Asymmetric growth effect of capital flows: Evidence and quantitative theory

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Abstract

Empirical evidence of the causal relationship between capital flows and economic growth over the decades is largely indecisive. While the promised benefits to countries that open for capital inflows have not been realized, sudden and massive capital outflows often visibly wreak havoc on the economy. By using the recently developed asymmetric Granger causality test, we find overwhelming evidence across nine selected Asian countries in support of asymmetric effect of capital flow on economic growth in the sense that cumulative capital inflows are growth irrelevant, whereas cumulative capital outflows are growth destructive. Based on a small open-economy model expanded with heterogeneous investment goods and endogenous nonlinear credit constraint, we provide an economic intuition for the asymmetry that survives different level of financial developments. In particular, arbitrage condition between heterogeneous investment goods sets a boundary over which massive and persistent capital inflows would leave no impact on long-run growth. Whereas endogenous nonlinear credit constraint triggers debt deflation process, making large and persistent capital outflows growth destructive.

Keywords: Capital flows; Economic growth; Asymmetric Granger causality test; Investment composition; Nonlinear credit constraint

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1. Introduction

Prior to the onset of the Asian financial meltdown in 1997/98, East and Southeast Asian emerging economies that liberalized capital accounts in the early 1990s were the darlings of international investors. The fast and stable economic expansion during that time was often claimed to be the outcome of capital account liberalization. As the crisis unfolded and capital flows suddenly reversed from net inflow to outflow in 1997, one economy after another fell sharply into deep recession. With the benefit of hindsight, we now learn that while it remains empirically dubious to attribute the miraculous economic growth to massive capital inflows in the early 1990s, it is beyond controversy to associate the Asian economic recession with the drastic capital outflows.

In fact, the evidence of asymmetric relationships between capital flows and economic growth extends beyond Asia. From the one perspective, after decades of effort spent searching for answers to the question of whether capital account liberalization spurs growth, the evidence in support of this premise is weak. Although some have found a positive effect conditional on the existence of good institutions, legitimate doubts are often cast on the robustness and context-sensitivity of such a conditional effect (see, for instance, Jeanne et al., 2012; Kose et al., 2009a; Kose et al., 2009a; Gamra, 2009). Prasad et al. (2007) and Gourinchas and Jeanne (2006) have even found that the fastest growing countries did so without much foreign capital.

On the other hand, a sudden stop in capital flows has been the recurring theme of financial and economic crises. A massive capital flow reversal depreciates the exchange rate and plunges asset prices, which, in turn, devalues the worth of collateral for borrowing, thus instigating an adverse balance-sheet effect on domestic agents indebted in foreign currency. The resulting contraction in aggregate demand amplifies the damaging deleveraging process (Jeanne et al., 2012). The common thread that links currency crash and financial and economic crises is foreign currency debt (see, for instance, Bordo et al., 2010; Bordo and Meissner, 2006). In other words, in the absence of foreign currency debt, a slump in the currency driven by capital flows reversal is not likely to trigger the

balance-sheet effect and poses no immediate threat to the economy. This finding is evidenced by the resilience of emerging economies to weather the storm of capital flow reversals during the recent global financial crisis, despite the fact that disruption in cross-border capital flows seriously affected the advanced economies (Tille, 2012).

Motivated by these observations, the first goal of this paper is to formally investigate whether there is an asymmetric causal relationship between capital flow and economic growth. While our paper naturally fits into the larger literature on the growth effect of capital inflow, we hope it is useful in this enterprise by addressing different questions. We rethread the old song of "whether net capital flow precedes growth" with a new chorus: Does net capital flow *asymmetrically* precede growth? Are net capital inflows irrelevant to growth while net capital outflows being detrimental to growth? We address this question in Section 2 by using the asymmetric Granger causality testing procedures recently developed by Hatemi-J's (2012). We for the first time find overwhelming evidence, as elaborated in Section 3, across nine selected Asian countries in support of such asymmetry, in that cumulative capital inflows are found to be growth irrelevant whereas cumulative capital outflows are found to be growth destructive. The results also decisively reject the possibility of reverse causality from growth to capital flows.

Having quantified the asymmetry, our second goal is to find out why: What causes the asymmetry? Drawn on a quantitative model developed in Section 4, the underlying mechanisms are heterogeneous investment goods, inspired by Aghion et al. (2010), and endogenous nonlinear credit constraint in the spirit of vast literature on sudden stops and Fisherian deflation (Calvo et al., 2006; Bianchi, 2011; Mendoza, 2010; Korinek and Mendoza, 2014). Of different types of investments, we assume that only long-term investment contributes to long-run growth. Arbitrage condition between short-term and long-term investments, effectuated by the law of diminishing marginal return, embeds an upper bound, over which even persistently massive portfolio capital inflows would not incentivize long-term investments and hence would have no effects on long-run growth.

By assuming that long-term investment requires financing, which can be sourced either from the regulated domestic financial intermediaries or the competitive foreign creditors, optimal long-term investment decision is influenced by the conventional opportunity cost and credit constraint as well. Because the latter is endogenous to the entrepreneur's creditworthiness in nonlinear fashion, a binding credit constraint due to large and persistent portfolio capital outflows or a sudden stop (massive capital flows reversal) can trigger debt deflation process. Deteriorating creditworthiness reinforces cutback in the cheaper foreign financing, making only the more expensive domestic credits available for long-term investment.

Nevertheless, debt-deflation process is not explosive, as the resultant increasing marginal return on long-term capital stock would make long-term investment profitable even when it is financed by the more expensive domestic credits. Gradually restored long-term investment revives long-run growth over time. In Section 5, we further show that our mechanism of asymmetry survives different levels of financial development.

2. Does capital flow precede growth? An asymmetric Granger causality approach

Consider a *p*-th order bivariate system of invertible stationary processes for output Y_t and net capital flow $\mathcal{CF}_t$, as in the following autoregressive representation:

$$\begin{bmatrix} Y_t \\ \mathcal{CF}_t \end{bmatrix} = \mathbb{a}_0 + \sum_{i=1}^{p} \begin{bmatrix} \alpha_{11,i} & \alpha_{12,i} \\ \alpha_{21,i} & \alpha_{22,i} \end{bmatrix} \begin{bmatrix} Y_{t-i} \\ \mathcal{CF}_{t-i} \end{bmatrix} + \begin{bmatrix} \varepsilon_{Y,t} \\ \varepsilon_{\mathcal{CF},t} \end{bmatrix} \tag{1}$$

where $\mathbb{a}_0$ is a vector of deterministic terms, $\alpha_{jk,i}$ for $j, k = 1,2$ are finite polynomials, $\varepsilon_{Y,t}\left(= \sum_{i=0}^{p} \varepsilon_{Y,t+i}\right)$ and $\varepsilon_{\mathcal{CF},t}\left(= \sum_{i=0}^{p} \varepsilon_{\mathcal{CF},t+i}\right)$ are taken to be two uncorrelated white-noise series where $E\left[\varepsilon_{\mathcal{CF},t}\varepsilon_{\mathcal{CF},s}\right] = E\left[\varepsilon_{Y,t}\varepsilon_{Y,s}\right] = 0$. Then, for $\alpha_{12,i} = 0$, where $i = 1,2, \dots, p$, we contend that capital flow is not Granger-causal for output growth as none of its lags appears in the Y_t equation. In other

words, capital flow is Granger-causal for output growth if at least one of the $\alpha_{12,i}$ is not zero. This is the standard Granger causality test principle.

That said, the shortcomings of the standard Granger causality test are obvious. For example, the test has nothing to say about whether it is the capital inflow or outflow that Granger causes growth, it sheds no light on whether capital flow (either in or out) Granger causes positive or negative economic growth, and hence, it does not allow an asymmetric Granger causal relationship. To address this shortcoming, we make use of the asymmetric Granger causality test recently developed by Hatemi-J (2012). Hatemi-J (2012) extends the idea originated in Granger and Yoon (2002) of decomposing the stochastic disturbance terms into positive and negative shocks. With respect to our context, it means that we can now explicitly decompose the causal impact of positive changes in capital flows (which indicate net inflows) from the negative changes (which indicate net outflows).

The intuition is simple. Assume that capital flow and economic growth follow a random walk in such a way that

$$\mathcal{CF}_t = \mathcal{CF}_{t-1} + \varepsilon_{\mathcal{CF},t} = \mathcal{CF}_{10} + \sum_{i=1}^{t} \varepsilon_{\mathcal{CF}i} \tag{2}$$

$$Y_t = Y_{t-1} + \varepsilon_{\mathrm{Y},t} = Y_{20} + \sum_{i=1}^{t} \varepsilon_{Yi} \tag{3}$$

where $t = 1,2,\dots,T$ denotes discrete-time periods, the constants $\mathcal{CF}_{10}$ and Y_{20} indicate the initial values for capital flow and economic growth, respectively, and $\varepsilon_{\mathcal{CF}i}$ and ε_{Yi} are white-noise disturbance terms. We decompose the disturbance terms into positive and negative shocks

$$\varepsilon_{\mathcal{CF}i} = \varepsilon_{\mathcal{CF}i}^{+} + \varepsilon_{\mathcal{CF}i}^{-} \tag{4}$$

$$\varepsilon_{Yi} = \varepsilon_{Yi}^{+} + \varepsilon_{Yi}^{-} \tag{5}$$

where $\varepsilon_{\mathcal{CF}i}^{+} = \max(\varepsilon_{\mathcal{CF}i}, 0)$, $\varepsilon_{\mathcal{CF}i}^{-} = \min(\varepsilon_{\mathcal{CF}i}, 0)$, $\varepsilon_{Yi}^{+} = \max(\varepsilon_{yi}, 0)$, and $\varepsilon_{Yi}^{-} = \min(\varepsilon_{yi}, 0)$. Eqs. (2) and (3) can then be rewritten as

$$\mathcal{CF}_t = \mathcal{CF}_{t-1} + \varepsilon_{\mathcal{CF},t} = \mathcal{CF}_{10} + \sum_{i=1}^{t} \varepsilon_{\mathcal{CF}i}^{+} + \sum_{i=1}^{t} \varepsilon_{\mathcal{CF}i}^{-} \tag{6}$$

$$Y_t = Y_{t-1} + \varepsilon_{Y,t} = Y_{20} + \sum_{i=1}^{t} \varepsilon_{Yi}^{+} + \sum_{i=1}^{t} \varepsilon_{Yi}^{-} \tag{7}$$

The cumulative positive and negative shocks, respectively, constitute capital inflows (economic growth) and capital outflows (economic downturn) in such a way that

$$\mathcal{CF}_t^+ = \sum_{i=1}^{t} \varepsilon_{\mathcal{CF}i}^+ \tag{8}$$

$$\mathcal{CF}_t^- = \sum_{i=1}^{t} \varepsilon_{\mathcal{CF}i}^- \tag{9}$$

$$Y_t^+ = \sum_{i=1}^{t} \varepsilon_{Yi}^+ \tag{10}$$

$$Y_t^- = \sum_{i=1}^{t} \varepsilon_{Yi}^- \tag{11}$$

This implies that each shock has a long-lasting effect on the underlying variable. With these variables, we can test for asymmetric causality using the standard vector autoregressive model of order *p*, VAR(*p*). Suppose we are interested to test the causal relationship between capital inflows and economic growth. Eq. (1) now reads

$$\mathbb{y}_t^+ = \mathbb{a}_0 + \mathrm{A}_1 \mathbb{y}_{t-1}^+ + \cdots + \mathrm{A}_p \mathbb{y}_{t-p}^+ + \mathbb{u}_t^+ \tag{12}$$

where $\mathbb{y}_t^+ = [Y_t^+ \quad \mathcal{CF}_t^+]'$ and $\mathbb{u}_t^+$ is a 2 x 1 vector of the cumulative sum of positive error terms. The null hypothesis that capital *inflow* is not Granger-causal for *economic growth* can be tested depending on whether row j, column k elements in A_r, where $j = 1, k = 2$, equal zero for $r = 1, \ldots, p$. By the same token, we can test whether *capital outflow* Granger-cause *economic downturn* by examining

$$\mathbb{y}_t^- = \mathbb{a}_0 + \mathrm{A}_1 \mathbb{y}_{t-1}^- + \cdots + \mathrm{A}_p \mathbb{y}_{t-p}^- + \mathbb{u}_t^- \tag{13}$$

In this paper, we test four combinations for each direction of causality.

The optimal lag order (*p*) is selected based on the information criteria suggested by Hatemi-J (2003), which proves to be robust for the ARCH effect and performs well when the VAR model is used.

$$\mathrm{HJC} = \ln\left(\left|\widehat{\Omega}_j\right|\right) + j\left(\frac{n^2 \ln T + 2n^2 \ln(\ln T)}{2T}\right) \tag{14}$$

where $j = 0, \ldots, p$, $\left|\widehat{\Omega}_j\right|$ is the determinant of the estimated variance-covariance matrix of the error terms in the VAR (j) model, n is the number of equations the VAR model has, and T is the number of observations. As suggested in Hatemi-J (2012) and following Toda and Yamamoto (1995), additional unrestricted lag is added to the VAR model to accommodate the effect of one unit root. Given the short time span of data, we apply the bootstrapping simulation technique as detailed in Hatemi-J (2008). This

technique helps to achieve better size and power properties compared to the test that is based on asymptotical distribution. It also makes causality test foolproof to outliers in capital flows due to sudden stop episodes during 1997/98 and 2008/09. The bootstrapped critical values are generated at three different levels of significance based on ten thousand repetitions of the simulation. Interested readers can refer to Hatemi-J (2012) for technical details.

3. Empirical findings

3.1 The data

We collect annual time-series data that spans over 32 years, 1980 to 2011, for nominal gross domestic products (GDP), current account, and capital account for nine Asian countries, including China, India, Indonesia, Japan, Republic of Korea, Malaysia, the Philippines, Singapore and Thailand. The data are sourced from International Financial Statistics and Balance of Payments Statistics issued by the International Monetary Fund. Divided by population, the resultant per capita nominal GDP is then adjusted for purchasing power parity (PPP) in terms of the U.S. dollar and takes the form of a natural logarithm. In short, we call PPP-adjusted per capita GDP the per capita real GDP.

Current account and capital account as a share of GDP are used as two different proxies for net capital flows. While the former encompasses both official and private capital flows, the latter reflects pure private capital flows. Last, we turn the value of the current account balance to the opposite sign so that current account surplus (deficit) can be easily interpreted as capital outflow (inflow). The time plots of the current account as a share of GDP (-CA/GDP) and the capital account as a share of GDP (KA/GDP), along with real GDP growth rate, are as shown in Figure 1, and the time plots of the real GDP per capita in logarithm value are shown in Figure 2. Figure 3 describes the cumulative positive and negative sums of per capita real GDP and capital flows represented by -CA/GDP and KA/GDP, respectively. Causality that runs from capital flow (in and out) to the economy (growth and downturn), and vice versa, for each country are formally tested. As each direction of causality involves four

hypotheses with two different proxies for capital flow, there are a total of 144 causality tests to be conducted.

[INSERT FIGURES 1, 2, and 3 HERE]

Before proceeding to formal testing, it is worthwhile to eyeball the asymmetric relationship between capital flows and real economic growth over time in Figure 1. At first glance, there are many instances in which capital outflows are associated with falling economic growth, particularly during the Asian currency and financial crises. However, a case such as Thailand, where capital inflows are clearly associated with rising economic growth, is the exception rather than the norm. More puzzling is the observation that capital outflows occur along with rising economic growth. China's economic expansion after year 2000, for instance, has witnessed continuous capital outflows as did Malaysia, the Philippines, and Singapore after the year 2002.

3.2 Pre-testing

Preceding asymmetric causality testing, we need to determine whether unit roots are present in the time series. To do so, we use the Dickey-Fuller generalized least squares (DF-GLS) test. This test dominates the ordinary DF test in terms of small sample size and power (Elliott et al., 1996). Though not shown (but available upon request), the series are all difference-stationary. However, the causality test between integrated series remains to be implemented within the VAR-in-level framework without pre-testing for co-integration. Gospodinov et al. (2013) have recently shown that VAR-in-level specification is robust to the potential uncertainty about exact integration and co-integration properties of the data. This is supported by the seminal Toda and Yamamoto (1995) that co-integration does not matter with respect to causality testing when additional lags of each variable based on the maximum order of integration are added to the model.

3.3 Results

Table 1 reports the results of the asymmetric causality test when –CA/GDP is used as a proxy for capital flows. The findings are overwhelmingly in favor of the asymmetric relationship between

capital flow and economic growth in that cumulative capital inflows ($\mathcal{CF}_t^+$) do not Granger-cause economic growth ($\mathcal{Y}_t^+$), whereas cumulative capital outflows ($\mathcal{CF}_t^-$) Granger-cause economic downturn ($\mathcal{Y}_t^-$) with strong statistical significance. Meanwhile, with very few exceptions, other null hypotheses for different combinations of cumulative capital flows and economic growth cannot be rejected at any widely accepted level of significance. Table 1 also convincingly demonstrates that economic growth performance does not Granger-cause capital flow. All these findings are robust to different proxies for capital flows. Table 2 shows the results of the asymmetric causality test when KA/GDP, which considers only private capital flows, is used in the tests. The finding that capital outflow is growth-crashing remains true and that capital inflow is growth-irrelevant also holds.

[INSERT TABLES 1 and 2 HERE]

4. Modeling the asymmetry

What causes the asymmetry? In this section, we lay out a small open-economy model to account for the asymmetric effect of capital flows on economic growth. The key property is the combination of heterogeneous investment goods and endogenous nonlinear credit constraint. The latter is drawn on a large literature on sudden stop (see Korinek and Mendoza, 2014 for an overview of a class of models that explain stylized facts of sudden stop) However, what differentiates ours from sudden stop literature is the mechanism of growth-destructive sudden stop.

Instead of resorting to asset price amplification to initiate debt-deflation process, we bring in Aghion et al.'s (2010) insight on short-term versus long-term investments. By short term we mean the corresponding capital stock has lower gross marginal return and contributes only to short-term growth. In contrast, long-term capital stock has higher gross marginal return but needs financing, and contributes to long-term growth. We shall see later how such a simple device not only enables us to trigger a debt-deflation process, but also to account for the asymmetric effects of capital flows on long-run economic growth.

4.1 Long-run growth equation

Following Aghion and Howitt (2008, p.331), we define long-term economic growth as first difference in productivity trend due to accumulation of long-term capital stock

$$\Delta T_t \equiv \ln T_t - \ln T_{t-1} = \mathcal{F}\left(\frac{Z_t}{Z_{t-1}} - 1\right) \tag{15}$$

where T_t denotes productivity trend, Z_t is long-term capital stock, and $\mathcal{F}$ is the fraction of entrepreneurs who can access to credit market. A financial market is well developed and unrestricted when credit is accessible for all entrepreneurs, facilitating entrepreneurial undertaking in long-term investment that leads to long-run growth. For that we have $\mathcal{F} = 1$. In other words, an underdeveloped financial market, in which $\mathcal{F}$ approximates zero, holds back incentive for long-term investment, limiting long-run growth.

We can also interpret $\mathcal{F}$ in terms of financial market's ability to monitor borrowers' behavior ex post borrowing. Better monitoring, which indicates more advanced financial system, minimizes moral hazard incidence, ensuring a higher proportion of credit-financed long-term investment acquisition that leads to greater long-run growth. The parameter $\mathcal{F}$ is thus one of the two indicators for domestic financial development in this paper.

4.2 Household as entrepreneur and debtor with endogenous credit constraint

Our model economy is populated by a unit mass of households. In each period, they work for wage income W_t, they consume C_t, they accumulate wealth in the form of domestic B_t and foreign bonds B_t^*, and they invest in short-term $I_{K,t}$ and long-term investment goods $I_{Z,t}$. Each investment, be it physical or financial, contributes to the stock accumulation that earns them a return. Flow budget constraint and stock constraints for a household take the form

$$\frac{B_t - (1+r_{t-1})B_{t-1}}{P_t} + C_t + I_{K,t} + I_{Z,t} + \mathbb{K}_{hf,t} + \Phi_{K,t}K_{t-1} + \Phi_{Z,t}Z_{t-1} + \Phi_{\mathbb{K},t}S_t\frac{B_{t-1}^*}{P_t} +$$

$$\left(1 + r_{L,t}\right)\frac{L_{t-1}}{P_t} + \left(1 + r_{L,t}^*\right)\left(\frac{S_t}{P_t}\right)L_{t-1}^* = r_{K,t}K_{t-1} + r_{Z,t}Z_{t-1} + W_tN_t \tag{16}$$

$$K_t = (1-\delta_K)K_{t-1} + \exp(\zeta_{K,t})\, I_{K,t} \tag{17}$$

$$Z_t = (1-\delta_z)Z_{t-1} + \exp(\zeta_{Z,t})\, I_{Z,t} \tag{18}$$

$$\frac{S_t B_t^*}{P_t} = (1+r_{t-1}^*)\frac{S_t B_{t-1}^*}{P_t} + \exp(\zeta_{\mathbb{K},t})\, \mathbb{K}_{hf,t} \tag{19}$$

where S_t refers to domestic value of a foreign currency, and $e_t(= S_t P_t^*/P_t)$ is real exchange rate. Eqs. (16) and (17) are the law of motion of short-term and long-term capital stock, respectively, with δ_i indicates deprecation rate. $\zeta_{K,t}$ and $\zeta_{Z,t}$ are first-order autoregressive investment-specific technology shock hitting short-term and long-term investment. Eq. (19) simply puts forward a point that difference between the end of current and last year's stocks of foreign bonds constitutes a capital outflow from home to foreign countries $\mathbb{K}_{hf,t}$, net of the reinvestment of interest earnings. $\zeta_{\mathbb{K},t}$ is first-order autoregressive capital outflow shocks by domestic residents. Besides, every capital and portfolio adjustment involves adjustment cost, which takes quadratic form. In particular, we model the adjustment cost

$$\Phi_{K,t} = \frac{1}{2}\Phi_K\left(\frac{I_{K,t}}{K_{t-1}} - \delta\right)^2; \Phi_{Z,t} = \frac{1}{2}\Phi_Z\left(\frac{I_{Z,t}}{Z_{t-1}} - \delta\right)^2; \Phi_{\mathbb{K},t} = \frac{1}{2}\Phi_{\mathbb{K}}\left(\frac{P_t\mathbb{K}_{hf,t}}{S_t B_{t-1}^*} - \delta_{\mathbb{K}}\right) \tag{20}$$

where Φ_i is a scale parameter.

Last but not least, note that there are two types of loans to be serviced by a household in every period's flow budget constraint (16). She has to service principal and interest for real domestic loans L_{t-1}/P_t, and as well real foreign loans in domestic currency $S_t L_{t-1}^*/P_t$. High price level reduces real burden, while depreciated currency at date t amplifies burden incurred at one period earlier. The borrowing is made due to the financing requirement for long-term physical investment. She has to secure loans one period earlier before an investment undertaking either from domestic source that costs an interest rate of $r_{L,t}$ or foreign source of funds at a rate of $r_{L,t}^*$. We assume that foreign intermediaries are competitive with unregulated interest rate, and hence are able to offer a lending rate

that adjusts along its cost of funds, $r_{L,t}^* = r_t^*$. On the other hand, domestic financial intermediaries suffer from financial repression that takes the form of controlled interest rate. For the sake of simplicity, we assume a constant (regulated) interest margin by c to give $r_{L,t} = r_t + c$. This is the second characteristic of imperfect domestic financial market, which accommodates for the fact that allowing for foreign borrowing at cheaper cost relaxes borrowing constraint, leading to higher investment and higher average growth (Ranciere et al., 2006).

Let ρ_t be the fraction of long-term investment financed by the cheaper foreign loans, whereas the remaining $1 - \rho_t$ indicates the fraction financed by the more expensive domestic credits. Credit-in-advanced constraints for long-term investment can be presented as

$$\rho_t I_{Z,t} = S_{t-1} L_{t-1}^* / P_{t-1} \tag{21}$$

$$(1 - \rho_t) I_{Z,t} = L_{t-1} / P_{t-1} \tag{22}$$

Whether the entrepreneur can finance long-term investment entirely by foreign loans depends on her creditworthiness. We let her creditworthiness depends on the value of profit that can be generated from the investment, $\varpi \Pi_t$, where ϖ is a scale parameter. Therefore the entrepreneur will undertake long-term investment with cheaper foreign finance whenever profit generated is at least as large as total foreign debt obligation in local currency, $\varpi \Pi_t \geq e_t \left(1 + r_{L,t}^*\right) L_t^*$. Thus, probability of obtaining foreign loans, which can be comprehended as endogenous creditworthiness, is equal to

$$\rho_t = \exp\left(- e_t \left(1 + r_{L,t}^*\right) L_t^* / \varpi \Pi_t\right) \quad \textit{(Endogenous creditworthiness)} \tag{23}$$

For strong profit performance such that $\varpi \Pi_t > e_t \left(1 + r_{L,t}^*\right) L_t^*$, $\rho_t = \exp(-0) \approx 1$. Otherwise, the entrepreneur has to opt for domestic loans that are more expensive but less stringent on creditworthiness requirement in securing loans, as $\rho_t < 1$,.

Household optimally chooses the sequences of $C_t, N_t, B_t, \mathbb{K}_{hf,t}, B_t^*, I_{K,t}, K_t, I_{Z,t}, Z_t, L_t^*, L_t$ to maximize the following utility function

$$u = \mathbb{E}_t \left[\sum_{t=0}^{\infty} \beta^t \exp(\zeta_{H,t}) \left(\frac{{C_t}^{1-\sigma}}{1-\sigma} - \frac{{N_t}^{1+\chi}}{1+\chi} \right) \right]$$

subject to flow constraint (16), stock constraints (17) to (19), and credit-in-advance constrains (21) to (22). σ is the risk aversion parameter, χ is wage elasticity of labor supply, and β is subject discount factor. $\zeta_{H,t}$ is first-order autoregressive preference shock. Consumption bundles C_t consist of locally produced $C_{h,t}$ and imported consumer goods $C_{fh,t}$ in CES fashion at market price of $P_{h,t}$ and $S_t P_{fh,t}^*$. The latter indicates a complete exchange rate pass-through into import price as export goods are invoiced at producer currency. We assume that price is set as a markup over real marginal cost, $P_{h,t} = \mu \Theta_t$. Optimal demand for local and imported consumer goods takes the following form

$$C_{h,t} = \gamma \left(P_{h,t} / P_t \right)^{-\varphi} C_t \tag{24}$$

$$C_{fh,t} = (1-\gamma) \left(S_t P_{fh,t}^* / P_t \right)^{-\varphi} C_t \tag{25}$$

where P_t is utility-based consumer price index

$$P_t = \left(\gamma {P_{h,t}}^{1-\varphi} + (1-\gamma) \left(S_t P_{fh,t}^* \right)^{1-\varphi} \right)^{1/(1-\varphi)} \tag{26}$$

By denoting $\lambda_t, \Omega_{K,t}, \Omega_{Z,t}, \Lambda_t, \varrho_t', \varrho_t$, respectively, as Langragian multiplier for Eqs. (16) to (19), and (21) and (22), the first-order conditions are

$$\beta^t \exp(\zeta_{H,t}) \, {C_t}^{-\sigma} = \lambda_t \tag{27}$$

$${C_t}^{\sigma} {N_t}^{\chi} = W_t \tag{28}$$

$$\lambda_{t+1} (1 + r_t) P_t = \lambda_t P_{t+1} \tag{29}$$

$$\mathbb{K}_{hf,t} = S_t \frac{B_{t-1}^*}{P_t}\left(\frac{1}{\Phi_{\mathbb{K}}}\left(q_{\mathbb{K},t}\exp\left(\zeta_{\mathbb{K},t}\right) - 1\right) + \delta_{\mathbb{K}}\right) \tag{30}$$

$$q_{\mathbb{K},t} = \mathbb{E}_t\left(\frac{S_{t+1}}{S_t}\right)\left(\frac{1}{1+r_t}\right)\left(q_{\mathbb{K},t+1}(1+r_t^*) + pac_{t+1}\right) \tag{31}$$

$$I_{K,t} = K_{t-1}\left(\frac{1}{\Phi_K}\left(q_{K,t}\exp\left(\zeta_{K,t}\right) - 1\right) + \delta_K\right) \tag{32}$$

$$q_{K,t} = \mathbb{E}_t\left(\frac{P_{t+1}}{P_t}\right)\left(\frac{1}{1+r_t}\right)\left(q_{K,t+1}(1-\delta_K) + r_{K,t+1} + kac_{t+1}\right) \tag{33}$$

$$I_{Z,t} = Z_{t-1}\left(\frac{1}{\Phi_Z}\left(\underbrace{q_{Z,t}\exp\left(\zeta_{Z,t}\right) - 1}_{opportunity\ cost}\underbrace{-\rho_t\left(\frac{\varrho_t'}{\lambda_t}\right) - (1-\rho_t)\left(\frac{\varrho_t}{\lambda_t}\right)}_{liquidity\ constraint}\right) + \delta_Z\right) \tag{34}$$

$$q_{Z,t} = \mathbb{E}_t\left(\frac{P_{t+1}}{P_t}\right)\left(\frac{1}{1+r_t}\right)\left(q_{Z,t+1}(1-\delta_Z) + r_{Z,t+1} + zac_{t+1}\right) \tag{35}$$

$$\frac{\varrho_t'}{\lambda_t} = \mathbb{E}_t\left(\frac{1+r_{L,t}^*}{1+r_t}\right)\left(\frac{S_{t+1}}{S_t}\right) \tag{36}$$

$$\frac{\varrho_t}{\lambda_t} = \mathbb{E}_t\left(\frac{1+r_{L,t}}{1+r_t}\right) \tag{37}$$

where

$$pac_{t+1} = \frac{1}{2}\Phi_{\mathbb{K}}\left(\frac{P_{t+1}\mathbb{K}_{hf,t+1}}{S_{t+1}B_t^*} - \delta_{\mathbb{K}}\right)\left(\frac{P_{t+1}\mathbb{K}_{hf,t+1}}{S_{t+1}B_t^*} + \delta_{\mathbb{K}}\right)$$

$$kac_{t+1} = \frac{1}{2}\Phi_k\left(\frac{I_{K,t+1}}{K_t} - \delta_K\right)\left(\frac{I_{K,t+1}}{K_t} + \delta_K\right)$$

$$zac_{t+1} = \frac{1}{2}\Phi_Z\left(\frac{I_{Z,t+1}}{Z_t} - \delta_Z\right)\left(\frac{I_{Z,t+1}}{Z_t} + \delta_Z\right)$$

Eq. (27) is marginal utility of consumption. Together with Eq. (29), we have the typical Euler consumption equation. Eq. (28) is marginal rate of substitution between consumption and leisure. Eq. (30) is capital outflow dynamics by domestic residents that is driven by an exogenous shock and

"Tobin's *q*" in capital flows, as derived in Eq. (31). Three state factors drive capital outflows: interest rate differentials, expected depreciation, and expected value of purchasing foreign bonds. By the same token, we can easily derived the corresponding capital inflow dynamics by foreign residents

$$\mathbb{K}_{fh,t} = \frac{B_{t-1}}{S_t P_t^*}\left(\frac{1}{\Phi_{\mathbb{K}}^*}\left(q_{\mathbb{K}}^* \exp\left(\zeta_{\mathbb{K},t}^*\right) - 1\right) + \delta_{\mathbb{K}}^*\right) \tag{38}$$

$$q_{\mathbb{K},t}^* = \mathbb{E}_t\left(\frac{S_t}{S_{t+1}}\right)\left(\frac{1}{1+r_t^*}\right)\left(q_{\mathbb{K},t+1}^*(1+r_t) + pac_{t+1}^*\right) \tag{39}$$

Eqs. (33) and (35) are Tobin's *q* in short-term and long-term investment, respectively, driven by differentials between real marginal return on capital and expected real return on bonds.

Eqs. (32) and (34) are the respective corresponding short-term and long-term investment dynamics. What makes long-term investment dynamics different from the short-term one is that the latter is driven only the opportunity cost of investment, as captured by Tobin's *q*, while the former is determined by both opportunity cost of investment *and* liquidity constraints. According to Eq. (36), lower foreign borrowing rate and expected appreciation ease foreign liquidity constraint, promoting greater long-term investment. Meanwhile, domestic liquidity constraint is influenced by domestic financial repression. Greater is interest margin control, as represented by higher c, tighter domestic liquidity constraint would be.

4.3 Household as producer

There are two production sectors in the model economy: consumption goods and investment goods sectors. Households purchase and transform final goods from consumption goods sector into investment goods. In the spirit of Aghion et al. (2010), transformation technology involves labor effort in linear function. In particular, let the technology of producing long-term investment goods be $I_{Z,t} = \theta_Z N_{Z,t}$, whereas the technology of producing short-term investment goods be $I_{K,t} = \theta_K N_{K,t}$. θ_i is the corresponding labor productivity, where $N_{Z,t} + N_{K,t} = N_t$. Different from Aghion et al. (2010), we

assume $\theta_Z > \theta_K$. Because households can allocate work hours unrestrictedly across sectors, real wage compensation for laborer efforts in both short-term and long-term capital goods sectors is identical at W_t.

Households optimally allocate effective labors for short-term and long-term capital goods production to minimize cost of production, $W_t(N_{K,t} + N_{Z,t})$. By assuming a unit markup, first order conditions give us optimal price of short-term and long-term investment goods that correspond to effective wage, respectively.

$$P_{K,t} = W_t/\theta_K; \qquad P_{Z,t} = W_t/\theta_Z \tag{40}$$

Both short-term and long-term investment goods are then purchased at market prices to contribute to the accumulation of capital stock at the end of current period, which would be used as inputs for consumption goods production in next period.

Against this background, problem facing households in consumption goods sector can be formulated

$$\Pi_t = \exp(\zeta_{TFP,t})\, K_{t-1}^{\alpha} Z_{t-1}^{1-\alpha} - P_{K,t-1} I_{K,t-1} - P_{Z,t-1} I_{Z,t-1} = \exp(\zeta_{TFP,t})\, K_{t-1}^{\alpha} Z_{t-1}^{1-\alpha} - P_{K,t-1}(K_{t-1} - (1-\delta_K)K_{t-2}) - P_{Z,t-1}(Z_{t-1} - (1-\delta_K)Z_{t-2}) \tag{41}$$

Second equality takes Eqs. (17) and (18) into account. Following Aghion and Howitt (2008, p. 329), aggregate total factor productivity shock takes the form

$$\zeta_{TFP,t} = \ln T_t + \zeta_{a,t} \qquad (\textit{Aggregate TFP}) \tag{42}$$

It has two components: trend productivity endogenous to long-term productivity growth and exogenous productivity shock $\zeta_{a,t}$ that follows first-order autoregressive process. Optimally choosing K_t and Z_t gives us the following marginal profitability of short-term and long-term capital

$$\frac{\partial \Pi_{t+1}}{\partial K_t} = \alpha \exp(\zeta_{TFP,t+1})\, K_t^{\alpha-1} Z_t^{1-\alpha} - P_{K,t} = 0 \tag{43}$$

$$\frac{\partial \Pi_{t+1}}{\partial Z_t} = (1-\alpha) \exp(\zeta_{TFP,t+1})\, K_t^{\alpha-1} Z_t^{1-\alpha} - P_{K,t} = 0 \tag{44}$$

Inserting Eqs. (43) and (44) into production function of consumption goods gives us real marginal cost

$$\Theta_t = \exp\left(\zeta_{TFP,t+1}\right)^{-1} \left(\frac{P_{K,t}}{\alpha}\right)^{\alpha} \left(\frac{P_{Z,t}}{1-\alpha}\right)^{1-\alpha} \tag{45}$$

In equilibrium, marginal profitability of short-term and long-term capital is equalized. Together with Eq. (40), it means

$$\alpha Y_t/K_{t-1} - W_t/\theta_K = (1-\alpha)Y_t/Z_{t-1} - W_t/\theta_Z \quad \textit{(Arbitrage condition)} \tag{46}$$

4.4 A discussion on the mechanism

In general, capital inflows ease liquidity constraints, promoting long-run growth, whereas capital outflows or sudden stop in capital inflows desiccate liquidity, holding back long-run growth. But it is not a symmetric dimension. Arbitrage condition in equilibrium (46) acts as an upper bound that limits favorable long-run growth effect of capital inflows. The intuition for arbitrage condition is straightforward. Given the real wage W_t, long-term capital stock is larger than short-term capital stock in equilibrium. However, one would not continuously accumulate long-term capital stock due to the law of diminishing marginal return. The entrepreneurs would accumulate more short-term capital when marginal revenue of long-term capital falls short than that of short-term capital. As a result, further capital inflows, though easing liquidity constraint, have no impact on long-run growth. In other words, the boundary of long-run growth effect of capital inflows is the opportunity cost effect that dominates investment decision when liquidity constraint is non-binding.

We can also see how favorable long-run growth effect of capital inflows is bounded in steady state from Eqs. (31) to (34). In steady states, where $x_t = x_{t-1} = \bar{x}$, from Eqs. (17) and (18) we know that $\bar{I}_K = \delta_K \bar{K}$ and $\bar{I}_Z = \delta_Z \bar{Z}$. This is compatible with short-term investment decisions in Eqs. (32) only when $\bar{q}_K = 1$. We also assume a strong entrepreneur's creditworthiness in steady state in that $\bar{\rho} = 1$. Along with $\bar{I}_Z$ and $\bar{r}_L^* = \bar{r} = \beta^{-1} - 1$, we get $\bar{q}_Z = 2$. All these give us

$$\bar{r} = \bar{r}_K - \delta_K; \quad \bar{r} = \frac{1}{2}\bar{r}_Z - \delta_Z \tag{47}$$

The intuition is also identical to that of arbitrage condition. In steady state, marginal return on long-term capital is greater than marginal return on short-term capital, allowing the size of long-term capital to be larger in steady state. However, the accumulation of long-term capital in steady state is also bounded by the law of diminishing marginal return when liquidity constraint is non-binding, making capital inflows irrelevant to long-run growth in steady state.

4.5 Debt flow dynamics

Through a framework identical to the derivation of portfolio capital flows, marginal willingness to extend loans to home entrepreneurs, or "Tobin's *q*" in international lending, debt inflow dynamics, and evolution of total foreign debt from foreign resident's point of view can be derived as

$$q_{\mathbb{D},t} = \left(q_{\mathbb{D},t+1}\rho_t\left(1 + r^*_{L,t}\right) + dac_{t+1}\right)/(1 + r^*_t) \tag{48}$$

$$\mathbb{D}_{fh,t} = \frac{L^*_t}{P^*_t}\left(\frac{1}{\Phi_{\mathbb{D}}}\left(q_{\mathbb{D},t}\exp\left(\sigma_{\mathbb{D}}\zeta_{\mathbb{D},t}\right) - 1\right) + \delta_{\mathbb{D}}\right) \tag{49}$$

$$L^*_t = \rho_t\left(1 + r^*_{L,t}\right)L^*_{t-1} + \exp\left(\zeta_{\mathbb{D},t}\right)P^*_t\mathbb{D}_{fh,t} \tag{50}$$

where $dac_{t+1} = \frac{1}{2}\Phi_{\mathbb{D}}\left(\frac{\mathbb{D}_{t+1}}{L^*_t/P^*_{t+1}} - \delta_{\mathbb{D}}\right)\left(\frac{\mathbb{D}_{t+1}}{L^*_t/P^*_{t+1}} + \delta_{\mathbb{D}}\right)$ is debt flow adjustment cost, and $\sigma_{\mathbb{D}}$ is a constant . Foreign decision to lend depends on differentials between "effective lending rate" $\rho_t\left(1 + r^*_{L,t}\right)$ and foreign interest rate. Holding others constant, a rising foreign interest rate reduces foreign residents' incentive to lend internationally, causing a "debt flow reversal". Such a reversal is also possible when home entrepreneurs' creditworthiness deteriorates (a falling ρ_t), reducing effective return on foreign lending.

4.6 Short-run growth, balance of payments, and monetary policy

Market for consumptions goods is clear when the output is consumed locally, exported $C_{hf,t}$, and reinvested. From here we can write aggregate demand function as

$$AD_t = C_t + I_{Z,t} + I_{K,t} + C_{hf,t} - C_{fh,t} \tag{51}$$

Short-run growth is then defined as change in aggregate demand

$$\Delta AD_t = \ln AD_t - \ln AD_t \tag{52}$$

Balance of payments, where current account and capital account sum to zero, implies that

$$C_{hf,t} - C_{fh,t} + \mathbb{D}_{fh,t} + \mathbb{K}_{fh,t} - \mathbb{K}_{hf,t} = 0 \tag{53}$$

Lastly, the model is closed with a monetary policy reaction function

$$1 + r_t = (1 + r_{t-1})^{\rho_M} \left((1 + \bar{r}) \left(\frac{1+\pi_t}{1+\bar{\pi}}\right)^{\omega_\pi} \left(\frac{1+\Delta AD_t}{1+\Delta T_t}\right)^{\omega_y} \right)^{1-\rho_M} \exp(\sigma_M \varepsilon_{M,t}) \tag{54}$$

where inflation is defined as change in consumer price, $\pi_t = P_t/P_{t-1} - 1$. $\varepsilon_{M,t}$ is i.i.d monetary policy shock, and σ_M is a constant shock volatility.

4.5 Parameterization

Table 3 shows the parameter values used for model simulation in next section. All persistence parameters for first-order autoregressive shocks are preset around 0.7 to 0.9 to be in line with the literature. Because we assume all i.i.d shocks that hit the baseline model are one standard deviation from the mean, we adjust shock volatility to produce the model moments that best fit actual moments. For structural parameters, some are preset and others are calibrated to find coherent steady states.

For instance, we assume a subject discount factor of 0.99, implying annual discount rate of 4%. Households are risk averse, $\sigma = 2$ with wage elasticity of labor supply at $\chi = 5$. We also assume a very small fraction of entrepreneurs that have access to domestic financial market $\mathcal{F} = 0.01$, and a regulated interest margin at $c = 0.05$. This means our baseline model has an underdeveloped domestic financial market. To strengthen our case that domestic financial market is more restricted than the foreign one, we assume a high portfolio adjust cost in domestic bonds market $\Phi_{\mathbb{K}}^* = 0.6$ while pre-setting a nearly unrestricted and highly competitive foreign bonds market $\Phi_{\mathbb{K}} = 0.01$. Once installed, long-term capital adjustment cost is assumed to be greater than that of short-term capital.

Lastly, the parameter values for short-term capital share α, and labor productivity in capital goods sectors are calibrated to attain arbitrage condition (46) in steady state, depreciation rates for short-term and long-term capital to meet equivalence of net marginal return in Eq. (47), and share of capital outflows in total foreign bonds held to clear the balance of payments (53).

[INSERT TABLE 3 HERE]

Table 4 reports simulated moments compared with actual moments for Korea, Malaysia, Thailand, and the Philippines on average. The statistics on actual moments are adopted from Aguiar and Gopinath (2007). Overall, given a simple production structure and trade linkage in the model, while it is reasonable to observe some anomalies, the model reasonably produces volatility, autocorrelation, and cross-correlation that replicate at best and partially account for at worst the actual moments. For instance, simulated short-run growth volatility at 1.771 approximates the actual one at 1.865. So does the ratio between consumption volatility and aggregate demand volatility. The simulated ratio is 1.209, slightly higher than actual ratio of 1.16. Besides, cyclical movements of simulated aggregate demand has autocorrelation coefficient of 0.715 that is close to the actual coefficient of 0.848. Simulated cross-correlation coefficients for consumption and investment, respectively, and aggregate demand also substantially account for the actual cross-correlation coefficients.

[INSERT TABLE 4 HERE]

5. Asymmetric growth effect: The composition of investment and credit constraints

In this section, we would observe how the quantitative model economy responds to shocks hitting portfolio capital inflows and outflows, debt inflows, and debt inflows reversal. Figure 4 illustrates dynamic responses of short-run and long-run growth, short-term and long-term investment, interest rate, and consumer price inflation rates relative to one standard deviation shock that hit those capital flows. Relative impulse responses facilitate our understanding on how the economy may react differently in magnitude and direction in responding to shocks to different types of capital flows.

[INSERT FIGURE 4 HERE]

Overall, there is no asymmetric long-run growth effect of capital flows when shocks hitting capital flows are small. We observe trivial responses of long-run growth toward portfolio capital flows. In addition, inflation, interest rate, and short-term investment also barely respond to portfolio capital flows, both in and out. Interestingly, a stronger response of long-term investment doesn't translate into greater long-run growth rates. Responses of the economy are much stronger when facing debt flow shocks. In particular, debt inflows raise long-run growth whereas debt inflows reversal takes a toll on the long-run growth. However, responses are symmetric.

By thinking through our model, it is not unreasonable to obtain relative dynamic responses as depicted in Figure 4. Without hitting arbitrage condition, asymmetry would not kick in following capital inflows. On the flipside, without crashing the entrepreneur's creditworthiness that causes liquidity constraint to bind, long-run growth would not collapse as a consequence of capital outflows. In this respect, small shock to portfolio capital flows would leave no mark on long-run growth.

At the same time, symmetric growth effect of debt flows can be interpreted jointly through the lens of endogenous long-run trend, aggregate total factor productivity equation, arbitrage condition, and endogenous probability of securing foreign loans. A positive shock to debt inflows expands the amount of loans available for long-term capital accumulation, lifting long-run trend and hence aggregate TFP. As a result, frontier of arbitrage condition is raised, which allows positive long-run growth of debt inflows to take effect. Law of diminishing return, however, ensures that growth effects die off over time. In contrast, debt inflow reversal cut backs cheaper foreign loans available for long-term investment, resulting in immediate fall in long-run growth. However, reduction in long-term capital stock implies a greater marginal return that makes long-term investment remains profitable even when it is financed by more expensive domestic loans. As a result, long-run growth recovers over time.

5.1 Implication of large and persistence shocks hitting capital flows

Against this conjecture, it is possible to observe the emergence of asymmetry in growth effects when shocks hitting portfolio capital flows are large and persistent. But large and persistent debt inflow reversals are likely to only amplify responses of the economy without instigating asymmetry. We conduct another exercise by hitting the model economy with shocks of four standard deviations over zero mean. The large debt inflow reversal by four standard deviations is especially interesting as it fits the key defining characteristics of a sudden stop: a sharp, sudden reversal in international capital flows (Calvo et al. 2006, 2008). That means large shock to portfolio capital outflows is not a sudden stop incidence because no reversal of flow takes place. We make the shock persistent by setting a near unit-root autocorrelation coefficient for capital flows shock, $\rho_{\mathbb{K}} = \rho_{\mathbb{K}}^{*} = \rho_{\mathbb{D}} = 0.99$.

[INSERT FIGURE 5 HERE]

Figure 5 depicts relative impulse responses of the economy to large and persistent shocks hitting capital flows. It is apparent that asymmetry in growth comes on-stream for portfolio capital flows. While both short-run and long-run growth barely responds to large and persistent capital inflows shocks, long-run growth drops by nearly 0.1% and short-run growth falls by about 30%. Meanwhile, falls in growth, investment, interest rate, and inflation below trend are amplified when there is large and persistent debt inflows reversal. Nevertheless, as inferred earlier, there is no mark of asymmetry.

5.2 Role of imperfect financial market

Is there a role for imperfect domestic financial market in instigating asymmetric growth effect of capital flows? Would the dynamic responses be different if domestic financial market is equally competitive and advanced as foreign financial market without financial repression? We undertake the last exercise by setting $\mathcal{F} = 1$ and $c = 0$, respectively. The former implies that all credit-financed long-term investment would contribute to long-run growth perhaps due to unrestricted access to credit market for the entrepreneurs, or because of more advanced monitoring device from the financial intermediaries that ensures all borrowers are incentivized to carry the productive plan as proposed. The

latter implies an equally competitive domestic financial market, as now lending rates are equalized across countries, $r_{L,t}^{*} = r_{L,t}$.

[INSERT FIGURE 6 HERE]

Figure 6 illustrate relative dynamic responses under baseline case, "$\mathcal{F} = 1$" case, and "$c = 0$" case when the economy is hit by large and persistent capital flow shocks. Three interesting observations stand out. First, financial market development in the sense that domestic entrepreneurs have greater access to credit market and that moral hazard incidence can be minimized due to more advanced monitoring device is critical to make the economy responsive to capital flows. As evidenced in Figure 6, portfolio capital inflows can be favorable to long-run growth with meaningful magnitude, although it doesn't contribute to productive investments. Growth effect of debt inflows is also amplified. This finding in a way corroborates existing literature that found benign growth effects of capital inflows conditional to the existence of strong and good institutions (see, for instance, Alfraso et al., 2007; Bekaert et al., 2005; Friedrich et al., 2013; Kyaw and MacDonald, 2009; Masten et al., 2008). However, it should be noted that while greater access to credit market implies greater chances for the entrepreneurs, the ugly flipside holds true as it also implies more severe shakeup to the economy in the face of greater collapse in credit-financed investments when capital flows retreat. In other words, deeper and liberalized financial market is not a foolproof guarantee for the economy to escape financial fragility stirred by the wreak-havocking sudden stops (Ranciere et al., 2006).

Second, the asymmetry survives. Although greater financial depth strengthens the favorable effects of capital inflows on growth, so does the unfavorable growth effect of capital outflows. Lastly, eliminating domestic interest rate control when the entrepreneurs already have access to cheaper foreign credits has no impact on how the economy responds to capital flow shocks. It looks like a "pseudo" Pareto improvement in the sense that it harms no one but it benefits no one as well.

6. Conclusion

When financial liberalization with unrestricted capital flows was promoted as the recipe for economic development in developing countries in the 1990s, the promise was largely grounded on untested theoretical good will. With the benefit of hindsight, it is now determined that the output gain to capital inflows is largely elusive. However, we are constantly reminded by the lessons from the Asian financial crisis of 1997/98, as well as the global financial crisis of 2008, that abrupt capital outflows can easily wreak havoc on the economy.

This paper contributes to the literature with respect to empirical evidence and the underlying mechanism. By using an asymmetric Granger causality test on a sample of Asian countries, this paper for the first time finds statistically significant empirical evidence showing that while capital inflows hardly Granger-cause economic growth, capital outflows Granger-cause economic downturn. To explain this finding, we construct a small open-economy model that incorporates different compositions of investment and endogenous nonlinear credit constraint. Of different types of investments, only long-term investment contributes to long-run growth. Arbitrage condition between short-term and long-term investments hence sets an upper bound, over which further capital inflows would not incentivize long-term investments and hence are decoupled from long-run growth.

Because long-term investment need financing that is endogenous to the entrepreneur's creditworthiness, nonlinear credit constraint triggers debt-deflation process once capital outflows deteriorate the entrepreneur's creditworthiness, which, in turn, reinforcing cutbacks in foreign financing. Nevertheless, debt-deflation process is not explosive in the model, as the resultant increasing marginal return would make long-term investment profitable even when it is financed by the more expensive domestic credits. Our mechanism of asymmetry survives different level of financial development.

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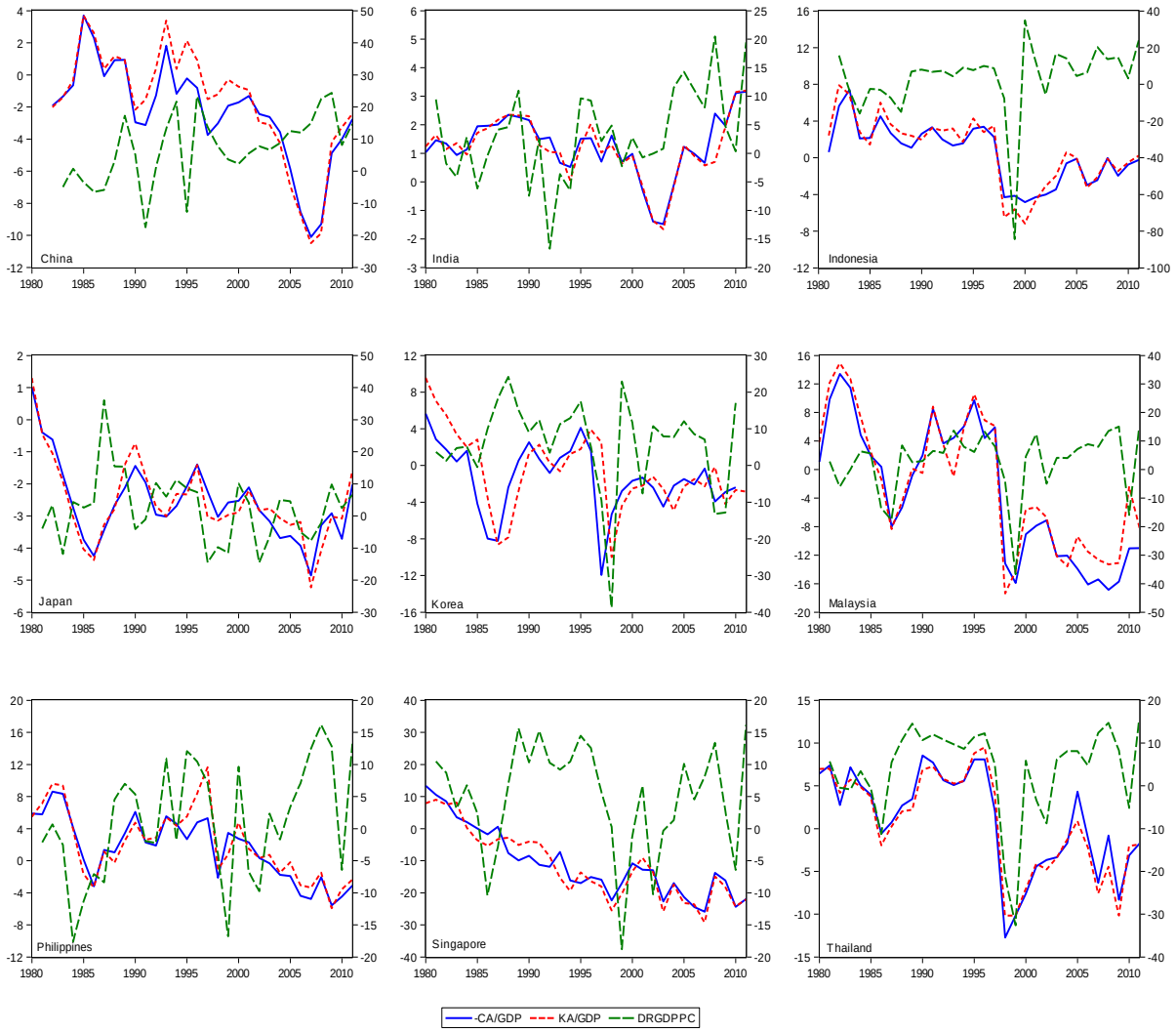


Notes: -CA/GDP: current account as a share of GDP; KA/GDP: capital account as a share of GDP; DRGDPPC: Per capita real GDP growth rate. Declining –CA/GDP and KA/GDP indicates capital outflows, and vice versa.

Fig. 1 Asymmetric relationship between capital flows and economic growth

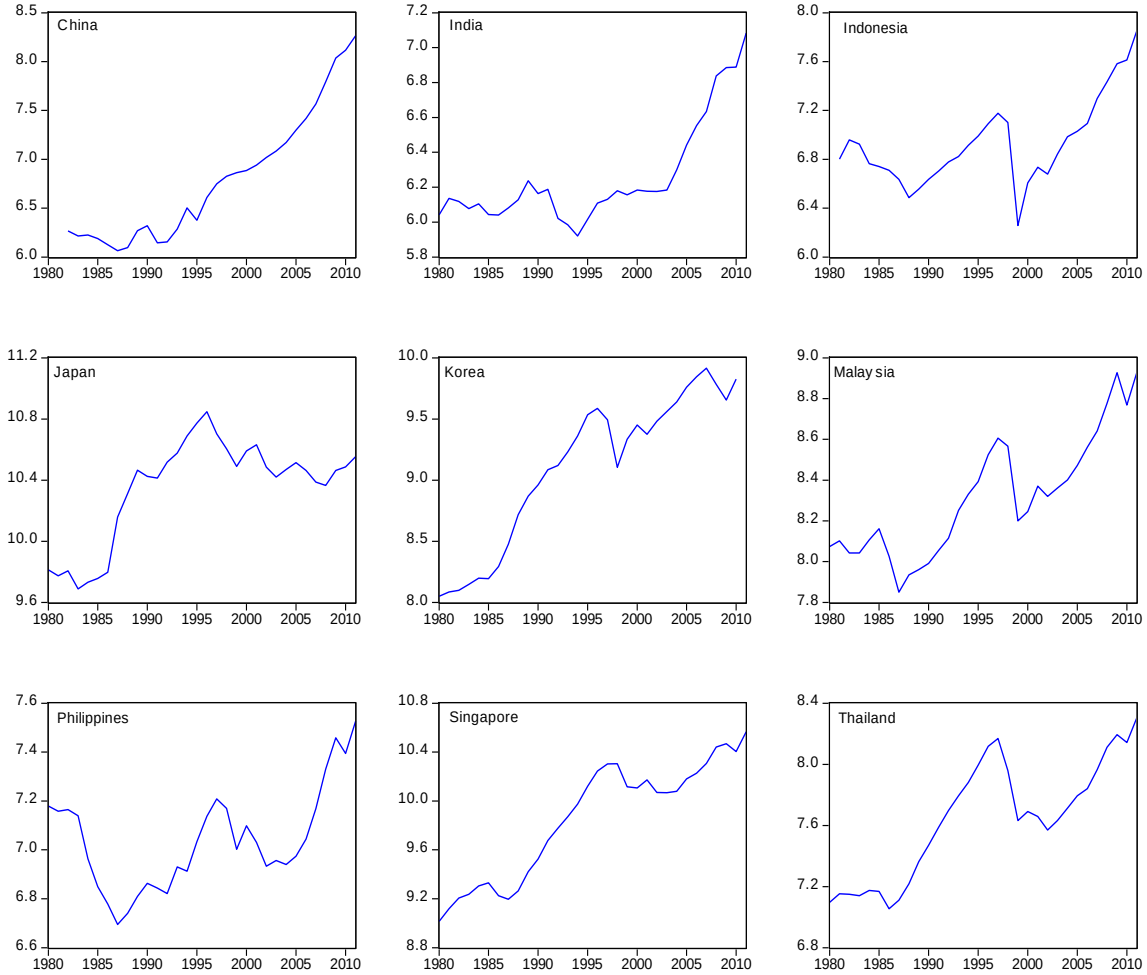
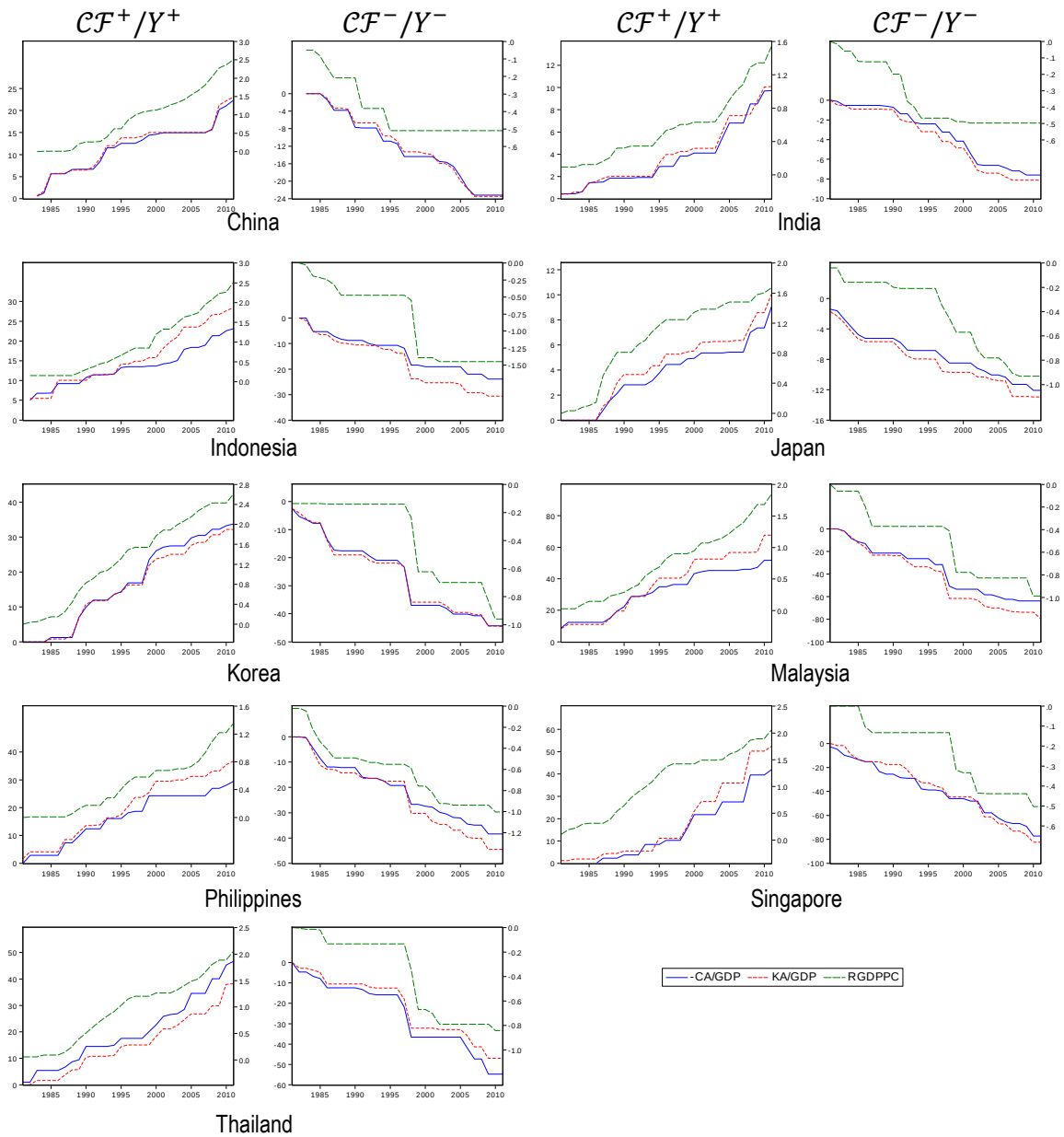
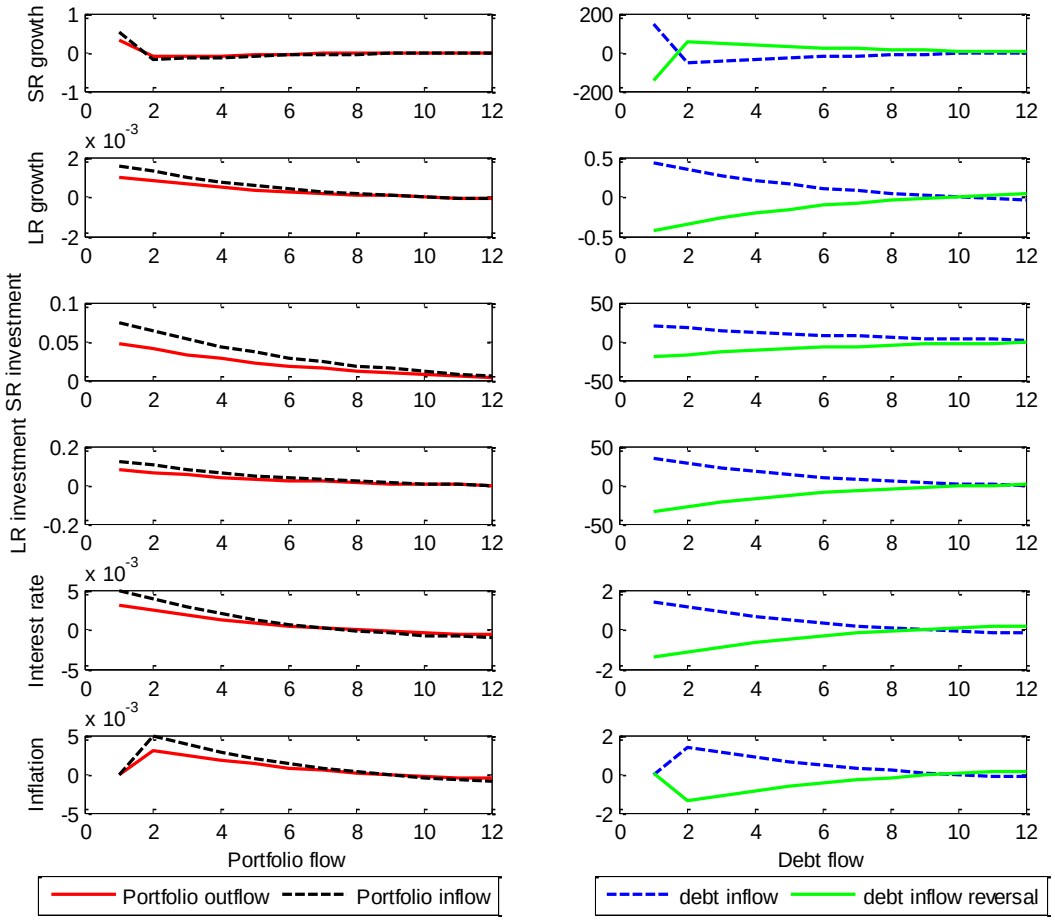


Fig. 2 Time plots of per capita real gross domestic product for selected Asian countries



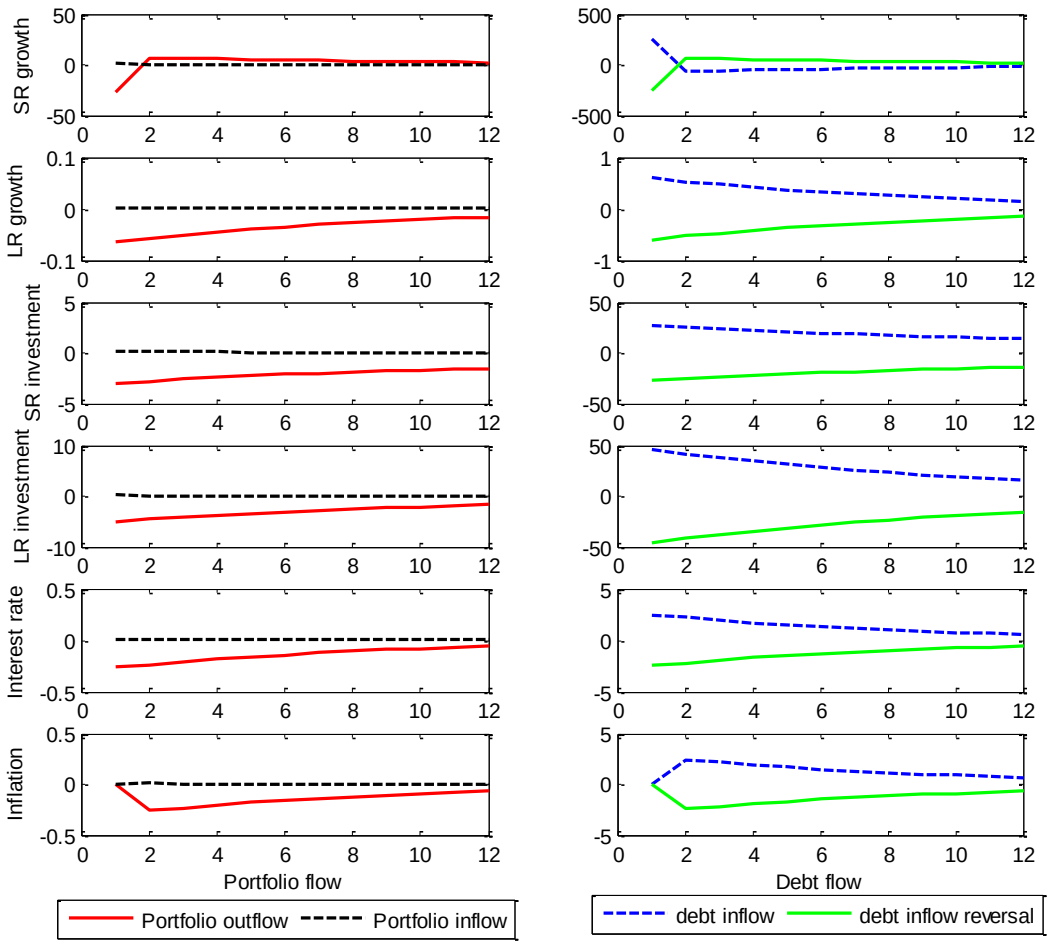
Notes: $\mathcal{CF}$ denotes capital flows proxied by –CA/GDP and KA/GDP, Y denotes per capita real GDP (RGDPPC). The sign + indicates cumulative positive sum and – indicates cumulative negative sum.

Fig. 3 Cumulative positive and negative sum of capital flow and economic growth



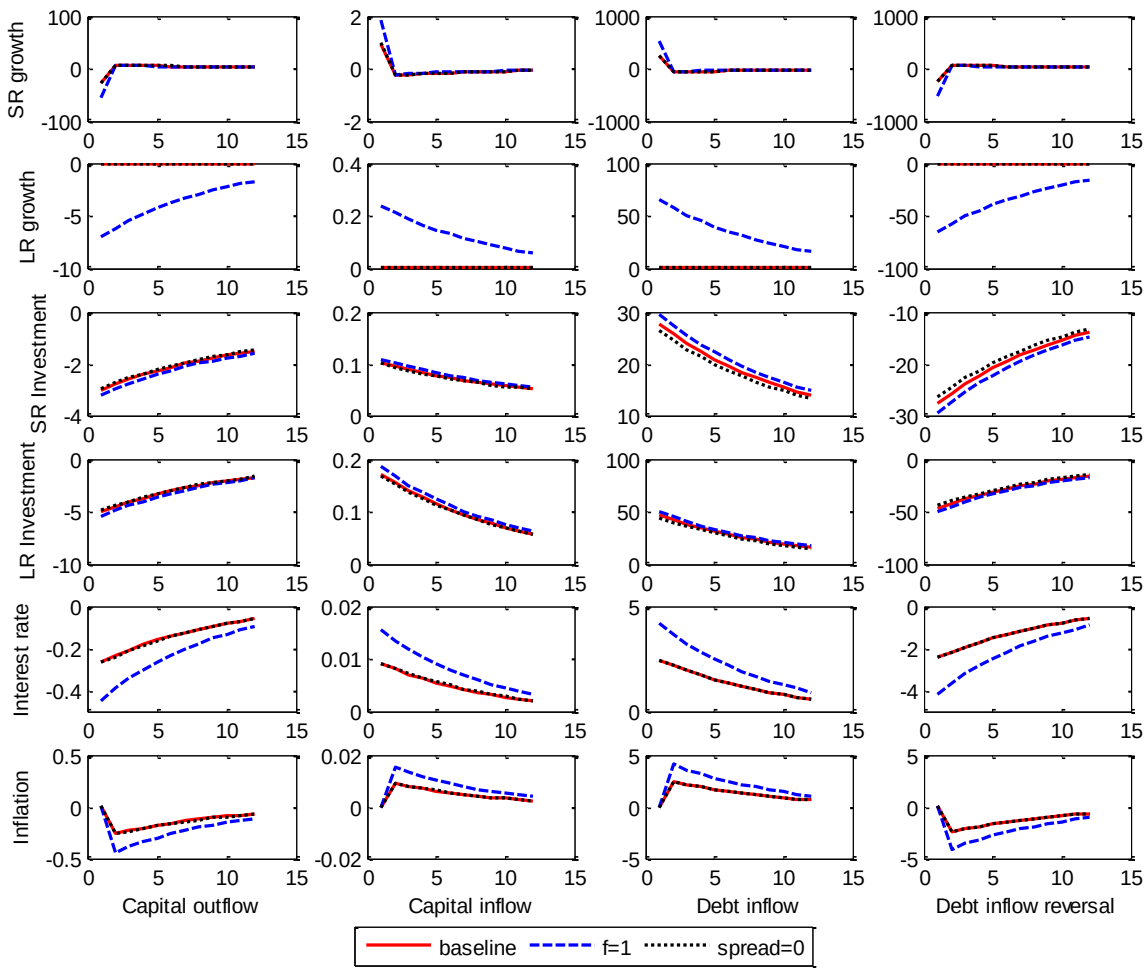
Note: (Y-axis) Percentage; (X-axis) Quarter

Fig. 4 Relative dynamic responses to shocks hitting capital flows by one standard deviation



Note: (Y-axis) Percentage; (X-axis) Quarter

Fig. 5 Relative dynamic responses to near unit root shocks hitting capital flows by four s.d.



Note: (Y-axis) Percentage; (X-axis) Quarter. Baseline refers to those in Fig. 5, f=1 implies unrestricted assess of entrepreneurs to domestic credit market, and spread=0 means unregulated domestic lending rate

Fig. 6 Implication of imperfect credit market

Table 1

Results of asymmetric causality tests

	China	India	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore	Thailand
Ho: $CF^{+} \neq > RGDPC^{+}$									
Wstat	0.395	3.05*	1.932	0.328	2.266	1.207	0.45	0.014	1.295
Bootstrap CV 1%	8.52	7.525	15.003	9.937	7.916	7.834	8.629	7.169	8.531
Bootstrap CV 5%	4.244	4.391	9.641	4.72	4.214	4.38	4.45	4.079	4.771
Bootstrap CV 10%	2.902	3.026	7.222	3.101	2.955	3	2.967	2.947	3.313
Ho: $CF^{+} \neq > RGDPC^{-}$									
Wstat	5.984*	3.945*	30.598***	3.947	16.616***	0.355	1.120	0.014	0.576
Bootstrap CV 1%	12.507	8.491	18.375	12.357	11.846	7.629	7.776	7.169	7.48
Bootstrap CV 5%	7.14	4.575	10.385	7.249	7.018	4.206	4.277	4.079	4.154
Bootstrap CV 10%	5.285	3.161	7.797	5.299	5.24	2.94	2.997	2.947	2.933
Ho: $CF^{-} \neq > RGDPC^{+}$									
Wstat	0.292	0.310	0.049	0.001	2.11	0.251	3.908	0.053	0.592
Bootstrap CV 1%	12.921	8.608	9.43	10.005	15.062	8.69	12.163	10.709	9.338
Bootstrap CV 5%	5.232	4.366	4.6	4.986	5.972	4.331	7.031	4.241	4.659
Bootstrap CV 10%	3.04	3.044	2.94	3.217	3.403	2.835	5.126	2.658	3.001
Ho: $CF^{-} \neq > RGDPC^{-}$									
Wstat	11.733**	1.087	23.027***	0.489	50.180***	19.65***	15.351***	1.375	22.513***
Bootstrap CV 1%	13.055	8.646	14.529	7.912	24.873	15.898	9.751	10.128	15.944
Bootstrap CV 5%	7.477	4.376	5.098	4.318	10.731	5.721	4.972	4.503	8.362
Bootstrap CV 10%	5.466	2.897	2.992	2.903	6.854	3.229	3.186	2.928	5.749
	China	India	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore	Thailand
Ho: $RGDPC^{+} \neq > CF^{+}$									
Wstat	0.888	0.281	2.068	2.159	1.293	0.656	0.175	0.319	0.045
Bootstrap CV 1%	8.545	8.188	17.146	9.66	9.261	8.058	7.968	8.823	8.477
Bootstrap CV 5%	4.478	4.374	10.429	4.51	4.733	4.558	4.279	4.638	4.592
Bootstrap CV 10%	3.064	3.02	7.815	2.94	3.221	3.087	2.951	3.196	3.197
Ho: $RGDPC^{+} \neq > CF^{-}$									
Wstat	0.003	0.121	0.613	0.383	1.008	5.231**	0.276	0.319	0.505
Bootstrap CV 1%	11.665	8.168	10.027	8.581	11.524	10.568	12.649	8.823	10.016
Bootstrap CV 5%	5.139	4.342	4.889	4.548	4.839	4.521	7.262	4.638	4.709
Bootstrap CV 10%	3.118	2.895	3.073	2.985	2.922	2.906	5.282	3.196	3.038
Ho: $RGDPC^{-} \neq > CF^{+}$									
Wstat	7.641**	0.001	1.017	6.715*	0.909	0.614	0.187	2.966	0.001
Bootstrap CV 1%	12.813	8.351	14.358	12.762	11.664	7.921	7.981	12.432	8.231
Bootstrap CV 5%	7.257	4.387	8.736	7.075	6.915	4.293	4.521	7.417	4.6
Bootstrap CV 10%	5.262	3.064	6.691	5.284	5.171	2.928	3.053	5.577	3.33
Ho: $RGDPC^{-} \neq > CF^{-}$									
Wstat	0.091	2.156	0.021	1.665	0.305	2.541	0.047	0.066	1.499
Bootstrap CV 1%	11.807	10.261	9.828	8.602	12.898	8.205	8.168	8.427	12.785
Bootstrap CV 5%	7.015	4.827	4.305	4.485	7.782	4.364	4.305	4.271	7.658
Bootstrap CV 10%	5.229	3.074	2.812	3.039	5.828	2.915	2.912	2.923	5.64

Notes: RGDPC denotes per capita real GDP (in log) and CF denotes capital flow proxied by current account as a share of GDP (-CA/GDP). The sign + denotes cumulative positive shock which indicates capital inflow and positive economic growth, whereas the sign – denotes negative cumulative shock that implies capital outflow and negative economic growth, respectively. Wstat and CV stand for Wald statistics and critical value, respectively. The denotation ≠> indicates "does not Granger cause". ***, **, *, respectively, denote 1%, 5%, and 10% level of significance.

Table 2

Further results of asymmetric causality test

	China	India	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore	Thailand
Ho: $CF^{+} \neq > RGDPC^{+}$									
Wstat	0.303	4.082*	0.101	0.362	3.172*	3.358*	0.087	2.825	4.769
Bootstrap CV 1%	8.547	8.634	8.42	8.267	7.845	7.648	8.395	16.028	13.577
Bootstrap CV 5%	4.265	4.332	4.36	4.62	4.224	4.242	4.47	10.023	7.849
Bootstrap CV 10%	2.88	3.01	2.986	3.13	2.894	2.94	3.078	7.591	5.852
Ho: $CF^{+} \neq > RGDPC^{-}$									
Wstat	0.591	0.635	17.322**	2.160	21.103***	0.861	1.135	2.825	0.378
Bootstrap CV 1%	8.465	8.585	17.957	14.567	12.034	7.549	7.705	16.028	7.11
Bootstrap CV 5%	4.554	4.602	10.099	7.768	6.999	4.055	4.119	10.023	4.106
Bootstrap CV 10%	3.11	3.081	7.575	5.406	5.293	2.849	2.936	7.591	2.898
Ho: $CF^{-} \neq > RGDPC^{+}$									
Wstat	0.224	1.082	0.000	0.604	2.038	0.441	11.021**	0.048	0.198
Bootstrap CV 1%	13.555	8.908	12.478	9.896	13.67	9.518	11.472	11.184	12.634
Bootstrap CV 5%	5.379	4.591	4.638	4.749	6.03	4.42	6.768	4.214	4.759
Bootstrap CV 10%	3.062	3.066	2.926	3.159	3.547	2.856	5.044	2.675	2.821
Ho: $CF^{-} \neq > RGDPC^{-}$									
Wstat	9.531***	1.847	59.601***	0.047	38.262***	29.147***	27.108***	1.315	25.076***
Bootstrap CV 1%	8.411	8.074	23.463	9.207	22.671	18.006	10.511	9.328	15.66
Bootstrap CV 5%	4.265	4.226	8.625	4.521	9.688	6.734	4.946	4.624	8.063
Bootstrap CV 10%	2.929	2.862	5.559	2.961	6.068	3.696	3.08	3.02	5.7
	China	India	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore	Thailand
Ho: $RGDPC^{+} \neq > CF^{+}$									
Wstat	2.011	3.322*	6.603**	1.377	3.141*	1.035	0.634	5.139	0.768
Bootstrap CV 1%	8.868	8.199	9.402	8.928	8.808	8.138	8.394	18.086	12.956
Bootstrap CV 5%	4.567	4.147	4.536	4.572	4.623	4.436	4.539	10.893	7.594
Bootstrap CV 10%	3.078	2.825	3.014	3.084	3.13	3.135	3.187	8.29	5.626
Ho: $RGDPC^{+} \neq > CF^{-}$									
Wstat	0.009	0.031	0.126	0.99	0.343	3.549*	0.220	5.139	0.129
Bootstrap CV 1%	13.212	8.253	10.865	8.779	10.935	10.16	11.567	18.086	11.087
Bootstrap CV 5%	5.37	4.35	4.706	4.474	4.663	4.42	7.035	10.893	4.854
Bootstrap CV 10%	3.037	2.927	2.945	3.045	2.897	2.827	5.081	8.29	2.966
Ho: $RGDPC^{-} \neq > CF^{+}$									
Wstat	1.594	0.457	1.254	2.544	1.030	0.312	0.463	0.107	0.132
Bootstrap CV 1%	8.113	8.68	13.515	13.737	11.766	7.894	7.785	8.853	7.999
Bootstrap CV 5%	4.418	4.548	8.301	7.437	6.934	4.321	4.311	4.668	4.596
Bootstrap CV 10%	3.03	3.146	6.326	5.186	5.177	3.024	2.976	3.152	3.265
Ho: $RGDPC^{-} \neq > CF^{-}$									
Wstat	0.072	0.062	2.081	0.329	0.301	1.226	0.038	0.005	1.447
Bootstrap CV 1%	8.73	9.471	13.701	8.847	12.979	7.772	7.886	8.204	12.876
Bootstrap CV 5%	4.456	4.587	7.967	4.386	7.612	4.123	4.375	4.336	7.716
Bootstrap CV 10%	3.006	3.022	5.864	2.92	5.743	2.822	2.905	2.969	5.644

Notes: Capital account as a share of GDP is used as proxy for capital flow (CF). RGDPC denotes per capita real GDP (in log). The sign + denotes cumulative positive shock which indicates capital inflow and positive economic growth, whereas the sign – denotes negative cumulative shock that implies capital outflow and negative economic growth, respectively. Wstat and CV stand for Wald statistics and critical value, respectively. The denotation ≠> indicates "does not Granger cause". ***, **, *, respectively, denote 1%, 5%, and 10% level of significance.

Table 3
Parameterization

Parameters				Shocks	
Pre-set		*Calibrated*		*Pre-set Shock persistence*	
β	0.99	α	0.4885		
σ	2	$\delta_{\mathbb{K}}$	0.202	ρ_a	0.85
χ	5	δ_K	0.04	ρ_H	0.7
c	0.05	δ_Z	0.015	ρ_K	0.9
$\mathcal{F}$	0.01	θ_K	0.7762	ρ_Z	0.9
ϖ	150	θ_Z	1.228	$\rho_{\mathbb{K}}$	0.9
$\delta_{\mathbb{K}}^*$	0.1			$\rho_{\mathbb{K}}^*$	0.9
$\delta_{\mathbb{D}}$	0.1			$\rho_{\mathbb{D}}^*$	0.9
$\Phi_{\mathbb{K}}$	0.01			*Volatility*	
$\Phi_{\mathbb{K}}^*$	0.6			σ_a	0.0001
$\Phi_{\mathbb{D}}$	0.01			σ_H	0.005
Φ_K	0.1			σ_K	0.01
Φ_Z	0.3			σ_Z	0.2
γ	0.7			$\sigma_{\mathbb{K}}$	0.2
φ	1.5			$\sigma_{\mathbb{K}}^*$	0.2
ρ_M	0.7			$\sigma_{\mathbb{D}}^*$	0.2
ω_π	1.5			σ_M	0.0001
ω_y	0.03125			σ_M^*	0.00001

Table 4
A comparison between actual and simulated moments

	Data	Model Simulation
$\sigma(AD)$	3.24	1.971
$\sigma(\Delta AD)$	1.865	1.771
$\rho(AD)$	0.848	0.715
$\rho(\Delta AD)$	0.33	-0.054
$\sigma(C)/\sigma(AD)$	1.16	1.209
$\sigma(I)/\sigma(AD)$	3.868	0.219
$\rho(C, AD)$	0.78	0.382
$\rho(I, AD)$	0.828	0.505

Notes: Data is computed based on business cycles statistics for South Korea, Malaysia, the Philippines, and Thailand reported in Aguiar and Gopinath (2007). Simulated series are de-trended using HP filter at $\lambda = 1600$.