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Nonlinear Capital Flow Tax: Capital Flow Management and Financial Crisis Prevention in China

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Abstract

How to promote capital account liberalization while preventing financial crises is a challenging task for policymakers. This study proposes a nonlinear (progressive) capital flow tax as a solution. We first demonstrate that the collateral requirement of international borrowing can give rise to multiple equilibria and self-fulfilling financial crises. We then show that the crisis equilibrium characterized by large exchange rate depreciation, capital flight and welfare loss can be eliminated by imposing a nonlinear (progressive) tax scheme on capital outflows with the marginal tax rate increasing with the size of individual capital outflows. The implementation of such a tax scheme in China is also discussed.

Key words: capital account openness, financial crisis, nonlinear capital flow tax
JEL codes: F34, F41, H21

I. Introduction

To what extent developing countries should open up their capital accounts is a central yet controversial issue for both academic researchers and policymakers.[1] This question is particularly important for China. Since its accession to the World Trade Organization (WTO), China has adopted a "prudent and steady" strategy for capital account openness, but its openness has now reached a critical stage. On the one hand, with a growing economic size and expanding degrees of openness in trade and foreign

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[1]See the literature review section for details, and Eichengreen (2001) and Kose et al. (2006).

direct investment (FDI), the potential efficiency gain from capital account openness has increased dramatically. On the other hand, China's economic growth in recent years has been slowing down and facing uncertainties and external shocks. Other complementary financial reforms are also still in progress. Thus, maintaining financial stability and avoiding crises become policy objectives of first order importance.

The contributions of this study are twofold. First, we empirically examine the link between capital account openness and financial crisis. Unlike previous studies that focused on the average effects of capital openness, our focus is on exploring the economic conditions under which capital account openness is particularly crisis prone. These empirical findings provide important guidance for policymakers regarding the preconditions and timing of openness. Second, we build a theoretical model and show that international borrowing may lead to multiple equilibrium and self-fulfilling financial crisis. Based on our model, we develop a nonlinear capital outflow tax framework and discuss the implementation of such a policy tool at the micro level.

Using a cross-country panel dataset that covers 79 countries during 1973–2010, we find strong evidence that the effect of capital account openness on the likelihood of financial crises varies substantially under different economic conditions. Specifically, when a country faces a slowdown in its growth or overvaluation of its exchange rate, opening up its capital account significantly increases the risk of a financial crisis occurring. Moreover, exchange rate flexibility is also critical, and a fixed exchange rate regime is associated with a much higher risk of financial crisis when a country opens up its capital account. This finding has important implications for the pecking order of financial reforms as it indicates that a country should first remove restrictions on fluctuations of the exchange rate before opening their capital account. Apart from domestic factors, external shocks also have a significant impact. We find that if the opening up of the capital account is accompanied by a reversal/tightening up of the monetary policy in the core country, such as the US, then the risk of financial crisis rises significantly. Our results suggest that the effect of opening up a capital account depends crucially upon underlying economic conditions.

Since the late 1990s, there has been a general trend among emerging market economies to open up their capital accounts. However, quite a few have subsequently suffered financial crises of varying degrees. A recently emerging strand of literature pays particular attention to the underlying reasons why the opening up of capital accounts in emerging market economies often leads to financial crises (Bianchi, 2011; Korinek, 2011; Korinek and Mendoza, 2014). Studies in the optimal capital flow management literature show that with free capital mobility, private financing decisions can lead to a negative pecuniary externality to the country as a whole. Such negative externality provides room for government intervention through capital flow tax. To correct the negative externality, some existing studies have proposed imposing capital flow taxes as a solution. Some emerging countries, such as Brazil, have adopted this policy suggestion but the results have generally been unsatisfactory.

In the theoretical part of our analysis, we construct a model to study how the government can achieve the social optimum by introducing a capital flow tax. Specifically, we construct a two-sector model of a small open economy with tradable and non-tradable goods. In our model, domestic agents need to collateralize their domestic output when they borrow from foreign lenders. Consequently, the exchange rate has a positive relationship to the borrowing limit. We find that when the level of foreign debt is sufficiently high, there could be multiple equilibria in this model: when individuals are optimistic of the exchange rate, they will increase domestic consumption. This will lead to a higher exchange rate and raise the borrowing limit, which in turn supports relatively high consumption. In contrast, if individuals have pessimistic expectations of the exchange rate and borrowing limit, they will correspondingly reduce domestic consumption and borrowing, leading to a decrease in the exchange rate and capital outflow. In this case, the borrowing limit will tighten, thereby increasing the pressure of repayment on the private sector. The private sector will thus reduce its consumption and lending, causing a financial crisis and welfare loss. A pessimistic expectation could hence be self-fulfilling.

We further show that the linear capital flow tax scheme currently adopted by many emerging economies does not help to eliminate multiple equilibria and cannot prevent financial crises. In order to achieve social optimum, we propose that the capital flow tax should be nonlinear, that is, the marginal tax rate increases along with the amount of capital outflow. We also illustrate how to implement such a nonlinear capital flow tax at the micro level operationally, which is consistent with our proposed nonlinear tax at the macro level to create a self-stabilizing mechanism. Another important contribution of our study is that by introducing a fixed account openness fee, we offer a mechanism that can effectively solve the problem of tax evasion through opening multiple accounts.

The remainder of the paper is organized as follows. Section II provides a review of the existing literature. Sections III and IV exposit our empirical and theoretical analyses, respectively. Section V illustrates our mechanism to implement the nonlinear capital flow tax and provides our policy implications, and Section VI concludes.

II. Literature Review

The opening up of capital accounts has always been a controversial topic. Theoretically, the neoclassical models, which assume perfect competition, find that a free capital market contributes to the efficient allocation of financial resources. Capital would flow from developed to developing countries, which lowers the capital costs in the developing countries and facilitates their investment and economic growth (Summers, 2000; Fischer, 2003). However, there is no empirical consensus on whether capital account openness affects a country's economic growth. Many researchers have found that opening up capital accounts does not lead to significant growth or even cause negative growth effects (Alesina et al., 1994; Rodrik, 1998; Arteta et al., 2001). Henry (2007) conducted a simple before and after comparison of opening up the capital market (five years before and five years after), and found that opening up the stock market has a short-term growth effect. Kose et al. (2006) reviewed the literature and performed a detailed empirical analysis, finding that capital account openness does not have a significant direct impact on growth, and if there is a benefit it is more likely to be indirect, for instance, by facilitating the development of financial markets and institutions.

Because the opening-up of capital markets among emerging market economies in the late 1990s is associated with financial crises, recent literature on capital market openness has directed attention to the effect of openness on economic stability. Stiglitz (2000) proposed that short-term flows of capital have a large externality, which destabilizes the economy. Rey (2015) also argued that regardless of the exchange rate regime, opening up a country's capital account would make it susceptible to monetary policy shocks generated from central countries (e.g. the US). The recent literature on managing capital flows re-examined the effects of opening up capital accounts on financial crisis. Mendoza (2010) and Korinek and Mendoza (2014) found that sudden cessations in capital inflow (and corresponding sudden increases in current account deficit) are the main cause of financial crises. Sudden cessations of capital inflows are usually accompanied by a drop in output, a massive devaluation of the real exchange rate and a fall in asset prices. Based on the stylized facts above, recent theoretical research has focused on analyzing the negative externality resulting from private borrowing on exchange rate fluctuations (e.g. Mendoza, 2010; Bianchi, 2011; Korinek, 2011; Korinek and Mendoza, 2014). The borrowing limit of a country depends on the value of its collateral, measured in foreign currencies. When the economy suffers a negative shock, the repayment behavior of the private sector on aggregate leads to net capital outflows, thereby causing devaluation of the domestic currency and a fall in the collateral value; this, in turn, increases the pressure of repayment on the private sector. The reduction in borrowing forces the private sector to reduce their spending, which leads to further depreciation of the exchange rate, ultimately leading to a vicious cycle. In essence, this is a Fisherian debt-deflation process (Fisher, 1933). Because the private sector does not internalize the negative externality, it accumulates too much debt during economic booms. In other words, the cost of private (firm) lending is lower than the social cost of lending, and therefore a negative externality results. From a social point of view, the final result is over-indebtedness. Therefore, a country's currency management institutions must adopt policy measures to control the private sector's external borrowing to reduce the possibility and negative consequences of financial crisis.

The presence of this negative externality forms the basis of the current theory of optimizing capital flows. Many researchers have proposed addressing this negative externality by taxing capital flows (e.g. Korinek, 2011, 2018; Korinek and Mendoza, 2014). Furthermore, Korinek (2011) considered two kinds of capital control: control before a crisis happens (ex ante) and after a crisis has been triggered (ex post). He found that the optimal control policy is a combination of both ex ante and ex post policies. Bianchi (2011) found that a country's optimal capital control depends on the country's foreign asset holdings. Farhi and Werning (2012) analyzed the optimal control under various shocks in a small open economy with a fixed exchange rate regime and nominal price rigidity. They found that capital control is especially effective in shielding the economy from the fluctuations of foreign investors' demanded risk premium. They also examined whether there is a welfare gain for international coordination among policymakers when they implement capital control policies, and found that the benefit of such coordination is limited.

In contrast to the literature discussed above, Benigno et al. (2013) and Schmitt-Grobé and Uribe (2016) argued that the problem in the private sector is "under-borrowing" rather than "over-borrowing." Benigno et al. (2013) argued that the government sector, through ex ante and ex post management, can effectively reduce the detrimental effects of a crisis. Correspondingly, the private sector does not need to undertake precautionary savings in preparation for a possible crisis, and can thus borrow more than the competitive level. However, their paper does not consider the existence of multiple equilibria. We use a similar methodology to that used by Schmitt-Grobe and Uribe (2016), but they did not provide a workable proposal for implementation or explicitly provide the conditions for the existence of multiple equilibria. In contrast, our research shows that only when a country's foreign debt reaches a relatively high level does the existence of multiple equilibria become possible.

In the empirical literature, there is no consensus as to whether openness of the capital market leads to crisis. Glick et al. (2006) even found that opening up the capital account would lower the risk of a financial crisis. Frankel and Wei (2004) and Tong and Wei

(2010) further investigated the relationship between the structure of capital flows and financial crisis. They found that, relative to FDI, short-term capital flows are particularly susceptible to fluctuations of exchange and interest rates. If short-term capital flows account for a large proportion of capital flows, financial crises become likely.

III. Empirical Analysis

In this section, we conduct empirical analysis using cross-country data. We focus on two main issues. First, we conduct before and after crisis comparisons of several key economic outcome measures. We then examine the effect of capital market openness on the likelihood of crises using regression analysis. To carry out our empirical exercises, we follow Gourinchas and Obstfeld (2012) and construct a panel dataset that includes a total of 79 countries for the years 1973–2010. Among the 79 nations in our sample, 57 are developing countries. Our sample period covers the post-Bretton era. The main data sources used in our study include World Development Indicators (WDIs), *International Financial Statistics* (IFS), the Global Financial Database (GFD) and the Penn World Table (PWT). In addition, we also obtain crises information from Gourinchas and Obstfeld (2012) and the personal website of Carmen Reinhart.[2]

1. Costs of Financial Crises: Some Visual Evidence

Financial crises are typically perceived to have detrimental effects on the macro economy, such as large drops in output and exchange rate depreciations. Here we provide some visual evidence by conducting a series of simple before and after comparisons. Specifically, we follow the method used by Gourinchas and Obstfeld (2012) and choose a seven-year window, which includes three years prior to a crisis, the crisis year and three years after a crisis. To save space, we report before and after comparison results for currency crisis episodes only. We also conduct the same exercises for banking and debt crises, and the results are similar.

Figure 1 shows the results for the three main outcome variables: the real output gap, the real exchange rate gap and the ratio of public debt/GDP. Figure 1a illustrates the average output gap across the 79 countries in the seven-year window. We found that the output gap increases first and reaches its peak (approximately 1.5 percent above the

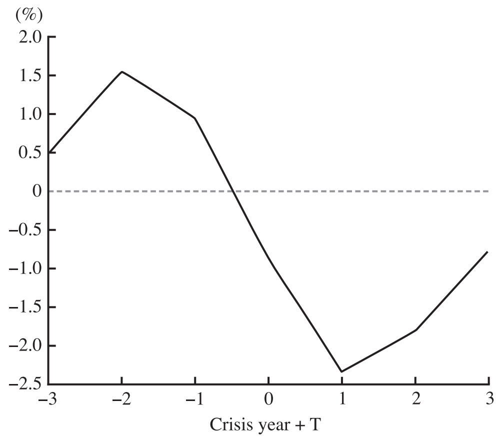
[2]Gourinchas and Obstfeld (2012) provide the years in which a crisis occurred. We used this information for before and after comparison. Reinhart's website (http://www.carmenreinhart.com/data/browse-by-topic/topics/7/) offers additional information on the duration of crises, which we used for our regression analysis. Detailed data sources and variable definitions are listed in the Appendix.

long-term trend) two years before the crisis. It then exhibits a sharp decline and turns negative. It reaches its trough about one year after the crisis and then starts to recover. The trough is approximately 2.5 percent below the trend.

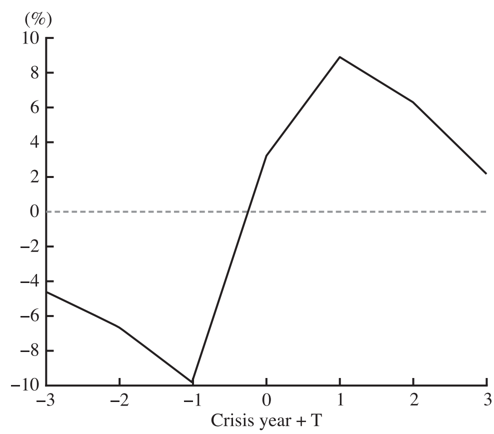
We then focus on the real exchange rate gap. According to Reinhart and Rogoff (2009), currency crises often lead to large nominal depreciation (15 percent or more) of the domestic currency. Because of the price rigidity, we expect the real exchange rate to exhibit a similar pattern in the short term. Figure 1b confirms our expectation. The real exchange rate appreciates first and reaches its lowest point approximately one year before the crisis. This is followed by a sharp devaluation during the crisis (an average of 13 percent). One year after the crisis, the real exchange rate starts to recover to its long-term trend.

Figure 1. Before and After Comparisons of Key Macro Variables

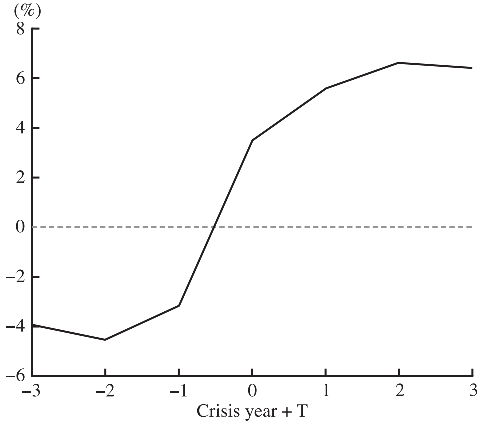
(a) Reaction of GDP Gap to Currency Crisis



(b) Reaction of Real Exchange Rate Gap to Currency Crisis



(c) Reaction of Public Debt/GDP to Currency Crisis



Source: Authors' calculations.

Notes: The percentage deviations of GDP, real exchange rate and the public debt/GDP ratio from their respective long-run trends are generated using the Hodrick–Prescott Filter and are reported on the vertical axes. The horizontal axes represent the number of years before (negative sign) and after a currency crisis. For example, Crisis year + T means T year after the crisis year. The series are averaged across the 79 countries in the sample.

Finally, Figure 1c shows a before and after comparison of the debt/GDP ratio. Before a crisis, this ratio is approximately 4 percent lower than its yearly average. It increases dramatically starting from the year before the crisis and reaches 6 percent above the long-run average after a crisis. This finding is consistent with that presented in Figure 1b. Appreciation of the domestic currency before the crisis reduces the debt burden denominated in domestic currency, but the subsequent sharp devaluation leads to a large increase in debt. Overall, the before and after comparisons provide consistent evidence that currency crises have significant adverse effects on the macro economy.

2. Capital Account Openness and Crises: Regression Analysis

In this subsection, we further explore the link between capital account openness and the likelihood of crisis. Specifically, we consider the following probit model:

$$\Pr\ (Crisis_{j,t} = 1 \mid X_{j,t-1}) = \Phi\ (X'_{j,t-1}\beta)\ , \quad (1)$$

where $Crisis_{j,t}$ is a binary variable for currency crisis that takes the value of 1 if a currency crisis occurs in country j in year t, and 0 otherwise. $X_{j,t-1}$ is a set of country-year level control variables, including current account/GDP ratio, public debt/GDP ratio, (Hodrick–Prescott (HP) filtered) real output and exchange rate gaps, inflation rate (in natural log) and foreign reserves/GDP ratio. Φ is the cumulative distribution function of the standard normal distribution, and β represents the list of coefficients to be estimated.

Our main variable of interest is the degree of a country's capital account openness. Here we use the capital account openness index constructed by Chinn and Ito (2006), which is commonly used in the literature. This index ranges from 0 to 1 with a larger value indicating a higher degree of financial openness. In addition to the average effect of capital account openness, we are also interested in exploring the potential heterogeneous effects, which enables us to examine under what conditions capital account openness contributes to the likelihood of a crisis. To explore the heterogeneous effects, we interact the capital account openness measure with other macro variables, such as the real output gap, the real exchange rate gap, a proxy of US monetary tightening and exchange rate regimes. All of the right-hand side variables are lagged for one period to alleviate the potential endogeneity concern. We also control for country and year fixed effects.

The regression results are reported in Table 1. Column (1) regresses the binary crisis variable on our measure of capital account openness and its interaction with the real output and exchange rate gaps along with the controls. We found that the estimated coefficient of capital account openness per se is negative and statistically significant. This finding seems to be consistent with that documented by Glick et al. (2006) whose study focused on the average effect of financial openness. Interestingly, we also found that the coefficients of the two interaction terms are also negative and significant, suggesting that capital account openness increases the likelihood of crisis when the real output is below its trend value (negative output gap) or when there is real overvaluation (negative real exchange rate gap). For control variables, we found that public debt/GDP and inflation are positively related to the likelihood of crisis, while foreign reserves/GDP is negatively associated with the likelihood of crisis.

We next examine how changes in US monetary policy stance influence the impact of capital account openness on the likelihood of crisis. A shift in US monetary policy stance from easing to tightening makes US dollar assets more attractive and often increases the return volatility of assets denominated in other currencies. Moreover, a high degree of financial openness facilitates large expectation-based capital flows, making the host country more likely to experience a crisis. As a result, we expect that a US monetary policy stance reversal from easing to tightening contributes to the impact of capital account openness. To test this hypothesis, we create a binary indicator for US monetary policy stance reversal from easing to tightening using federal funds rate data. Specifically, the binary variable takes the value of 1 if the change in federal funds rate turns from negative to positive in a particular year and 0 otherwise. We then interact it with our capital account openness measure and include this interaction term in our regression. As shown in column (2) of Table 1, the results confirm our speculation that capital account openness is more likely to lead to a currency crisis in years when there is a reversal in US monetary policy stance. The estimated coefficient of the interaction term is found to be positive and significant.

Table 1. Capital Account Openness and the Likelihood of Currency Crisis

Variable	(1)	(2)	(3)
Current account/GDP	–0.003 (0.017)	–0.003 (0.016)	–0.011 (0.016)
Real output gap	0.051 (0.031)	0.017 (0.018)	0.022 (0.019)
Real exchange rate gap	–0.016** (0.008)	–0.032*** (0.007)	–0.035*** (0.007)
Public debt/GDP	0.006* (0.003)	0.006** (0.003)	0.009*** (0.003)
Foreign reserves/GDP	–2.635* (1.461)	–2.609* (1.348)	–3.401** (1.437)
Log *Inflation rate*	2.676*** (0.839)	2.648*** (0.764)	2.530*** (0.672)
Capital account openness	–1.151*** (0.347)	–1.056*** (0.322)	–0.553 (0.392)
Openness × Real output gap	–0.108* (0.056)		
Openness × Real exchange rate gap	–0.060*** (0.018)		
Openness × US monetary reversal		0.528* (0.314)	
Floating dummy			0.868*** (0.259)
Openness × Floating dummy			–0.733* (0.430)
Country fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Number of observations	1389	1389	1348
Pseudo R^2	0.40	0.41	0.41

Notes: *, **, *** represent 10, 5 and 1 percent significance levels, respectively. Robust standard errors clustered at the country level are in parentheses. A constant is included but not reported in all regressions.

Finally, in column (3) of Table 1, we further explore the role of exchange rate regimes for determining the effect of capital account openness on crisis. Based on the de facto classification of exchange rate regimes used by Reinhart and Rogoff (2004), we create a dummy variable for a floating exchange rate regime that takes the value of 1 if a country's exchange rate regime falls into either a managed floating or a freely floating category. We then include this dummy variable and its interaction with capital account openness in the regression. The estimated coefficient of the floating exchange rate dummy is positive and significant, which is consistent with view that exchange rates under a floating exchange regime are more volatile and thus more likely to experience large changes. What is more interesting is that the estimated coefficient on the interaction term is significantly negative. This suggests that, for countries with a fixed exchange rate prior to the crisis, opening the capital account is more likely to result in a current account crisis.

Overall, the regression results presented in Table 1 suggest that capital account openness has significant heterogeneous effects on the likelihood of currency crisis. Its net effect depends on business cycles, the real exchange rate, external monetary shocks and exchange rate regimes. Our empirical findings have important policy implications. First, they suggest that the right timing for opening the capital account is crucial. A country should avoid capital account liberalization in times when its real output is below its potential, the real exchange rate exhibits overvaluation or there is a US monetary policy reversal. Second, the results in column (3) imply a pecking order of reforms – exchange rate reform should be established ahead of capital account liberalization. Given the current slowdown of Chinese economic growth and the future normalization of US monetary policy, caution should be taken with further financial liberalization.

IV. A Benchmark Model

In this section, we theoretically analyze the adverse effect of capital account openness on financial stability, and how the government can avoid financial crisis by designing a proper tax scheme for international capital flows. In particular, we construct a small open economy with tradable and non-tradable sectors. Because foreign debt has to be collateralized by the real output, the borrowing limit of the representative household is positively related to the real exchange rate.

A key finding of the model is that when the initial debt level is high enough, multiple equilibria exist, and which equilibrium is realized depends on people's expectations. When people are optimistic and believe that a crisis will not happen, they choose high consumption, which boosts the price of the non-tradable good and the exchange rate. The borrowing constraint is then relaxed, which makes the households' choice of high consumption affordable as they have a large amount of cash on hand.

On the contrary, if people are pessimistic and believe a currency crisis will occur, they reduce their consumption and borrowing, which depresses the exchange rate and results in capital outflows. The borrowing constraint is then tightened, which further reduces consumption and the exchange rate. This is the classic Fisherian debt-deflation channel (Fisher, 1933). Consequently a crisis occurs, which justifies people's initial pessimistic expectations. In other words, a crisis is self-fulfilling.

Next, we discuss how to prevent a currency crisis by correctly designing the tax scheme for international capital flow. First, we show that multiple equilibria always exist under a linear tax scheme. In contrast, when the tax scheme is nonlinear (progressive), the crisis equilibrium can be removed. As a result, to maintain the financial stability of a country with an open capital market, the tax scheme has to be nonlinear. We also examine how to implement a nonlinear tax scheme by setting the proper tax rates to different scales of capital flows. Finally, as tax evasion can naturally emerge with a progressive tax scheme, we analyze how to prevent this problem by imposing a fixed fee on individual bank accounts for capital transactions.

1. Setup of the Model

We consider a deterministic small open economy with two goods: tradable and non-tradable. The objective function of the representative household is expressed as follows:

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

where E_0 is the expectation operator in period 0, $\beta \in (0,1)$ is the discount factor and $u(\cdot)$ is the period utility function, which is strictly concave. We assume that $u(\cdot)$ takes the following constant relative risk aversion (CRRA) form: $u(C_t) = \dfrac{C_t^{1-\sigma} - 1}{1-\sigma}$, $\sigma \geqslant 1$. C_t is the consumption in period t, which is a composition of goods consisting of both tradable, c_t^T, and non-tradable, c_t^N:

$$C_t = \left[\theta \left(c_t^T \right)^{\frac{\varepsilon-1}{\varepsilon}} + (1-\theta) \left(c_t^N \right)^{\frac{\varepsilon-1}{\varepsilon}} \right], \tag{3}$$

where ε is the substitution elasticity parameter between these two goods and $0 < \theta < 1$.

The household can trade a single-period, risk-free bond on the international market with the price denominated by units of the tradable goods. The gross interest rate is fixed at R. In addition, the households have three sources of income: a constant endowment of the tradable goods, y^T, labor income and capital income, which are both paid in units of non-tradable goods. The budget constraint is expressed as follows:

$$c_t^T + p_t c_t^N + q_t k_{t+1} + Rb_t = y^T + p_t w_t L + (q_t + p_t d_t)k_t + b_{t+1}\,. \tag{4}$$

In Equation (4), the left-hand side is expenditure. The price of the tradable goods is normalized to 1, and the price of the non-tradable goods is p_t. The consumption of c_t^T and c_t^N, the household, also holds capital k_{t+1} (whose price is q_t), and pays back the debt accumulated from the previous period, Rb_t. The right-hand side represents the sources of funding, including endowment of non-tradable goods, y^T, labor income, $p_t w_t L$, capital income and new debt, b_{t+1}. We assume the labor supply is inelastic. With d_t being the dividend paid to each unit of capital holding k_t, the gross return to capital holding is $q_t + p_t d_t$.

The non-tradable goods are produced by capital and labor using a Cobb−Douglas production function: $y_t^N = AK_t^{\alpha} L_t^{1-\alpha}$. We assume that the supply of capital is constant, $\overline{K} = 1$ and there is no depreciation. With constant productivity A, the supply of the non-tradable goods is also constant, $y_t^N \equiv y^N$. As the factor market is competitive, we can express the wage and dividend as:

$$w_t \equiv (1-\alpha) A L^{-\alpha}\,, \tag{5}$$

$$d_t \equiv \alpha A L^{1-\alpha}\,. \tag{6}$$

The budget constraint in Equation (4) can then be written as:

$$c_t^T + p_t c_t^N + q_t k_{t+1} + Rb_t = y^T + p_t (1-\alpha) y^N + (q_t + p_t \alpha y^N) k_t + b_{t+1}\,. \tag{7}$$

From the market clearing condition in the factor market, the demand of capital is always equal to the constant supply: $k_t \equiv \overline{K} = 1$. Besides the budget constraint, we assume the representative household is also subject to the following collateral constraint of borrowing:

$$b_{t+1} \leqslant \phi\ (y^T + p_t y^N)\,, \tag{8}$$

such that the amount of debt cannot exceed a fraction ϕ of the real GDP of this country, $y^T + p_t y^N$, which is taken as exogenous to the household. The borrowing constraint here is the same as that used by Bianchi (2011), which arises from informational and institutional friction in international borrowing–lending relationships. However, the price of the non-tradable goods (real exchange rate), p_t, is actually endogenous and determined in equilibrium. A higher exchange rate relaxes the collateral constraint, which allows individual households to borrow more from the international market. However, p_t is taken as exogenous by the households, and as a result, individual choices impose negative pecuniary externality on social welfare. We next discuss this externality in detail and provide a solution.

Given the constraints of Equations (7) and (8), a sequence of prices, $\{p_t, q_t\}_{t=0}^{\infty}$, and an initial debt level b_0, the representative household chooses $\{c_t^T, c_t^N, k_{t+1}, b_{t+1}\}_{t=0}^{\infty}$ to maximize their objective function. Denote the Lagrangian multiplier of the period t budget constraint in Equation (7) as $\beta^t\lambda_t$, and the multiplier of the collateral constraint in Equation (8) as $\beta^t\lambda_t\mu_t$. The first-order-conditions are then expressed as:

$$c_t^T: \qquad \lambda_t = \theta(C_t)^{-\sigma+1/\varepsilon}(c_t^T)^{-1/\varepsilon}, \tag{9}$$

$$c_t^N: \qquad p_t\lambda_t = (1-\theta)(C_t)^{-\sigma+1/\varepsilon}(c_t^N)^{-1/\varepsilon}, \tag{10}$$

$$k_{t+1}: \qquad q_t\lambda_t = \beta(q_{t+1} + p_{t+1}\alpha y^N)\lambda_{t+1}, \tag{11}$$

$$b_{t+1}: \qquad \lambda_t(1-\mu_t) = \beta R\lambda_{t+1}. \tag{12}$$

From Equations (9) and (10), we can express the real exchange rate as:

$$p_t = \frac{1-\theta}{\theta}\left(\frac{c_t^T}{c_t^N}\right)^{\frac{1}{\varepsilon}}, \tag{13}$$

and the market clearing conditions as:

$$k_{t+1} = \overline{K} = 1, \tag{14}$$

$$c_t^N = y^N, \tag{15}$$

$$c_t^T = y^T - Rb_t + b_{t+1}. \tag{16}$$

The definition of equilibrium is: (i) given a sequence of prices, $\{p_t, q_t\}_{t=0}^{\infty}$, an initial debt level b_0, and constraints of Equations (7) and (8), Equations (9)–(12) are satisfied; and (ii) markets clear.

Replacing p_t in Equation (8) by Equation (13) and imposing the market clearing conditions, we obtain:

$$b_{t+1} \leqslant \phi\left[y^T + y^N\frac{1-\theta}{\theta}\left(\frac{y^T - Rb_t + b_{t+1}}{y^N}\right)^{\frac{1}{\varepsilon}}\right], \tag{17}$$

where both sides are functions of b_{t+1}. If the curvature of the expression on the right-hand side is large enough (or ε small enough), there can be multiple b_{t+1} to keep the inequality of Equation (17) holding, and we may obtain multiple equilibria.

2. Analysis of Multiple Equilibria

For the ease of presentation, let us introduce the concept of steady state equilibrium. Steady state equilibrium is an equilibrium in which bond holding and consumption are constant over time: $b_{t+1} = b_t$, $c_{t+1}^T \equiv c_t^T$, $\forall t \geqslant 0$. In addition, we assume $\beta R = 1$. In steady state equilibrium, based on Equation (11), the collateral constraint is slack, that is, $\mu_t \equiv 0$. Imposing $b_{t+1} = b_t = b$ in Equation (11), we have:

$$b \leqslant \phi\left[y^T + y^N \frac{1-\theta}{\theta}\left(\frac{y^T - (R-1)b}{y^N} \right)^{\frac{1}{\varepsilon}} \right], \tag{18}$$

where the left-hand side is increasing in b, and the right-hand side is decreasing in b.[3] Thus there is an upper bound of borrowing, $\tilde{b}$, and any initial debt level $b_0 \leqslant \tilde{b}$ constitutes a steady state equilibrium. In the steady state equilibrium, we have:

$$b_{t+1} = b_0, \tag{19}$$

$$c^T_t = y^T - (R-1)b_0, \tag{20}$$

$$p_t = \frac{1-\theta}{\theta}\left(\frac{y^T - (R-1)b_0}{y^N} \right)^{\frac{1}{\varepsilon}}, \tag{21}$$

$$\mu_t \equiv 0, \tag{22}$$

$\forall t \geqslant 0$. Imposing these values into the equilibrium conditions, we find that the market clearing and first-order conditions are satisfied. Furthermore, the welfare level achieved in the steady state equilibrium is Pareto optimal because the household achieves complete consumption smoothing over time.

However, when $b_0 \leqslant \tilde{b}$, steady state equilibrium may not be the only equilibrium. Given $\varepsilon < 1$, the right-hand side of Equation (17) is convex in b_1, and thus there may be multiple solutions of b_1 to satisfy Equation (17). Combining Equation (17) with the optimal choice of borrowing, $b_1 = b_0$, the value of b_1 can be determined by the following equation:

$$b_1 = \max\left\{ b_0, \phi\left[y^T + y^N \frac{1-\theta}{\theta}\left(\frac{y^T - Rb_0 + b_1}{y^N} \right)^{\frac{1}{\varepsilon}} \right] \right\}. \tag{23}$$

We find that if the borrowing constraint is slack, the household chooses $b_1 = b_0$; otherwise borrowing is determined by the borrowing limit.

We proceed by imposing the parameter values in Table 2. The endowments of both tradable and non-tradable goods are set to 1, $y^T = y^N = 1$. The yearly gross interest

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[3]Because foreign debt cannot exceed the natural borrowing limit, we always have $y^T - (R-1)\, b > 0$.

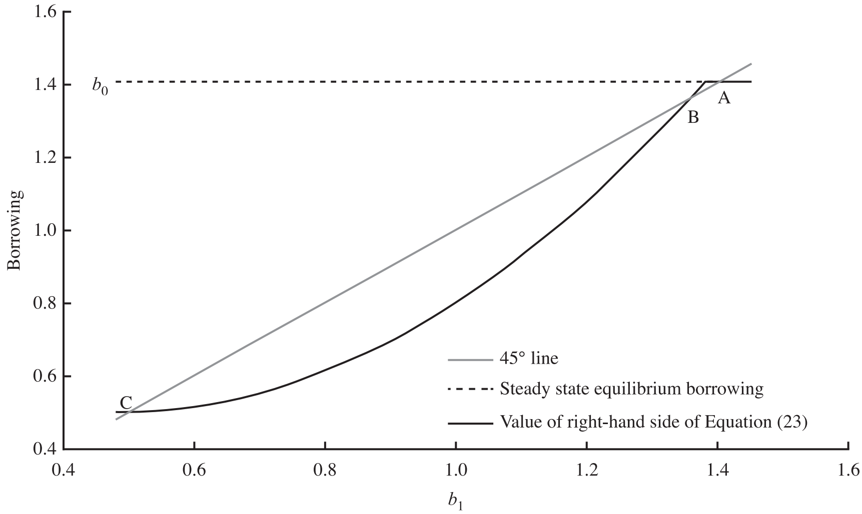
rate is R = 1.05 and the discount factor is $\beta = 1/R = 0.95$. The coefficient of collateral constraint is ϕ = 0.5 and the CRRA is $\sigma = 2$. Following Bianchi (2011), the weight of the tradable goods in the composition of consumption is set at $\theta = 0.31$. The value of ε is important to our results. Only when $\varepsilon < 1$ is the expression of the collateral constraint convex in b_1, which makes the multiple equilibria possible. In a literature survey by Akinci (2017), the majority of empirical studies found that ε lies in the interval [0.43, 0.74]. We therefore set $\varepsilon = 0.5$. Finally, b_0 determines the initial position of the economy. According to Eichengreen et al. (2006), the annual probability of financial crisis among the developing countries is 5.5 percent. Taking Argentina as an example, we generate empirical distribution of the external debt-to-GDP ratio between 1970 and 2011 using data from Lane and Milesi-Ferretti (2007). The ratio at the 5.5 quantile is –0.48, corresponding to $b_0 = 1.41$ in our model.

Table 2. Parameter Values

Parameter	Value	Description
R	1.05	Annual gross interest rate
β	$1/R$	Discount factor
ϕ	0.5	Coefficient of collateral constraint
ε	0.5	Elasticity of substitution between tradable and non-tradable
y^T	1	Endowment of tradable
y^N	1	Endowment of non-tradable
θ	0.31	Weight of tradable in utility
σ	2	Constant relative risk aversion coefficient
b_0	1.41	Initial debt

We plot both sides of Equation (23) in Figure 2. The left-hand side of Equation (23), a 45-degree line, is plotted by the dashed line. The dotted horizontal line is b_0, which is the optimal level of b_1 in the steady state equilibrium. The solid line represents the right-hand side of Equation (23) as the minimum between b_0 and the collateral constraint. We find that the solid line crosses the 45-degree line three times, denoted from left to right as points A, B and C, respectively. At point A, b_1 is high enough and the collateral constraint is slack, and the first-best allocation in the steady state equilibrium, $b_1 = b_0$ is achieved. However, two other equilibria emerge, except for A. At points B and C, the value of b_1 is low, which depresses consumption of the tradable goods, c^T_1. According to Equation (13), the real exchange rate is low and the borrowing constraint is tight. As a result, consumption and social welfare are negatively affected.

Figure 2. Determining Multiple Equilibria



To summarize, given the parameter values in Table 2, there are multiple equilibria with different borrowing and exchange rates, and which one arises depends on people's expectations of the future. If people are optimistic and thus borrowing and consumption levels remain constant, then the steady state equilibrium is realized and the Pareto optimal is achieved. In contrast, if households expect currency depreciation and reduce their borrowing and consumption, capital will flow out of the country and the exchange rate drops. The borrowing limit is tightened, which eventually triggers a financial crisis, as in the cases of points B and C.

A natural question is: What is the difference in welfare levels among the equilibria? If the difference is small, government policy interventions are not necessary given the market distortion and the corresponding welfare loss of government policies. Because the equilibrium at point B is unstable, we compare the welfare at points A and C. Point A represents the steady state equilibrium, in which $b_{t+1} = b_0$, $c_t^T = y^T - (R-1)\, b_0$, $p_t = \frac{1-\theta}{\theta}\left(\frac{y^T-(R-1)b_0}{y^N}\right)^{\frac{1}{\varepsilon}}$, $\mu_t \equiv 0$, and $\forall t \geqslant 0$. At point C, we have $b_1 < b_0$, $c_1^T = y^T - Rb_0 + b_1$, $\mu_0 > 0$, $b_t = b_1$, $c_t^T = y^T - (R-1)\, b_1$, $\mu_t \equiv 0$ and $\forall t \geqslant 1$, which shows that there are capital outflow and currency crises in period 0 but starting from $t = 1$, and new steady state equilibrium is achieved, $b_t = b_1$. We can easily check that the equilibrium conditions are satisfied under these paths of allocations. Denote the welfare levels at points A and C as V^A and V^C, respectively. The question is: How large is the welfare loss at point C compared to point A? To demonstrate this, we compute Δ, the proportional consumption loss needed at point A to reduce the household's welfare level to point C.

Using the expression of the utility function, Δ can be expressed as:

$$\Delta = 1 - \left(\frac{V^C}{V^A} \right)^{\frac{1}{1-\sigma}}. \tag{24}$$

Using the parameter values in Table 2, $\Delta = 41\%$, suggesting significant welfare loss if a financial crisis occurs.

We need to point out that the existence of multiple equilibria depends on the level of the initial debt. In Table 3, we list the welfare losses of the financial crisis under different values of the initial debt. We find that the welfare loss increases in b_0. Actually, when $b_0 < 1.21$, there is no crisis equilibrium. The corresponding debt-to-GDP ratio at $b_0 = 1.21$ is −0.14, which is the first decile in the debt-to-GDP ratio distribution of Argentina between 1970 and 2011. This is to say that in 90 percent of the case, Argentina is not exposed to the risk of financial crisis triggered by the multiple equilibria problem. However, once the existing debt level is high enough, a financial crisis may arise, which will result in capital flight and welfare loss.

Table 3. Welfare Loss under Different Initial Debt

Initial debt b_0	Welfare loss Δ (%)
1.41	41
1.35	11.4
1.3	5.6
1.25	2.7
< 1.21	No crisis

3. Nonlinear Capital Flow Tax

In this subsection, we investigate how to design the proper policy tools to remove the crisis equilibrium and prevent possible financial crisis. As we have shown in Subsection IV.2, a crisis occurs when the initial debt is high enough. When households are pessimistic, they reduce their consumption and borrowing. With capital flight, the exchange rate plunges and borrowing constraint is further tightened, which triggers a crisis. Our objective here is to prevent capital flight, thus we focus on capital flow tax for capital flow management.

Define the net capital outflow in period t as $X_t = Rb_t - b_{t+1}$. Assume the government does not keep any revenue, and the total tax income collected under tax scheme $\Psi(X_t)$ is rebated to households, $W_t - \Psi(X_t)$. The household's budget constraint then becomes:

$$c_t^T + p_t c_t^N + q_t k_{t+1} + Rb_t = y^T + p_t(1-\alpha)y^N + (q_t + p_t\alpha y^N)k_t + b_{t+1} - \Psi(Rb_t - b_{t+1}) + W_t, \quad (25)$$

and the first-order condition of borrowing becomes:

$$\lambda_t\left[1-\mu_t + \Psi'(Rb_t - b_{t+1})\right] = \beta R\lambda_{t+1}. \quad (26)$$

The other first-order conditions and the market clearing conditions remain unchanged.

$\Psi(X_t)$ should be designed properly with such a tax scheme, and the financial crisis equilibria, such as points B and C in Figure 2, can be removed, while the steady state equilibrium at point A is kept. At point A, from Equations (19) and (22), we obtain $b_{t+1} = b_t$ and $\mu_t = 0$, respectively. From Equation (11) and our parameter choice, βR=1, we also have $\lambda_{t+1} = \lambda_t$. Thus from Equation (26), the marginal tax rate at $X_t = (R - 1)\, b_t$ should be 0. Actually, there is no need to tax capital outflows when $X_t \leqslant (R - 1)\, b_t$, because the representative household will never choose X_t below $(R - 1)\, b_t$, the socially optimal level. Thus, without loss of generality, we set $\Psi(X_t) = 0$, $X_t \leqslant (R - 1)\, b_t$. When capital outflow is higher than the threshold value, $\Psi(X_t)$ is an increasing function of X_t, and thus a decreasing function of b_{t+1}; that is, a larger b_{t+1} means less capital outflow and thus fewer tax payments need to be made. In other words, borrowing from overseas is encouraged rather than punished.

(1) Why a Linear Tax Scheme Cannot Prevent Crisis

Assume the tax scheme is linear when capital outflow is above $(R-1)b_t$:

$$\Psi(X_t) = \begin{cases} 0, & \text{if } X_t \leqslant (R-1)b_t \\ \tau[X_t - (R-1)b_t], & \text{if } X_t > (R-1)b_t, \end{cases} \quad (27)$$

in which τ is the constant tax rate when $X_t > (R - 1)\, b_t$. We find that the steady state equilibrium at point A in Figure 2 can be achieved with this tax scheme, and there is no distortion to the economy. However, the key question is, can we remove the crisis equilibria, such as points B and C in Figure 2? With a constant tax rate, Equation (26) can be written as:

$$\lambda_t(1-\mu_t-\tau) = \lambda_{t+1}. \quad (28)$$

We find that unless τ is sufficiently large, the crisis equilibria cannot be removed by the linear tax scheme. The collateral constraint on Equation (8) is not affected by the tax scheme. As a result, when the collateral constraint is binding, from Equation (23), the foreign borrowing at points B or C are not affected by the tax scheme either. Take point C as an example. Denote foreign borrowing at point C as b^C_{t+1}. Based on Equation (9), using the parameter values in Table 2, we obtain the shadow price of the collateral constraint as:

$$\mu_t = 1 - \left(\frac{y^T - Rb_t + b_{t+1}^C}{y^T - (R-1)b_{t+1}^C}\right)^2 - \tau. \tag{29}$$

If $\tau < 1 - \left(\frac{y^T - Rb_t + b_{t+1}^C}{y^T - (R-1)b_{t+1}^C}\right)^2$, such a tax scheme has no real effect on consumption and borrowing, but only reduces the shadow price of the collateral constraint, μ_t. As a result, the crisis equilibrium at point C still exists. If $\tau > 1 - \left(\frac{y^T - Rb_t + b_{t+1}^C}{y^T - (R-1)b_{t+1}^C}\right)^2$, $\mu_t < 0$ at point C, which means that the cost of capital outflow is too high and point C is no longer an equilibrium. The multiple equilibria problem can then be resolved. However, the required tax rate is unrealistically high. Using the parameters in Table 2, the tax rate needs to be at least 99.97 percent to remove the crisis equilibrium. This is essentially equivalent to shutting down the capital market to foreign investors, which will trigger panic and international dispute, and thus is not a good option.

(2) Nonlinear Capital Flow Tax

The purpose of our study is to establish a reasonable tax scheme $\Psi(X_t) = \Psi(Rb_t - b_{t+1})$, such that on the one hand the crisis equilibrium can be removed, while on the other hand the impact on international capital flow and the incurred distortion should be modest. Using the parameter values in Table 2, we can rewrite Equation (26) as:

$$\left(\frac{c_t^T}{c_{t+1}^T}\right)^2 = 1 - \Psi'(Rb_t - b_{t+1}) - \mu_t. \tag{30}$$

We need to design $\Psi(X_t)$ properly such that when $b_{t+1} < b_t$, the implied $\mu_t < 0$ and, consequently, the crisis equilibria do not exist. Thus the crisis can be avoided. In particular, replacing c_t^T and c_{t+1}^T in Equation (30) by their respective market clearing conditions, we obtain:

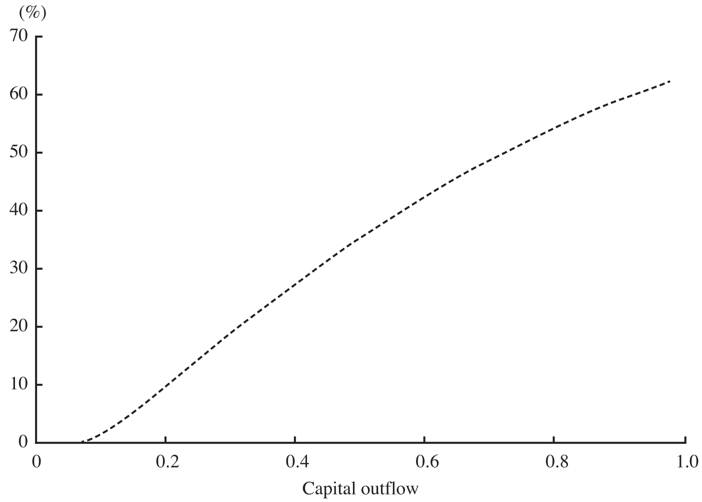
$$\Psi'(X_t) > 1 - \left(\frac{y^T - Rb_t + b_{t+1}}{y^T - (R-1)b_{t+1}}\right)^2. \tag{31}$$

We can also express the tax scheme as a function of capital flow:

$$\Psi'(X_t) = \begin{cases} 0, \text{ if } X_t \leqslant (R-1)b_t \\ 1 - \left(-\frac{1}{R-1} + \frac{\left(\frac{R}{R-1}\right)y^T - Rb_t}{y^T - R(R-1)b_t + (R-1)X_t}\right)^2, \text{ if } X_t > (R-1)b_t. \end{cases} \tag{32}$$

The multiple equilibria problem can be resolved by this tax scheme. Notice that the tax scheme is progressive, for example, the marginal tax rate increases with the size of the capital outflows. Compared to a linear tax scheme, the distortion incurred by the nonlinear tax scheme is minimal. Using the parameter values in Table 2, we plot the average tax rates corresponding to different sizes of capital outflow ($\Psi(X)/X$) in Figure 3.

Figure 3. Average Tax Rate with Different Size of Capital Outflow



V. Implementation of Nonlinear Tax and Policy Suggestions

We have thoroughly analyzed the relationship between capital account openness and financial stability. At present, the domestic and international risks associated with capital account openness in China should not be neglected. Theoretically, multiple equilibria may exist with different levels of exchange rates and foreign borrowing, and a linear tax scheme is inefficient for preventing financial crises triggered by people's pessimistic expectations. In this section, based on the theoretical results, we provide specific policy recommendations, and demonstrate how to implement the nonlinear capital flow tax in reality.

1. Nonlinear Capital Flow Tax as a Policy Instrument

A linear tax scheme imposes the same tax rate on all capital flows regardless of their type, maturity and size. However, such a scheme suffers from several drawbacks. First, it is difficult to determine the optimal tax rate in reality, which was the key when movements in international capital flows were large during the 2008 global financial crisis. Excessive capital flows cannot be prevented if the tax rate is set too low, but if the tax rate is set too high, reasonable capital flows will be hampered and the policy will lead to many distortions. Second, adjustment of the tax rate has to be proven by certain government agencies following certain bureaucratic procedures. Because of delays in initiating policy, the government cannot usually respond to irregular capital flows in a timely fashion. Last and most importantly, as we show in Subsection IV.3, a linear tax scheme does a poor job of preventing financial crisis and in reality is not a good option.

We suggest that the tax scheme should be nonlinear with the marginal tax rate increasing with the size of capital outflow. Such a tax scheme has three advantages compared to a linear one. First, a financial crisis can be prevented. Second, similar to the progressive income tax, a nonlinear capital flow tax scheme acts as an automatic stabilizer with the average tax rate adjusting simultaneously with the size of the capital flow. Finally, a nonlinear tax scheme can act as the first response to abrupt capital flow fluctuations, and is especially useful when the fluctuations are large, such as those during the 2008 global financial crisis.

2. Implementation of Nonlinear Tax

The tax scheme we proposed in Equation (32) is on the aggregate level, in which the average tax rate depends on the size of the aggregate capital outflows. On the one hand, such a scheme requires the financial authority to be able to observe the size of the aggregate flows correctly and adjust the tax rate in a timely manner in response to capital flow fluctuations, which is difficult to implement in reality. On the other hand, the size distribution of capital outflows in an economy also matters. Some outflows may be small, while others can be quite large. How to design a tax scheme that is actually implementable is important to both researchers and policymakers.

Therefore, we assume that given the aggregate capital outflow X, the size distribution of capital outflows is $G(x|X)$. We need to design the tax scheme $\tau(x)$ at the micro level such that the related scheme at the aggregate level in Equation (32) can be realized. Mathematically, doing so requires the following equation to hold for all possible values of X:

$$\int_{x \geqslant 0} \tau(x) dG(x \mid X) = \Psi(X), \forall X . \tag{33}$$

To simplify our analysis, we assume that $G(x|X)$ is a uniform distribution of the interval $[0, 2X]$, with the corresponding cumulative distribution function as $G(x \mid X) = \frac{x}{2X}$. Equation (33) can then be written as:

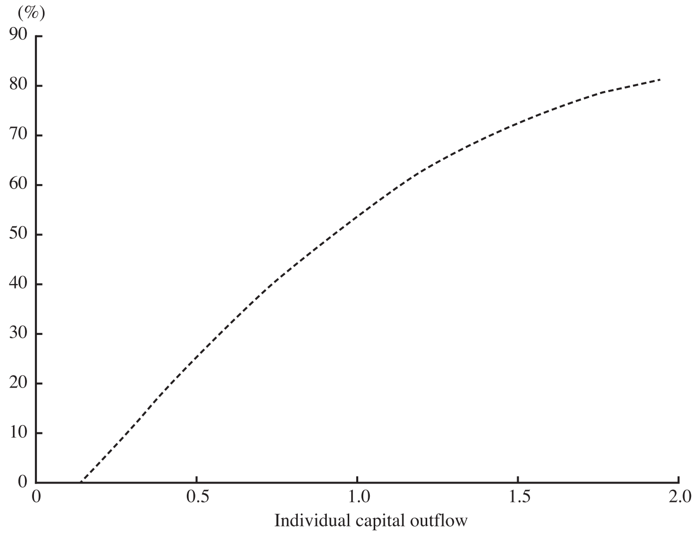
$$\int_0^{2X} \tau(x) dx = 2X\Psi(X) . \tag{34}$$

With the definition of a definite integral, we have $\int_0^{2X} \tau(x)dx = T(2X) - T(0)$. Using the initial condition $\tau(0) = 0$ and $T'(x) = \tau(x)$, the tax scheme on the micro level, $\tau(x)$ satisfies:

$$\tau(x) = \Psi\left(\frac{x}{2}\right) + \frac{x}{2}\Psi'\left(\frac{x}{2}\right). \tag{35}$$

The values on the right-hand side can be computed using Equation (32). $\tau(x)$ is also nonlinear. We plot its average tax rate in Figure 4.

Figure 4. Progressive Tax Rate at the Individual Level



Based on the theoretical model and the parameter values from Table 2, we suggest imposing the tax scheme in Table 4. According to a study by Lane and Milesi-Ferretti (2007), Argentina's average annual debt capital outflow is US$2bn (in 2005 prices). Because a capital outflow larger than US$1bn needs to be approved, we focus on transactions smaller than US$1bn and obtain the following tax rates:

Table 4. Tax Rate of Capital Flows

Size of outflow (US$)	Tax rate (%)
0 ~ 50m	0
50 ~ 200m	2
200 ~ 500m	5
500m ~ 1bn	10
Above 1bn	20

3. How to Deal with Tax Evasion

With a nonlinear tax scheme, the motivation to evade tax naturally arises. Because the marginal tax rate is much higher for large capital outflows, given that the monetary authority is unable to identify the firm behind these transactions, an individual firm can divide the outflow into several small transactions to reduce its tax payment. To be specific, a firm i with total capital outflow x_i needs to pay $\tau(x_i)$ if only one account is used; but if the firm opens two bank accounts and divides the capital outflow equally to $\frac{x_i}{2}$, the total tax payment becomes $2\tau\left(\frac{x_i}{2}\right)$. Because the tax scheme is progressive, $2\tau\left(\frac{x_i}{2}\right) < \tau(x_i)$. In fact, because the marginal tax rate at 0 is $\tau'(0) = 0$, essentially a firm can reduce the tax payment to 0 by setting the size of each transaction small enough.

Such tax evasion clearly compromises the role of capital flow tax as a tool to secure financial stability. To prevent tax evasion, the government can impose c, a fixed fee to open each transaction account. If a firm opens n accounts for sending capital x_i overseas, the total cost becomes $nc + n\tau\left(\frac{x_i}{n}\right)$. Taking a derivative of this expression, the optimal number of accounts, n^* satisfies:

$$c + \tau\left(\frac{x_i}{n^*}\right) - \frac{x_i}{n^*}\tau'\left(\frac{x_i}{n^*}\right) = 0. \tag{36}$$

We find that n^* cannot be too large. Using the implicit function theorem, n^* decreases in c. Thus, when c is high enough, firms still choose $n^* = 1$, and tax evasion can be avoided.

As an example, assume the fixed fee to open each account is US$10m.[4] Using the tax rates in Table 4, if a firm sends US$300m overseas, the relation between the number of accounts and total tax payments is given in Table 5. We find that with a fixed fee, tax evasion is not profitable and thus can be prevented.

Table 5. Number of Accounts and Total Cost with US$300m Capital Outflow

Number of accounts	Total cost (US$m)
1	25
2	26
3	36
4	46
5	56
6	60

[4]In reality, this amount can be adjusted depending on the size of each transaction.

VI. Conclusions

This study examines the potential risks of capital account openness in China and proposes a policy tool to accommodate such risks. First, using a large cross-county panel dataset, we provide empirical evidence that capital account openness is more likely to lead to a crisis when a country has a below-trend output, real exchange rate overvaluation or a fixed exchange rate. Moreover, capital account openness is also riskier when the US monetary policy stance shifts from easing to tightening.

We built a theoretical model to examine how the government can reduce risks of financial crisis and maximize social welfare using capital flow taxes. In our model, the exchange rate and international capital flows can have multiple equilibria when a country has a high level of external debt. If domestic residents are pessimistic about the exchange rate and capital outflows, they will reduce consumption and foreign borrowing, which in turn negatively affects the real exchange rate and lowers the domestic country's external borrowing capacity. As a result, a financial crisis will occur and social welfare will be reduced. In this sense, pessimistic expectations can be self-fulfilling.

Finally, we consider the adoption of capital flow taxes in our theoretical framework to avoid the undesirable outcomes associated with multiple equilibria and to maximize social welfare. We show that the linear capital flow tax scheme currently adopted by some emerging countries cannot eliminate the possible multiple equilibria that lead to frequent financial crises. The optimal capital flow tax scheme, according to our study, should be nonlinear. That is, the marginal tax rate increases with the quantity of capital outflows. After calculating the optimal tax rate at the macro level, we show how to implement such a nonlinear tax scheme at the micro level in detail so that it can serve as a stabilizer of capital flows. Another important contribution of our study is that by introducing a fixed account openness fee, we offer a mechanism that can effectively solve the problem of tax evasion by opening multiple accounts.

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Appendix

Detailed variable definitions and data sources for our study are listed below:

Real GDP gap: Nominal GDP data in current US dollars were obtained from the World Bank's World Development Indicators. They were first adjusted by the GDP deflator and then the Hodrick–Prescott (HP) Filter was used to yield the real GDP gap data.

Current account/GDP: Current accounts in current local currency for each country were obtained from IMF *International Financial Statistics*. They were then converted to the current dollar value using the nominal exchange rate. GDP is also measured in current USD.

Real exchange rate gap: We obtained the nominal exchange rate from the Penn

World Table (version 7.1) and then calculated the real exchange rate by multiplying the nominal exchange rate by the US GDP deflator and dividing it by a country's own GDP deflator. Finally, the HP filter was applied to yield the real exchange rate gap.

Public debt/GDP: Obtained from Carmen Reinhart's website.

Capital account openness: Obtained from Chinn and Ito (2006).

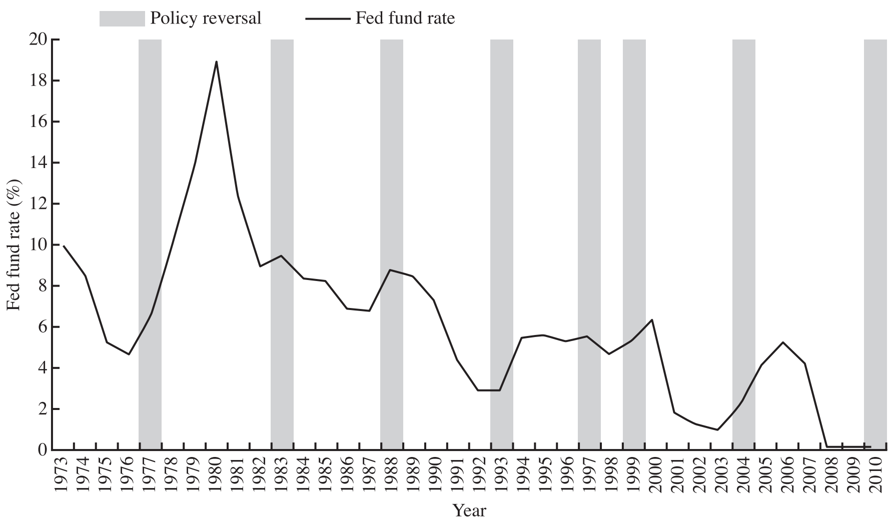
Foreign reserves/GDP: The foreign reserves in current US dollars for each country were obtained from IMF *International Financial Statistics*. This ratio was obtained by dividing foreign reserves with GDP in current US dollars.

Floating exchange rate: De facto exchange rate regime classifications were obtained from Reinhart and Rogoff (2004). A floating exchange rate means either a managed floating or a freely floating regime.

Inflation rate: Obtained from the World Development Indicators (in natural log).

US monetary policy reversal: A binary indicator for a change in US monetary policy stance from easing to tightening. It takes the value of 1 if the change in the federal funds rate turns negative to positive in a particular year and 0 otherwise. The federal funds rate data were obtained from the St. Louis Fed's FRED database (the shaded areas in the Figure denote policy reversal events).

Figure: Monetary Policy Reversal Indicator in the US, 1973–2010



Note: Fed fund denotes federal funds.

(Edited by Zhinan Zhang)