ADBI Working Paper Series

THE INTEREST RATE EFFECT ON PRIVATE SAVING: ALTERNATIVE PERSPECTIVES

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No. 715
April 2017

Asian Development Bank Institute

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Suggested citation:

Aizenman, J., Y.-W. Cheung, and H. Ito. 2017. The Interest Rate Effect on Private Saving: Alternative Perspectives. ADBI Working Paper 715. Tokyo: Asian Development Bank Institute. Available: https://www.adb.org/publications/interest-rate-effect-private-saving-alternative-perspectives

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Aizenman and Ito gratefully acknowledge the financial support of faculty research funds of University of Southern California and Portland State University. Cheung gratefully acknowledges the Hung Hing Ying and Leung Hau Ling Charitable Foundation (孔慶熒及梁巧玲慈善基金) for their support through the Hung Hing Ying Chair Professorship of International Economics (孔慶熒講座教授(國際經濟)).

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Abstract

Conventional logic suggests that lowering the policy interest rate will stimulate consumption and investment while discouraging people from saving, but low interest rates may also prompt people to increase their saving to compensate for the low rate of return. Using data on 135 countries from 1995 to 2014, this paper shows that a low-interest rate environment can yield different effects on private saving across country groups under different economic environments. A well-developed financial market, an aging population, and output volatility can all contribute towards turning the relationship between interest rates and saving negative. Among developing countries, when the nominal interest rate is not too low, we detect the substitution effect of the real interest rate on private saving. However, among industrial and emerging economies, the substitution effect is detected only when the nominal interest rate is lower than 2.5%. In contrast, emerging-market Asian countries are found to have the income effect when the nominal interest rate is below 2.5%. When we examine the interactive effects between the real interest rate and the variables for economic conditions and policies, we find that the real interest rate has a negative impact—i.e., income effect—on private saving if any output volatility, old dependency, or financial development is above a certain threshold. Further, when the real interest rate is below 1.5%, greater output volatility would lead to higher private saving in developing countries.

JEL Classification: F3, F31, F32, F36

Contents

1. INTRODUCTION

In the summer of 2014, when the European Central Bank changed its interest rate on excess bank reserves to –0.1%—a negative policy interest rate for the first time in not only its own history but also in the history of major central banks—advanced economies implementing unconventional monetary policies entered a new phase.[1] Eighteen months later, this action was followed by the Bank of Japan's decision to adopt negative interest rates. As of the fall 2016, 19 euro countries, plus Japan, Denmark, Sweden, and Switzerland, have adopted negative policy interest rates.

As unconventional actions often face opposition in general, negative interest-rate policies have also faced challenges against their effectiveness. Conventionally speaking, lower interest-rate monetary policy is supposed to encourage present-day consumption (as opposed to future consumption), by lowering the rewards for postponing consumption. More simply, lowering the policy interest rate is expected to stimulate consumption and investment while discouraging people from saving. Expected as a further drastic action, negative interest rates would not just discourage, but also penalize people if they postpone consumption. Hence, conceptually, negative interest rates should lead people to spend now rather than later and therefore discourage saving.

Recently, debates have proliferated regarding the effectiveness of negative interest-rate policy. Some people have argued that negative interest rates may not work as central bankers expect.

As for the link between the interest rate and saving, the argument is as follows: lower or negative interest rates may contribute to higher, not lower, saving rates because the rate of return per financial instrument is so low that people may try to compensate by increasing their aggregate amount of saving. This scenario can be especially true in an economy with an aging population, as people might want to target their saving to be better prepared for retirement. Such a tendency can also be strong in an economy in which sufficient social protections such as social securities and unemployment benefits are not available. Generally, people may want to increase their aggregate amount of saving in response to lower interest rates if they face a gloomy and more volatile economic outlook. Thus, the behavior of precautionary saving may change depending on economic or policy conditions.

This is not just an issue for advanced economies with low or negative interest rates, but for developing economies as well. In fact, in a developing economy with financial repression, nominal interest rates tend to be artificially repressed and therefore the real rates of return tend to be low. This situation can exacerbate if the economy of concern experiences high inflation. If such an economy is also coupled with underdeveloped public social-protection programs, people have reason to increase the aggregate amount of saving for precautionary purposes.

While the interest rate effect on private saving is commonly perceived to be positive, Nabar (2011) notes that the People's Republic of China (PRC) experienced a combination of rising household saving and declining real interest rates during the 2000s. Using province-level data over the 1996–2009 period, Nabar empirically shows that when the return to saving declines, household saving rises.

[1] As an exception, Denmark had lowered its benchmark rate to a negative figure in mid-2012. Another exception is Switzerland, which levied negative interest rates on CHF deposits from non-residents in 1972 to curb rapid capital inflows. This policy lasted until 1978.

Is the PRC's documented interest-rate-saving link an isolated instance or an example of the negative income effect of the interest rate? To shed some light on this question, we employ a panel of countries to conduct an extensive empirical study on the link between interest rates and private saving. At the outset, we recognize that the interest rate effect on private saving can be ambiguous. As noted earlier, low interest rates can discourage saving because of the substitution effect, or conversely, encourage saving via the income effect to achieve, say, a targeted saving goal.

Because of the conflicting channels, the observed or final effect of the interest rate on saving can depend on the level of the interest rate itself as well as on other contributing factors. In an environment in which the interest rate is extremely low, the income effect may, for example, outweigh the substitution effect. In other words, in such an environment, agents may be worried about the possibility of not meeting financial investment objectives such as retirement, and therefore try to overcome the low return by increasing the aggregate volume of saving. In this case, lower interest-rate levels would lead to higher levels of saving. Or, the effect of the interest rate on saving may differ depending on macroeconomic or demographical conditions or policy environment.

Examining the link between the interest rate and saving is important. In the short term, whether policy interest rates and saving rates have a positive or negative relationship also refers to the kind of impact a monetary policy would have on consumption and is therefore related to the question of stabilization measures.

Furthermore, this issue is also important in the context of the global imbalance debate. In the years leading up to the Global Financial Crisis of 2008 (GFC), many emerging market economies in East Asia (most notably the PRC) and oil exporters persistently ran current-account surpluses during the global trend of lower real interest rates. Some economists argue that high savings in rapidly growing emerging markets are responsible for such current account surpluses and thus contributing to global economic instability (Greenspan 2005a, b; and Bernanke 2005). Hence, investigating how an ultra-low-interest rate environment would contribute to saving on a global scale is important.

In the long term, the impact of the interest rate on saving is related to the question of capital accumulation, which would determine future income level and thereby present-day consumption and saving. Thus, the nature of the interest-rate–saving link can be an important determinant for the sustainability of long-term economic development.

Therefore, we investigate whether the interest rate has the income (i.e., negative) effect or the substitution (i.e., positive) effect on private saving by using panel data of 135 countries over the 1995–2014 period while controlling for other factors that can affect the behavior of private saving. Furthermore, we will empirically examine whether and how the impact of the interest rate on saving can be affected by economic, demographical, and policy conditions.

Throughout the paper, we pay special attention to Asian emerging market economies. This is because, first, the Asian region has been identified as one of the most dynamic regions in terms of its robust economic growth and development, and second and more importantly, the region receives much attention and sometimes criticisms for its excess saving allegedly contributing to global current account imbalances.

In the next section, we introduce potential determinants of private saving and discuss their impacts. In the same section, we present some stylized facts of private saving and the real interest rates to show general trends of these variables. In Section 3, we introduce our estimation model and discuss the results from the baseline estimations.

We extend our analysis and examine whether any interactive effects exist between the real interest rate and other macroeconomic and structural conditions in Section 4. In this section, we also discuss the implications of our estimation results for several major emerging market economies. In Section 5, we offer concluding remarks.

2. THEORY AND EVIDENCE ABOUT PRIVATE SAVING

2.1 What Kind of Saving Do We Focus On?

A large number of studies have investigated the determinants of saving; a sample of these studies include Masson et al. (1998), Loayza et al. (2000a, 2000b), Aizenman et al. (2015), and Aizenman and Noy (2013). Since these studies have provided comprehensive reviews on theory and empirical evidence pertaining to the determinants of saving, we focus on the theoretical predictions of the factors relevant to our empirical analysis.

Before introducing potential determinants of saving, we need to clarify the kind of saving we are referring to. In this paper, we consider private saving, which we define as the difference between domestic saving and public saving. Considering that our interest is to assess the relative importance of income and substitution effects on shaping the interest-rate impact on saving, it would have been ideal if we had been able to focus on household saving.

However, we have two reasons for avoiding using household saving data—one practical and the other conceptual. First, in a practical sense, household saving data are extremely limited. One reason for this scarcity is that household saving data are typically derived from government surveys that could be based on a wide variety of methods across countries (and over time). Even if we had a uniform survey method, disagreements could arise over what to include in consumption, saving, or disposable income when calculating the saving rate. For example, the question exists whether capital gains from financial investments should be included in saving or disposal income, or both. Similar concerns arise for social security payments, or depreciation of household assets in saving or income. Depending on the methodologies of data construction, there can be a wide variety of household saving.[2] Different types of household saving data exist for different countries. Also, the type of items that should be included in saving and income to compute the saving rate depends on the aspect of saving behavior a researcher chooses to study. Hence, a data set of household saving rate that is consistently compiled is hard to obtain. Although the Organisation for Economic Co-operation and Development (OECD) publishes consistent household saving data for 33 countries, the data are mostly composed from advanced economies.

There is also a conceptual reason that makes it difficult to use household saving data. The line between household and corporate saving, which sum up to define private saving, can be blurry. This issue is prevalent among developing countries because of the existence of vast informal labor markets that make it difficult to separate corporate income from household income and vice versa. To a certain extent, there are also difficulties in disentangling household, corporate income, and consumption in advanced economies.

[2] There can also be gross or net household saving. See Audenis et al. (2004) for details.

Hence, we focus on private saving as a share of gross domestic product (GDP), in which we obtain the amount of private saving by subtracting the general government–budget balance from domestic saving while assuming the latter equals the sum of household, corporate, and public savings.

2.2 Theoretical Predictions of the Determinants of Private Saving

We now discuss the theories underlying the determinants of private saving and, hence, the expected signs of estimated coefficients in the following empirical analysis.

Persistence: Considering that economic agents usually try to smooth their consumption, private saving should also be smoothed out, and therefore, it tends to be serially correlated. Also, the determinants of private saving can have impact with some time lags; thus, private saving tends to show inertia. A number of empirical studies include the lagged dependent variable as one of the explanatory variables, and the lagged dependent variable tends to be highly significant with relatively large magnitudes.

Public saving: The theory of Ricardian equivalence predicts that, in a world where tax policy creates no distortion, any change in public saving can be offset exactly by the same but opposite change in private saving, which makes its estimate negative with a magnitude of one. However, empirical studies usually show that a full offset is not existent, but that a partial offset is often prevalent, with the average absolute estimate ranging 0.25–0.60.[3]

Credit growth: If credit constraint is mitigated by credit growth, agents would increase their consumption, and hence, decrease saving (Loayza et al. 2000a, 2000b). Therefore, we can expect the estimate on credit growth to be negative. We include the growth rate of private credit creation (as a share of GDP) as a proxy for credit growth or credit availability.

Financial development: Further financial development or deepening could induce more saving through increased depth and sophistication of the financial system. As a contrasting view, more developed financial markets lessen the need for precautionary saving and thereby lower the saving rate. Thus, the predicted sign of the estimate for the financial development variable is ambiguous. We use private credit creation (as a share of GDP) as a proxy for financial development.

Financial openness: The impact of financial openness on saving behavior can also be explained similarly to that of financial development. To measure the extent of financial openness, we use the Chinn–Ito index (2006, 2008) of capital account openness.[4]

Both financial development and financial openness could affect the level of private saving through the price channel. That is, financial development and liberalization usually mitigates financial repression, in which the interest rate tends to be artificially depressed due to regulatory controls and lack of competition. Once financial repression is mitigated, higher interest rates can prevail and affect private saving, although the effect of interest rates on saving can be ambiguous. We can expect, at the very least, to see interactive effects between financial development or openness and the interest rate.

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[3] See de Mello et al. (2004).

[4] For both financial development and financial openness, Chinn et al. (2014) find negative effects on national saving.

Output volatility: Risk-averse consumers who face more volatile income flows might set resources aside for precautionary reasons in order to mitigate unexpected future income shocks and smooth their consumption streams.[5] Hence, generally, we can expect private saving to be positively correlated with output volatility.[6]

Income growth: Based on the permanent income hypothesis (Friedman 1957), higher income growth, which may represent higher future growth, should lead to higher saving. The life-cycle hypothesis (Modigliani and Brumberg 1954) is vague on such a link, making it conditional on other factors including credit constraint. A vast empirical literature has shown that income levels are positively correlated with saving.

Demography: The life-cycle hypothesis (Friedman 1957) shows that demographical distribution of the population affects saving behavior. Both young and old populations tend to dissave while the working population tends to save to both pay off past debt and prepare for retirement life.

Per capita income level (in PPP): The stage of development, as well as demographic characteristics, should also affect saving behavior. Highly developed economies may live on savings from periods when they were high-growth economies and thus the impact of economic development can be negative. However, both the permanent income hypothesis (Friedman 1957) and the lifetime-cycle hypothesis (Modigliani and Brumberg 1954) predict that the impact of income shocks on consumption—i.e., saving—depends on whether the shocks are temporary or permanent. Although temporary positive shocks to income would lead merely to an increase in saving but no change in consumption, permanent shocks might lead to an increase in consumption, that is, a decrease in saving.[7] In either case, per capita income should lead positively to saving based on these hypotheses. Furthermore, more practically, a measure of per capita income can be highly correlated with the level of institutional or legal development. Economies with more developed institutions or legal systems can provide a friendly environment for saving, which also suggests a positive impact of income level. Thus, the predicted sign of a measure of economic development should be ambiguous.

Interest rates: The effect of the interest rate on saving is equivocal. On the one hand, changes in the interest rate could have a substitution effect on saving; for example, the lower the interest rate, the higher the level of consumption—i.e., leading to a lower level of saving. On the other hand, changes in the interest rate could have an income effect. In other words, the lower the interest rate, the higher the expected level of saving, because the lower rate of return from investment must be compensated by a higher saving rate. Hence, the predictive power of the interest rate and its sign depends on the relative magnitude of income and substitution effects. In this paper, the interest rate refers to the real interest rate unless mentioned otherwise.[8]

Masson et al. (1998) find a positive effect of interest rates on saving while Loayza et al. (2000b) find a negative effect. Nabar (2011) uses provincial data in which an increase in urban saving rates in the PRC is negatively associated with a decline in real interest rates in the 1996– 2009 period.

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[5] See Skinner (1998), Zeldes (1989), and Hansen and Sargent (2010).

[6] Aizenman *et al.* (2015) focus on empirical evidence that saving rates and output volatility are *negatively* correlated and provide theoretical explanations.

[7] Obstfeld and Rogoff (1996) formalized the prediction in a simple intertemporal trade setting.

[8] We use the real interest rate that is calculated as: $r = \ln\left(\frac{1+i}{1+\pi}\right)$. See the data appendix for details.

2.3 Stylized Facts

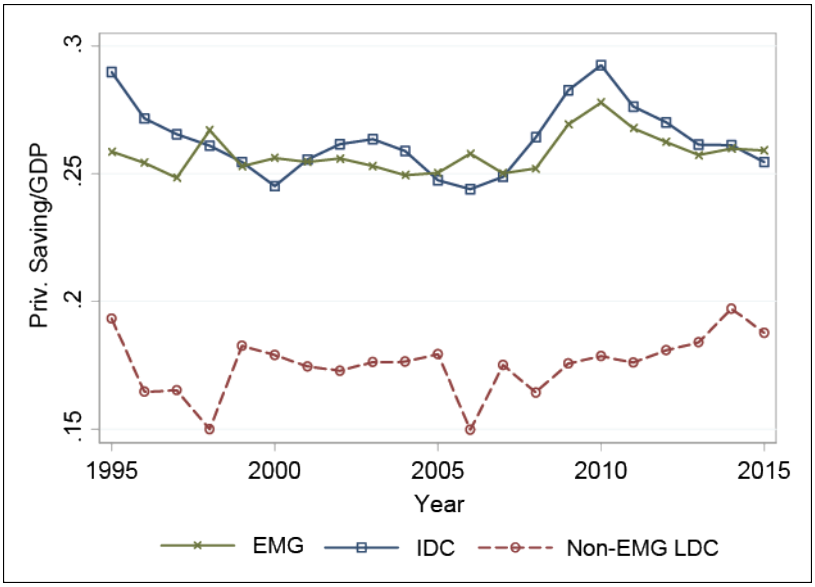
Before formally investigating the impact of the interest rate and other candidate determinants on private saving, we would like to grasp the general trends of private saving and the real interest rate. We use the panel data of 135 countries from 1995 to 2015, which includes 23 industrialized (IDC) and 113 developing countries (LDC). Out of the 135 developing countries, 45 countries are identified as emerging market countries (EMG).[9]

Figure 1 illustrates the development of private saving (as a share of GDP) over the last 2 decades for several country groups and selected individual countries. In Panel (a), country grouping is based on income levels while Panel (b) compares the group of emerging market economies in Asia excluding the PRC (ex-PRC EMG Asia) and Latin American economies with the United States (US), the eurozone, the PRC, and Japan.[10]

Interestingly, the private saving rates are comparable between the groups of IDC and EMG, while the group of developing countries excluding EMG (Non-EMG LDC) has much lower saving rates. In the 1995–2005 period, the saving rates of both EMG and non-EMG LDC appear relatively stable, whereas IDCs' saving rate falls in the late 1990s and rebounds in the early 2000s. IDCs' private saving rates start rising again in 2007, followed by EMG in 2008, with both peaking in 2010. Considering the mortgage crisis in the US and Europe in 2007 and the 2008 GFC, one interpretation is that people increased their savings in response to heightened economic uncertainty, which was accompanied with falls in interest rates.

Figure 1: Stylized Facts: Private Saving, 1995–2015

(a) Country Groups by Income Level



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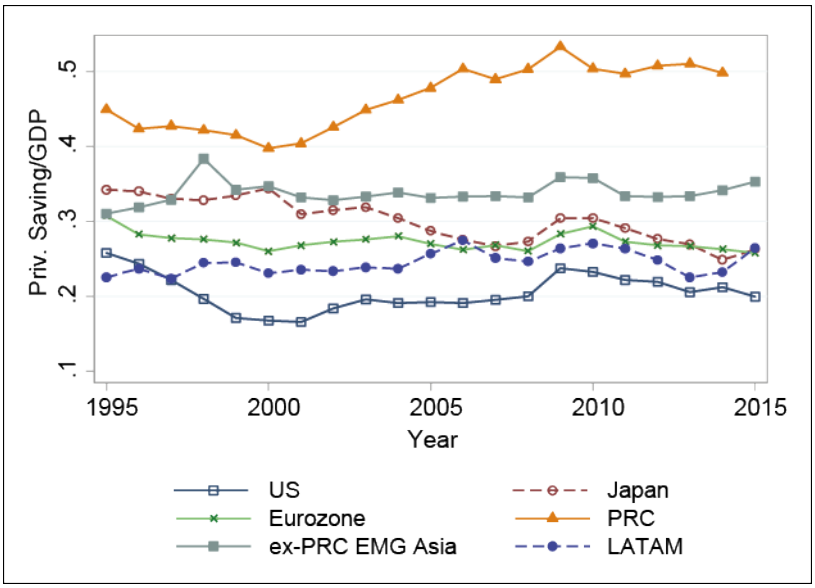
[9] The emerging market countries (EMG) are defined as the countries classified as either emerging or frontier during the period of 1980-1997 by the International Financial Corporation plus Hong Kong, China and Singapore.

[10] For all the figures, country-year's with the inflation rate greater than 40% are removed from the samples.

Figure 1 *continued*

(b) Country Groups by Region



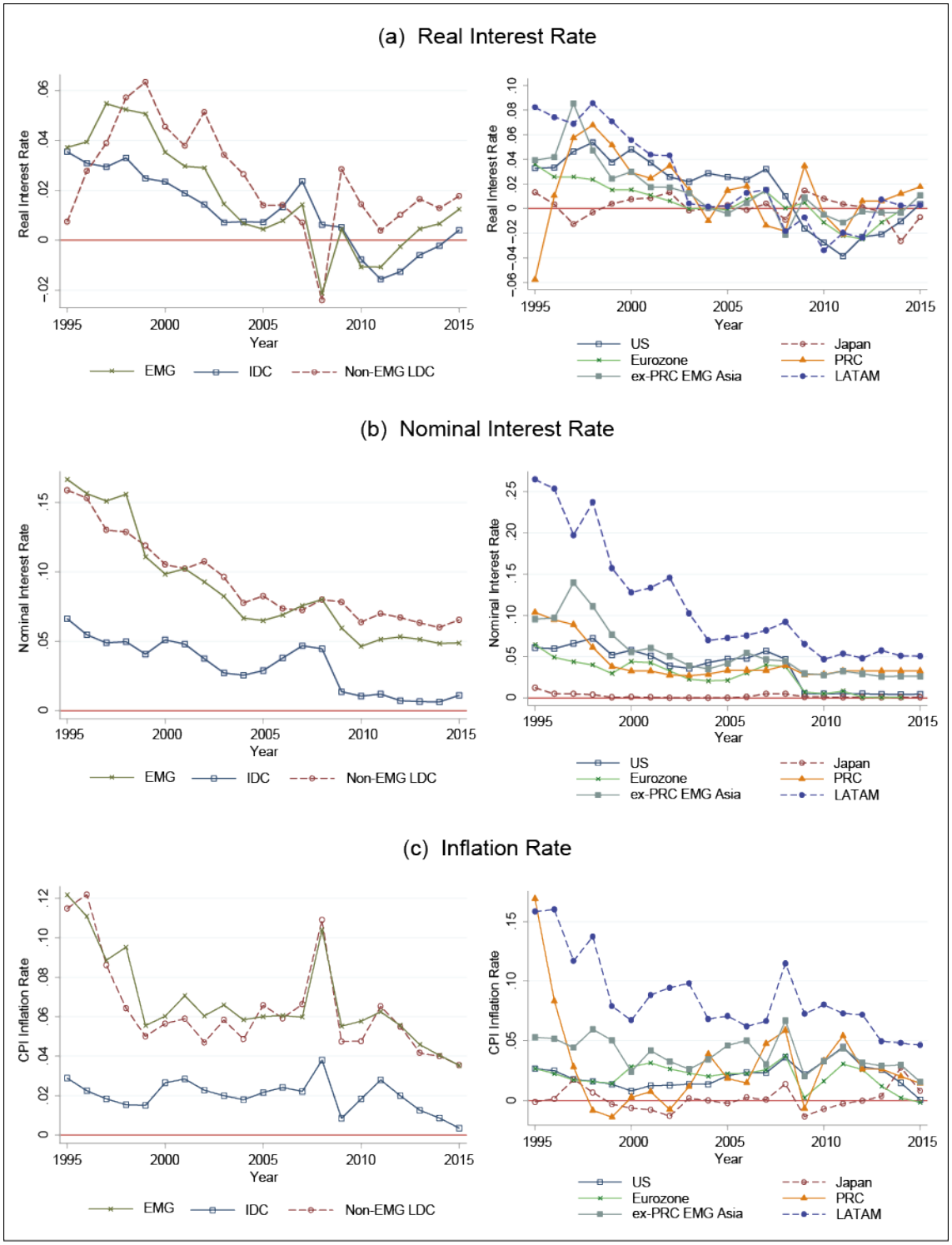
LATAM = Latin America; PRC = People's Republic of China; EMG = emerging market countries; LDC = least developed countries.

When we compare individual economies and regional groups of economies (Panel (b)), the PRC, with high saving rates, appears as an outlier—a fact that has been documented by many observers. The PRC is followed, with some gaps, by other emerging Asian market economies. The US also appears distinct with its low saving rates, whereas Japan's saving rate has been declining over the last 2 decades. All individual economies or country groups appear to have experienced a discrete rise in saving rates in 2009, followed by a moderate fall in the last 5 years of the sample.

We illustrate the evolution of the real interest rate along with the nominal interest rate and the inflation rate in Figure 2.

From the late 1990s through the mid-2000s, many countries experienced persistent declines in the real interest rates. Both panels on the top row show that the real interest rates converged throughout that period. At the same time, the nominal interest rate has continued to fall while the inflation rate has remained stable. All of these factors point to characteristics of the Great Moderation. In 2008, the real interest rates fell sharply, which reflected a sharp rise in inflation mostly due to high energy prices, as well as sharp drops in the nominal interest rates that were implemented as stabilization measures in response to the GFC. In the post-GFC period, advanced economies implemented the zero interest-rate policy, which was followed by declines in the nominal interest rates of developing countries and in EMG. During this period, while the nominal interest rates remained relatively constant (i.e., constantly low or constantly zero), inflation rates continuously fell after 2011. All of these factors contributed to a continuous rise in the real interest rates.

Figure 2: Real and Nominal Interest Rates and Inflation Rate, 1995–2015



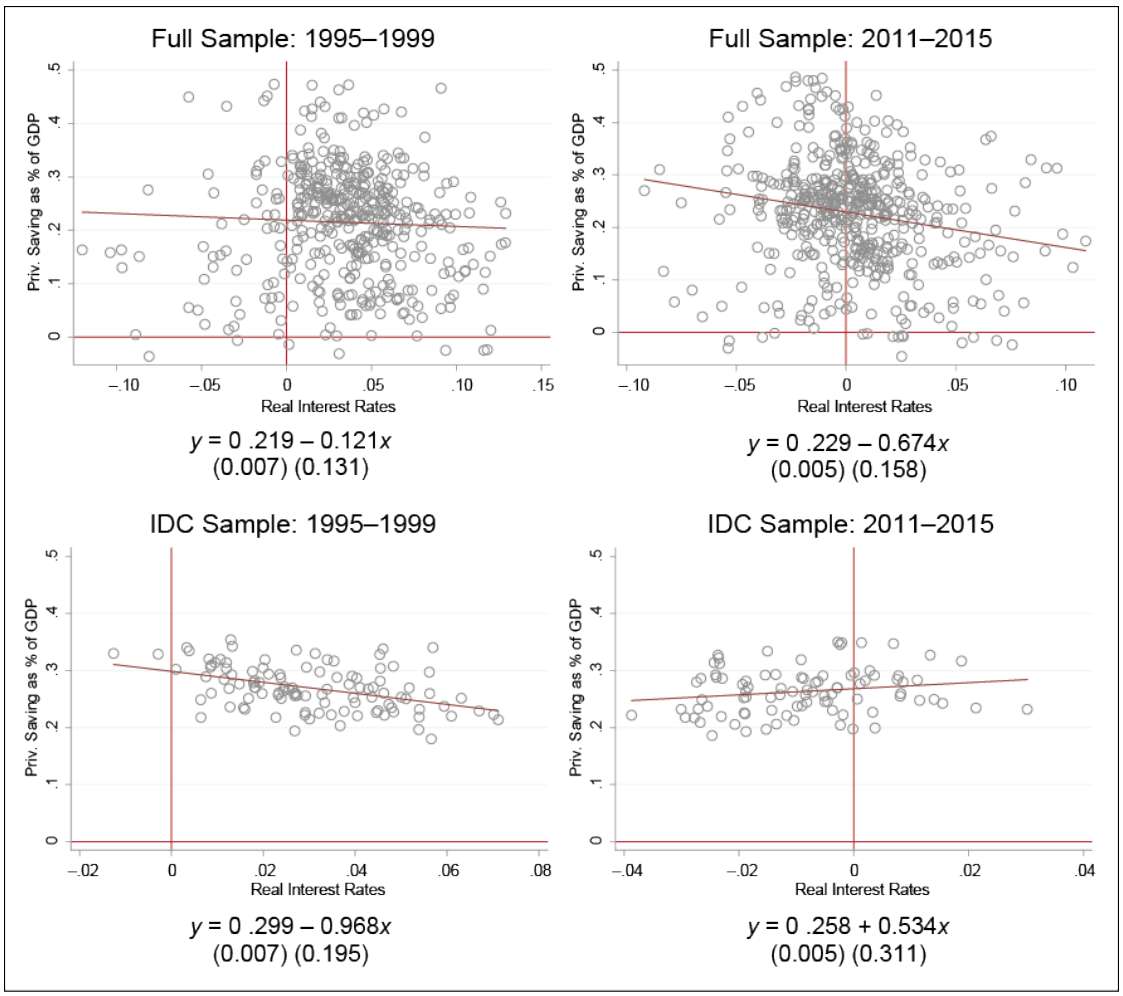
LATAM = Latin America; PRC = People's Republic of China; EMG = emerging market countries; LDC = least developed countries.

Note: For all the figures, country-year's with the inflation rate greater than 40% are removed from the samples.

In Figure 3, we compare the correlations of private saving and the real interest rates between the first five years (i.e., 1995–1999) of the sample period—when the real interest rates were generally high—and the last 5 years (i.e., 2011–2015)—when the

real interest rates were generally low.[11] The correlation for the full sample is significantly negative for the last 5 years, suggesting that the interest rate has had an income effect on private saving, while it is only insignificantly negative in the first 5 years. The slopes in the two periods are significantly different. When we look at the subgroups, the correlation is significantly negative for the EMG countries in both periods with no significant change in the slope between the two periods. The non-EMG LDC group has a significantly negative slope only in the last 5-year period, which is significantly different from the first 5 years. For the IDC group, interestingly, the correlation becomes positive in the last 5-year period, although it is significantly negative in the first period. Lastly, for the Asian emerging market (EMG) subgroup, the correlation is more significantly negative with a larger magnitude in the last 5 years compared to the first period. Overall, there is evidence that the nature of the correlation has changed over the two periods, and that, toward the end of the sample period, the correlation becomes more significantly negative with a larger magnitude for developing countries.

Figure 3: Correlations between Private Saving and the Real Interest Rates, 1995–1999 vs. 2011–2015



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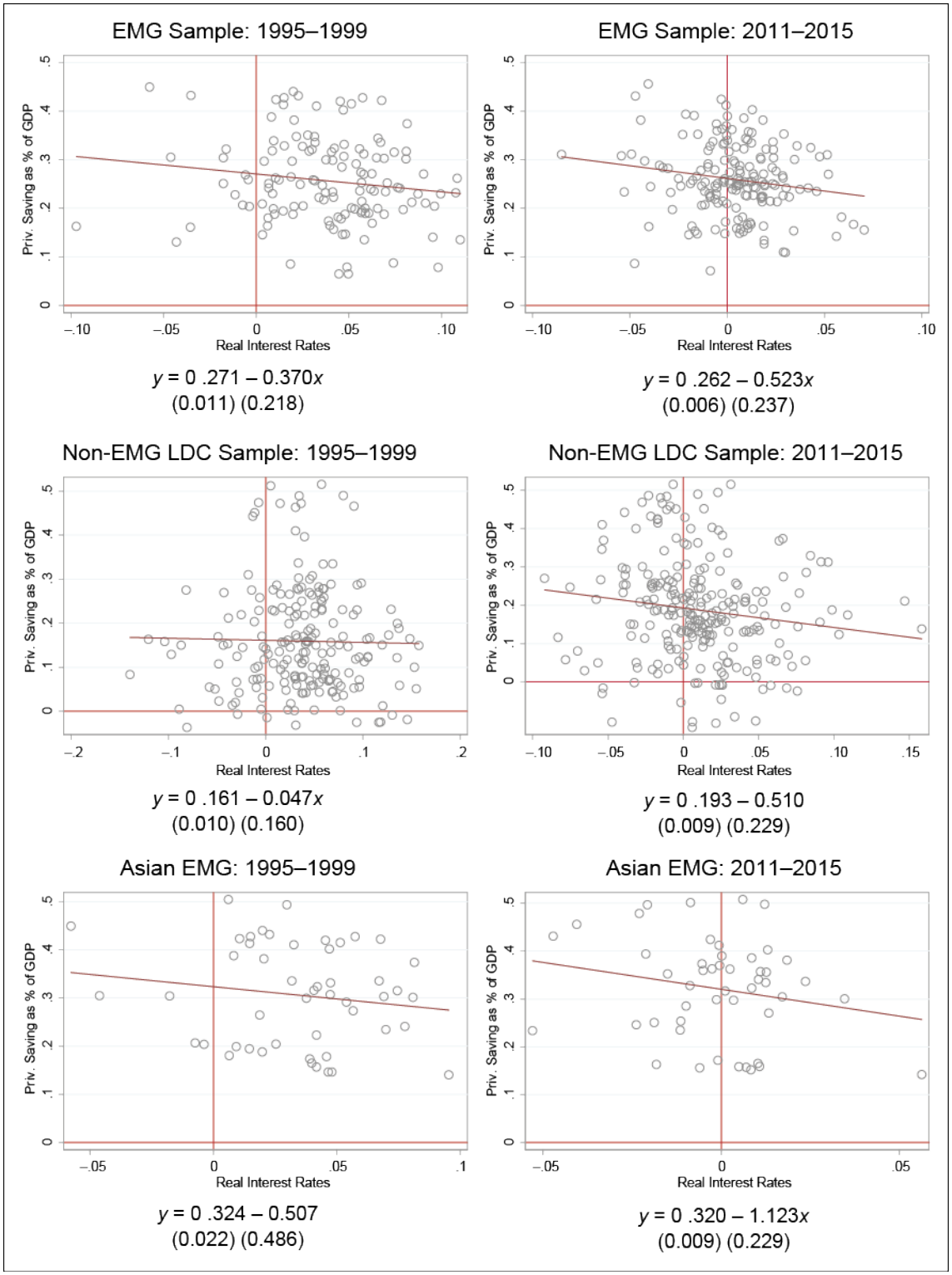
[11] To exclude outliers, we remove the 2.5 and 97.5 percentiles of private saving and real interest rate observations for each sample. We also remove country years for which the rate of inflation is greater than 40%.

Figure 3 *continued*



IDC = industrialized countries; EMG = emerging market countries; LDC = least developed countries.

Naturally, there are limits to this kind of exercise with unconditional correlations. Hence, we implement a more formal empirical analysis in the next section.

3. BASELINE ESTIMATION

3.1 Estimation Model

With the above theoretical discussions and stylized facts in mind, we estimate the determinants of private saving using the empirical specification:

$$y_{it} = \beta_0 y_{it-1} + \beta_1 r_{it} + X'\Gamma_{it} + Z'\Phi_{it} + u_i + \mu_t + \varepsilon_{it}, \quad (1)$$

where y_{it} is private saving (normalized by GDP); X is a vector of endogenous variables; Z is a vector of exogenous variables; and r_{it} is the real interest rate. u_i refers to unobserved, time-invariant, country-specific effects, whereas μ_t is a time-specific effect variable. ε_{it} is the *i.i.d.* error term.

Equation (1) entails a few possible technical issues. First, as we have already discussed, private saving can involve inertia. To allow for persistency in private saving data, we need to estimate a dynamic specification that can address both short- and long-term effects of explanatory variables. Second, some of the explanatory variables can be jointly determined with the saving rate. Hence, we have to account for joint endogeneity of the explanatory variables. Last, we need to control for unobserved country-specific effects correlated with the regressors. The system generalized method of moments (GMM) estimation method, which can consistently estimate a dynamic panel while allowing for joint endogeneity and controlling for potential biases arising from country-specific effects, is therefore adopted for our empirical exercise (Arellano and Bond 1991; Arellano and Bover 1995; Blundell and Bond 1998).

In the vector X of endogenous variables, we include public saving (i.e., the general government budget balance normalized by GDP); financial development that is measured by private credit creation as a share of GDP; credit growth that is measured by the growth rate of private credit creation; and per capita income. These variables are treated as "internal instruments" in the GMM estimation. As exogenous variables, vector Z includes young and old dependency ratios, public healthcare expenditure (as a share of GDP), financial openness, output volatility, and per capita income growth.

The variable of our focus is the real interest rate *r*. If the substitution effect outweighs the income effect, the estimate of β_1 is expected to be positive. That is, the higher the interest rate, the more the country would save. On the other hand, if the income effect outweighs the substitution effect, β_1 would be negative; that is, the higher the interest rate, the less private saving.

3.2 Estimation Results

Table 1 reports the results of the estimations for the full sample and the subsamples of IDC, LDC, EMG, Latin American, Asian economies, (Asia), and the emerging market countries in Asia (Asian–EMG).[12]

Before discussing the system GMM estimates, we conduct diagnostic tests for the validity of the instruments and serial correlation in estimated residuals. For the former, we conduct the Hansen-J test against the null hypothesis that the instrumental variables are uncorrelated with the residuals. If the test fails to reject the null hypothesis, the specification is free of the issue of over-identification. As for serial

[12] The sample period becomes 1995–2014 due to data limitations for the year 2015.

correlation, we conduct an AR(2) test with the null hypothesis that the errors in the differenced equation exhibit no second-order correlation. This is because the system GMM method involves a first-difference transformation of the original estimation model to eliminate the unobserved country-specific effect.

The estimated system GMM model specification is supported if no evidence exists of second-order autocorrelation (even there is first-order autocorrelation) and the over-identifying restrictions are not rejected at conventional levels of confidence.

In Table 1 and the other tables, the reported diagnostic test results—both the Hansen-J and AR(2) test results—support the use of the system GMM model specification for all of these samples. That is, the Hansen test fails to reject the null hypothesis of over-identifying restrictions, and the AR(2) test confirms that the estimated errors in the differenced equation exhibit no second-order correlation.[13]

Generally, the estimation results are consistent with our theoretical discussions.

First, the real interest rate, the variable of our focus, enters the estimation significantly for the full sample and the subsample of Asian economies group with a positive sign. This means we detect that the substitution effect outweighs the income effect for these groups of countries. For the other samples, the estimates are positive, except in the cases of the Latin American (LATAM) and Asian EMG, which are not significant.

The behavior of private saving is found to be somewhat persistent. The degree of persistency is 0.390 for the full sample, although this varies across different subsamples. The groups of Asian economies and Asian EMG have higher degrees of persistency, 0.70 and 0.67 respectively, which is consistent with the prevailing observation that Asian economies' saving rates are consistently high.

We can observe evidence for the partial Ricardian offset in the estimated coefficient for public saving. The results of the full sample indicate that about 44% of an increase in public saving would be offset by a worsening of private saving. The size of the offset is much larger among industrialized countries than in developing economies, which may be because the tax system in the former is less distortive than in the latter.

While the level of financial development only matters for industrialized economies, credit growth is found to be a negative contributor for developing economies. Once credit conditions improve, a developing country tends to experience growth in its consumption—that is, a fall in its saving rate.

Financial openness, in contrast, is a positive contributor, although only for the IDC and the LATAM. For these economies, financial openness helps increase private saving through increasing investment opportunities.

Although both the level and the growth of per capita income are found to positively contribute to private saving, output volatility has opposing effects for developed countries and the group of Asian–EMG economies.

[13] However, Roodman (2006) argues that including too many instruments can not only overly fit endogenous variables, but also weaken the power of the Hansen test to detect over-identification. He suggests that high *p*-values (such as "1.00") for the Hansen test may signal that the test wrongly failed to detect over-identification. In fact, in Table 1 and others, we see that the smaller the sample is (such as IDC, EMG, and regional country groups), the more tendency there is for the Hansen test's p-value to take the value of "1.00." This can be related to the fact that in a smaller sample, *N* (= the number of countries) tends to be small relatively to *T* (= the number of years)—the GMM estimation is more suitable for a data set with the dimension of large *N* and small *T*. However, when we apply the random effect model (not reported), the estimation results are qualitatively intact; in fact, they tend to become more robust. Hence, we focus on discussing the results from the GMM estimations.

Table 1: Determinants of Private saving – System–GMM, 1995–2014

	FULL	IDC	LDC	EMG	LATAM	Asia	Asia EMG
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Private saving (*t*–1)	0.390	0.250	0.360	0.484	0.366	0.704	0.672
	(0.080)***	(0.078)***	(0.088)***	(0.094)***	(0.076)***	(0.088)***	(0.064)***
Public saving	–0.443	–0.715	–0.317	–0.651	–0.634	–0.458	–0.364
	(0.150)***	(0.130)***	(0.167)*	(0.102)***	(0.125)***	(0.140)***	(0.137)***
Credit growth	–0.041	–0.020	–0.034	–0.026	–0.012	–0.005	0.015
	(0.012)***	(0.024)	(0.014)**	(0.017)	(0.024)	(0.017)	(0.024)
Fin. development, HP-filtered	–0.040	–0.022	–0.013	0.016	–0.085	0.014	0.140
	(0.023)*	(0.013)*	(0.038)	(0.047)	(0.055)	(0.033)	(0.032)***
Income/capita level (log, PPP)	0.091	0.205	0.103	0.041	0.066	0.024	0.006
	(0.028)***	(0.042)***	(0.031)***	(0.026)	(0.036)*	(0.018)	(0.015)
Real interest rate	0.075	0.048	0.070	0.020	–0.054	0.080	–0.002
	(0.045)*	(0.193)	(0.044)	(0.052)	(0.047)	(0.040)**	(0.058)
Old dependency	–0.172	–0.206	–0.156	–0.268	–0.538	–0.259	0.136
	(0.130)	(0.191)	(0.182)	(0.199)	(0.159)***	(0.122)**	(0.334)
Young dependency	0.099	–0.348	0.147	–0.147	0.023	–0.092	–0.057
	(0.098)	(0.235)	(0.119)	(0.136)	(0.177)	(0.100)	(0.076)
Health expenditure	–1.321	–0.400	–1.748	–1.749	–0.206	–0.904	–3.592
(% of GDP)	(0.486)***	(0.482)	(0.488)***	(0.534)***	(0.493)	(0.289)***	(0.903)***
Financial openness	–0.009	0.017	–0.020	–0.007	0.059	0.012	–0.008
	(0.021)	(0.034)	(0.022)	(0.020)	(0.016)***	(0.029)	(0.024)
Output volatility	–0.009	0.870	0.001	0.271	0.376	–0.150	–0.357
	(0.109)	(0.519)*	(0.119)	(0.198)	(0.311)	(0.294)	(0.165)**
Income/capita growth	0.173	0.326	0.198	0.192	0.125	0.209	0.001
	(0.058)***	(0.137)**	(0.062)***	(0.081)**	(0.068)*	(0.091)**	(0.081)
N	2,313	431	1,882	755	436	364	218
# of countries	135	23	112	42	24	21	11
Hansen test (p-value)	0.08	1.00	0.58	1.00	1.00	1.00	1.00
AR(1) test (p-value)	0.00	0.03	0.00	0.01	0.06	0.00	0.02
AR(2) test (p-value)	0.47	0.80	0.40	0.85	0.33	0.93	0.87

IDC = industrialized countries; LDC = least developed countries; EMG = emerging market countries; LATAM = Latin America.

Notes: * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The dependent variable is private saving as a share of GDP. The system GMM estimation method is employed. Although the constant term is estimated, it is omitted from presentation. The subsample "Asia" includes Japan and East and South Asian economies.

The higher the country's level of old dependency, the lower the rate of private saving it tends to experience. Although the estimate on the old dependency variable is not significant for the LDC or EMG group, the estimates for the subgroups of LATAM, Asia, and Asian–EMG are significant and their magnitudes tend to be large. The fact that smaller numbers of countries are included in each of the estimations indicates that demographical change happened rather drastically in the sample period and had significant impact on private saving for the countries in these subsamples.

Healthcare expenditure, which we measure by public health expenditure as a share of GDP, has a negative impact on private saving. That is, if healthcare is more readily available with the support of the public sector, people would reduce saving because they would not have to save for precautionary reasons. The estimate is robust across the different country groups based on income levels (i.e., full, IDC, LDC, and EMG).

Also, when we use social expenditure as a share of GDP that is available in the OECD database, the results are essentially unchanged.[14]

Although we carefully chose explanatory variables, this sort of exercise can still be subject to missing variable bias. Here, we test two variables as potential determinants of private saving.

The first one we suspect as a potential determinant is net investment position. Depending on time preferences and endowments, some become net lenders (i.e., current account surplus countries) at the present time while others become net borrowers. Hence, net investment positions, whose incremental changes are comparable to current account balances, can be related to private saving. From a different angle, foreign saving may crowd out or complement domestic private saving. Developing countries often try to mitigate credit constraint in their own domestic markets by importing foreign saving, though they also have to face external borrowing constraints such as difficulties in borrowing in their own currencies or for long-terms (i.e., the "original sin" argument).[15]

We test whether net investment positions affect the private saving rate by including a dummy for country-years in which the net position is negative.[16] The estimation results (Table 3A) show that the saving rate tends to be lower for net debt countries, indicating that the saving rate tends to be lower for net debt countries. That means that foreign saving complements domestic saving. Another variable of our suspect is property prices. A rise in house prices could create a "wealth effect" on consumption while simultaneously mitigating credit constraint. Either way, we expect property prices to have a negative impact on saving. When we include real property price index in the estimation, we find such a negative impact only for EMG (Appendix 3, Table A1). For that group, as (real) property prices rise, the saving rate tends to fall.[17] However, when we test the growth-rate impact of property prices, we find that its estimate is significantly negative for the full sample and the LDC subgroup (Table A2). In these samples, what matters is not so much the level of property prices as its growth rate. A rapid rise in property prices may signal an increase in future or permanent income flows.

1.1.1 Level Impacts of the Interest Rates

The weak evidence of the real interest-rate effect in Table 1 is likely to be attributable to its dependency on other economic conditions affecting the saving decision. Our sample period, for instance, includes the GFC and consequential implementations of unconventional monetary policy by advanced economies, such as quantitative easing and negative interest-rate policies. These unconventional monetary policies were implemented primarily in response to financial instabilities experienced by the US and several euro member countries. However, these policies also created repercussions among emerging market economies through surges of capital flows triggered by

[14] The data are available only for OECD countries as well as for 1980, 1985, 1990, 1995, 2000, 2005, and 2009–2014.

[15] Aizenman, et al. (2007) estimate that only 10% of the capital stock in developing countries is funded with foreign saving, which means that 90% is self-financed. They also show that countries with higher self-financing ratios grew significantly faster than countries with low self-financing ratios.

[16] When we normalize external assets minus liabilities, both from the Lane–Ferretti dataset (2001, 2007, updates), by GDP, we find that the net investment position variable enters the estimation insignificantly for all the samples (not reported). This is not surprising given that the data for financial center countries (e.g., Ireland; Hong Kong, China; Singapore) and heavily indebted countries can be outliers affecting the estimation results.

[17] Nabar (2011) and Geerolf and Grjebine (2013) find similar results.

extremely low rates of return in advanced economies and now possible retrenchment of such flows due to US monetary contraction, which began in late 2013. Thus, spillovers of the GFC and unconventional monetary policy heightened the level of uncertainty among advanced economies as well as emerging market economies, which may have impacted saving behavior. More specifically, low interest rates may signal future monetary uncertainty or financial condition uncertainty and thereby encourage people toward precautionary saving.

Against this backdrop, we examine whether low real or nominal interest rates have any impact on the link between the real interest rate and the private saving rate.

The estimation model shown below includes the interaction between the real interest rate and the dummy for a certain threshold of the real or nominal interest rate. In the following regression equation, D takes a value of one when the interest rate of concern is below a certain threshold; that is D = I (interest rate < threshold value),

$$y_{it} = \beta_0 y_{it-1} + \beta_1 r_{it} + \beta_2 D_{it} \cdot r_{it} + \beta_3 D_{it} + X'\Gamma_{it} + Z'\Phi_{it} + u_i + v_{it} + \varepsilon_{it}. \quad (2)$$

Here, we are interested in examining whether any threshold impact exists regarding the real or nominal interest rates, or both,. Conceptually, it is reasonable to simply focus on the real interest rate as a threshold. However, since the implementation of zero- or negative-interest rate policies, the nominal interest rate has received more general attention. Also, given nominal rigidities that create a money illusion, setting the nominal interest rate at an extremely low level can have more than mere announcement effects. Hence, we investigate whether and how low real and nominal interest rates impact private saving.

Table 2 reports the estimation results. The first column of the top of Panel (a) reports only the estimates for the real interest-rate variable (β_1), and for the interaction term (β_2) between the real interest rate and the dummy variable that assumes a value of one when the real interest rate is below –2%. The other estimates are omitted to conserve space. The second column reports the estimates for the real interest rate and its interaction term but the threshold is –1%, with the other columns showing the cases of 0%, 1%, and 2% thresholds, respectively, toward the farthest right.[18] The bottom of Panel (a) reports the estimates on the same variables, but the value of the dummy variable is assigned based on the threshold of the nominal interest instead of the real interest rate, taking the values of 0.5%, 1%, 1.5%, 2%, or 2.5%, as seen from the farthest left column to the right.

While Panel (a) uses the full sample for the estimation, Panels (b) through (f) report the results for IDC, LDC, EMG, Asia, and Asian EMG, respectively.

When the estimate (β_2) is found to be significant, it would mean that the impact of the real interest rate on private saving changes when the real or nominal interest rate is below a certain level.

[18] For example, column 1 of the top of Panel (a) shows that the estimate on the real interest rate (0.104) is the response of private saving to the real interest rate when it is above –2%, whereas the response is (0.104–0.048) when the real interest rate is below –2%, although both estimates are statistically insignificant. When the nominal interest rate is used as the threshold, the response would not be different from when the nominal interest rate is above 2.5% because the estimate of the interaction (i.e., 0.045) is statistically insignificant.

Table 2: Impacts of Extremely Low Interest Rates

(a) Full Sample	(1)	(2)	(3)	(4)	(5)
	Threshold: Real Interest Rate				
	–2%	**–1%**	**0%**	**1%**	**2%**
β_1: Real interest rate	0.092	0.091	0.096	0.103	0.098
	(0.078)	(0.078)	(0.084)	(0.083)	(0.084)
β_2:Real interest rate x D(real)	–0.027	–0.034	–0.041	–0.046	–0.041
	(0.078)	(0.076)	(0.081)	(0.079)	(0.079)
	Threshold: Nominal Interest Rate				
	0.5%	**1%**	**1.5%**	**2%**	**2.5%**
β_1: Real interest rate	0.074	0.077	0.078	0.074	0.079
	(0.044)*	(0.044)*	(0.042)*	(0.040)*	(0.041)*
β_2:Real interest rate x D(nominal)	0.440	0.107	0.054	0.253	0.164
	(0.230)*	(0.163)	(0.149)	(0.128)**	(0.127)
(b) Industrial (IDC)	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
	Threshold: Real Interest Rate				
	–2%	**–1%**	**0%**	**1%**	**2%**
β_1: Real interest rate	0.084	–0.051	0.071	–0.030	0.115
	(0.205)	(0.154)	(0.201)	(0.190)	(0.265)
β_2:Real interest rate x D(real)	1.392	0.981	0.532	0.390	0.139
	(1.082)	(0.289)***	(0.349)	(0.286)	(0.289)
	Threshold: Nominal Interest Rate				
	0.5%	**1%**	**1.5%**	**2%**	**2.5%**
β_1: Real interest rate	0.134	0.070	0.073	0.044	0.071
	(0.185)	(0.225)	(0.204)	(0.204)	(0.208)
β_2:Real interest rate x D(nominal)	0.420	0.421	0.400	0.434	0.492
	(0.282)	(0.234)*	(0.221)*	(0.231)*	(0.237)**
(c) Developing (LDC)	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
	Threshold: Real Interest Rate				
	–2%	**–1%**	**0%**	**1%**	**2%**
β_1: Real interest rate	0.078	0.076	0.076	0.084	0.078
	(0.082)	(0.081)	(0.087)	(0.088)	(0.089)
β_2:Real interest rate x D(real)	–0.008	–0.014	–0.018	–0.025	–0.019
	(0.081)	(0.080)	(0.083)	(0.082)	(0.083)
	Threshold: Nominal Interest Rate				
	0.5%	**1%**	**1.5%**	**2%**	**2.5%**
β_1: Real interest rate	0.069	0.073	0.074	0.069	0.074
	(0.042)	(0.043)*	(0.041)*	(0.040)*	(0.040)*
β_2:Real interest rate x D(nominal)	0.503	0.060	0.017	0.205	0.160
	(0.294)*	(0.204)	(0.172)	(0.131)	(0.123)

continued on next page

Table 2 *continued*

(d) Emerging (EMG)	(1)	(2)	(3)	(4)	(5)
	Threshold: Real Interest Rate				
	–2%	**–1%**	**0%**	**1%**	**2%**
β_1: Real interest rate	0.023	0.043	0.046	0.009	–0.041
	(0.082)	(0.082)	(0.087)	(0.081)	(0.081)
β_2:Real interest rate x D(real)	0.017	–0.008	–0.038	–0.013	0.044
	(0.097)	(0.093)	(0.102)	(0.091)	(0.088)
	Threshold: Nominal Interest Rate				
	0.5%	**1%**	**1.5%**	**2%**	**2.5%**
β_1: Real interest rate	0.018	0.022	0.020	0.006	0.014
	(0.052)	(0.053)	(0.053)	(0.045)	(0.046)
β_2:Real interest rate x D(nominal)	0.741	0.236	0.103	0.285	0.250
	(0.403)*	(0.174)	(0.150)	(0.120)**	(0.130)*
(e) Asia	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
	Threshold: Real Interest Rate				
	–2%	**–1%**	**0%**	**1%**	**2%**
β_1: Real interest rate	–0.023	–0.063	–0.050	–0.065	–0.057
	(0.101)	(0.107)	(0.115)	(0.111)	(0.124)
β_2:Real interest rate x D(real)	0.288	0.282	0.238	0.269	0.227
	(0.235)	(0.237)	(0.231)	(0.217)	(0.213)
	Threshold: Nominal Interest Rate				
	0.5%	**1%**	**1.5%**	**2%**	**2.5%**
β_1: Real interest rate	0.064	0.053	0.063	0.066	0.071
	(0.038)*	(0.037)	(0.038)*	(0.038)*	(0.036)*
β_2:Real interest rate x D(nominal)	–0.253	0.246	0.154	0.265	0.111
	(0.458)	(0.342)	(0.317)	(0.357)	(0.285)
(f) Asian EMG	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
	Threshold: Real Interest Rate				
	–2%	**–1%**	**0%**	**1%**	**2%**
β_1: Real interest rate	0.037	0.030	0.021	–0.005	–0.046
	(0.091)	(0.100)	(0.076)	(0.079)	(0.099)
β_2:Real interest rate x D(real)	0.053	–0.090	–0.106	0.034	0.069
	(0.247)	(0.321)	(0.246)	(0.156)	(0.134)
	Threshold: Nominal Interest Rate				
	0.5%	**1%**	**1.5%**	**2%**	**2.5%**
β_1: Real interest rate	0.007	0.031	0.048	0.024	0.034
	(0.058)	(0.058)	(0.053)	(0.046)	(0.048)
β_2: Real interest rate x D(nominal)	0.956	–0.134	–0.297	–0.541	–0.464
	(0.247)***	(0.190)	(0.159)*	(0.123)***	(0.109)***

IDC = industrialized countries; LDC = least developed countries; EMG = emerging market countries.

In Panel (a), in the presence of real interest rate regime variables, there is no evidence of significant the real interest rate effect (β_1). However, when we control for low nominal interest rate regimes, the real interest rate effect becomes significantly positive—the estimated substitution effect is in accordance with the full sample result in Table 1. Furthermore, the magnitude of the substitution effect gets much larger when the *nominal* interest rate is below 2%.[19] This result suggests that as far as the full sample is concerned, low nominal interest rates affect the way the real interest rate affects private saving.

For the subsample of industrialized countries (Panel (b)), the real interest rate has the substitution effect when the real interest rate is lower than –1% or the nominal interest rate is lower than 2.5%. In fact, when we test the threshold of 3%, the interaction term is still significant, and it becomes insignificant at the 3.5% threshold (not reported). For this group of countries, the substitution effect is dominant but only when the real or nominal interest rate is low.

Results in Panel (c) are quite similar to the results of the full sample. According to the panel, when the nominal interest rate is above 0.5%, the real interest rate has the substitution effect on private saving whereas countries with nominal interest rates below 0.5% have much stronger substitution effects.[20] These results indicate that, overall, the positive real interest rate effect is the norm for this group of economies, and the threshold of the nominal interest rate is more relevant than that of the real interest rate.

When we look at the EMG group (panel (d)), the real interest rate has the positive effect on private saving when the *nominal* interest rate is below 2.5%.[21] Also, again, the magnitude of the effect is quite large.

When we restrict our sample to Asian economies (Panel (e)), we only find that the real interest rate generally has a substitution effect on private saving. The group of Asian EMG economies, however, displays a different pattern of real interest rate effects. In Panel (f), the estimated β_2 is now significantly negative for the threshold of 2.5% while the threshold of 3% is found to be insignificant (not reported).[22] That is, when the nominal interest rate is below 2.5%, private saving for Asian EMG would negatively respond to the real interest rate movement. That is, the income effect outweighs the substitution effect.[23]

[19] The dummy for the 0.5% threshold is also significant, but it can be considered as reflecting a "subset" of the dummy for 2.0%.

[20] The countries with nominal interest rates below 0.5% in this sample include Panama, The Bahamas, Belize, Trinidad and Tobago, Bahrain, Cyprus, Oman, Qatar, Nepal, Singapore, Algeria, Bulgaria, Czech Republic, Slovak Republic, Estonia, Latvia, Lithuania, Croatia, and Slovenia in years after the GFC.

[21] The threshold of 3% is found to be insignificant (not reported).

[22] When the nominal interest rate is below 0.5%, the real interest rate effect becomes positive with a large magnitude. In this case, however, the dummy for the nominal interest rate threshold only reflects Singapore from 2011 through 2014. Hence, the positive estimate here is only specific to this country.

[23] The countries whose nominal interest rates are below 2.5% in this sample include Republic of Korea, Malaysia, Pakistan, Philippines, Singapore, and Thailand.

4. INTERACTIVE EFFECTS

4.1 Empirical Findings

Results in the previous section show that the real interest-rate effect, if significant, tends to be positive; the substitution effect tends to dominate the income effect. The effect varies across different country groups, and its magnitude can be influenced by the level of nominal interest rate. In the case of the Asian EMG group, the real interest-rate effect has become negative when the nominal interest rate is lower than 2.5%. Overall, these results suggest that the effect of the real interest rate on private saving can depend on the economic environment at large.

In this section, we use interaction variables to explore the real interest-rate effect under alternative economic conditions. For example, when an economy experiences a high level of output volatility, a low interest rate can be interpreted as a sign of economic weakness and thus, can strengthen the saving incentive. Alternatively, for an economy in which old dependency is increasing, a lowering of the interest rate might encourage people to increase their rates of saving to reach pre-determined target levels of retirement saving.

In the following, we investigate influences of the economic environment because we suspect that the threshold effect of the nominal interest rate on the real interest rate may be reflecting the economic conditions where it is in. Specifically, we investigate the effect of output volatility, old dependency, healthcare expenditure, financial development, and financial openness on real interest-rate effects. In the estimation, we include the term $r_{it} \cdot W_{it}$, where W_{it} is the economic environment variable under consideration to examine the interactive effect in the modified saving regression equation:

$$y_{it} = \beta_0 y_{it-1} + \beta_1 r_{it} + \beta_2 r \cdot W_{it} + \beta_3 W_{it} + X'\Gamma_{it} + Z'\Phi_{it} + u_i + v_{it} + \varepsilon_{it}. \quad (3)$$

Table 3 presents the effect of the real interest rate under alternative output-volatility scenarios.[24] The real interest-rate variable has a positive coefficient estimate for the full-country sample and the three subsamples, but it is only statistically significant for the full sample and the subsample of LDC. The output volatility is insignificant in all four samples under consideration. The interaction term between output volatility and real interest rate is positive and statistically significant in the case of the IDC subsample and negative in the other three cases. Most likely, the significant negative effect of the interaction term found in the full sample is driven by the LDC subsample.

[24] To ensure a wider variation in the variables, we report results only for the full, IDC, LDC, and EMG samples. Also, because the estimations with the interaction terms between the real interest rate and healthcare expenditure or financial openness turn out to be consistently insignificant, we only discuss the results from the estimations with interaction terms of output volatility, old dependency ratios, and financial development.

Table 3: Determinants of Private Saving, Interacting with Output Volatility

	FULL (1)	IDC (2)	LDC (3)	EMG (4)
Private saving (*t*–1)	0.367	0.264	0.339	0.506
	(0.077)***	(0.063)***	(0.085)***	(0.081)***
Public saving	–0.466	–0.688	–0.335	–0.625
	(0.155)***	(0.125)***	(0.175)*	(0.107)***
Credit growth	–0.046	–0.019	–0.040	–0.029
	(0.016)***	(0.024)	(0.017)**	(0.016)*
Fin. development, HP-filtered	–0.041	–0.022	–0.014	0.021
	(0.023)*	(0.013)*	(0.038)	(0.047)
Income/capita level	0.095	0.200	0.104	0.038
(log, PPP)	(0.023)***	(0.039)***	(0.026)***	(0.027)
Real interest rate	0.209	–0.373	0.193	0.116
	(0.047)***	(0.290)	(0.048)***	(0.125)
Old dependency	–0.158	–0.175	–0.153	–0.241
	(0.128)	(0.185)	(0.170)	(0.185)
Young dependency	0.105	–0.314	0.145	–0.138
	(0.083)	(0.220)	(0.098)	(0.132)
Health expenditure	–1.397	–0.448	–1.811	–1.677
(% of GDP)	(0.432)***	(0.463)	(0.471)***	(0.515)***
Financial openness	–0.011	0.016	–0.021	–0.006
	(0.019)	(0.033)	(0.020)	(0.021)
Output volatility	0.021	0.539	0.030	0.269
	(0.103)	(0.479)	(0.113)	(0.176)
Output volatility x	–2.262	21.430	–1.993	–3.012
Real interest rate	(0.618)***	(7.094)***	(0.635)***	(3.089)
Income/capita growth	0.179	0.274	0.202	0.174
	(0.060)***	(0.136)**	(0.063)***	(0.081)**
N	2,313	431	1,882	755
# of countries	135	23	112	42
Hansen test (p-value)	0.07	1.00	0.60	1.00
AR(1) test (p-value)	0.00	0.02	0.00	0.01
AR(2) test (p-value)	0.46	0.99	0.42	0.83

IDC = industrialized countries; LDC = least developed countries; EMG = emerging market countries.

Notes: * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The dependent variable is private saving as a share of GDP. The system GMM estimation method is employed. Although the constant term is estimated, it is omitted from presentation.

Results in Table 3 indicate the possibility that, when output volatility increases, the real interest-rate effect can change from positive to negative in the cases of the full-country sample and the LDC sample. For instance, the estimates from the full sample suggest that when the output volatility is less than 9.24%, the marginal real interest-rate effect is positive, and when it is larger than that amount, the marginal effect will be negative.[25]

[25] For the full sample, the estimate of $\beta_1 + \beta_2 W$ is found to be $0.209 - 2.262 W_{it}$. Thus, the output volatility threshold of the marginal real interest-rate effect is given $W_{it} < 0.209 / 2.262 = 0.0924$.

The threshold is found to be 9.68% for the LDC subsample, very similar to the case of the full sample. When output volatility is higher than the threshold, the income effect tends to strengthen and dominate the substitution effect. This interpretation is in accordance with the notion that a high level of output volatility and a low level of the real interest rate signal uncertainty and encourage people to increase precautionary saving to meet pre-determined saving targets. However, the level of output volatility greater than the threshold only happens in 3.2% of the LDC sample, which indicates that the negative interest rate effect is more of an exception and happens only when output volatility is fairly high.

This interactive effect is depicted graphically in the left panel of Figure 4. Because the results of the full sample seem to be driven by developing countries, the figure is created using the estimates from the LDC group. The linear line in the figure represents the effect of real interest rates conditional upon the level of output volatility; the higher the level of output volatility, the weaker or more negative the impact of the real interest rate. The dots in the figure show the interactive effects for selected Asian developing economies using the observed data of the real interest rate and *W* as of 2014. In the figure, we can see that Asian developing economies are generally clustered at lower levels of output volatility, far from the threshold of 9.68% (shown with the dotted vertical line). Hence, for these economies, the real interest-rate movement would have a positive effect on private saving.

When we focus on $\beta_3 W + \beta_2 r \cdot W$, we can see that the results for the full sample and LDC indicate that output volatility would increase private saving if the real interest rate is lower than a certain level. Based on these estimation results, the threshold is 0.93% for the full sample and 1.5% for the LDC sample. These results suggest that when output movements become volatile in a very low-interest rate environment, agents would respond to such an environment by increasing saving. The right panel of Figure 4 show that for many Asian developing economies, the real interest rates are lower than the threshold, which indicates that higher output volatility could lead to higher private saving.

Table 4 reports the estimation results when we include the interaction term between the real interest rate and the old dependency ratio. The estimate on the interaction term is found to be negative for the full sample and the LDC subsample. The estimation results indicate that the real interest rate has a negative impact (income effect) on private saving if the economy of concern has a higher ratio of old dependency than 15.3% for the full sample and 16.1% for the LDC subsample. In the full sample, 34.2% of the countries have higher old-dependency ratios than the threshold, while 18% of the sample has higher ratios than the threshold among developing countries.

Thus, an aging economy would tend to have higher saving when the real interest falls. Moreover, based on the estimates for the old dependency ratio and its interaction term with the real interest rate, an economy with a higher level of old dependency tends to have lower private saving, as predicted by the lifetime income hypothesis. However, the negative impact on private saving tends to be smaller when its real interest rate is lower, suggesting that lower real-interest rates would give people in aging populations less incentive to dissave. Thus, based on these results, an economy such as Hong Kong, China, which has both a low real-interest rate and a high old-dependency ratio, tends to experience higher private saving.

Table 4: Determinants of Private Saving, Interacting with Old Dependency

	FULL (1)	IDC (2)	LDC (3)	EMG (4)
Private saving (*t*–1)	0.407	0.238	0.372	0.511
	(0.081)***	(0.077)***	(0.088)***	(0.077)***
Public saving	–0.449	–0.718	–0.328	–0.643
	(0.147)***	(0.133)***	(0.168)*	(0.104)***
Credit growth	–0.035	–0.019	–0.031	–0.026
	(0.012)***	(0.023)	(0.013)**	(0.017)
Fin. development, HP-filtered	–0.037	–0.023	–0.014	0.017
	(0.022)*	(0.014)*	(0.038)	(0.046)
Income/capita level	0.098	0.205	0.106	0.039
(log, PPP)	(0.028)***	(0.041)***	(0.030)***	(0.026)
Real interest rate	0.220	–0.232	0.179	0.110
	(0.064)***	(0.742)	(0.057)***	(0.121)
Old dependency	–0.117	–0.218	–0.112	–0.259
	(0.123)	(0.179)	(0.173)	(0.193)
Old dependency x	–1.441	1.187	–1.110	–1.078
Real interest rate	(0.531)***	(2.993)	(0.467)**	(1.074)
Young dependency	0.134	–0.344	0.168	–0.140
	(0.095)	(0.240)	(0.113)	(0.133)
Health expenditure	–1.461	–0.400	–1.814	–1.658
(% of GDP)	(0.473)***	(0.476)	(0.480)***	(0.516)***
Financial openness	–0.014	0.018	–0.023	–0.006
	(0.021)	(0.035)	(0.022)	(0.020)
Output volatility	–0.024	0.892	–0.013	0.251
	(0.107)	(0.500)*	(0.118)	(0.191)
Income/capita growth	0.174	0.318	0.194	0.179
	(0.058)***	(0.146)**	(0.063)***	(0.080)**
N	2,313	431	1,882	755
# of countries	135	23	112	42
Hansen test (p-value)	0.12	1.00	0.73	1.00
AR(1) test (p-value)	0.00	0.03	0.00	0.01
AR(2) test (p-value)	0.37	0.56	0.33	0.83

IDC = industrialized countries; LDC = least developed countries; EMG = emerging market countries; PPP = purchasing power parity; GDP = gross domestic product.

Notes: * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The dependent variable is private saving as a share of GDP. The system GMM estimation method is employed. Although the constant term is estimated, it is omitted from presentation.

In Table 5, while the real interest rate has a positive impact (substitution effect) on private saving, its impact can become negative (income effect) if the economy of concern is equipped with more developed financial markets. The thresholds in terms of private credit creation (as a share of GDP) are 31.5% for the full sample and 27.9% for the LDC sample, accounting for 56.3% and 49.1% of each respective sample. At the same time, an economy with highly developed financial markets tends to have lower private saving (as there is less need for precautionary saving). The level of financial development alone contributes negatively to private saving, although the estimate of

the level term for financial development is not significant. The negative effect, however, becomes weaker as the real interest rate falls, because agents would need to save more to compensate for the low real-interest rate.

Table 5: Determinants of Private Saving, Interacting with Financial Development

	FULL	IDC	LDC	EMG
	(1)	(2)	(3)	(4)
Private saving (*t*–1)	0.386	0.254	0.366	0.497
	(0.081)***	(0.081)***	(0.087)***	(0.085)***
Public saving	–0.418	–0.719	–0.300	–0.654
	(0.148)***	(0.126)***	(0.163)*	(0.105)***
Credit growth	–0.040	–0.020	–0.033	–0.026
	(0.012)***	(0.025)	(0.014)**	(0.017)
Fin. development, HP-filtered	–0.035	–0.024	–0.011	0.012
	(0.022)	(0.016)	(0.038)	(0.048)
Financial Development x	–0.314	0.101	–0.315	0.136
Real interest rate	(0.120)***	(0.323)	(0.161)**	(0.301)
Income/capita level	0.092	0.204	0.103	0.035
(log, PPP)	(0.028)***	(0.043)***	(0.031)***	(0.024)
Real interest rate	0.099	–0.085	0.088	–0.022
	(0.041)**	(0.314)	(0.044)**	(0.085)
Old dependency	–0.186	–0.206	–0.156	–0.282
	(0.129)	(0.189)	(0.178)	(0.192)
Young dependency	0.100	–0.341	0.150	–0.165
	(0.097)	(0.228)	(0.118)	(0.132)
Health expenditure	–1.305	–0.392	–1.696	–1.657
(% of GDP)	(0.488)***	(0.490)	(0.492)***	(0.486)***
Financial openness	–0.011	0.017	–0.021	–0.003
	(0.021)	(0.035)	(0.022)	(0.020)
Output volatility	–0.015	0.853	–0.010	0.282
	(0.108)	(0.519)	(0.117)	(0.197)
Income/capita growth	0.169	0.320	0.192	0.187
	(0.059)***	(0.139)**	(0.063)***	(0.080)**
N	2,313	431	1,882	755
# of countries	135	23	112	42
Hansen test (p-value)	0.07	1.00	0.63	1.00
AR(1) test (p-value)	0.00	0.03	0.00	0.01
AR(2) test (p-value)	0.47	0.80	0.36	0.82

IDC = industrialized countries; LDC = least developed countries; EMG = emerging markets; PPP = purchasing power parity; GDP = gross domestic product.

Notes: * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The dependent variable is private saving as a share of GDP. The system GMM estimation method is employed. Although the constant term is estimated, it is omitted from presentation.

In Table 6, the estimation model includes all three kinds of interaction terms: “output volatility x real interest rate”; “old dependency ratio x real interest rate”; and “financial development x real interest rate.” By having all the interaction terms, we can observe the relative levels of robustness among the interaction terms.

Table 6: Determinants of Private Saving, Interacting with Output Volatility, Old Dependency, and Financial Development

	FULL	IDC	LDC	EMG
	(1)	(2)	(3)	(4)
Private saving (*t*–1)	0.364	0.258	0.349	0.523
	(0.078)***	(0.076)***	(0.083)***	(0.080)***
Public saving	–0.448	–0.691	–0.335	–0.635
	(0.146)***	(0.127)***	(0.162)**	(0.106)***
Credit growth	–0.042	–0.018	–0.037	–0.029
	(0.015)***	(0.023)	(0.017)**	(0.017)*
Fin. development, HP-filtered	–0.034	–0.025	–0.012	0.015
	(0.023)	(0.015)	(0.038)	(0.044)
Income/capita level	0.095	0.196	0.100	0.033
(log, PPP)	(0.024)***	(0.038)***	(0.026)***	(0.026)
Real interest rate	0.390	–0.838	0.332	0.093
	(0.133)***	(0.701)	(0.124)***	(0.178)
Old dependency	–0.171	–0.199	–0.181	–0.257
	(0.126)	(0.163)	(0.164)	(0.172)
Young dependency	0.103	–0.302	0.127	–0.152
	(0.083)	(0.211)	(0.096)	(0.124)
Health expenditure	–1.394	–0.426	–1.744	–1.589
(% of GDP)	(0.433)***	(0.448)	(0.467)***	(0.499)***
Financial openness	–0.012	0.018	–0.019	–0.002
	(0.019)	(0.033)	(0.020)	(0.021)
Output volatility	0.005	0.528	0.017	0.266
	(0.102)	(0.458)	(0.109)	(0.179)
Income/capita growth	0.170	0.253	0.187	0.170
	(0.060)***	(0.135)*	(0.064)***	(0.080)**
Output volatility x	–2.353	22.280	–2.012	–1.876
Real interest rate	(0.793)***	(7.472)***	(0.738)***	(2.653)
Old dependency x	–1.160	1.841	–0.824	–0.639
Real interest rate	(0.562)**	(2.847)	(0.504)	(0.815)
Financial Development x	–0.421	0.028	–0.478	0.156
Real interest rate	(0.198)**	(0.287)	(0.240)**	(0.333)
N	2,313	431	1,882	755
# of countries	135	23	112	42
Hansen test (p-value)	0.05	1.00	0.58	1.00
AR(1) test (p-value)	0.00	0.01	0.00	0.01
AR(2) test (p-value)	0.46	0.69	0.39	0.80

IDC = industrialized countries; LDC = least developed countries; EMG = emerging markets; PPP = purchasing power parity; GDP = gross domestic product.

Notes: * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The dependent variable is private saving as a share of GDP. The system GMM estimation method is employed. Although the constant term is estimated, it is omitted from presentation.

The table shows that the magnitudes of the estimates of the three interaction terms do not differ very much compared to when each of them is included in the estimation individually. Neither does the relative levels of statistical significance differ among the different samples; the estimates are significant mainly for the full sample or the LDC subsample (except for the interaction between output volatility and real interest rate that is also significant for the IDC subsample). The three interaction terms can be ranked in terms of statistical significance as "output volatility x real interest rate" being the most robust, followed by "financial development x real interest rate" and "old dependency ratio x real interest rate," the last of which becomes insignificant for the LDC subsample.

Our analysis yields interesting results.

First, the positive effect of the real interest rate on saving appears to be the common wisdom, which tends to be supported by many empirical studies, only a few of which have reported a negative effect. Our baseline estimations affirm the positive effect.

However, we are able to reveal that an economic environment in which an interest rate policy is implemented can mask negative interest-rate effects.

The marginal negative effect is likely to occur among LDCs when certain economic conditions are met. Extremely high levels of output volatility could make the interest rate effect negative. In economies with high levels of old dependency, lower interest rates are associated with higher saving (i.e., the income effect of the lower interest rate dominates), and thus in countries with more developed financial markets.

When the interactive effects between these economic condition variables and the real interest rate are compared, the influence of output volatility is found to be the most robust, followed by financial development and old dependency ratios.

A low nominal-interest rate policy can yield different effects across country groups under different economic environments. This means that low-interest rate policies adopted by advanced countries to stimulate their economies could yield contractionary effects on developing countries, leading them to increase saving while reducing consumption.

4.2 Implications for the World and Asia

In the previous subsection, we showed that the impact of the real interest rate on private saving depends on several macroeconomic or demographical conditions and economic policies. Let us now look into these conditions as they apply to several selected countries and country groups.

The triangle charts in Figure 7 are helpful for tracing the patterns of output volatility, old dependency, and financial development, all of which were found to have interactive effects with the real interest rate. Each of these variables are normalized as:

$$\overline{W}^{n} = \frac{\overline{W} - \min_{2011\text{–}14}(\overline{W})}{\max_{2011\text{–}14}(\overline{W}) - \min_{2011\text{–}14}(\overline{W})}, \tag{3}$$

where $\overline{W}$ is the average of W over the 2011–2014 period and W refers to output volatility, old dependency, and financial development. In each triangle, three vertices measure the three variables with the origin normalized so as to represent zero (i.e., the minimal value) level. The observed (and normalized) values of the three variables shown in solid lines are also compared with the normalized thresholds based on the estimation models for the LDC sample shown in Tables 3 through 5.[26] The thresholds are illustrated with dotted lines in each figure—the shape of the dotted lines is the same in each triangle. The figure illustrates the triangles for the groups of EMG, non-EMG LDC, Latin American EMG, and ex-PRC Asian EMG, as well as the PRC and Republic of Korea.

Based on the results of Tables 3 through 5 and their illustrations in Figures 4 through 6, the real interest rate has a negative impact—i.e., income effect—on private saving if any output volatility, old dependency, or financial development is above the threshold.

Figure 4: Interactive Effects – Real Interest Rate and Output Volatility

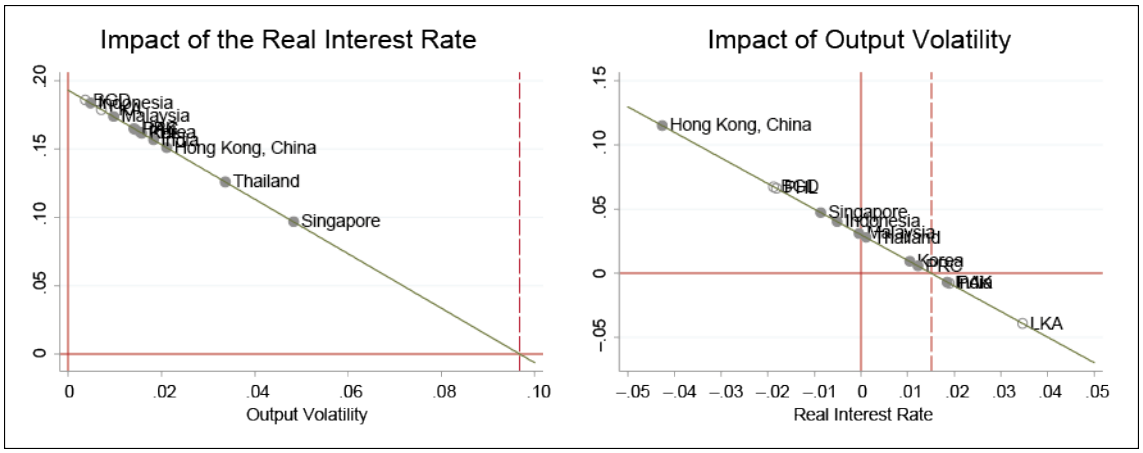
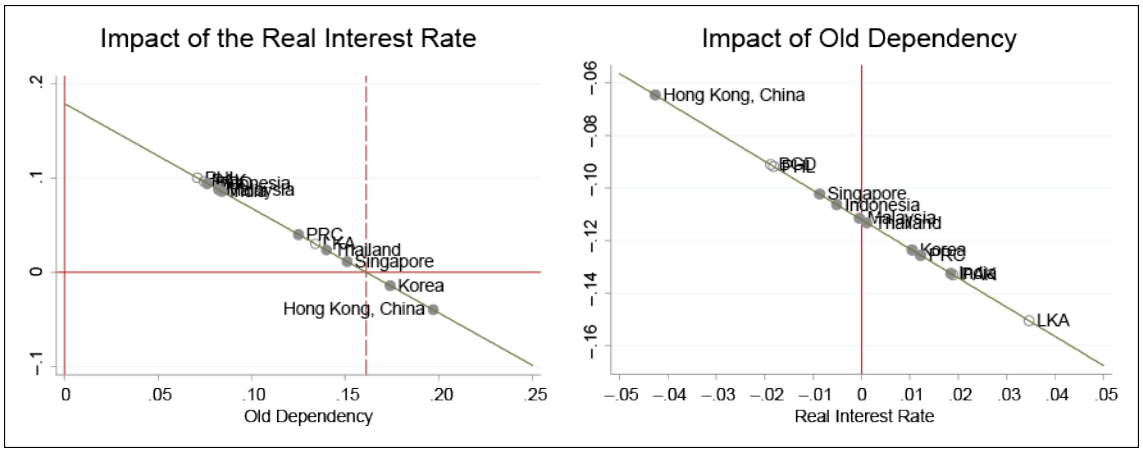
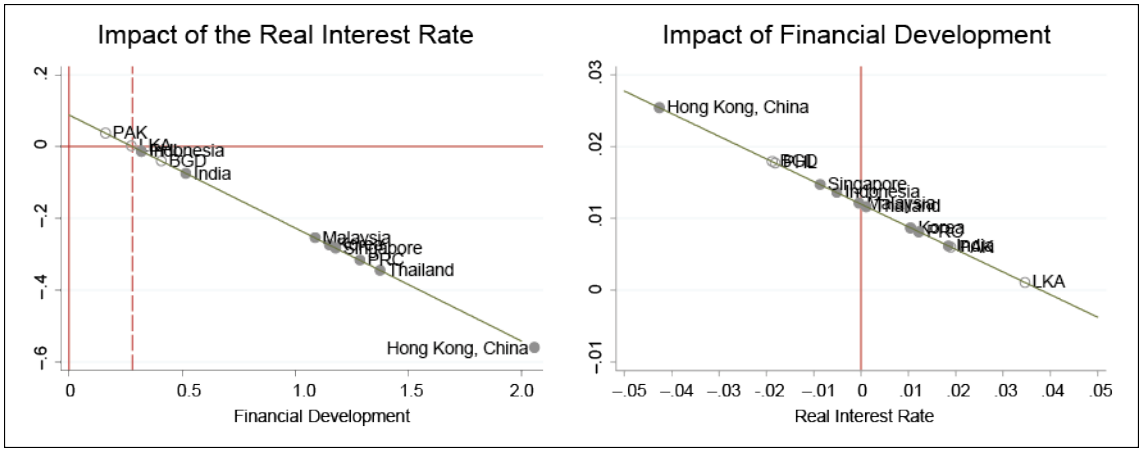


Figure 5: Interactive Effects – Real Interest Rate and Old Dependency



[26] While we found significant results for the full sample, we conclude that the estimation results for the full sample are primarily driven by developing countries. Hence, we focus our discussions on the LDC estimation results. Also, we cannot do this exercise using the estimation results reported in Table 6. In this estimation exercise, the threshold of one variable, say, output volatility depends on the values of the other two variables (which are interacted with the real interest rate variable), i.e., old dependency ratio and financial development.

Figure 6: Interactive Effects – Real Interest Rate and Financial Development



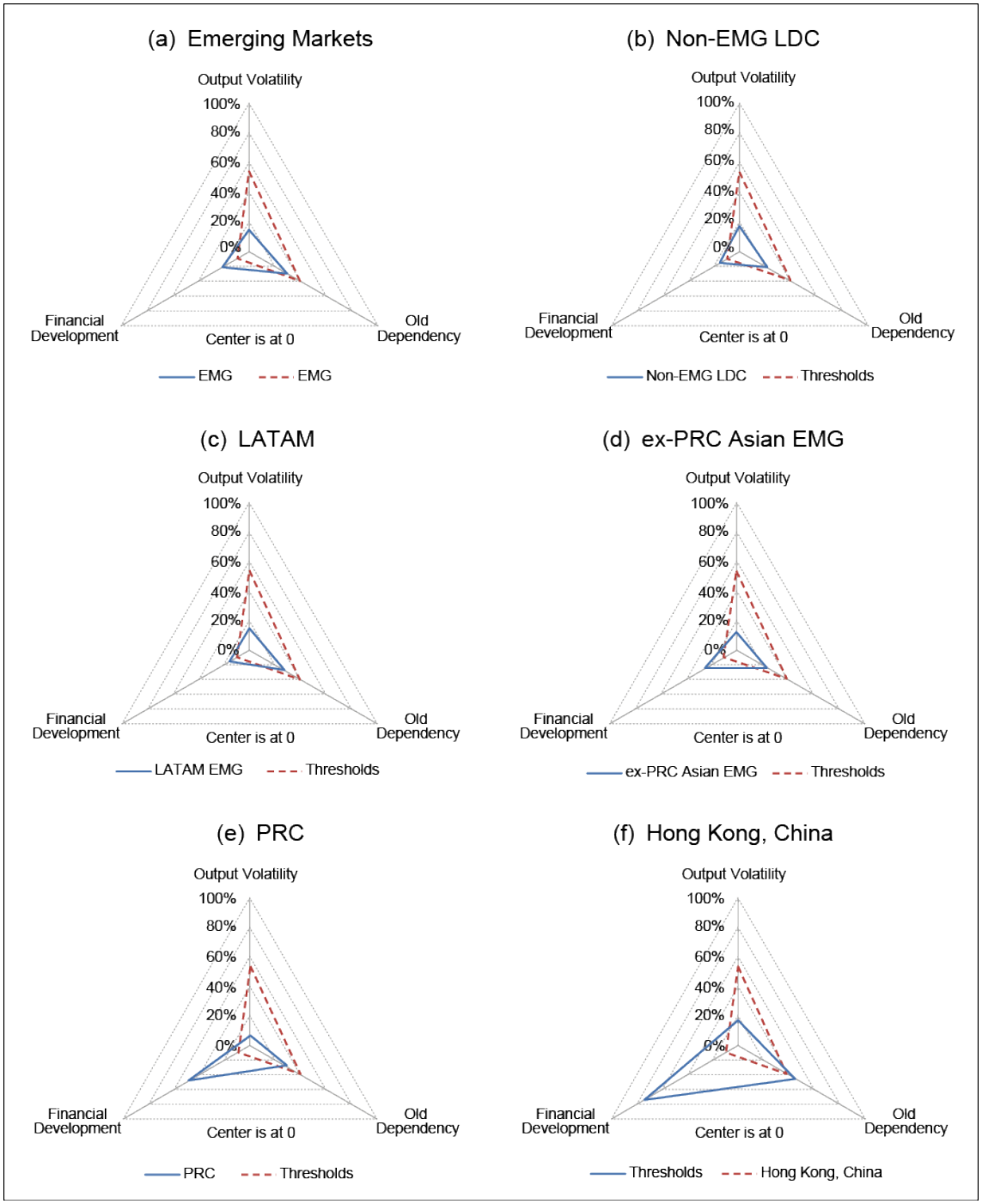
We can see that on average, EMG countries have an average level of financial development above the threshold. However, the two other conditions, i.e., output volatility and the old dependency ratio, are below the threshold. This applies to the group of ex-the PRC Asian EMG, and, to a lesser extent, Latin American EMG, and non-EMG LDC.

Both the PRC and Hong Kong, China stand out from the EMG group with their high levels of financial development, which contribute to these two countries facing the negative impact of the real interest rate. Furthermore, Hong Kong, China has an average old dependency ratio above the threshold, providing an example in which the real interest rate can have an income effect on an aging-population economy.

Figure 8 illustrates the actual real interest rate effects conditional upon output volatility, old dependency, and financial development for the PRC; Hong Kong, China; Republic of Korea; and the group of Asian emerging market economies excluding the PRC. The fourth bar from the left-hand side of the figure (i.e., the light blue bar) shows the real interest rate effects conditional on output volatility, old dependency, and financial development when each of the three economic conditional variables takes the average over the 1995–1999 period, that is, $\hat{\beta}_1 + \hat{\beta}_2^{OV}\overline{Output\_vol}_{1995-99} + \hat{\beta}_2^{OD}\overline{Old\_dep}_{1995-99} + \hat{\beta}_2^{FD}\overline{FD}_{1995-99}$, whereas the first three bars from the left-hand side of the figure show the effects for each of the three disaggregates, namely, $\hat{\beta}_2^{OV}\overline{Output\_vol}_{1995-99}$, $\hat{\beta}_2^{OD}\overline{Old\_dep}_{1995-99}$, and $\hat{\beta}_2^{FD}\overline{FD}_{1995-99}$, respectively. The set of four bars on the right-hand side are comparable to the left four bars, except that the economic conditional variables are averaged as of the 2010–2014 period.

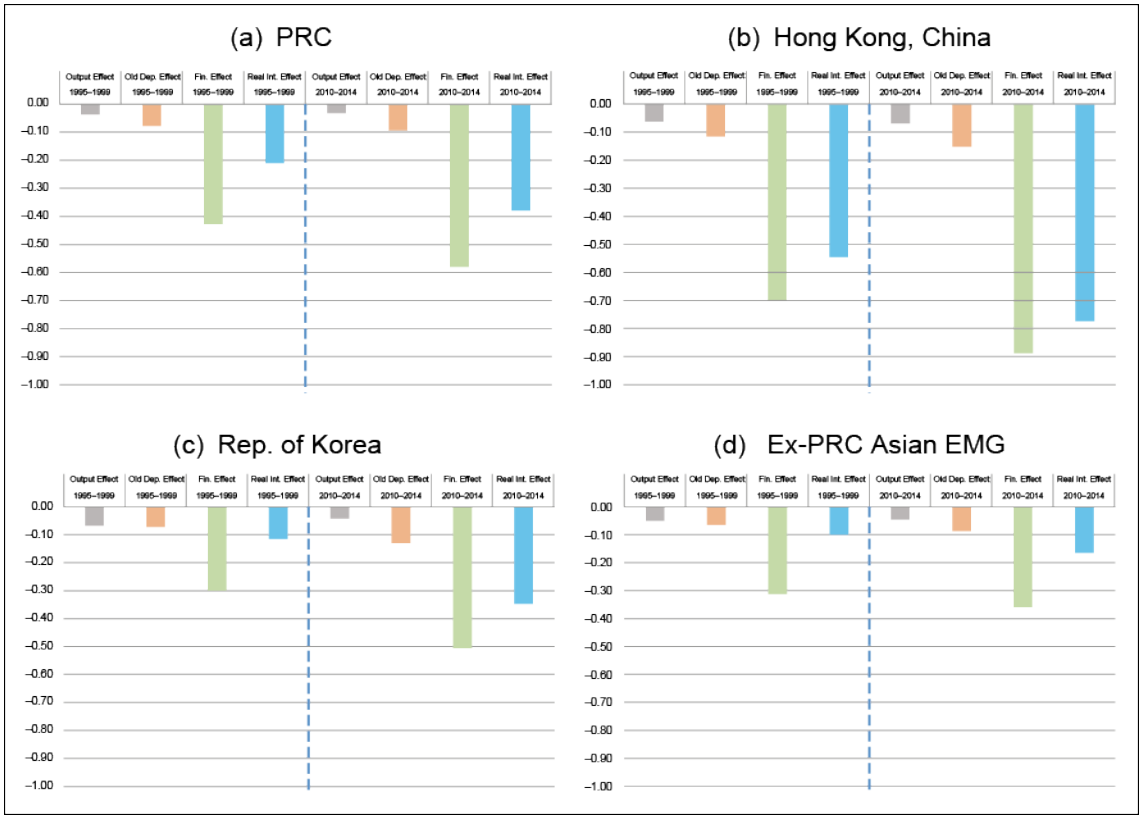
These bar figures help us grasp how the real interest rate effect has changed over time. As we saw in Figures 2 and 3, the first 5 years represent the period when the real interest rate was relatively high while the last 5 years is the period with very low real interest rates.

Figure 7: Triangle Charts



LATAM = Latin America; PRC = People's Republic of China; EMG = emerging market countries; LDC = least developed countries.

Figure 8: The Real Interest Rate Effect Conditional on Economic Conditions



PRC = People's Republic of China; EMG = emerging market countries.

We can make several interesting observations from the figure.

First, for all the three economies and the ex-PRC Asian EMG, the real interest rate effect is negative for both periods. Second, the magnitude of the negative effect increased between the two periods. The extent of increase in the absolute magnitude is especially bigger for the three individual economies.

Based on the estimation results reported in Table 6, the short-term real interest rate effect for the PRC conditional upon the three economic condition variables as of 2010–2014 is –0.381, which means the long-term effect is –0.585(=–0.381/(1–0.349)). These figures are higher compared with the short- and long-term effects of the real interest rate as of 1995–1999 that are –0.210 and –0.323, respectively. A 4 percentage point decline in the real interest rate, which is about the same as one standard deviation for the PRC and also the same as the change that occurred between 1995–1999 and 2010–2014, would lead to a 2.3 percentage point increase in the country's private saving rate. Given that a 2.3 percentage point increase is equivalent to a 0.567 standard deviation increase in the private saving, the effect is economically significant.

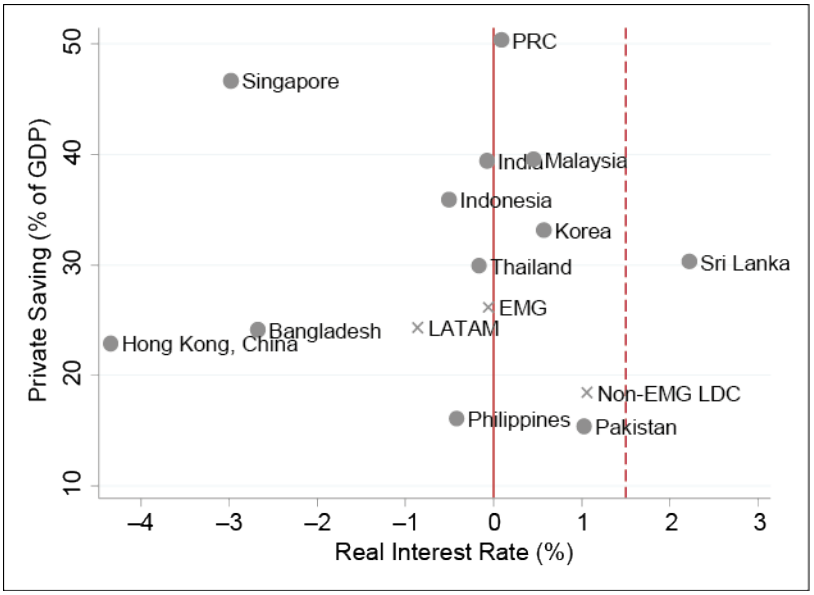
Third, when we focus on the disaggregated effects of the real interest rate for each of the three conditional variables, the panels in the figure illustrate that the effect of financial development is the largest, followed by old dependency and output volatility, though the interactive effect of old dependency is found to be statistically insignificant (Table 6). Furthermore, the impact of financial development on the real interest rate effect has increased in the last 2 decades because the economies of our concern all experienced further financial development. Hence, it is safe to conclude that the reason

why Asian emerging market economies are experiencing weaker substitution effects or stronger income effects in their real interest rates in recent years is mainly because these economies have experienced financial development.

As a last issue, let us look at the impact of low real interest rates on private saving for the economies of our interest. Table 3 and Figure 4 show that when the real interest rate is below 1.5%, greater output volatility would lead to higher private saving. Tables 4 and 5 (and Figures 5 and 6) show that the old dependency ratio and financial development can have negative impacts on private saving, but such negative impacts in absolute values tend to become smaller as the real interest rate falls. Thus, under low real interest rates, output volatility tends to increase private saving, and old dependency ratio and the stage of financial development display a reduced negative impact on private saving.

Figure 9 illustrates the ratios of private saving in GDP and the real interest rates, but only for selected Asian economies, EMG, non-EMG LDC, and Latin American EMG. The dotted line depicts the threshold of 1.5% for the impact of output volatility for developing countries.

Figure 9: Private Saving and the Real Interest Rate for Asia and Others



EMG = emerging markets; LATAM = Latin America; H.K. = Hong Kong, China; LDC = least developed countries; Korea = Republic of Korea.

In this figure, we can see that Asian developing economies are distributed at lower levels of the interest rate, with all of them, except for Sri Lanka, below the 1.5% threshold. Thus, these economies tend to respond negatively to output volatility and less negatively to shocks to old dependency, thus, to financial development.

5. CONCLUSION

In the aftermath of the GFC, unconventional monetary policies, such as quantitative easing and negative interest-rate policies were implemented by advanced economies. While such policies may have contributed to jumpstarting these economies, their implementation also created uncertainty over the future direction of the economies and the financial systems. In particular, the effectiveness of interest rate policies such as zero or negative interest-rate policies have been questioned, along with implications for the financial sector. One frequently asked question is whether an extremely low or negative interest-rate policy would lead to lower or higher consumption or saving. In this paper, we focus on this question and empirically investigate the link between the interest rate and private saving. Our primary focus is whether the interest rate effect is dominated by the income (i.e., negative) or the substitution (i.e., positive) effect.

First, our baseline estimations generally affirm the positive effect of the real interest rate on private saving, although its estimate is significant only for the full sample and marginal for the subsample of Asian economies.

Given the weakly positive estimates, we suspect that if the interest rate has any impact on private saving, its effect can be masked by uncertain economic environment. Our motive for this investigation is that recent low interest rates may be coupled with greater uncertainty of future monetary or financial conditions and thereby encourage people to engage in precautionary saving when interest rates become very low.

When we investigate whether the real interest rate affects private saving differently depending on whether the real, or nominal, interest rate is below a certain threshold, we find some evidence that the impact of the real interest rate on private saving changes when the *nominal* interest rate is below a relatively low level. This finding may indicate that certain economic environments affect the way interest rate policy is conducted and can impact interest rate effects.

Therefore, we examine the impact of the real interest rate conditional upon economic circumstances such as output volatility, old dependency ratio, and financial development. From this investigation, we find that these conditions matter. Extremely high levels of output volatility could make the interest rate effect negative. In economies with high levels of old dependency, the income effect associated with a low interest rate dominates, and a similar observation applies to countries with well-developed financial markets.

We also find that the impacts of such economic factors could also be affected by the real interest rate. The impact of output volatility is found to be conditional upon the real interest rate, especially when it is at a low level. That is, when the real interest rate is below 1.5%, greater output volatility would lead to *higher* private saving in developing countries. Lastly, we find that an old dependency ratio and financial development have negative impacts on private saving, but that negative impacts in absolute values tend to become smaller as the real interest rate falls.

Thus, a low-interest rate environment can yield different effects on private saving across country groups under different economic environments. This means that low-interest rate policies adopted by advanced countries to stimulate their economies can yield contractionary effects on developing countries through encouraging saving and reducing consumption.

Such findings are relevant to Asian economies. Many of them are characterized by relatively well-developed financial markets. Some of these economies are also experiencing rapidly aging populations. Our empirical findings suggest that these factors are associated with the dominance of the income effect on private saving.

It has been documented that advanced economies' monetary or financial conditions can have spillover effects on emerging market economies (e.g., Aizenman et al. 2016a and 2016b). This means that, in emerging market economies, unconventional monetary policies can guide interest rates to lower levels. Low interest rates could then contribute to higher private saving. All of these findings suggest that an active low-interest rate policy in advanced economies can contribute to keeping global imbalances perennial.

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APPENDIX 1: SAMPLE COUNTRY LIST

Industrialized Countries	Bulgaria	Malaysia (AE)
	Burkina Faso	Maldives
Australia	Burundi	Mali
Austria	Cote d'Ivoire	Mauritius
Belgium	Cameroon	Mexico
Canada	Central African Republic	Moldova
Denmark	Chad	Mongolia
Finland	Chile	Morocco
France	Colombia	Mozambique
Germany	Comoros	Myanmar
Greece	Congo, Dem. Rep.	Namibia
Iceland	Congo, Rep.	Nepal
Ireland	Costa Rica	Niger
Italy	Croatia	Nigeria
Japan	Cyprus	Oman
Malta	Czech Rep.	Pakistan (AE)
Netherlands	Dominican Rep.	Panama
New Zealand	Ecuador	Paraguay
Norway	Egypt	Peru
Portugal	El Salvador	Philippines (AE)
Spain	Estonia	Poland
Sweden	Fiji	PRC (AE)
Switzerland	Gabon	Qatar
United Kingdom	Gambia, The	Romania
United States	Georgia	Russian Federation
	Ghana	Rwanda
Developing Countries	Grenada	Senegal
	Guinea–Bissau	Seychelles
Albania	Hungary	Sierra Leone
Algeria	India (AE)	Singapore (AE)
Angola	Indonesia (AE)	Slovak Rep.
Antigua and Barbuda	Israel	Slovenia
Argentina	Jamaica	South Africa
Armenia	Jordan	Sri Lanka (AE)
Azerbaijan	Kazakhstan	St. Lucia
Bahamas, The	Kenya	St. Vincent and the Grenadine
Bahrain	Korea, Rep. of (AE)	Swaziland
Bangladesh (AE)	Kuwait	Tajikistan
Barbados	Kyrgyz Republic	Tanzania
Belarus	Lao PDR	Thailand (AE)
Belize	Latvia	Togo
Benin	Lebanon	Trinidad & Tobago
Bolivia	Lithuania	Tunisia
Botswana	Madagascar	
Brazil (LE)	Malawi	

(AE) refers to Asian emerging market economies.

APPENDIX 2: DATA DESCRIPTIONS

Private saving (as a share of GDP): Private saving is obtained by subtracting public saving, which we measure by general budget balance (as a share of GDP), from domestic saving (as a share of GDP). The domestic saving data are obtained from the *World Development Indicators (WDI)* database.

Public saving (as a share of GDP) is measured by general government budget balance whose data are extracted from the International Monetary Fund's *World Economic Outlook* database.

Credit growth: is measured by the growth rate of private credit creation (as a share of GDP), which is included as a proxy for credit growth or credit availability.

Financial development: Private credit creation (as a share of GDP) is used as a proxy for financial development. The data are extracted from the Global Financial Development Database (GFDD).

Financial openness: To measure the extent of financial openness, we use the Chinn–Ito index (2006, 2008) of capital account openness.

Output volatility: Agents in economies who face more volatile income flows might save more for precautionary reasons so that they can smooth their consumption streams. At the

Income growth: Income growth is measured by the growth rate of per capital income in local currency, which is available from the WDI database.

Demography: The dependency ratios are calculated by dividing the young (less than 24 years old) population and old populations (older than 64 years old) by the working population (between 24 and 64 years old). The population data for the demographical groups are obtained from the *WDI*.

Per capita income level (in PPP): The data of per capita income in PPP are available from the Penn World Table 9.0.

Real interest rate: is calculated as: $r = \ln\left(\frac{1+i}{1+\pi}\right)$. The nominal interest rates are mainly policy interest rates or money market rates, and the rate of inflation is calculated as the growth rate of consumer price index, both of which are extracted from the International Monetary Fund's *International Financial Statistics.*

Health expenditure: is measured as "total health expenditure as a share of GDP." "Public health expenditure as a share of GDP" is also used in a robustness check. Both data series are available in the WDI database.

Social expenditure: is aggregate expenditure for social protection as a share of GDP, available in the OECD database.

Property price changes: is the percentage growth of the property price index. The property price index is drawn from the Bank for International Settlements' *Residential Property Price Statistics database*, complemented by the CEIC, OECD, and Haver databases. The index is converted to a real index series by using respective countries' consumer price indexes.

Net investment positions: is external assets minus external liabilities divided by GDP. The data of external assets and external liabilities are extracted from Lane and Milesi–Ferretti (2000, 2007, updates).

APPENDIX 3: ADDITIONAL ESTIMATION RESULTS

Table A1: Determinants of Private Saving, 1995–2014 with Net Investment Position Dummy

	FULL	IDC	LDC	EMG
	(1)	(2)	(3)	(4)
Private saving (*t* 1)	0.366	0.219	0.318	0.484
	(0.089)***	(0.062)***	(0.097)***	(0.088)***
Public saving	–0.420	–0.730	–0.291	–0.640
	(0.177)**	(0.132)***	(0.210)	(0.098)***
Credit growth	–0.037	–0.010	–0.034	–0.031
	(0.013)***	(0.021)	(0.014)**	(0.017)*
Fin. development, HP-filtered	–0.030	–0.017	–0.019	0.008
	(0.022)	(0.010)*	(0.041)	(0.047)
Income/capita level (log, PPP)	0.108	0.197	0.123	0.040
	(0.035)***	(0.040)***	(0.038)***	(0.021)**
Real interest rate	0.066	0.016	0.058	0.028
	(0.045)	(0.195)	(0.045)	(0.057)
Net debtor dummy	–0.031	–0.021	–0.032	–0.020
	(0.014)**	(0.009)**	(0.020)*	(0.010)**
Dependency, old	–0.054	–0.244	0.025	–0.260
	(0.144)	(0.188)	(0.211)	(0.174)
Dependency, young	0.165	–0.291	0.213	–0.147
	(0.122)	(0.247)	(0.141)	(0.105)
Health expenditure, public	–1.693	–0.553	–1.865	–1.678
(% of GDP)	(0.589)***	(0.499)	(0.570)***	(0.498)***
Financial openness	–0.040	0.024	–0.049	–0.010
	(0.027)	(0.036)	(0.027)*	(0.017)
Output volatility	–0.037	0.857	–0.088	0.211
	(0.112)	(0.515)*	(0.125)	(0.165)
Income/capita growth	0.179	0.337	0.190	0.176
	(0.061)***	(0.129)***	(0.068)***	(0.078)**
N	2,169	431	1,738	747
# of countries	130	23	107	42
Hansen test (p-value)	0.60	1.00	1.00	1.00
AR(1) test (p-value)	0.00	0.03	0.01	0.01
AR(2) test (p-value)	0.48	0.84	0.51	0.95

IDC = industrialized countries; LDC = least developed countries; EMG = emerging market countries.

Notes: * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The dependent variable is private saving as a share of GDP. The system GMM estimation method is employed. Although the constant term is estimated, it is omitted from presentation.

Table A2: Determinants of Private Saving, 1995 – 2014 with Property Price Level

	FULL (1)	IDC (2)	LDC (3)	EMG (4)
Private saving (*t*–1)	0.545	0.335	0.734	0.757
	(0.096)***	(0.086)***	(0.079)***	(0.062)***
Public saving	–0.677	–0.643	–0.775	–0.777
	(0.120)***	(0.125)***	(0.137)***	(0.147)***
Credit growth	–0.021	–0.013	–0.026	–0.012
	(0.015)	(0.022)	(0.020)	(0.017)
Fin. development, HP-filtered	–0.057	–0.021	–0.047	0.005
	(0.016)***	(0.014)	(0.013)***	(0.015)
Income/capita level (log, PPP)	0.048	0.174	0.043	0.019
	(0.017)***	(0.043)***	(0.012)***	(0.010)*
Real interest rate	–0.167	0.142	–0.271	–0.212
	(0.149)	(0.196)	(0.125)**	(0.099)**
Real property price level	–0.008	–0.007	–0.010	–0.027
	(0.014)	(0.018)	(0.013)	(0.010)***
Dependency, old	–0.492	–0.215	–0.374	–0.417
	(0.185)***	(0.182)	(0.157)**	(0.123)***
Dependency, young	–0.199	–0.265	–0.195	–0.237
	(0.138)	(0.226)	(0.119)	(0.074)***
Health expenditure, public	–0.279	–0.263	–1.434	–1.212
(% of GDP)	(0.378)	(0.473)	(0.365)***	(0.357)***
Financial openness	0.005	0.011	0.002	0.033
	(0.018)	(0.030)	(0.014)	(0.011)***
Output volatility	0.027	0.777	–0.032	–0.213
	(0.219)	(0.530)	(0.161)	(0.121)*
Income/capita growth	0.189	0.369	0.107	0.108
	(0.105)*	(0.127)***	(0.078)	(0.059)*
N	713	345	368	305
# of countries	53	23	30	24
Hansen test (p-value)	1.00	1.00	1.00	1.00
AR(1) test (p-value)	0.00	0.02	0.00	0.00
AR(2) test (p-value)	0.50	0.65	0.94	0.12

IDC = industrialized countries; LDC = least developed countries; EMG = emerging market countries.

Notes: * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The dependent variable is private saving as a share of GDP. The system GMM estimation method is employed. Although the constant term is estimated, it is omitted from presentation.

Table A3: Determinants of Private Saving, 1995 – 2014 with Property Price Change

	FULL (1)	IDC (2)	LDC (3)	EMG (4)
Private saving (*t*–1)	0.610	0.310	0.743	0.738
	(0.096)***	(0.090)***	(0.067)***	(0.058)***
Public saving	–0.595	–0.606	–0.733	–0.697
	(0.131)***	(0.135)***	(0.110)***	(0.132)***
Credit growth	–0.015	–0.013	–0.019	–0.009
	(0.014)	(0.021)	(0.015)	(0.013)
Fin. development, HP-filtered	–0.044	–0.021	–0.040	0.007
	(0.013)***	(0.016)	(0.012)***	(0.016)
Income/capita level (log, PPP)	0.021	0.180	0.031	0.011
	(0.018)	(0.049)***	(0.010)***	(0.010)
Real interest rate	–0.071	0.238	–0.199	–0.125
	(0.122)	(0.196)	(0.104)*	(0.113)
Real property price Increase	–0.054	–0.039	–0.028	–0.018
(%)	(0.019)***	(0.029)	(0.016)*	(0.019)
Dependency, old	–0.478	–0.210	–0.353	–0.401
	(0.171)***	(0.185)	(0.117)***	(0.113)***
Dependency, young	–0.248	–0.269	–0.205	–0.251
	(0.125)**	(0.237)	(0.087)**	(0.060)***
Health expenditure, public	0.005	–0.295	–1.285	–1.133
(% of GDP)	(0.335)	(0.513)	(0.340)***	(0.306)***
Financial openness	0.022	0.010	0.008	0.035
	(0.025)	(0.031)	(0.015)	(0.010)***
Output volatility	–0.069	0.829	–0.013	–0.150
	(0.181)	(0.617)	(0.159)	(0.122)
Income/capita growth	0.256	0.389	0.170	0.145
	(0.089)***	(0.138)***	(0.085)**	(0.075)*
N	688	334	354	294
# of countries	55	23	32	25
Hansen test (p-value)	1.00	1.00	1.00	1.00
AR(1) test (p-value)	0.00	0.01	0.00	0.00
AR(2) test (p-value)	0.63	0.60	0.56	0.19

IDC = industrialized countries; LDC = least developed countries; EMG = emerging market countries.

Notes: * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The dependent variable is private saving as a share of GDP. The system GMM estimation method is employed. Although the constant term is estimated, it is omitted from presentation.