M. (2015). International liquidity and exchange rate dynamics. *The Quarterly Journal of Economics*, *130*, 1369–1420.

Henry, P. B. (2007). Capital account liberalization: Theory, evidence, and speculation. *Journal of economic Literature*, *45*, 887–935.

Ilzetzki, E., Reinhart, C. M., & Rogoff, K. S. (2019). Exchange arrangements entering the twenty-first century: Which anchor will hold? *The Quarterly Journal of Economics*, *134*, 599–646.

Jeanne, O., & Korinek, A. (2020). Macroprudential regulation versus mopping up after the crash. *The Review of Economic Studies*, *87*, 1470–1497.

Keller, L. (2019). Capital controls and risk misallocation: evidence from a natural experiment. *Jacobs Levy Equity Management Center for Quantitative Financial Research Paper*, .

Korinek, A., & Sandri, D. (2016). Capital controls or macroprudential regulation? *Journal of International Economics*, *99*, S27–S42.

Lorenzoni, G. (2008). Inefficient credit booms. *The Review of Economic Studies*, *75*, 809–833.

Lustig, H., Roussanov, N., & Verdelhan, A. (2011). Common risk factors in currency markets. *The Review of Financial Studies*, *24*, 3731–3777.

Mendoza, E. G. (2010). Sudden stops, financial crises, and leverage. *American Economic Review*, *100*, 1941–66.

Mendoza, E. G., & Rojas, E. (2019). Positive and normative implications of liability dollarization for sudden stops models of macroprudential policy. *IMF Economic Review*, *67*, 174–214.

Menkhoff, L., Sarno, L., Schmeling, M., & Schrimpf, A. (2012). Currency momentum strategies. *Journal of Financial Economics*, *106*, 660–684.

Menkhoff, L., Sarno, L., Schmeling, M., & Schrimpf, A. (2017). Currency value. *The Review of Financial Studies*, *30*, 416–441.

Ostry, J. D., Ghosh, A. R., Chamon, M., & Qureshi, M. S. (2012). Tools for managing financial-stability risks from capital inflows. *Journal of International Economics*, *88*, 407–421.

Rebucci, A., & Ma, C. (2019). Capital controls: A survey of the new literature, .

Schmitt-Grohé, S., & Uribe, M. (2016). Downward nominal wage rigidity, currency pegs, and involuntary unemployment. *Journal of Political Economy*, *124*, 1466–1514.

Verdelhan, A. (2018). The share of systematic variation in bilateral exchange rates. *The Journal of Finance*, *73*, 375–418.