The Interest Rate Effect on Private Saving: Alternative Perspectives

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Abstract

Lowering the policy interest rate could stimulate consumption and investment while discouraging people from saving. However, such a move may also prompt people to save more to compensate for the low rate of return. Using the data of 135 countries from 1995 to 2014, we show that a low-interest rate environment can yield different effects on private saving under different economic environments. The real interest rate affects private saving negatively if output volatility, old-age dependency, or financial development is above a certain threshold. Depending on a country's specific economic circumstances, these effects are significant for the economy—a four-percentage point decline in the real interest rate, which is approximately the same as one standard deviation for China, would lead to a 1.52 percentage point increase in the Chinese private saving rate. Further, when the real interest rate is below 1.1%, greater output volatility would lead to higher private saving in developing countries.

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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 fall 2017, 19 euro countries, plus Japan, Denmark, Sweden, and Switzerland, had adopted negative policy interest rates.

As unconventional actions often face opposition in general, negative interest-rate policies have also faced challenges in regards to their effectiveness. Conventionally speaking, lower interest-rate monetary policy is supposed to encourage present-day consumption (as opposed to future consumption), by lowering rewards for postponing consumption. More simply, lowering the policy interest rate is expected to stimulate consumption and investment while discouraging people to save. Negative interest rates, expected as further drastic action, would not just discourage but also penalize people, if they postponed consumption. Hence, theoretically, negative interest rates can 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 have argued that negative interest rates may not work as central bankers expect.

The argument goes as follows: lower or negative interest rates may contribute to higher, not lower, saving rates because the rate of return is so low that people may try to compensate by increasing their aggregate amount of

[1]As an exception, Denmark 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.

saving. This scenario could especially occur in an economy with an aging population, as people might want to target their savings to better prepare for retirement. Such a tendency could also be strong in an economy in which sufficient social protections, such as social security 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, precautionary saving may change according to economic or policy conditions.

This is not just an issue for advanced economies with low or negative interest rates, but also for developing economies. 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. Such a situation could be exacerbated if the economy of concern experiences high inflation. If such an economy were also coupled with underdeveloped public social-protection programs, people would have reason to increase their 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 China 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.

Is China's documented interest-rate-saving effect an isolated instance or an example of a 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 previously noted, 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 may depend on the interest-rate level 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 worry 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. The effect of the interest rate on saving may also differ depending on the macroeconomic, institutional, or demographical conditions, or the 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 important in the context of the global imbalance debate. In the years leading up to the Global Financial Crisis (GFC) of 2008, many emerging market economies in East Asia (most notably, China) and oil exporters persistently ran current-account surpluses during the worldwide trend of lower real interest rates. Some economists have argued that high savings in rapidly growing emerging markets are responsible for such current account surpluses and thus contributed 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 worthwhile.

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 levels

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.

We investigate whether the interest rate has the income (i.e., negative) effect or the substitution (i.e., positive) effect on private saving using panel data from 135 countries over the 1995–2014 period while controlling for other factors that can affect private saving behavior.

Furthermore, we empirically examine whether and how the impact of the interest rate on saving can be affected by economic, demographical, and policy conditions. We suspect that the effect of the real interest rate on private saving can depend on the economic environment at large and be masked by varying economic conditions. That may explain the ambiguous or no effect of the interest rate as a level, which this and other papers find. The innovative contribution of this paper, we believe, is to show whether and how the interest rate affects private saving interactively with output volatility, old-age dependency, and financial development.

Our estimation exercise focuses on the saving behavior of developing countries rather than advanced economies, though it is the latter group of countries that initially started a low interest rate environment. Unconventional monetary policies implemented by the U.S. and other advanced economies in response to financial instabilities caused repercussions among emerging market economies as we first witnessed surges of capital flows in search for higher yields in emerging market economies and now possible retrenchment of such flows driven by U.S. monetary contraction since late 2013.[2] Thus, spillovers of the GFC and unconventional monetary policy heightened the level of uncertainty among emerging market economies as well as advanced economies, with low

[2] For studies that identify financial spillovers from the center economies to peripheral economies, refer to Aizenman, et al. (2016, 2017a,b).

interest rates signaling future uncertainty of monetary or financial conditions and thereby possibly encouraging people toward precautionary saving. As far as we are aware, there do not seem to be studies that do research on the impact of the environment of extremely low interest rates on the saving of countries, especially non-advanced economies. Thus, we think it is also important and innovative to focus on the link between the interest rate and the saving behavior of developing economies.

Throughout the paper, we pay special attention to emerging market economies in Asia. This is because, first, the Asian region has been identified as one of the world's most dynamic regions in terms of its robust economic growth and development. Second, and more importantly, the region receives much attention, often critical, for its excess saving that allegedly worsens 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 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 Asian emerging market economies. In Section 5, we offer concluding remarks.

2. Private Saving Theory and Evidence

2.1 What Kind of Saving Do We Focus On?

Many 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 saving data under examination. 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, ideally, we would have focused on household saving.

While the benefit of focusing on household saving is rather obvious, there are downsides in using household saving in our analysis.

First, in a practical sense, it is almost implausible to obtain consistent household saving data across countries. Household saving data are typically derived from government surveys that are conducted based on a wide variety of methods across countries (and over time). Even with a uniform survey method, disagreements could arise over what should be included in consumption, saving, or disposable income when calculating the saving rate. For example, a 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.[3] Depending on the survey and data-compiling methodologies, a wide variety of household saving data exists.

Thus, different types of household saving data exist for different countries. The list of items to be included in saving and income to compute the saving rate depends on the specific saving behavior a researcher chooses to study. Hence, a consistently compiled data set of household saving rate is hard to obtain. Although the OECD publishes relatively consistent household saving data, the

[3] There is an issue about the distinction between gross and net household saving. See Audenis *et al.* (2004) for details.

data are mostly compiled for 33 countries, mostly advanced economies.

Second, there is also a conceptual reason that makes it difficult to use household saving data. As Gale and Sabelbaus (1999) put, “the distinctions between personal and corporate saving are thin and somewhat arbitrary.” Gale and Sabelbaus (1999) also argue that certain income sources from holding financial assets such as corporate dividend payments, corporate share repurchases, and capital gains are not consistently recorded as part of personal income even though they all involve shifting funds from the corporate to the household sector.

The difficulty in defining the boundary between household and corporate saving is more severe for developing countries. Generally speaking, in developing countries, informal labor markets are usually prevalent and vast, that makes it difficult to distinguish 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. For example, unincorporated companies are usually included in the household sector in the National Accounts, although they will be included in the corporate sector once they get incorporated.

Thus, data availability and conceptually inconsistent definition of household saving (and corporate saving) make us use private saving as a share of GDP as the saving rate we focus on. However, using private saving, i.e., the aggregate of household and corporate saving, is not without problems.

One drawback of focusing on private saving instead of household saving is that, typically, the corporate saving rate tends to be higher than the household saving rate. That means that the movement of the private saving rate can be more driven by corporate saving than by household saving.

Another is that, if a rise in household saving is matched with a fall with the same magnitude in corporate saving, or vice versa, that would leave the level of private saving unchanged, which may make aggregation of household and

corporate saving inappropriate. Empirically, however, it has been shown that households do not necessarily "pierce the corporate veil." That is, a one unit change in corporate saving is not fully cancelled with a 1:1 ratio change in household saving with the opposite sign, but only cancelled partially with a less-than-one-unit change (Bebczuk and Cavallo, 2016).

After all, we think that data availability and conceptually inconsistent definition of household saving (and corporate saving) are sufficient reasons for us to use private saving as the saving rate of our focus.[4]

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.[5]

2.2 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.[6]

Persistence: Many empirical studies have found that there is a high degree of persistence in the series of private saving. In addition, the determinants of private saving can have a lagged-time impact; thus, private saving tends to show inertia. We attempt to capture this by including the lagged dependent variable as an explanatory variable.

Public saving: The theory of Ricardian equivalence predicts that, in a world where tax policy creates no distortion and where agents are assumed to

[4] Hall (1999) agrees with Gale and Sabelbaus (1999) on the fuzziness of the boundary between household saving and corporate saving and the lack of conceptually consistent definitions of both types of savings.

[5] Aizenman *et al*. (2015) and Aizenman and Noy (2013) also use the private saving data derived in the same way.

[6] For data definitions, refer to Appendix: Data Descriptions.

foresee future taxation and optimize (infinitely) into the future, 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. While empirical studies usually show that full offset does not exist, a partial offset is often prevalent, with the average absolute estimate ranging 0.25–0.60.[7]

Credit growth: If credit constraint is mitigated, agents would increase their consumption, and hence, decrease saving (Loayza *et al.*, 2000a, 2000b). We include the growth rate of private credit (as a share of GDP) as a proxy for credit conditions and expect a negative estimate.

Financial development: Further financial development 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.[8]

Financial openness: The impact of financial openness on saving behavior can also be explained similarly to that of financial development.[9]

Output volatility: Risk-averse consumers who face more volatile income flows might set resources aside for precautionary reasons to mitigate unexpected future income shocks and smooth their consumption streams.[10] Hence, we can generally expect private saving to be positively correlated with output volatility.

Income growth: Based on the permanent income hypothesis (Friedman, 1957), higher income growth, if it represents higher future growth, should lead to higher consumption with no change in saving, but if it is a temporary growth, it should lead to higher saving only. The life-cycle hypothesis (Modigliani and

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[7] See de Mello *et al.* (2004).

[8] To mitigate the effects of business cycles, HP-detrended series are used.

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

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

Brumberg, 1954) is vague on such a link, making it conditional on other factors, including credit constraint. Vast empirical literature has shown that income levels are positively correlated with saving.

Demography: The life-cycle hypothesis (Modigliani and Brumberg, 1954) 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): Stage of development, as well as demographic characteristics, should 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 as we already described. Although temporary positive shocks to income would lead merely to an increase in saving, but not to a change in consumption, permanent shocks might lead to an increase in consumption, but not to a change in saving.[11] Furthermore, more practically, a measure of per capita income can be highly correlated with the level of institutional or legal development. Economies with developed institutions or legal systems can provide a friendly environment for saving, suggesting 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

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

consumption, thus 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 depend on the relative magnitude of income and substitution effects.

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 China is associated with a decline in real interest rates in the 1996–2009 period.

In this paper, the interest rate refers to the real interest rate unless mentioned otherwise, which is consistent with saving behavior theory and customary in the literature. We use the real interest rate that is calculated as: $r = \ln\left(\frac{1+i}{1+\pi}\right)$.[12]

2.3 Stylized Facts

Before formally investigating the interest rate impact 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 136 countries from 1995 to 2015, which includes 23 industrialized (IDC) and 113 developing countries (LDC). Out of the 113 developing countries, 43 countries are identified as emerging market countries (EMG).[13]

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[12] For the nominal interest rate, we use money market rates to represent policy short-term interest rate. The data are extracted from the IMF's *International Financial Statistics* (60B..ZF...). For the countries whose money market rates are unavailable or extremely limited, the money market data are supplemented by the discount rates (60...ZF...) and the deposit rates (60L..ZF...) series from *IFS*.

[13] We define emerging market countries (EMG) as countries classified as either emerging or frontier during the period of 1980–1997 by the International Financial Corporation plus Hong Kong and Singapore.

Figure 1 illustrates the development of private saving (as a share of GDP) over the last two 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 China (ex-China EMG Asia) and Latin American economies with the U.S., the euro area, China, and Japan.[14]

Interestingly, the private saving rates are comparable between the IDC and EMG groups, 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. This pattern suggests that people increased their savings in response to heightened economic uncertainty as a result of the mortgage crisis in the U.S. and Europe in 2007 and 2008.

Comparing individual economies and regional groups of economies (Panel (b)), we can see that China, with high saving rates, appears as an outlier—a fact that has been documented by many observers. China is followed, with some gaps, by other emerging Asian market economies. The U.S. also appears distinct with its low saving rates, whereas Japan's saving rate has been declining over the last two 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 five 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 have

[14] Observations with their corresponding country-year inflation rates greater than 40% are removed from these figures.

experienced persistent declines in their real interest rates. The top rows in both panels show that real interest rates have been converging throughout this 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 steeply, which reflected a sharp rise in inflation mostly due to high energy prices, as well as to sharp drops in the nominal interest rates implemented 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, although the nominal interest rates remained relatively constant around a low level or zero, inflation rates continuously fell after 2011. All of these factors contributed to a continuous rise in the real interest rates.

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 five years (i.e., 2011–2015)—when the real interest rates were generally low.[15] The correlation for the full sample is significantly negative for the last five years, suggesting that the income effect of the interest rate on private saving dominates the substitution effect, while in the first five years it is only insignificantly negative. 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 five-year period, which is significantly different from the first five years. For the IDC group, interestingly, the correlation becomes positive in the last five-year period, although it is

[15] 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 data points for which the corresponding inflation rate is greater than 40%.

significantly negative in the first period. Overall, evidence exists 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.

Naturally, there are limits to this kind of exercise with unconditional correlations. We implement a formal statistical analysis to address such limits 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:

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

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 must account for joint endogeneity of the explanatory variables. Third, we need to control for unobserved country-specific effects that correlate with the regressors.

For our empirical exercise, we adopt 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. Furthermore, when the explanatory variables tend to be persistent over time—which can be the case for some of our explanatory variables—lagged levels of these variables can be weak instruments for the estimation in differences. Hence, we choose the system GMM method over the difference GMM (Arellano and Bond, 1991; Arellano and Bover, 1995; Blundell and Bond, 1998). Last, considering that the time dimension of our panel is larger than the cross-country dimension, an overabundance of moment conditions can lead to an over-identification and downward bias in standard errors. To mitigate this, we make a finite-sample correction (Windmeijer, 2005) to standard errors.[16]

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

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 income 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 estimation results from the full sample and the

[16] We also use the "collapse" option in STATA's xtabond2 command to reduce the number of instruments.

subsample of LDC.[17]

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 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 if first-order autocorrelation exists) 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.[18]

Generally, the estimation results are consistent with our theoretical

[17] The estimation sample period becomes 1995–2014 because some data are not available for 2015.

[18] 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 fails to detect over-identification. In fact, for smaller subsamples such as the IDC, EMG, and regional country groups for which the country dimension (*N*) is relatively smaller to the time dimension (*T*), there is a tendency for the Hansen test's p-value to take the value of "1.00" (not reported). Thus, we do not include these cases with a small country sample size.

discussions.

First, the real interest rate, the variable of our focus, enters the estimation as a positive contributor, though statistically insignificantly. This suggests that the substitution effect may outweigh the income effect on average, although it is not statistically confirmed.

The behavior of private saving is found to be somewhat persistent. The degree of persistency is 0.394 and 0.395 for the full sample and the LDC subsample, respectively.

We observe evidence of partial Ricardian offset in the estimated coefficient for public saving. The results of the full sample indicate that a one percentage point increase in public saving would be offset by approximately a 0.46 percentage points decrease in private saving. The size of the offset is slightly smaller among developing countries, which may be because, in such countries, the tax systems can be more distortive compared to industrialized countries. Furthermore, these countries tend to lack developed financial markets, which therefore does not allow for smooth intertemporal trade.

While the effect of financial development is found to be insignificant, credit growth is found to be a significantly negative contributor for both developing economies and the full sample. Once credit conditions improve, a developing country tends to experience growth in its consumption—that is, a fall in its saving rate.

While controlling for other factors including financial development, it turned out that financial openness, in contrast, is an insignificant factor, implying that financial openness does not necessarily help increase private saving or allow foreign saving to crowd out domestic private saving.

Both the level and growth of per capita income are found to positively contribute to private saving, but the effect of output volatility is found to be ambiguous.

The higher the country's level of old-age dependency, the lower the rate of private saving it tends to experience, although the estimate is not significant for either the full or LDC sample.

Healthcare expenditure, which we measure by public health expenditure as a share of GDP, has a negative impact on private saving. In other words, 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 magnitude of the estimate is larger for the LDC subsample, suggesting that private saving in the countries in this group is more flexible in regards to changes in the availability of public healthcare. Also, when we use social expenditure as a share of GDP that is available in the OECD database, the results are essentially unchanged.[19]

3.3 Robustness Checks

Other Estimation Methods

Although we discussed the reasons for why we employ the System GMM method for the estimation, it should still be informative if we employ other types of estimation methods as robustness checks. Besides the System-GMM, we tested using pooled OLS (with no fixed effects), OLS with time fixed effects, OLS with both time and country fixed effects, and OLS with random effects. Appendix Table 1 reports the estimation results with different estimation methods for the LDC subsample.[20]

Overall, while there is some variation in the magnitudes of the estimates (especially for the first lag of private saving, public saving, financial development, and healthcare expenditure), statistical significance tends to be

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

[20] Column (1) of Appendix Table 1 is the same as Column (2) of Table 2.

consistent across different estimation methods.[21]

Furthermore, interestingly, the coefficient of the real interest rate variable was found to be significantly positive across different estimation methods, except for the System GMM.

Estimation with OECD data on household saving

As we previously mentioned, OECD reports household saving as the share of disposal income for 33 countries, two thirds of which are advanced economies. Let us use this data in place of private saving as the dependent variable as a robustness check. Because the data are available only a number of countries, we ran the estimation only for the full sample of 33 countries.

The small sample does not allow the System GMM method to yield meaningful estimation results mainly due to the lack of cross-country variation of the data. The results from the other estimation methods appear to be rather consistent.[22] The characteristics of the signs and statistical significance are the same as what we report in Table 1, except for the estimate of healthcare expenditure. Its estimate implies that agents tend to have higher household saving when their government authorities spend more for healthcare, which sounds to be counterintuitive. Interestingly, none of the estimation methods yielded significant estimates for the real interest rate.

Missing Variable Bias

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

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[21] For the IDC subsample, the System GMM method does not yield estimation results mainly due to the small number of countries in the sample (not reported).

[22] The estimation results are available from the authors upon request.

The first such variable is net investment position. Depending on time preferences and endowments, some economies become net lenders 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 perspective, foreign saving may crowd out or complement domestic private saving. Although developing countries often try to mitigate credit constraint in their own domestic markets by importing foreign saving, 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).[23]

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.[24] The estimation results show that the saving rate tends to be lower for net debtor countries,[25] meaning that foreign saving complements domestic saving. This result is opposite to the view of intertemporal trade theory that a net foreign creditor country may experience a worsening of its net saving due to dynamic convergence to more balanced net investment position.

The second suspect variable 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 the real property price index in the estimation, we do

[23] Aizenman *et al*. (2007) estimate that only 10% of the capital stock in developing countries is funded with foreign saving and 90% are self-financed. They also show that countries with higher self-financing ratios grew significantly faster than those with a lower self-financing ratio.

[24] When we used the variable which normalizes external assets minus liabilities, both from the Lane-Ferretti data set (2001, 2007, updates), with GDP, we find that the net investment position variable enters the estimation insignificantly for all the samples (not reported). The insignificant result is likely attributable to extreme observations for financial center economies (e.g., Ireland, Hong Kong, Singapore) and heavily indebted economies.

[25] We also included the interaction term between the real interest rate and the dummy for net debtor countries. However, the estimate on the interaction term was not found to be significant, suggesting that the real interest-rate elasticity is not different for net debtor countries.

not find such a negative impact for either the full sample or the LDC subsample (results not reported). When we test the growth-rate impact of property prices, we find that its estimate becomes negative but not significantly (not reported).[26] These weak results could be due to smaller sample sizes since property price data are quite limited.[27]

Inflation might lead economic agents to save more because the opportunity cost of holding cash can be higher. At the same time, inflation might lead to less saving and more consumption if the agents think they cannot maintain the same level of purchasing power from saving. Hence, the predicted effect of inflation on saving can be ambivalent. We reestimated by including the rate of inflation and found that its impact is significantly positive.

However, we think including the inflation variable would be misleading, because the real interest rate used in the estimation is derived by subtracting the rate of inflation from the nominal interest rate.

We instead included the variable for inflation volatility – standard deviations of the rate of inflation over rolling 36-month windows – as a variable that represents monetary uncertainty. Inflation volatility is usually higher when the rate of inflation is higher, but it is usually not correlated with the real interest rate. When the variable for inflation volatility is included in the estimation, the estimated coefficient turned out to be insignificant. Even when some outliers of the inflation volatility variable are removed, it still continued to be statistically insignificant.

Changes in terms of trade should affect the motives to save especially for precautionary reasons. We included the rate of change in the terms of trade index,

[26] When the pooled OLS or the random effect model is used, the statistical significance rises to make the estimate significant.

[27] The number of countries for the full sample is only 46, about half of which are developing countries.

but found that it never enters the estimation as a significant contributor. We also tested the 5-year moving standard deviations of the rate of change in the terms of trade index as a measure of terms of trade uncertainty, but it did not enter the estimation significantly either.

Accessibility to retirement pension funds should certainly affect the motive for saving. In the baseline model, we tested the effect of healthcare expenditure and social expenditure (both as a share of GDP) and found that both variables are negative contributors to private saving as we expected. Here, we examine more directly the effect of retirement pensions.

We use the data on retirement pension spending by the public sector or the private sector (as a share of GDP) from the OECD database. Although the data are available only for 33 countries, we still tested for the full sample if pension spending by the public sector or the private sector affects private saving. Due to the small number of countries in the sample, the GMM estimation could not yield results. As far as the other estimation methods' results are concerned, all the estimations yielded significantly negative estimates on public pension spending, though the estimate on private pension spending was never found to be statistically significant. As far as the countries we estimated are concerned, there is some evidence that the more spending made by the public sector for pension plans, the more likely the countries are to experience a fall in private saving.

4. Interactive Effects

4.1 Empirical Findings

Results in the previous section show that the real interest-rate effect is ambiguous; the estimate was found to be positive, but insignificantly so. Given these results, we suspect that the effect of the real interest rate on private saving can depend on the economic environment at large and be masked by varying

economic conditions.

Here, we are interested in analyzing the impact of economic uncertainty; if the level of uncertainty rises in an economy, economic agents may take a protective or precautionary saving behavior, i.e., a behavior that leads to an increase in saving as a buffer against uncertainty. If uncertainty can arise in a certain macroeconomic environment and if that environmental change involves a fall in the interest rate, the interest rate fall could lead to a rise in (private) saving, that means that the income effect of the interest rate on saving outweighs the substitution effect. Hence, our hypothesis is, when an economy faces a rise in the degree of uncertainty, the income effect of the interest rate on saving outweighs the substitution effect, making the correlation between the interest rate and saving negative.

We regard rising output volatility, not just output growth (or downtown), and rising old age dependency as variables representing a higher degree of economic uncertainty. 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-age dependency is increasing, a lowering of the interest rate might encourage people to increase their rates of saving to reach predetermined target levels of retirement saving.

Furthermore, an agent in the economy equipped with well-developed financial markets must be better-prepared to deal with economic uncertainty since she must be able to benefit more from risk sharing and portfolio diversification. Hence, the agent's saving behavior in response to a change in the interest rate should be affected by on the level of financial development. The more developed financial markets an agent is in, the less likely it is for her to conduct protective or precautionary saving when she sees a fall in the interest rate. That should contribute to a weaker income effect in comparison to the substitution effect.

Thus, in this section, we investigate the effect of output volatility, old-age dependency, and financial development on the link between the interest rate and private saving.[28]

In the literature, empirical evidence on the effect of the interest rate on private saving is mixed, which reflects its theoretical ambiguity as we previously discussed; the effect of the interest rate depends on relative strengths of the income and substitution effects.[29] Here, we take a further step to examine the nuance of the interest rate effect, which we suspect can be conditional upon other macroeconomic factors. This is an important contribution of this paper.

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:

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

Columns (1) and (2) of Table 2 present the effect of the real interest rate under alternative output-volatility scenarios. The estimate on the real interest-rate variable now becomes significantly positive with a much larger magnitude for both the full sample and the LDC subsample. While the output volatility is insignificant in both samples, the interaction term between output volatility and real interest rate is significantly positive for both samples. Most likely, the significant negative effect of the interaction term found in the full sample is driven by the LDC subsample.

Results in Columns (1) and (2) of Table 2 indicate that, when output

[28] We also examined the interaction effects of healthcare expenditure and financial openness since these variables may affect the impact of the interest rate in the same way as financial development does. However, these effects turned out to be insignificant and thus not discussed for brevity. We also tested a possible interactive effect between the real interest rate and output growth rate, but found no significant effect.

[29] For a review of the literature on the determinants of private saving including the interest rate, refer to (Loayza, et al. 2000a,b).

volatility increases, the real interest-rate effect can change from positive to negative. The estimates from the full sample suggest that when the output volatility is less than 8.43%, the marginal real interest-rate effect is positive, and when it is larger than 8.43%, the marginal effect will be negative.[30] The threshold is found to be 9.1% for the LDC subsample, 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, a level of output volatility greater than the threshold only happens in 4.0% 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.

When we focus on $\beta_3 W + \beta_2 r \cdot W$, we can see that the results for the full sample and the LDC subsample 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 1.1% for the full sample. This suggests that when output movements become volatile in a very low-interest rate environment, agents would respond to such an environment by increasing saving.

Columns (3) and (4) in Table 2 report the estimation results when we include the interaction term between the real interest rate and the old-age dependency ratio. The estimate on the interaction term is found to be negative for both the full and LDC samples. The estimation results indicate that the real interest rate has a negative impact on private saving (i.e., the income effect dominating the substitution effect) if the economy of concern has a ratio of old-

[30] For the full sample, the estimate of $\beta_1 + \beta_2 W$ is found to be $0.179 - 2.123 W_{it}$. Thus, the output volatility threshold of the marginal real interest-rate effect is given $W_{it} < 0.179/2.123 = 0.0843$.

age dependency higher than 14.7% for the full sample and 16.0% for the LDC subsample. In the full sample, 35.4% of the countries have higher old-age dependency ratios than the threshold, while 18.8% 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-age dependency ratio and its interaction term with the real interest rate, an economy with a higher level of old-age 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, which has both a low real-interest rate and a high old-age dependency ratio, tend to experience higher private saving.

Columns (5) and (6) in Table 2 illustrate that while the real interest rate has a positive impact (net substitution effect) on private saving, the impact can become negative (net income effect) if the economy of concern is equipped with well-developed financial markets. The thresholds in terms of private credit (as a share of GDP) are 30.0% for the full sample and 26.9% for the LDC sample. The observations with more developed financial markets than the threshold account for 56.9% and 51.26% of each respective sample. At the same time, an economy with highly developed financial markets tends to have lower private saving (as less need for precautionary saving exists). Although its estimate is insignificant, the level of financial development alone contributes negatively to private saving. 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.

In Columns (7) and (8), the estimation model includes all three kinds of

interaction terms: “output volatility x real interest rate,” “old-age dependency ratio x real interest rate,” and “financial development x real interest rate.” By including all the interaction terms, we can assess the relative relevance of these economic conditions.

The result shows that the magnitude and statistical significance of the estimates of the real interest rate and output-volatility interaction term are largely the same in the presence of the other two interaction terms. In the case of the interaction term between the real interest rate and financial development, the level of statistical significance increases for both the full and LDC samples, while the estimates’ magnitude slightly increases in absolute terms. The interaction term between the real interest rate and the old-age dependency ratio becomes less significant for both the full and LDC samples. Thus, 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 by “old-age dependency ratio x real interest rate.”

4.2 Implications for Asia and the World

In the previous subsection, we show that the impact of the real interest rate on private saving depends on macroeconomic, demographical, and institutional factors. Let us now look into these conditions as they apply to several selected economies and economy groups.

The triangle charts in Figure 4 are helpful for tracing the patterns of output volatility, old-age dependency, and financial development, all of which are found to have interactive effects with the real interest rate. Each of these variables are normalized as:

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

where $\overline{W}$ is the average of W over the 2011–2014 period; $\max_{2011-14}(\overline{W})$ and $\min_{2011-14}(\overline{W})$ are cross-country maximal and minimal values of $\overline{W}$ as of the 2011–2014 period, respectively; and W refers to output volatility, old-age dependency, and financial development. In each triangle, three vertices measure the three variables with the origin normalized to 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 Columns (2), (4), and (6) of Table 2.[31] 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-China Asian EMG, as well as China and Korea.

Based on the results of Table 2, the real interest rate has a negative impact—i.e., income effect outweighing the substitution effect—on private saving if any output volatility, old-age dependency, or financial development is above the threshold.

We can see that, in general, EMG economies have a standard level of financial development above the threshold. However, the two other conditions—i.e., output volatility and the old-age dependency ratio—are below the threshold. This applies to the group of ex-China Asian EMG, and, to a lesser extent, Latin American EMG, and non-EMG LDC.

Both China and Hong Kong, with their high levels of financial development, stand out from the EMG group. Such high levels contribute to these two economies facing a negative impact of the real interest rate. Furthermore,

[31] We cannot perform this exercise using the estimation results reported in Columns (7) and (8) of Table 2. In this estimation exercise, the threshold of one variable, say, output volatility, depends on the values of the other two variables (which have been interacted with the real interest rate variable)—i.e., old-age dependency ratio and financial development.

Hong Kong has an average old-age dependency ratio above the threshold, providing an example in which the real interest rate can have an income effect, dominating the substitution effect, on an aging-population economy.

Figure 5 illustrates the actual real interest-rate effects conditional upon output volatility, old-age dependency, and financial development for China, Hong Kong, Korea, and the group of Asian emerging market economies, excluding China. For this analysis, we use the results of the estimation done for the LDC subsample that includes all three interaction terms whose results are reported in Column (8) of Table 2. 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-age 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, with the exception 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 five years represent the period under which real interest rates were relatively high, while the last five years, the real interest rates are very low.

From Figure 5, we can make several interesting observations. First, in all three economies and the ex-China 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 specifically bigger for the three individual economies.

Based on the estimation results reported in Column (8) of Table 2, the short-term real interest-rate effect for China conditional upon the three economic condition variables as of 2010–2014 is -0.230, which means the long-term effect is -0.381(=-0.230/(1-0.397)). These figures are higher compared to the short- and long-term effects of the real interest rate as of 1995–1999 that are -0.105 and -0.174, respectively. A four-percentage points decline in the real interest rate, which is about the same as one standard deviation for China in the 1995-2014 period—and also the same as the change that occurred between 1995-1999 and 2010-2014—would lead to a 1.52-percentage point increase in the country's private saving rate, which is equivalent to an increase in private saving by 0.37 standard deviations based on the last twenty years of observations and 1.07 standard deviations based on the last ten years of observations. Thus, the effect is not just econometrically but also 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-age dependency and output volatility. Furthermore, the impact of financial development on the real interest-rate effect has increased in the last two decades because the economies under discussion have all experienced further financial development. Hence, it is safe to conclude that Asian emerging market economies are experiencing weaker substitution effects or stronger income effects of their real interest rates is mainly because these economies have undergone financial development.

Last, but not least, let us look at the impact of low real interest rates on private saving for the economies of interest. We have shown that when the real interest rate is below 1.1%, greater output volatility would lead to higher private saving. We have also shown that the old-age 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 the old-age dependency ratio, as well as the stage of financial development, displays a reduced negative impact on private saving.

Figure 6 plots the ratios of private saving to GDP against the real interest rates for selected Asian economies, EMG, non-EMG LDC, and Latin American EMG. The dotted line depicts the threshold of 1.1% for the impact of output volatility for our sample countries.

In this figure, we can see that Asian developing economies are distributed at lower levels of the interest rate, as all of them, with the exception of Sri Lanka, are below the 1.1% threshold. Thus, these economies tend to increase their saving with output volatility. Such low real interest rates, as we have shown in Table 2, would also help reduce the negative impact on private saving of higher old-age dependency and greater financial development.

5. Conclusion

In the aftermath of the GFC, advanced economies implemented unconventional monetary policies, such as quantitative easing and negative interest-rate policies. While these policies may have jumpstarted these economies, their implementation created uncertainty over the future course of the global economy and the global financial system. In particular, the effectiveness of near-zero or negative interest-rate policies has 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 a lower or higher level of consumption or saving. In this paper, we 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 estimation results generally suggest a positive effect of

the real interest rate on private saving, although its estimate is insignificant in the baseline model.

Given the weakly positive estimates, we expect that if the interest rate has any impact on private saving, its effect can be masked by uncertain economic environment. Our hunch is that recent low interest rates are coupled with great uncertainty of future monetary or financial conditions. An environment with persistently low, or even negative, interest rates is unprecedented in much of the world. While the unprecedentedness makes people worried about the state and future of monetary policy, persistently low or negative interest rates would harm the balance sheets of financial institutions, the latter of which may contribute to financial instability. Hence, anxieties over monetary and financial conditions might encourage people to save more for precautionary reasons when interest rates become very low.

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

The impacts of these economic factors depend on the level of real interest rate. For instance, when the real interest rate is below 1.1%, greater output volatility would lead to *higher* private saving in our sample countries. Also, we find that, although an old-age dependency ratio and financial development have negative impacts on private saving, 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 economies with different economic environments. That is,

low-interest rate policies adopted by advanced countries to stimulate their economies can yield contractionary effects on developing countries if they are transmitted to the latter; as for these countries, low interest rates can encourage saving and reduce consumption.

The findings are relevant to Asian economies, many of which 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.*, 2016 and 2017a). If emerging market economies guide their own interest rates to lower levels in response to unconventional monetary policies, and, if lower interest rates contribute to higher private saving, then our empirical findings suggest that an active low-interest rate policy in advanced economies can contribute to a perennial global imbalance.

Appendix 1: Sample Country List

Industrialized countries

Australia
Austria
Belgium
Canada
Denmark
Finland
France
Germany
Greece
Iceland
Ireland
Italy
Japan
Malta
Netherlands
New Zealand
Norway
Portugal
Spain
Sweden
Switzerland
United Kingdom
United States

Developing countries

Albania
Algeria
Angola
Antigua and Barbuda
Argentina (E) (LE)
Armenia
Azerbaijan
Bahamas, The
Bahrain
Bangladesh (E) (AE)
Barbados
Belarus
Belize
Benin
Bolivia
Botswana (E)
Brazil (E) (LE)
Bulgaria (E)
Burkina Faso
Burundi
Cote d'Ivoire (E)
Cameroon
Central African Republic
Chad
Chile (E) (LE)
China (E) (AE)
Colombia (E) (LE)
Comoros
Congo, Dem. Rep.
Congo, Rep.
Costa Rica
Croatia
Cyprus
Czech Rep. (E)
Dominican Rep.
Ecuador (E) (LE)
Egypt (E)
El Salvador
Estonia
Fiji
Gabon
Gambia, The
Georgia
Ghana (E)
Grenada
Guinea-Bissau
Hong Kong (E)
Hungary (E)
India (E) (AE)
Indonesia (E) (AE)
Israel (E)
Jamaica (E) (LE)
Jordan (E)
Kazakhstan
Kenya (E)
Korea (E) (AE)
Kuwait
Kyrgyz Rep.
Lao
Latvia
Lebanon
Lithuania (E)
Madagascar
Malawi
Malaysia (E) (AE)
Maldives
Mali
Mauritius (E)
Mexico (E) (LE)
Moldova
Mongolia
Morocco (E)
Mozambique
Myanmar
Namibia
Nepal
Niger
Nigeria (E)
Oman
Pakistan (E) (AE)
Panama
Paraguay
Peru (E) (LE)
Philippines (E) (AE)
Poland (E)
Qatar
Romania
Russia (E)
Rwanda
Senegal
Seychelles
Sierra Leone
Singapore (E) (AE)
Slovak Rep. (E)
Slovenia (E)
South Africa (E)
Sri Lanka (E) (AE)
St. Lucia
St. Vincent and the Grenadine
Swaziland
Tajikistan
Tanzania
Thailand (E) (AE)
Togo
Trinidad & Tobago (E) (LE)
Tunisia (E)
Turkey (E)
Venezuela (E)

(E) refers to emerging market economies.
(AE) refers to Asian emerging market economies.
(LE) refers to Latin American emerging market economies (or LATAM).

Appendix 2: Data Descriptions

Private saving (as a share of GDP): Private saving is obtained by subtracting subtract 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 Indicator (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: It is measured by the growth rate of private credit (as a share of GDP), is included as a proxy for credit growth or credit availability.

Financial development: Private credit (as a share of GDP) is used as a proxy for financial development. To mitigate the effects of business cycles, HP-detrended series are used. The original 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: It is calculated as the five year standard deviations of the growth rate of real per capita output in local currency.

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 15 years old) population and old populations (older than 64 years old) by the working population (between 15 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: It 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: It is measured as "public health expenditure as a share of GDP." "Total 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: It is aggregate expenditure for social protection as a share of GDP, available in the OECD database.

Household saving: It is household saving as a percentage of household disposable income, available in the OECD database.

Property price changes: It 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 index.

Net investment positions: It 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).

Inflation volatility: It is standard deviations of the monthly rate of inflation over rolling 36-month windows.

Terms of trade growth: It is the growth rate of terms of trade, which we measure by the net barter terms of trade index from the World Bank's *World Development Indicators.*

Public and private retirement pension spending: It is the spending made for retirement pensions by the public sector or the private sector (as a share of GDP), both obtained from the OECD database.

Appendix Table 1: Determinants of Private saving, 1995-2014, LDC Sample, Across Different Estimation Methods

	System GMM	Pool	w/ Time FE, but No Country FE	w/ both Time and Country FE	Random Effects
	(1)	(2)	(3)	(4)	(5)
Private saving (*t*–1)	0.394	0.873	0.874	0.543	0.874
	(0.085)***	(0.020)***	(0.019)***	(0.017)***	(0.011)***
Public saving	-0.377	-0.202	-0.193	-0.526	-0.193
	(0.160)**	(0.041)***	(0.041)***	(0.037)***	(0.031)***
Credit growth	-0.031	-0.028	-0.032	-0.038	-0.032
	(0.013)**	(0.010)***	(0.011)***	(0.008)***	(0.008)***
Financial development,	-0.024	-0.008	-0.007	-0.044	-0.007
HP-filtered	(0.039)	(0.004)**	(0.004)**	(0.014)***	(0.004)*
Income/capita level (log, PPP)	0.095	0.018	0.018	0.044	0.018
	(0.027)***	(0.003)***	(0.003)***	(0.006)***	(0.002)***
Real interest rate	0.055	0.048	0.050	0.039	0.050
	(0.040)	(0.023)**	(0.023)**	(0.016)**	(0.017)***
Income/capita growth	0.151	0.141	0.163	0.158	0.163
	(0.064)**	(0.038)***	(0.041)***	(0.029)***	(0.029)***
Old dependency (% of total)	-0.121	-0.021	-0.015	-0.000	-0.015
	(0.167)	(0.030)	(0.029)	(0.137)	(0.033)
Young dependency (% of total)	0.124	0.024	0.027	0.156	0.027
	(0.102)	(0.015)	(0.015)*	(0.038)***	(0.011)**
Health expenditure (% of GDP)	-1.728	-0.413	-0.425	-0.598	-0.425
	(0.492)***	(0.100)***	(0.100)***	(0.207)***	(0.104)***
Financial openness	-0.021	0.000	0.000	0.024	0.000
	(0.023)	(0.003)	(0.003)	(0.008)***	(0.004)
Output volatility	0.003	-0.050	-0.048	-0.018	-0.048
	(0.124)	(0.046)	(0.046)	(0.046)	(0.041)
N	1,902	1,902	1,902	1,902	1,902
# of countries	113	113	113	113	113
Hansen test (p-value)	0.97				
AR(1) test (p-value)	0.01				
AR(2) test (p-value)	0.45				
Adj. R^2		0.86	0.86	0.50	

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

	FULL	LDC
	(1)	(2)
Private saving (*t*–1)	0.383	0.394
	(0.078)***	(0.085)***
Public saving	-0.463	-0.377
	(0.144)***	(0.160)**
Credit growth	-0.035	-0.031
	(0.013)***	(0.013)**
Financial development, HP-filtered	-0.044	-0.024
	(0.026)*	(0.039)
Income/capita level (log, PPP)	0.085	0.095
	(0.023)***	(0.027)***
Real interest rate	0.060	0.055
	(0.044)	(0.040)
Income/capita growth	0.148	0.151
	(0.048)***	(0.064)**
Old-age dependency (% of total)	-0.173	-0.121
	(0.130)	(0.167)
Young dependency (% of total)	0.072	0.124
	(0.086)	(0.102)
Health expenditure (% of GDP)	-1.189	-1.728
	(0.466)**	(0.492)***
Financial openness	-0.006	-0.021
	(0.022)	(0.023)
Output volatility	-0.037	0.003
	(0.105)	(0.124)
N	2,333	1,902
# of countries	136	113
Hansen test (p-value)	0.43	0.97
AR(1) test (p-value)	0.01	0.01
AR(2) test (p-value)	0.54	0.45

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.

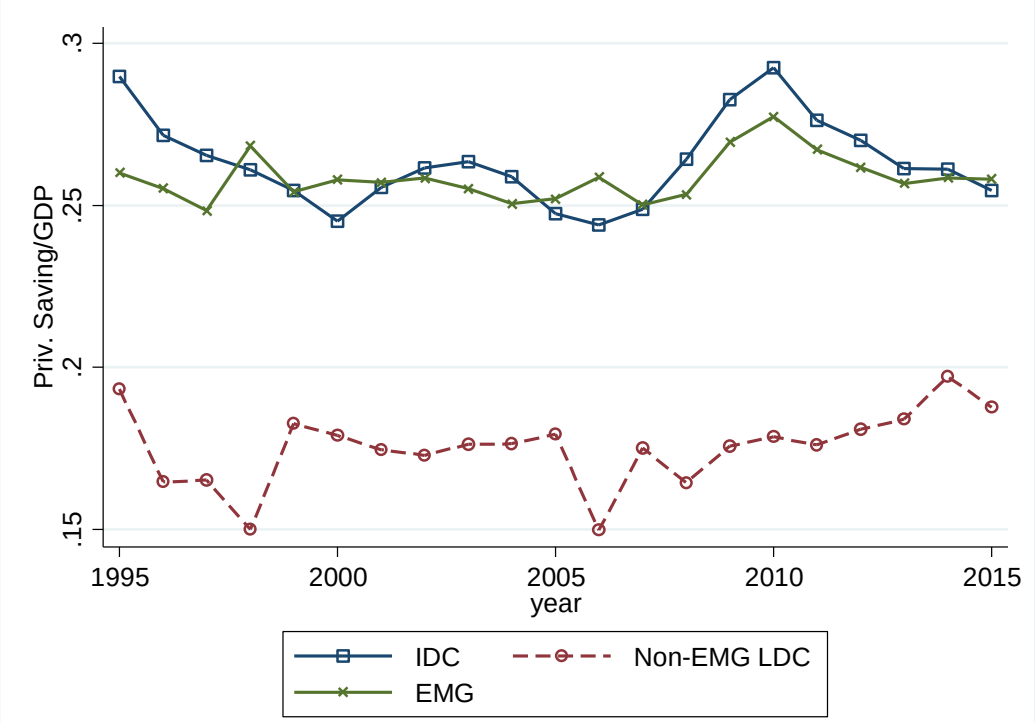
Table 2: Determinants of Private Saving, Interacting w/ Output Volatility

	Output volatility		Old-age dependency		Financial development		All three	
	FULL	LDC	FULL	LDC	FULL	LDC	FULL	LDC
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Private saving (*t*–1)	0.364	0.376	0.382	0.395	0.376	0.401	0.357	0.397
	(0.075)***	(0.084)***	(0.082)***	(0.091)***	(0.081)***	(0.087)***	(0.083)***	(0.091)***
Public saving	-0.501	-0.400	-0.496	-0.400	-0.450	-0.343	-0.487	-0.394
	(0.150)***	(0.170)**	(0.138)***	(0.168)**	(0.147)***	(0.162)**	(0.156)***	(0.155)**
Credit growth	-0.042	-0.036	-0.032	-0.029	-0.033	-0.030	-0.038	-0.035
	(0.014)***	(0.015)**	(0.011)***	(0.012)**	(0.013)***	(0.013)**	(0.015)**	(0.015)**
Financial development, HP-filtered	-0.050	-0.025	-0.047	-0.022	-0.045	-0.017	-0.043	-0.028
	(0.028)*	(0.038)	(0.025)*	(0.035)	(0.027)*	(0.037)	(0.026)	(0.034)
Income/capita level (log, PPP)	0.090	0.096	0.088	0.089	0.088	0.098	0.089	0.091
	(0.017)***	(0.021)***	(0.020)***	(0.022)***	(0.021)***	(0.028)***	(0.017)***	(0.021)***
Real interest rate	0.179	0.170	0.178	0.155	0.080	0.078	0.320	0.304
	(0.046)***	(0.047)***	(0.055)***	(0.059)***	(0.042)*	(0.042)*	(0.126)**	(0.107)***
Income/capita growth	0.156	0.151	0.149	0.147	0.129	0.129	0.136	0.137
	(0.057)***	(0.065)**	(0.056)***	(0.065)**	(0.051)**	(0.066)*	(0.054)**	(0.063)**
Old-age dependency	-0.150	-0.153	-0.142	-0.143	-0.193	-0.157	-0.186	-0.208
	(0.130)	(0.158)	(0.113)	(0.155)	(0.123)	(0.161)	(0.117)	(0.161)
Young dependency	0.078	0.110	0.087	0.097	0.076	0.136	0.080	0.098
	(0.065)	(0.087)	(0.075)	(0.092)	(0.079)	(0.110)	(0.067)	(0.084)
Health expenditure (% of GDP)	-1.316	-1.701	-1.199	-1.668	-1.102	-1.610	-1.183	-1.533
	(0.462)***	(0.479)***	(0.452)***	(0.486)***	(0.436)**	(0.531)***	(0.404)***	(0.511)***
Financial openness	-0.007	-0.025	-0.008	-0.022	-0.011	-0.024	-0.006	-0.022
	(0.020)	(0.020)	(0.020)	(0.022)	(0.021)	(0.024)	(0.020)	(0.023)
Output volatility	-0.023	0.015	-0.062	-0.020	-0.057	0.012	-0.041	0.017
	(0.095)	(0.127)	(0.105)	(0.124)	(0.108)	(0.138)	(0.103)	(0.137)
Output volatility x Real interest rate	-2.123	-1.874					-2.235	-1.848
	(0.588)***	(0.664)***					(0.701)***	(0.669)***
Old-age dependency x Real interest rate			-1.208	-0.968			-0.818	-0.900
			(0.441)***	(0.447)**			(0.594)	(0.550)*
Financial development x Real interest rate					-0.266	-0.290	-0.371	-0.326
					(0.102)***	(0.145)**	(0.166)**	(0.189)*
N	2,333	1,902	2,333	1,902	2,333	1,902	2,333	1,902
# of countries	136	113	136	113	136	113	136	113
Hansen test (p-value)	0.42	0.95	0.64	0.97	0.60	0.97	0.53	0.93
AR(1) test (p-value)	0.01	0.01	0.05	0.01	0.02	0.02	0.02	0.02
AR(2) test (p-value)	0.53	0.43	0.47	0.28	0.59	0.45	0.48	0.39

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.

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

(a) Country groups by income level



(b) Country group by region

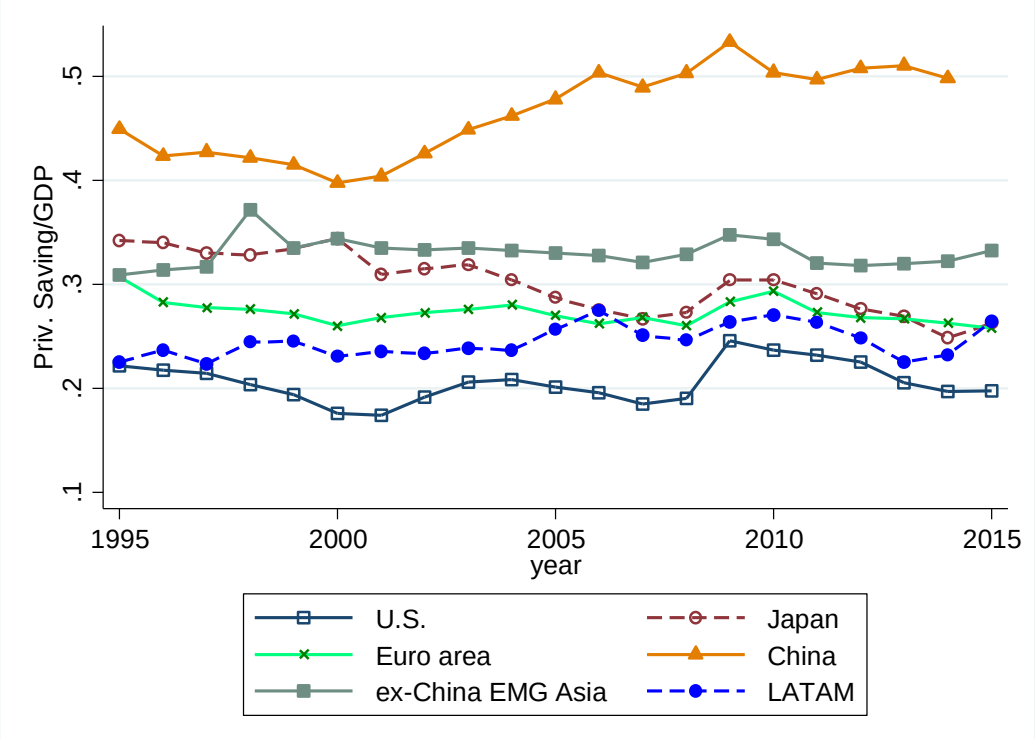
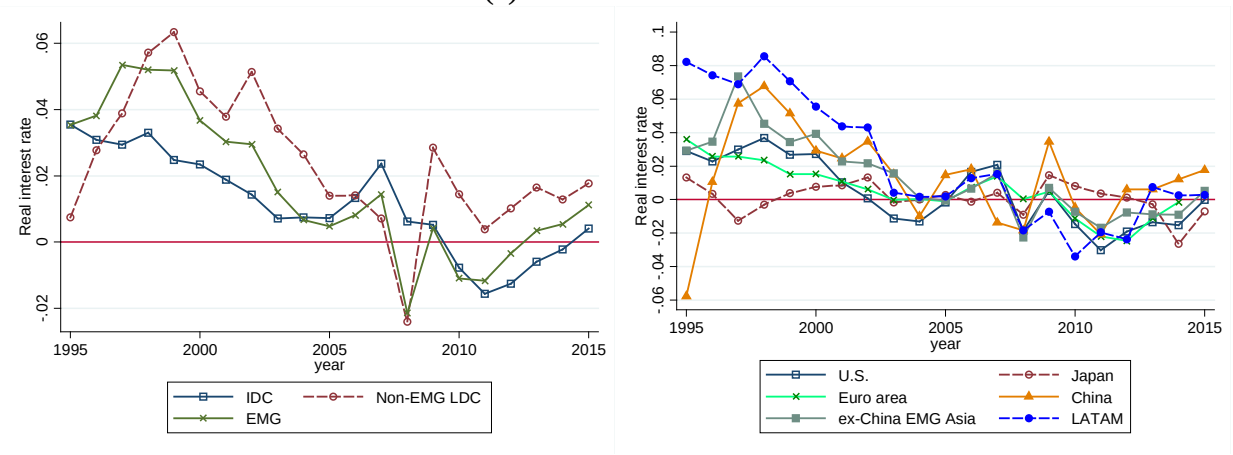
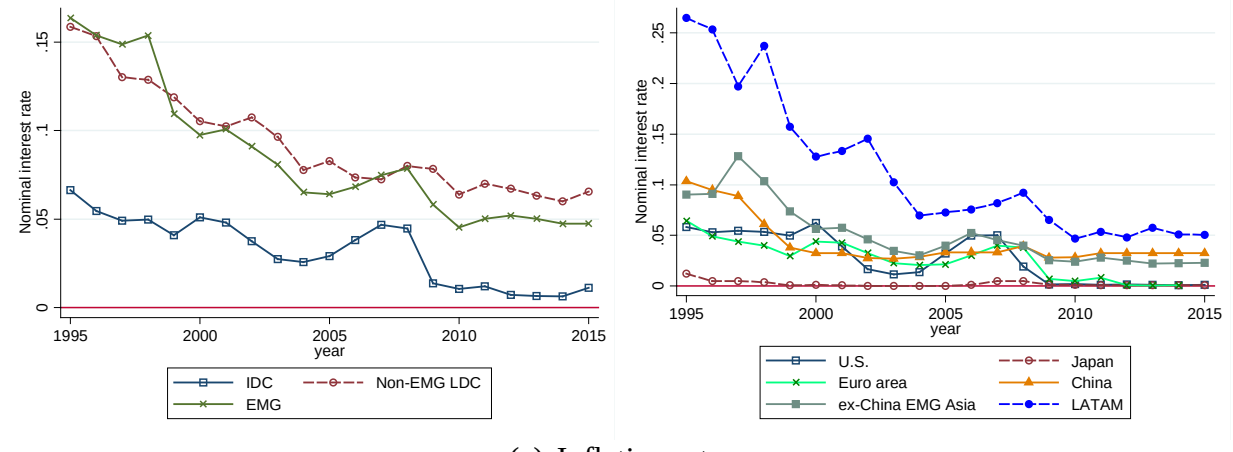


Figure 2: Real and Nominal Interest Rates and Inflation Rate, 1995-2015

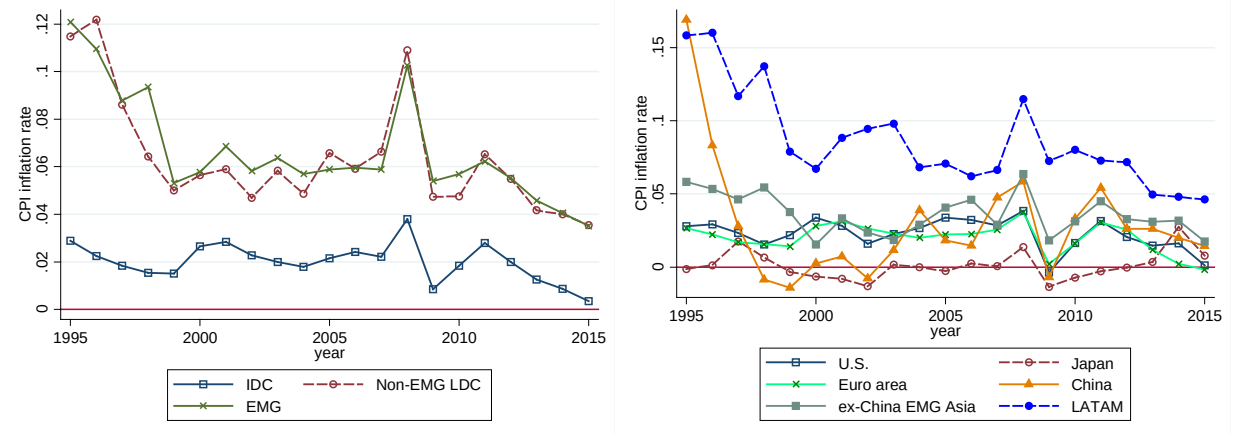
(a) Real interest rate



(b) Nominal interest rate

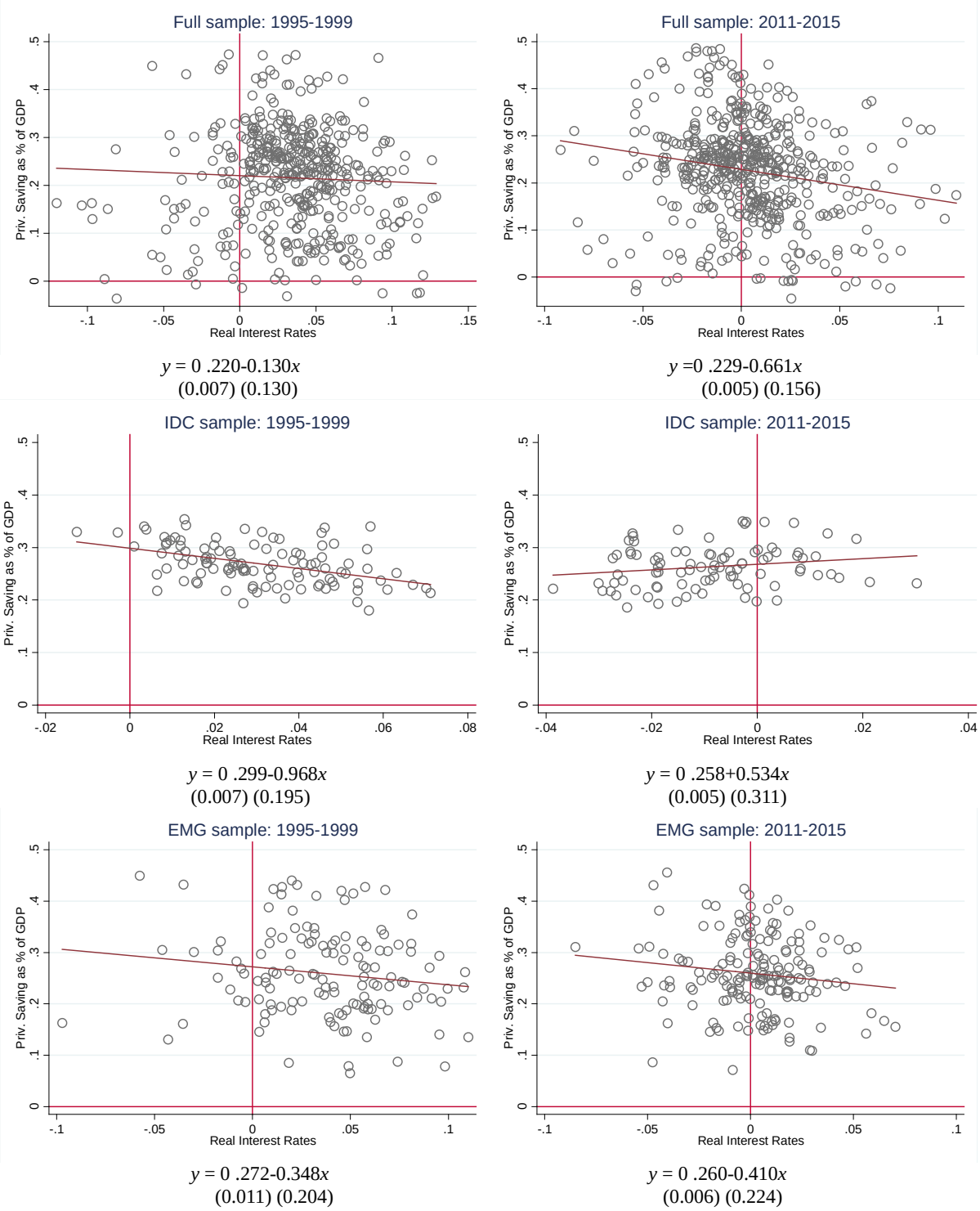


(c) Inflation rate



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

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



y = 0 .220-0.130x
(0.007) (0.130)

y =0 .229-0.661x
(0.005) (0.156)

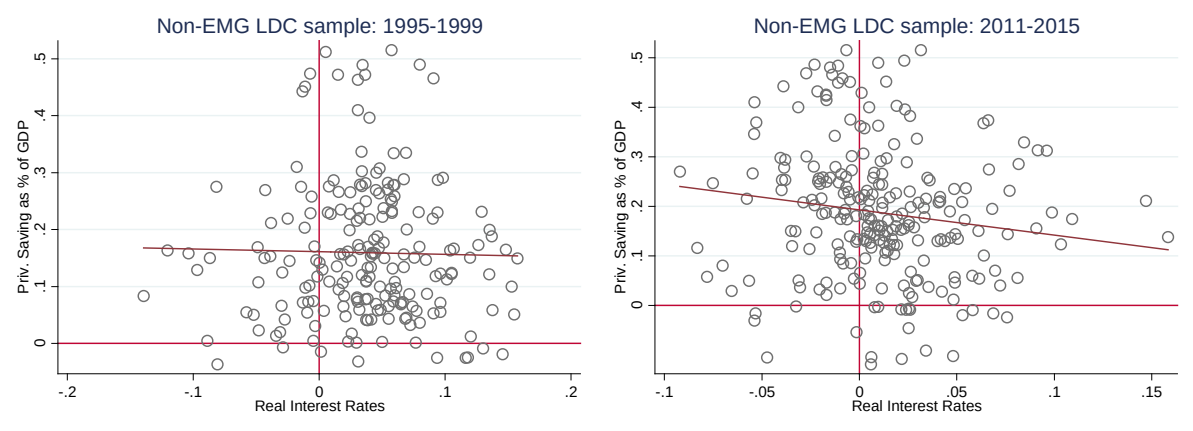
y = 0 .299-0.968x
(0.007) (0.195)

y = 0 .258+0.534x
(0.005) (0.311)

y = 0 .272-0.348x
(0.011) (0.204)

y = 0 .260-0.410x
(0.006) (0.224)

Figure 3, continued



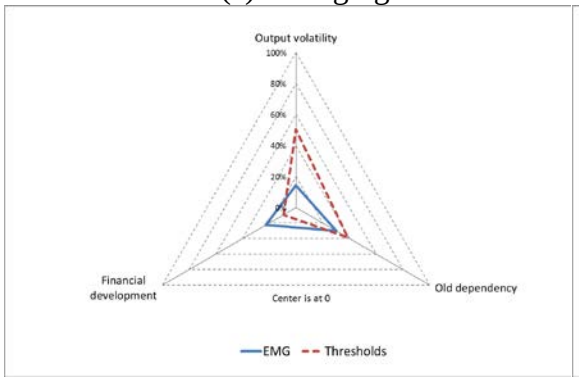
y =0 .161-0.047x
(0.010) (0.160)

y = 0 .193-0.510
(0.009) (0.229)

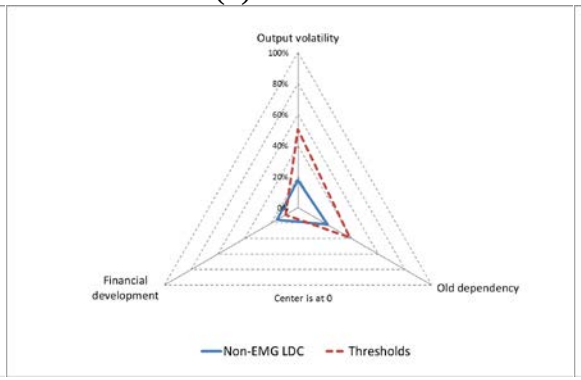
Note: Figures in parentheses are standard errors.

Figure 4: Triangle Charts

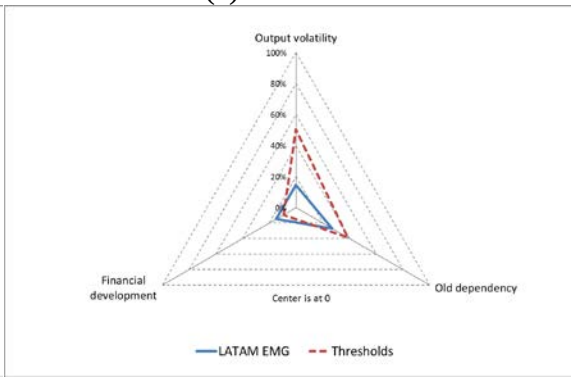
(a) Emerging markets



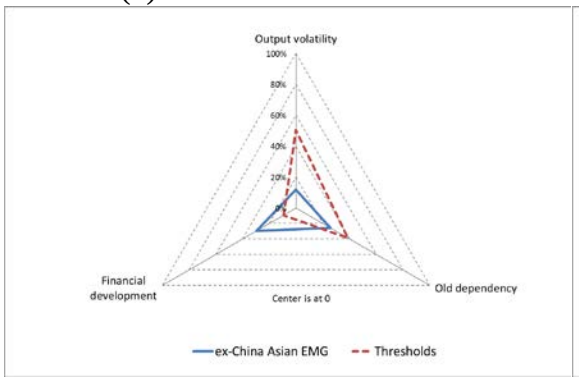
(b) Non-EMG LDC



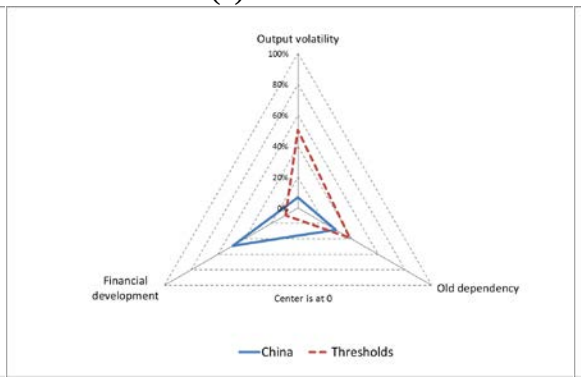
(c) LATAM



(d) ex-China Asian EMG



(e) China



(f) Hong Kong

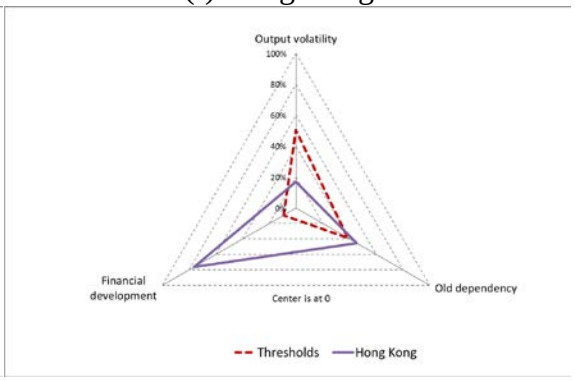
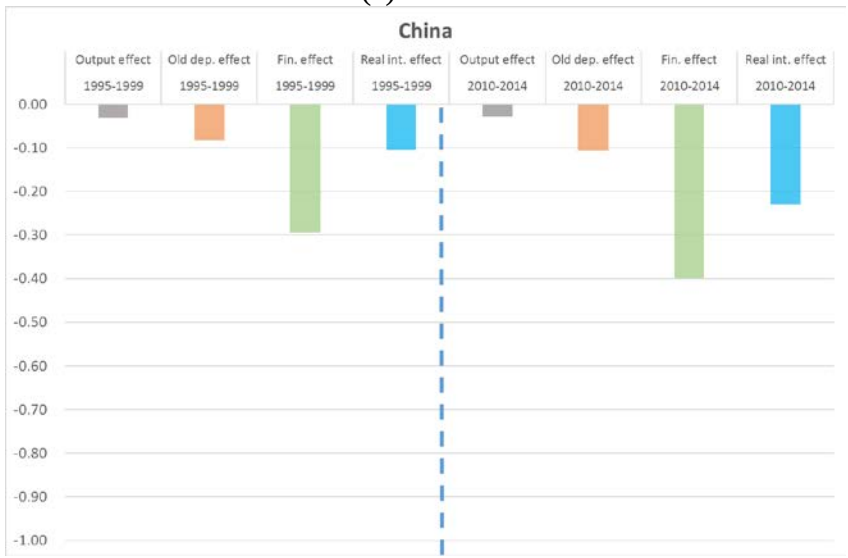
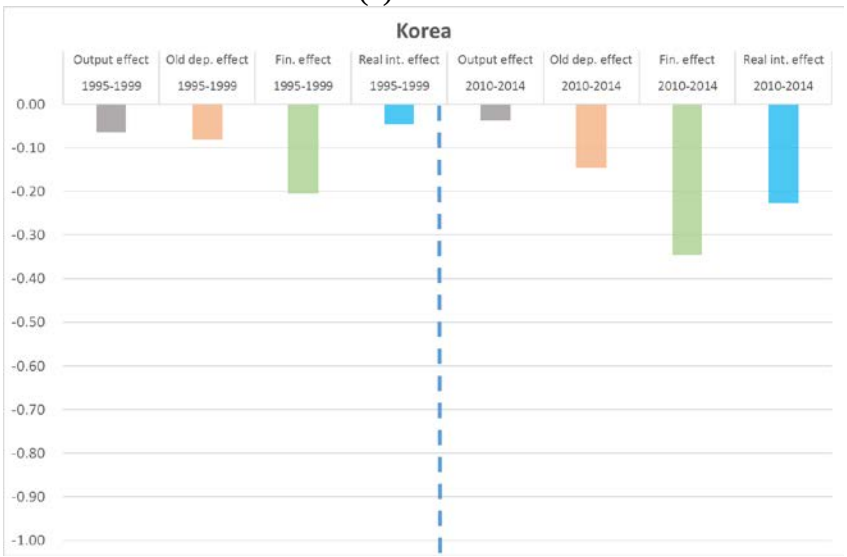


Figure 5: The Real Interest Rate Effect Conditional on Economic Conditions

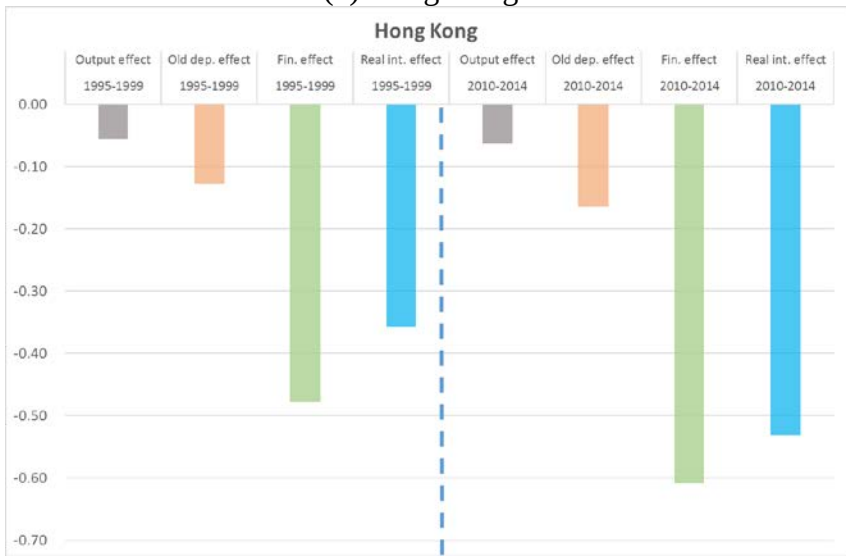
(a) China



(c) Korea



(b) Hong Kong



(d) Ex-China Asian EMG

Figure 6: Private Saving and the Real Interest Rate for Asia and Others