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Financial integration and economic growth: directional heterogeneity and threshold effect

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Abstract

Despite voluminous studies, the growth effects of international financial integration remain unresolved. Recent studies have shown that the effects depend on a wide variety of factors including the level of economic and financial development, the type of financial flows (debt or equity), the direction of flows (inflows or outflows), and the existence of the investment or saving constraint with the economy. In this paper, we implement a model that embodies double threshold effects where the thresholds are defined in terms of (i) per capita GDP and (ii) the economic growth rate. The results support the single threshold of the growth rate, which is expected to capture the existence of the investment or saving constraint with the economy. We find that developed and slowly developing economies are likely to benefit from capital outflows for higher investment incomes whereas emerging economies with growth rate higher than 3.4—5.7 percent can successfully take advantage of financial integration and resulting capital inflows. The findings are robust to changes in variable definition, model specification and data selection.

Keywords Financial integration, Economic growth, Direction heterogeneity, Threshold effect

JEL Classification F38, F43

1 Introduction

In typical classical models, international financial integration has a number of beneficial effects on the economies through a variety of channels such as consumption smoothing, enhancing both quantity and quality of fixed investment, and economic growth. Despite voluminous studies, however, the growth effects of financial integration remain unresolved, especially in developing economies. Recent studies have shown that the effects depend on a wide variety of factors including the level of economic and financial development, the type of financial flows (debt or equity), and the direction of flows (inflows or outflows). Econometric issues such the reverse causality (or endogeneity), and the time-varying nature of the relationship make empirical analysis difficult and yield inconclusive results. Increasing frequency of excessive capital flows and sudden stop episodes muddies the relationship further.

In this paper, we focus on the two factors: reverse causality (or endogeneity) and nonlinearity. To resolve the two key issues, we implement an empirical model that embodies the threshold effect where the threshold is defined in terms of overall financial development, and directional heterogeneity. In addition, capital inflows and outflows are allowed to exert asymmetric effects. The results indicate that developed and slowly developing economies are likely to benefit from capital outflows for higher investment incomes while emerging economies with growth rate higher than 3.4—5.7 percent can successfully take advantage of financial openness and resulting capital inflows. The findings are robust to changes in variable definition, model specification and data selection.

This paper is organized as follows. In Section 2 we review a series of empirical studies on the relationship between financial openness and economic growth and

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propose the hypothesis of directional heterogeneity and threshold effect. Section 3 embeds it into the threshold model by testing a benchmark linear model and an initial non-linear model. Section 4 examines the robustness of the results an estimation of threshold panel data model. Section 5 concludes with policy implications.

2 Financial development and economic growth: empirical issues

2.1 Overview of literature

In empirical studies, economic integration in physical trade tends to show up as a positive contributor to economic growth. However, financial integration is a different story. Empirical tests rarely produce significant and robust relationship between financial integration and economic growth. Influential studies such as Alesina et al. (1994), and Rodrik (1998) fail to find strong evidence that financial openness can promote economic growth significantly. (Schularick and Steger 2010).

The existing studies on the growth effects of financial integration can be divided into three groups according to research focus. The first group of papers tests the direct and indirect effects of financial integration on economic growth. The second group is focused on obtaining robust results with cross-country panel data by introducing additional variables in their regressions. The third group shifts attention to potential nonlinearity via threshold effects.

Studies in the first and earliest group try to find positive connection between capital account opening and growth rate via two channels: boosting domestic investment and institutional development. Among those focused on the first channel, Stulz (1999) and Bekaert (2000) find that financial integration boosts domestic investment. Reisen and Soto (2001) show that FDI and portfolio inflows have significantly positive effects on investment growth, while debt inflows can only do the job in economies with highly developed banking systems. Mody and Murshid (2005) and Bosworth and Collins (1999) report similar findings. Nevertheless, empirical tests are largely mixed. Alesina et al. (1994), Rodrik (1998), Kraay (1998), McKenzie (2001), and O'Donnell (2001) fail to obtain robust results.

The second channel of connection between financial development and economic growth hinges on institutional development. In addition to the traditional effects through improving productivity and allocative efficiency, financial integration can promote economic growth through institutional factors such as domestic financial market development, better governance, and greater macroeconomic discipline. Young (1993) and Bonfiglioli and Mendicino (2004) find significant evidence for these indirect channels. The positive role of financial integration is supported in Gourinchas and Jeanne (2002), and Bussiere and Fratzscher (2008) while it is questioned in other studies such as Aitken and Harrison (1999) and McKinnon et al. (1997, 1999). The ambiguity arises because the short-run positive effects through investment boom may cause economic and financial bubbles in the capital-recipient economy without generating the desirable institutional development and, in the end, cause financial crises, deep recessions, and long-run pains.

The second group of the studies purports to uncover third factors as prerequisite in the nexus between financial integration and economic growth. Important factors include (i) trade openness: Arteta et al. (2003) and Awojobi (2013), (ii) human capital: Borensztein et al. (1998), and (iii) macroeconomic stability: Arteta et al. (2001), Quinn and Toyoda (2008), and You et al. (2023). Studies in this group also emphasize the threshold effects in the linkage as illustrated by Kose et al. (2009) and Rodrik and Subramanian (2008). An economy below the (unidentified) threshold level may not benefit from financial integration due to the lack of absorptive capacity. In a comprehensive review of major studies, Kose et al. (2009) argue five potential factors may form the thresholds in the linkage from financial integration to economic growth: (i) financial market development, (ii) institutional quality, (iii) governance, (iv) macroeconomic policies, and (v) trade integration.

Rodrik and Subramanian (2008) distinguishes two different types of constraints in a typical developing economy: a saving constraint and an investment constraint. A developing economy with a saving constraint – i.e., no shortage of investment opportunities and limited national saving – has its capital demand exceeding the gross funds supplied by the domestic capital market. By liberalizing and opening international financial transactions, it can overcome the shortage by getting easier and cheaper access to international funds. In this case, financial opening will lead to increases in economic growth. On the other hand, a developing economy with an investment constraint lacks investment opportunities and consequently the ability to absorb foreign capital inflows efficiently. Capital inflows following financial opening are likely to end up in non-essential sectors such as real estate and resort building. The growth effect of financial opening will thus be small and short-lived and likely to be followed by financial crises.

This paper follows the approaches proposed by Kose et al. (2009) and Rodrik and Subramanian (2008). We also employ the method employed by Meller (2013) who uses Hansen's (1999) threshold panel data model to find evidence for a significant relation between international financial integration and output volatility. Another important element of our study is an explicit recognition that capital can flow out as well as it flows in even for economies in similar situations.[1] These puzzling capital flows might be an important source of conflicting results in existing studies.

2.2 The Hypothesis: Threshold effect with directional heterogeneity

Given widely different initial situations and diverse economic environment in developing economies, empirical tests that try to encompass all these countries with one single linear regression model is unlikely to produce meaningful results. The above discussion suggests the role of directional heterogeneity along with the threshold effect in understanding the growth effect of financial openness. Capital inflow and outflow are likely to have different growth effects and may well have opposite effects depending on the stage of economic development, which suggests the possibility of threshold effects. In addition, for developing economies below the threshold level of financial development, we have two different cases. Economies with sufficient saving but lacking investment opportunities can obtain higher investment income globally than domestically, thus will benefit from capital outflows. In contrast, economies with ample investment opportunities but insufficient saving will benefit from capital inflows and may be harmed from outflows. For developed economies above the threshold level of financial development, capital inflows may aggravate domestic capital market competition without funding investment opportunities. This may cause a negative effect of financial inflow openness on economic growth.

We adopt the per capita income as a proxy for financial development. As for the threshold variable that determines the relative saving/investment shortage or abundance, we employ the rate of economic growth. In other words, we postulate that an economy with a higher economic growth rate is one with abundant investment opportunities that exceed available domestic saving. The opposite holds for a slow growing economy. Thus, our hypothesis is that the economic growth rate and the level of economic development play the role of dual thresholds in the linkage between financial market integration and economic growth. In the proposed model of the threshold relationship between economic growth and financial integration, we employ both capital inflow and outflow openness indicators to test the directional heterogeneity. See Edison et al. (2004); Klein and Olivei (2006); Arteta et al. (2001) for related studies.

3 The model

3.1 The benchmark framework and dataset

3.1.1 The benchmark

As an initial test and for comparability with existing studies, we follow Schularick and Steger (2010), Kim et al. (2012), Meller (2013) and Rodriguez (2017) and adopt a framework developed by Bussiere and Fratzscher (2008) as follows. The growth rate of real GDP per capita, $g^p_{i,t}$, is related to its one-period lagged value, and a set of weakly exogenous independent controlling variables, $X_{i,t}$, and a cross-section fixed effect, μ_i. The controlling vector, $X_{i,t}$, includes fiscal policy, monetary policy, human capital or population and trade openness.

$$g^p_{i,t} = \tau g^p_{i,t-1} + \gamma X_{i,t} + \varepsilon_{i,t} + \mu_i \tag{1}$$

We employ a threshold panel data model with two potential threshold variables mentioned above. The lagged dependent variable generates endogeneity in a dynamic model. Noting that the population growth rate is one of the controlling variables as well as a part of the dependent variable at the same time, we separate the lagged dependent variable into the growth rates of real GDP and population to avoid the endogeneity issue. The above discussion leads to the following list of control variables:

$$Q_{i,t} = (g_{i,t-1}, \tau_{i,t}, p_{i,t}, yinitial_{i,t}, gov_{i,t}, tradeopen_{i,t})\prime \tag{2}$$

The lagged growth rate of real GDP, $g_{i,t-1}$, and growth rate of population, $p_{i,t-1}$, represent the factorization of trend per capita growth rate. $g^p_{i,t-1}$ is the rate of inflation, $\tau_{i,t}$, government expenditure, $gov_{i,t}$, and trade openness, $tradeopen_{i,t}$ are the proxies of monetary, fiscal policy, and trade openness, respectively. The initial real GDP per capita, $yinitial_{i,t}$, is employed as a proxy for the stage of economic development and institution. The choice of these control variables closely follows the growth literature and covers the potential threshold factors suggested in the second group of empirical tests, for instance, in Kose et al. (2009).

The data are collected from the World Bank and IMF's databases. All capital flows data are from IMF's *Balance of Payment Statistics* (BOPS) database. Others are from the World Bank database. Among them, inflation rate, $\pi_{i,t}$, the share of government expenditure in GDP, $gov_{i,t}$, and export and import share of GDP, $tradeopen_{i,t}$, are obtained directly from those databases. Others are calculated as follows. The growth rate of real GDP per capita, $g^p_{i,t}$, is the difference of the growth rate of real GDP

[1] Lucas (1990) observes that capital does not necessarily flow from developed countries to developing countries despite the fact that the latter have lower levels of capital per worker and therefore higher marginal return to capital. The recent controversies surrounding the Global Imbalances – which include, as important elements, large current account deficits of the United States and large surpluses of China – provide a vivid example of the anomaly termed the Lucas paradox.

Table 1 Description of variables

Variables			Definition and selection
Suspected endogenous variables	***Instrument variables***	***P value of Hausman test***	
$g_{i,t-1}$	*Lag 2*	0.2120	*Expected real growth rate of GDP* *- average real growth rate of GDP of next five years from time t-1*
$\tau_{i,t}$	*Lag 2*	0.1350	*Inflation rate of time t* *- average cpi of next five years from time t*
$p_{i,t}$	*Lag 2*	0.1987	*Population growth rate of time t* *- average population growth rate of next five years from time t*
Exogenous variables			
$yinitial_{i,t}$	-	-	*Initial real GDP per capita* *-log real PPP gpd per capita of time t*
$gov_{i,t}$	-	-	*Government expenditure* *- average government expenditure share of GDP of next five years from time t*
$tradeopen_{i,t}$	-	-	*Trade openness* *- average export and import share of GDP of next five years from time t*
$cif_{i,t}$	-	-	*Openness of capital inflows* *- average capital inflows share of GDP of next five years from time t*
$cod_{i,t}$	-	-	*Openness of capital outflows* *- average capital outflows share of GDP of next five years from time t*
Threshold variables			
$g_{i,t}$	-	-	*Real growth rate of GDP* *- average real growth rate of GDP of next five years from time t*
$Y_{i,t}$	-	-	*Initial real GDP per capita* *- real PPP GDP per capita of time t*
Dependent variables			
$g^{p}_{i,t}$	-	-	*Real growth rate of GDP per capita* *- average real growth rate of GDP per capita of next five years from time t*

[a] All variables except financial openness are collected from the World Bank database

[b] Financial openness variables are collected from the IMF database

[c] 69 countries data from 1980 to 2017 are used, and after the five-year average process, the dataset of this paper covers 69 countries from 1981 to 2013, a total of 2277 observations

in local currency, $g_{i,t}$, and the population growth rate, $p_{i,t}$. The real GDP per capita, $Y_{i,t}$, used as the threshold variable, is the ratio of real PPP GDP to population. The initial GDP per capita, $yinitial_{i,t}$, is the logarithm of $Y_{i,t}$. Consistent with our purpose to investigate the effects of financial openness separately in capital inflows and capital outflows, we obtain corresponding indexes for financial inflow openness $cif_{i,t}$ and financial outflow openness $cod_{i,t}$ in Eq. (1). Both are de facto measures based on gross capital inflows and outflows and calculated by using nominal GDP and nominal capital flows in US dollars. To avoid the interference of business cycles and to extract the core relationship of long-run economic growth from a mixture of short- and long-term effects of financial openness, we use the five-year average of annual data as in Quinn (2001, 2008), McKenzie (2001), and Eichengreen and Leblang (2003). We obtain a balanced panel data of 69 countries from 1980 to 2017 before the five-year average pretreatment. The definitions, descriptions, and pretreatments of all the variables in our model are summarized in Table 1. We apply the Hausman test for potential endogeneity of control variables. The insignificance of the instrument variables, which are lagged values of suspected endogenous variables, displayed in Table 1 strongly confirms the weak exogeneity of all non-predetermined and politically determined variables.

3.2 Modeling the threshold effect: tests of linear and interaction term models

We start with an initial test of the hypothesis in a linear regression.

$$g^{p}_{i,t} = \tau Q_{i,t} + \beta_1 cif_{i,t} + \beta_2 cod_{i,t} + \varepsilon_{i,t} + \mu_i \tag{3}$$

The regression results are reported in Table 2. The results are mostly consistent with existing studies, except the initial level of income. The negative growth effects of the inflation rate and government expenditure as proxies

Table 2 The linear model

Variables	Coefficient	t-Statistic	*P*-value
$g_{i,t-1}$	0.204	9.90	0.000
$\tau_{i,t}$	-0.001	-4.18	0.000
$yinitial_{i,t}$	1.917	2.65	0.008
$gov_{i,t}$	-0.287	-7.71	0.000
$tradeopen_{i,t}$	0.026	4.26	0.000
$p_{i,t}$	-0.935	-6.34	0.000
$cif_{i,t}$	-1.064	-1.19	0.236
$cod_{i,t}$	1.497	1.69	0.091
R^2	0.1253		
DW statistic	1.9386		

This model is estimated with first-order difference data to eliminate the fixed effect

Table 3 Preliminary tests for non-linear effect: interaction terms

Interaction terms	(1)	(2)	(3)
$cif_{i,t} * g_{i,t}$	-2.899**(-2.767)		
$cod_{i,t} * g_{i,t}$	2.843**(2.735)		
$cif_{i,t} * Y_{i,t}$		-126.9**(-3.122)	
$cod_{i,t} * Y_{i,t}$		128.4**(3.234)	
$cif_{i,t} * tradeopen_{i,t}$			-0.267(-1.114)
$cod_{i,t} * tradeopen_{i,t}$			0.2932(1.204)
$cif_{i,t}$	-0.812(-0.899)	2.193(1.621)	-1.643*(-1.652)
$cod_{i,t}$	1.241(1.394)	-1.826(-1.347)	2.039**(2.073)
R^2	0.128	0.129	0.126

The numbers in parentheses are t-statistics. "**" and "*" indicate significance at 95% and 90% confident level, respectively

of monetary and fiscal policy are interesting. See Barro and Lee (2013) for more discussion. Trade openness is positively related to economic growth. The variables of our main interest − $cif_{i,t}$ and $cod_{i,t}$− are statistically insignificant. Even when we employ capital inflows and outflows separately, there is no strong empirical evidence to support the growth effect of financial openness in this setup. It should be noted, however, that capital inflows and outflows have opposite effects on economic growth. This supports our hypothesis of directional heterogeneity, that is, openness in capital inflows and openness in capital outflows are likely to have differential effects.

To investigate the possible nonlinearity in the nexus of financial integration and economic growth caused by different development stages, we introduce three groups of interaction terms into Eq. (3):

$$g_{i,t}^{p} = \delta interaction_{i,t} + \tau Q_{i,t} + \beta_1 cif_{i,t} + \beta_2 cod_{i,t} + \varepsilon_{i,t} + \mu_i \tag{4}$$

where $interaction_{i,t}$ is a vector of three interaction terms:

1) the interactions of financial openness and growth rate,($cif_{i,t} * g_{i,t}$ $cod_{i,t} * g_{i,t}$)
2) the interactions of financial openness and economic development,($cif_{i,t} * Y_{i,t}$ $cod_{i,t} * Y_{i,t}$)
3) the interactions of financial openness and trade openness, ($cif_{i,t} * tradeopen_{i,t}$ $cod_{i,t} * tradeopen_{i,t}$).

The regression results are displayed in Table 3. They confirm the significance of the interaction effects of economic development level and growth but not trade openness. And more interestingly, financial openness in inflows and outflows continues to have opposite effects on economic growth, which are statistically significant. However, adding the simple nonlinear effects with the interaction terms does not significantly improve the fit as measured by R^2. (It does not significantly improve compared to the linear model.) This conflicting evidence suggests that there may be a higher level of nonlinear interaction in the nexus of financial openness and economic growth.

Based on the above results, we construct a panel threshold model by introducing two potential threshold variables – growth rate, $g_{i,t}$, and economic development level, $Y_{i,t}$ − into the model to incorporate the development stage and the diverse development constraints of each economy.

$$g_{i,t}^{p} = \tau Q_{i,t} + \beta_1(g_{i,t}, Y_{i,t}) cif_{i,t} + \beta_2(g_{i,t}, Y_{i,t}) cod_{i,t} + \varepsilon_{i,t} + \mu_i \tag{5}$$

We employ the method developed by Hansen (1999) for estimation. Regime-centralized data are used to handle the fixed effect and the regime-specific intercepts. The estimates for the thresholds are obtained by minimizing the sum of squared residuals.

4 Estimation results

4.1 Tests for the threshold effect

As our model contains two potential threshold variables, we examine the initial value of each potential threshold variable independently and the subsequent values on the basis of the *p-value* of the likelihood ratio generated by bootstrap sampling. The likelihood ratio is calculated for the sums of squared residuals of the null and alternative models. It is an indicator of model fitness improvement with the new threshold value. If it is statistically different from zero, it suggests a significant presence of the threshold effect. Specifically, for the first threshold value of each potential threshold variable, we employ the Hansen's (1999) test:

Table 4 Test statistics determining the number of thresholds

Hypothesis	*P*-value
Single threshold effect of $Y_{i,t}$	0.564
Single threshold effect of $g_{i,t}$	0.039
Double threshold effect of $g_{i,t}$	0.118
Mixed threshold effect of $Y_{i,t}$ *under* $g_{i,t}$	1.000
Bootstrap Replication	1000

Note: We use bootstrap simulation to obtain the distribution of each potential threshold value. Like Hansen (1999) and Meller (2013) the process is based on the likelihood ratio of each threshold value. The program is coded by MATLAB and the statistics results may vary for different times of running the program, but it has no influence on the thresholds determination result

$$\left\{ H_0 : LRT_{j,1} = 0 \ H_1 : LRT_{j,1} \neq 0 \right\} \tag{6}$$

where H_0 (H_1) represents the null (alternative) hypothesis and $LRT_{j,z}$ is the likelihood ratio of the z^{th} value of the threshold variable $j \in \{ g^p, Y \}$. For each additional potential threshold value, we test its significance on the basis of already confirmed threshold effects.

The null and alternative hypotheses, H_0 and H_1, can be spelled out as follows:

$$\left\{ H_0 : \begin{cases} LRT_{g^p,m+1|\left(g^p_{1,m} \ Y_{1,n}\right)} = 0 \ \text{if} j = g^p \\ LRT_{Y,n+1|\left(g^p_{1,m} \ Y_{1,n}\right)} = 0 \ \text{if} j = Y \end{cases} \ H_1 : \begin{cases} LRT_{g^p,m+1|\left(g^p_{1,m} \ Y_{1,n}\right)} \neq 0 \ \text{if} j = g^p \\ LRT_{Y,n+1|\left(g^p_{1,m} \ Y_{1,n}\right)} \neq 0 \ \text{if} j = Y \end{cases} \right\} \tag{7}$$

where $LRT_{g^p_{m+1}|\left(g^p_m \ Y_n\right)}$ is the likelihood ratio of the $m+1^{st}$ threshold value of g^p under the already confirmed threshold values of $\left(g^p_m, \ Y_m\right)$. Due to the discontinuity of the threshold value grid, it is infeasible to directly obtain the distribution of likelihood ratios. We employ bootstrap simulation as suggested by Hansen (1999) and Meller (2013).

In the first step, we obtain the distribution of the likelihood ratio for each possible threshold, and choose a single threshold effect of economic growth, as reported in Table 4. The tests against the single threshold effect are conducted on the null hypothesis of no threshold effect for both economic growth and the development stage. The results indicate a single threshold effect of economic growth with *p-values* 0.039 and 0.564, respectively. Then we test against the double threshold effect for economic growth, which yields the *p-value* of 0.118, and a mixed threshold effect for the development stage with the *p-value* of 1.000. Neither test rejects the null hypothesis of no further threshold effect. We thus choose a single threshold effect of economic growth in the following reports.

Table 5 reports the estimation results of the threshold regression model. The coefficient estimates of other variables, except for the initial economic condition $yinitial_{i,t}$, remain similar to those of the benchmark model in Table 2. The relation between the initial condition and economic growth is reversed to negative when using the threshold model. This is consistent with the long-held convergence hypothesis in the growth literature developed by Solow (1956) and Barro and Sala-i-Martin (1991). The single threshold is estimated to be the growth rate at 5.74 percent.

Table 5 Estimation results of the threshold model

Variables	Coefficient	t-Statistic	*P*-value
Threshold estimate			
$\hat{\gamma}$	5.74		
Regression estimates			
$g_{i,t-1}$	0.799	75.46	0.000
$\tau_{i,t}$	-0.001	-3.73	0.000
$yinitial_{i,t}$	-1.104	-10.30	0.000
$gov_{i,t}$	-0.029	-2.92	0.002
$tradeopen_{i,t}$	0.005	3.94	0.000
$p_{i,t}$	-1.115	-23.47	0.000
$cif_{i,t}\left(g_{i,t} \leq 5.7430\right)$	-1.461	-3.94	0.000
$cod_{i,t}\left(g_{i,t} \leq 5.7430\right)$	1.477	3.94	0.000
$cif_{i,t}\left(g_{i,t} > 5.7430\right)$	7.459	7.73	0.000
$cod_{i,t}\left(g_{i,t} > 5.7430\right)$	-3.480	-4.44	0.000
R^2	0.7767		

Estimation is done with regime-normalized data to take care of individual fixed effects and the discontinuity of each variable caused by threshold effect

All samples are then divided into two regimes based on their economic growth rate. Economies enjoying rapid growth, whose growth rates are higher than the threshold, benefit significantly from capital inflow openness with a coefficient of 7.459, while growth tends to be held back by capital outflow openness with a coefficient of -3.480. Economies in the low-growth regime, on the other hand, benefit from capital outflow openness and suffer from capital inflows as indicated by the coefficients of 1.477 and -1.461. Both sets of estimates are statistically significant.

Key supporting evidence of our hypothesis is provided in the last row which shows that the threshold model improves the fit of regression significantly, raising R^2 from 0.125 of the linear model (in Table 2), and 0.126 to 0.129 of the interaction models (in Table 3) to 0.777. The change of R^2 is critical to support our hypothesis of threshold effect. Although the nonlinear model successfully detects the nonlinearity in the nexus of financial integration and economic growth, interaction terms do not significantly improve the goodness of regression fit.

The huge improvement in the statistical fit of the data seems to result from the explicit consideration of the reversals of the growth effects of financial openness in different regimes when the sample switches from a low-growth regime to a high-growth one. In other words, it is important to allow both the threshold effect and the directional heterogeneity to have a proper understanding of the financial openness-growth nexus.

In sum, the empirical results support the hypothesis that developing economies with promising growth expectation will significantly benefit from capital inflows to overcome their saving-constraints, while either developed or slow-growing developing economies will benefit more from capital outflows and higher investment returns in international financial markets. The results confirm the hypothesis we have developed to understand conflicting empirical results in the existing studies.[2]

4.2 Robustness

In this section, we test the robustness of the results with respect to (i) variable definition, (ii) model specification and (iii) sample selection to obtain more convincing evidence independent from specific dataset or models. More specifically, (1) we estimate a dynamic panel data model withthe estimated threshold effect to identify whether the definition of the trend in the model will affect the regression results. (2) We estimate a dynamic panel model developed by Seo and Shin (2016) to test against potential endogeneity. And (3) we estimate an unbalanced panel data model with the dataset containing all data we can get from IMF and World Bank databases to investigate the influence of sample selection.

4.2.1 Tests of endogeneity: variation to variable definition and model specification

Our model in original specification is a threshold dynamic panel model:

$$g_{i,t}^{p} = \tau g_{i,t-1}^{p} + \gamma X_{i,t} + \beta_1 (g_{i,t}) cif_{i,t} + \beta_2 (g_{i,t}) cod_{i,t} + \varepsilon_{i,t} + \mu_i \quad (8)$$

With first differencing to deal with the fixed effect, the regression equation becomes:

$$\Delta g_{i,t}^{p} = \tau \Delta g_{i,t-1}^{p} + \gamma \Delta X_{i,t} + \beta_1 (g_{i,t}) \Delta cif_{i,t} + \beta_2 \Delta (g_{i,t}) cod_{i,t} + \Delta \varepsilon_{i,t} \quad (9)$$

Lagging Eq. (8) by one period yields:

$$\Delta g_{i,t-1}^{p} = (\tau - 1) g_{i,t-2}^{p} + \gamma X_{i,t-1} + \beta_1 (g_{i,t-1}) cif_{i,t-1} + \beta_2 (g_{i,t}) cod_{i,t-1} + \varepsilon_{i,t-1} + \mu_i \quad (10)$$

In Eq. (9), both $\Delta g_{i,t-1}^{p}$ and $\Delta \varepsilon_{i,t} = \varepsilon_{i,t} - \varepsilon_{i,t-1}$ contain the lagged error term $\varepsilon_{i,t-1}$, suggesting that it suffers from the problem of endogeneity of $\Delta g_{i,t-1}^{p}$. By factorizing the growth trend term into two weakly exogenous parts, $g_{i,t-1}$ and $p_{i,t}$, we treat them as the instrument variables to handle the endogeneity issue. However, using Hansen (1999)'s methodology we employ the OLS to estimate the model, which may produce biased estimates or even influence the significance of the threshold effect. We thus need to check the robustness of the estimation results reported in the previous sections.

Against the endogeneity issue, we consider two different variations in the model: (1) test the influence of endogeneity on regressors and (2) test the influence of endogeneity on the threshold effect. To check the possibility of bias due to the use of the IV-OLS method in our model, we start our robustness test with Eq. (8) and the given threshold value in Table 5. Endogeneity can affect not only the estimates, but also the whole regression. While the threshold effect is the core hypothesis stemming from the directional heterogeneity mechanism suggested by this paper, we need to check the robustness of the model specifications. Following the empirical results above that detect only one significant threshold effect of growth rate, we work with an alternative model with the threshold effect and endogeneity, similar to the dynamic panel data model with the threshold effect developed by Seo and Shin (2016).

We first employ GMM to estimate the model, Eq. (8). The results reported in Table 6 are generally similar to those of the panel-data estimation in terms of the value, sign, and significance of the regressors. Although the coefficient estimates are no longer significant in a few cases such as government expenditure, trade openness and capital outflow openness of high growth regime, we do not consider the finding sufficient enough to reject the threshold model, because GMM estimation is known to lack efficiency albeit unbiased. Furthermore, the *J-statistic* indicates that the dynamic model is well identified. In sum, the regression results in Table 6 indicate that potential endogeneity of the growth term has no significant influence in the empirical results.

[2] We also note that the conflicting results in the existing studies may arise from insufficient data of fast-growing developing economies. As most developed economies are in the low growth regime and have the most comprehensive data, while fast-growing developing economies do not offer the same data coverage as developed economies, among 5270 available observations in the whole dataset, 3964 observations (75.2 percent) are from developed economies. This consequently leads past studies employing linear models to conflicting results. Furthermore, the selection process of a balanced panel dataset inevitably eliminates data of developing economies more disproportionately and raises the observation proportion of developed economies to 84.9 percent. The latter yields a set of more biased regressors as shown in Table 2.

Table 6 GMM estimation of dynamic panel data model

Variables	Coefficient	t-Statistic	*P*-value
$g^p_{i,t-1}$	0.705	92.53	0.000
$\tau_{i,t}$	-0.002	-7.71	0.000
$yinitial_{i,t}$	-1.116	-7.40	0.000
$gov_{i,t}$	0.016	0.89	0.373
$tradeopen_{i,t}$	-0.003	-1.57	0.378
$cif_t(g_{i,t} \leq 5.743)$	-6.190	-2.42	0.002
$cod_t(g_{i,t} \leq 5.743)$	6.428	2.62	0.001
$cif_t(g_{i,t} > 5.743)$	7.695	3.03	0.006
$cod_t(g_{i,t} > 5.743)$	2.426	0.54	0.287
J-statistic (Sargan Test)	66.83		
P-value (J-statistic)	0.254		

Table 7 Dynamic panel data with threshold effect and endogeneity

Variables	Coefficient	S.E	P-value
Threshold estimate			
$\hat{\gamma}$	3.36		
Regression estimates			
$g^p_{i,t-1}$	0.599	0.019	0.000
τ_t	-0.0003	0.0002	0.058
$yinitial_t$	-0.548	0.105	0.000
gov_t	-0.006	0.012	0.328
$tradeopen_t$	0.002	0.001	0.095
$cif_t(g_t \leq 3.356)$	-3.351	0.753	0.000
$cod_t(g_t \leq 3.356)$	3.583	0.759	0.000
$\Delta\alpha$	-1.893	0.069	0.000
$cif_t(g_t > 3.356)$	1.275	0.635	0.022
$cod_t(g_t > 3.356)$	-1.315	0.645	0.021

To identify the robustness of our model's specification, we employ a dynamic panel model with threshold effect developed by Seo and Shin (2016) which tests the endogeneity and threshold effect simultaneously in one regression. The estimation results are reported in Table 7. They are consistent with the GMM estimation of Table 6. Government expenditure remains insignificant while trade openness has a weakly positive effect on economic growth. The effects of financial openness still have the same directions in the low-growth regime and for the capital inflows in the high-growth regime, but with estimates greater than those in Table 6. The difference in results is mainly caused by the new threshold value and regime-dependent intercepts. The former changes the regression sub-dataset for each regime and affects the coefficient estimates for financial openness.

The issue of regime-dependent intercepts results from the use of lagged difference values as instrument variables in Seo and Shin's (2016) model. Our threshold model employs normalized variables and eliminates sectional fixed effects and regime-dependent intercepts at the same time. The Hausman tests indicate there is no endogeneity problem in our regression. This suggests that lagged differences are unnecessary as instrument variables. Seo and Shin's (2016) dynamic panel data model employs first differences to deal with the fixed effect, thus omitting the difference of the regime-dependent intercepts, $\Delta\alpha$. Consequently, the existence of the intercept and the difference of fixed effect transformations lead to the inconsistent estimates of the threshold value. But the results reported in Table 7 confirm the threshold effect of economic growth, and that capital inflow and outflow openness measures have significantly different effects depending on their growth rates.

It should be noted that there exists a sizable difference between the estimated values of the threshold growth rate in Tables 5 and 7: 5.74 percent and 3.36 percent. It seems to be caused by the endogeneity problem. The implications are significant. The new estimate increases the number of eligible economies that can embrace international capital inflows and manage capital outflows to take advantage of financial integration and boost economic growth.

4.2.2 Tests of sample selection

As we discuss briefly in the literature review and in the discussion of empirical results, the asymmetry in dataset coverage is an important issue which may affect the coefficient estimates and the significance of related regressions of financial openness and economic growth. To investigate the bias due to sample selection, we employ the unbalanced dataset covering all 173 countries with the estimated threshold effect to test the robustness of universality of mechanisms and hypotheses.

Hansen's panel data threshold model requires balanced panel data. Our dataset collected from the World Bank and IMF database contains 5709 observations from 173 countries, only about half of them are used in regressions. The universality of empirical results is an issue that cannot be ignored.[3] So, in this section, we employ an unbalanced panel data model to check the robustness of sample selection on estimators.

The coefficients of control variables and financial openness variables are obtained by taking the given

[3] Meller (2013) also counters a similar problem and argues that, while the balanced panel data should be used to determine the threshold effect in empirical tests, the whole dataset still needs to be employed to test the robustness.

Table 8 Estimation results of the unbalanced panel

Variables	Coefficient	t-Statistic	P-value
$g_{i,t-1}$	0.778	76.95	0.000
$\tau_{i,t}$	-0.001	-3.90	0.000
$yinitial_{i,t}$	-1.478	-15.31	0.000
$gov_{i,t}$	-0.035	-3.77	0.000
$tradeopen_{i,t}$	0.008	5.94	0.000
$p_{i,t}$	-1.140	-26.59	0.000
$cif_{i,t}(g_{i,t} \le 5.7430)$	-0.507	-2.03	0.043
$cod_{i,t}(g_{i,t} \le 5.7430)$	0.484	1.90	0.058
$cif_{i,t}(g_{i,t} > 5.7430)$	6.307	7.65	0.000
$cod_{i,t}(g_{i,t} > 5.7430)$	-2.854	-3.82	0.000
R^2	0.7793		

threshold effect. While less constrained from the exclusion issue due to the unavailability of data for the control variables such as inflation rate and government expenditure, the estimates in Table 8 exhibit neither significant value changes of control variables nor sign reversals of regime-dependent variables. The sizes of the effect of financial openness on economic growth for both growth regimes have changed, however. By introducing more observations for the least developed and slowly developing economies into the low-growth group dataset, both the coefficients of capital inflows and outflows become smaller. Because the least developed economies rarely have capital inflows and suffer from capital outflows, the inclusion of more observations from them thus weakens the effects of capital inflow and outflow. For the high-growth regime, however, main change comes from China, which was excluded from the balanced panel due to the insufficient data for inflation in the World Bank database that starts from 1986. With extremely high economic growth rates and more controls on financial openness, including China in the sample makes the estimates of the threshold smaller. Although there are some differences in the estimates, they seem to be due to the inherent issues of the datasets in the panel. We consider the results presented in Table 8 confirm the robustness and the universality of our empirical test.

4.3 Implications

In the absence of the significant threshold effect of the level of income, our results do not seem to support the threshold effects related to development stages. We consider the empirical evidence of a single threshold effect of economic growth rate to be more consistent with Rodrik and Subramanian (2008) model of the dichotomous saving/investment constraint. In this section, we compare the sample distribution of the threshold effects with the development stage classification to investigate the empirical results with our hypothesis.

Based on the regression results, we obtain the percentage of time in years each country stays in the low-growth regime (PTLR). Obviously, the higher the value of PTLR, the greater the benefits from financial outflow openness. Their distributions in the form of boxplots are presented in Figs. 1 and 2. We employ two different country classifications: The World Economic Situation and Prospects (WESP 2021) reports published by the United Nations in Fig. 1 and the MSCI emerging &

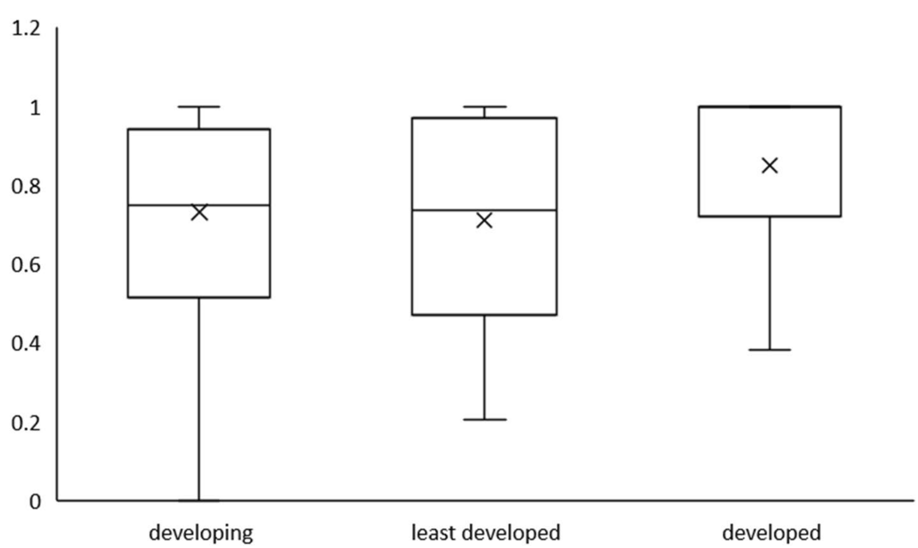

Fig. 1 PTLR distributions based on WESP classification

Economies used in Figs. 1 and 2 are listed in Additional File 1

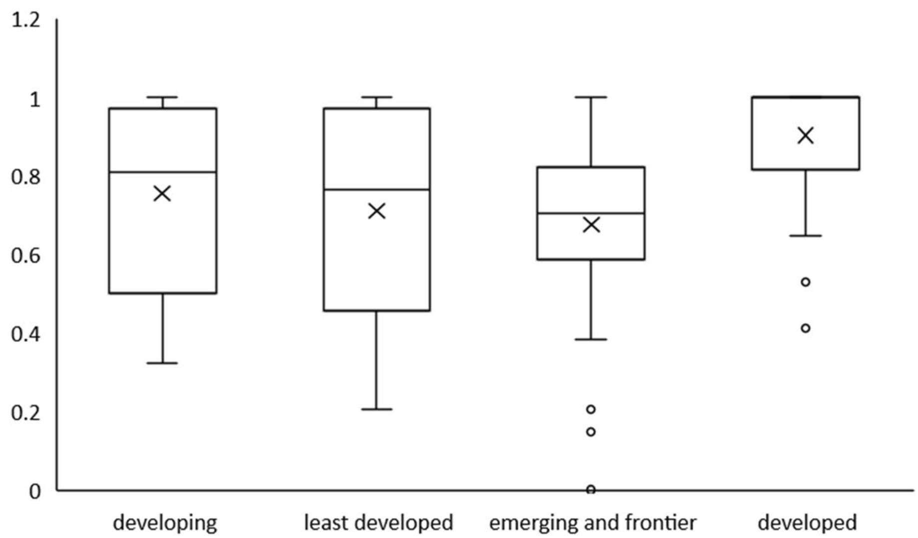

Fig. 2 PTLR distributions based on IMF classification

Economies used in Figs. 1 and 2 are listed in Additional File 1

frontier markets index in Fig. 2. (The WESP data does not separate emerging countries from developing countries, and we introduce MSCI classification to identify emerging and frontier economies.)[4] In the plots, each line of the box represents the quantile values of each group. Samples located beyond them are "singular" points. "x" denotes the average PTLR value of each group. A comparison with the median value indicated by the middle line within the box shows the skewed distributions of PTLRs. Outside the box, the two lines at the upper and lower ends define the statistical interval for each group. The value of upper (lower) band is calculated by adding (subtracting) one and half times the of quantile range to (from) the first (third) quantile value.

In the developed economies group, the upper limit, first quantile and the median PTLRs all coincide at the maximum value, 1. With median at 1 and the third quartile at 0.7205, nearly three quarters of developed economies stay in the low-growth regime during the whole sample period. Considering the potential role of development stage for some new rich countries, the PTLR of the developed economies would be even higher if we could classify each country for each year. Least developed economies and developing economies have similar distributions in terms of the first to third quartiles and average values and are significantly lower than the developed economies.

In Fig. 2, where emerging and frontier countries are separated from developing economies, the new group has significantly lower PTLRs, while the boxplot of developing economies group moves up slightly. The significant difference between the developed economy group and the emerging economy group still link our empirical results to the role of developing stage in the conventional hypothesis. Furthermore, consistent with the presumption of convergent development that, at some point, rising real income will be accompanied by slowing growth rates, the threshold effect of economic growth rate may overlap with that of economic development. In this sense, the plots in Figs. 1 and 2 suggest that the threshold variables pick up the development stage of economies.

Interestingly, there are a large number of developing economies whose PTLR distribution is quite similar to that of the least developed economy group but significantly different from that of emerging market economies. Our empirical results suggest that those developing economies are more likely to benefit from capital outflows than inflows. They also provide a clue to resolve the Lucas paradox or the puzzling capital flows from the South to the North against the prediction of the neoclassical model.

5 Concluding remarks

In this paper, we investigate the relationship between international financial integration and economic growth. Recent studies such as Kose et al. (2009) and Rodrik and Subramanian (2008) emphasize the absorptive capacity of the capital-recipient economy for inward movement of international capital to be efficiently used and contribute to economic growth. Most studies including Kose et al. (2009) consider financial development as the key

[4] IMF has discontinued the list of emerging economies. We thus choose MSCI index instead.

determinant of the absorptive capacity of the economy. Rodrik and Subramanian (2008), however, emphasizes the underlying nature of the economy and the cause of capital movement. If the economy faces a saving shortage with abundant investment opportunities, capital market opening and capital inflows would be growth-enhancing. If it suffers from an investment constraint, in marked contrast, capital inflows are more likely to be harmful and inhibit growth.

Our review of recent empirical studies suggests directional heterogeneity and endogeneity are two potential sources of conflicting findings among the existing studies. We consider two threshold variables: (i) the level of per capita real GDP as a proxy for financial/institutional development and (ii) the rate of economic growth as a determinant between saving shortage and excess saving. We find the empirical results obtained from a panel data model with a single threshold of economic growth to be robust to variations in variable definition, model specification and data selection. In sum, the empirical setup with directional heterogeneity and endogeneity allows us to determine the key source of mixed empirical findings in the nexus of financial integration and economic growth. Capital account openings in inflows and outflows are likely to have significantly different effects on economic growth while the role of the growth rate seems to be varying as the core characteristic of capital flow mechanism. We obtain robust evidence for the growth effect of financial openness with de facto measurements of financial integration and a cross-nation panel dataset of countries from the IMF and World Band databases.

Our results tend to support Rodrik's hypothesis in that economic growth is chosen over the development stage as the threshold variable. In other words, the economies in the high-growth regime are more likely to suffer from saving shortages than from lack of investment opportunities. The results have important policy implications. History's key lesson is that no country will remain on a high-speed growth trail indefinitely. Sooner or later, economic growth tends to fizzle down. This suggests that the benefits of financial market opening and the resulting capital inflows will be only temporary even in a successful high-growth economy. Once economic growth slows down, financial integration may turn into a growth-inhibiting mechanism. This is not inconsistent with the fact that frequent financial crises and the resulting severe disruptions derail a number of emerging market economies in the past few decades of financial market opening. Further investigation is warranted into this issue. Policymakers in developing/emerging market economies are advised that capital inflows need to be monitored carefully to maximize their benefits while minimizing their potential costs.

Supplementary Information

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Additional file 1.

Author's contributions

Chao Chen conceived the study and were responsible for the design and development of the data analysis. Yoonbai Kim revised the first draft and confirmed the content of the entire article. Chao Chen was responsible for supervision and funding acquisition.

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Declarations

Competing interests

The authors declare that there is no competing interest regarding the publication of this paper.

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