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Have high savings rates in East Asian emerging markets and oil exporting economies contributed to falling real interest rates in advanced economies?

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A B S T R A C T

The results are consistent with the hypothesis that high savings rates in oil exporting economies have contributed to falling interest rates in advanced economies. For East Asian emerging markets, this is not the case given that hypothetical shocks to the savings rates are associated with increases in advanced economy interest rates. However, there is evidence of unidirectional Granger causality from the savings rates of both country groups to the real interest rates of advanced economies. These results only emerge when using regional averages of savings and real interest rate.

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Introduction

Presently, low interest rates can be observed throughout many advanced economies around the world. In the euro zone, long-term interest rates have not been above 2% since mid-2014. In the U.S., long-term rates have risen since late 2016 but are still below 3% as of 2019 (OECD, 2020). Naturally, there is no shortage of attempted explanations by economists trying to unravel the causes of this phenomenon. Executive Board Member of the European Central Bank (ECB), Philip Lane (2019), cites “the decline in potential growth rates, demographic trends and the portfolio shift towards safe assets” (pg.1) as key factors depressing the equilibrium real interest rate in the euro zone. On the other side of the Atlantic Ocean, former Chair of the U.S. Federal Reserve, Ben Bernanke (2007), advocates that the answers to declining real interest rates may lie outside of advanced economies themselves. In particular, he contends that high savings rates in East Asian emerging markets and oil exporting economies have led to major global current account imbalances that in-turn depress real interest rates in industrial countries. This paper aims to empirically explore the latter of the two explanations, also known as *savings glut theory*. In doing so, an effort is made to answer the following question. Have high savings rates in East Asian emerging markets and oil exporting economies contributed to falling real interest rates in advanced economies?

Research in this field is of considerable social relevance for advanced economies. If a link between savings rates and real interest rates does exist, there are several economic implications. First of all, advanced economies may need to ask themselves whether they want to continue fueling East Asian savings rates by importing an immense value of goods from the region. After all, net exports of a country are equal to domestic savings minus domestic investment (Bernanke, 2005). Second, advanced economies could consider whether it is in their best interest to allow unregulated in-flows of accumulated savings from East Asia and oil exporting economies, if these flows have the potential to affect domestic interest rates.

Most academic literature dedicated to investigating this direct relationship between savings rates and real interest rates do so using theoretical models alone.[1] Empirical studies in this field tend to focus on the relationship between capital flows and real interest rates, often assuming that high savings rates in East Asian emerging markets and oil exporting

[1] See Bernanke (2005) and (2007), Dooley, Folkerts-Landau and Garber (2005)

economies lead to capital in-flows in advanced economies.[2] Hence, by making an effort to empirically analyze the direct association between savings rates and real interest rates, this paper differentiates itself from others in the field.

The author acknowledges that investigating the relationship described above may seem somewhat far-fetched at first. Therefore, the paper is structured as follows. Foremost, the determinants of savings rates in emerging markets and oil exporting economies will be explored through a literature review, to understand why these rates are so high in the first place. Thereafter, the theoretical connection between savings rates, global imbalances and real interest rates will be explained in order to justify the empirical analysis that follows.

Savings Rates in East Asian Emerging Markets and Oil Exporting Economies

Emerging markets – Some Defining Characteristics

While major organizations such as The World Bank or International Monetary Fund (IMF) refrain from giving explicit definitions of so-called "emerging markets", there exists a variety of literature that agrees on several key features these economies share. Firstly, emerging markets are often characterized by high levels of economic volatility and risk (Mody, 2004) (Lesmond, 2003). This observation goes hand-in-hand with political instability, more specifically regime changes, which tend to be one explanation of economic shocks. Consequently, growth trends are much less stable compared to developed economies, whereas they are frequently much steeper in emerging markets, yielding higher rates of return (Aguiar and Gopinath, 2007). It is this combination of higher growth rates and changing political climate that fuel the prospects of evolution towards a more market-orientated economy (Mody, 2004) and hence the name "emerging market". However, despite these dynamic features, emerging markets often lack the appropriate institutions to accompany fast growth such as developed financial markets, social security, and a credible legal environment. This can add to uncertainty as property rights, pensions, and reliable investment opportunities are jeopardized.

Another prominent feature of emerging markets is a high rate of savings compared to developed economies. Theoretically, the above-mentioned characteristics of emerging

[2] See Carvalho and Fidora (2015), Eggertsson, Mehrotra and Summers (2016), Warnock and Warnock (2009)

markets such as volatility and poor institutions could be explanations for these high savings rates. The following section will briefly describe how savings rates in East Asian emerging markets and oil exporting economies have developed over the past 50 years, proceeded with an analysis of what theoretically and empirically drives savings rates of households and governments to better understand why these rates are so high. The examined factors are volatility and economic crises, financial markets and institutions, demographic effects, and oil price increases.

Savings Rates – A Brief History

Figure 1 illustrates the behavior of gross domestic savings from 1970-2018 amongst East Asian emerging markets. All nine countries with the exception of the Philippines and Hong Kong have experienced net increases in savings and ended up with a rate of over 30% in 2018. China and Singapore had the highest savings rates upwards of 45% of GDP in 2018. Taking the average of all nine countries in figure 2 yields a clear growth in savings from 21% in 1970 to 33% of GDP in 2018. Noticeable declines in savings are observed after the East Asian financial crisis in 1997 and after the Great Recession in 2008. Figure 3 displays the savings rates of oil exporting economies used in the dataset. These savings rates exhibit a similar trend to that of the crude oil price, which dropped noticeably in the early 1980s before increasing again in the early 2000s (Hamilton, 2009). For the sake of comparison, figures 5 and 6 reveal that advanced economies in the dataset do have substantially lower savings rates than East Asian emerging markets and oil exporting economies. All mean savings rates of advanced economies lie below 25% of GDP, whereas only the emerging markets India and the Philippines reported mean rates below 25% (see table 1-4 for summary statistics).

Volatility and Economic Crises

The first alleged drivers of savings rates to be scrutinized are volatility and economic crises. Volatility and crises have the tendency of putting steady income flows at risk. During downturns of the business cycle, output falls along with employment, while the opposite happens during economic booms. For those at risk of losing their job or receiving less income during recession, savings accumulated during periods of prosperity are vital. Furthermore, the more frequently economic shocks occur or, in other words, the more volatile the economy, the more households rely on savings to smooth consumption (Hubbard, Skinner and Zeldes, 1993). This reliance on savings is reinforced if lacking institutions cannot aid households in consumption smoothing by facilitating transfer payments, for example. The empirical evidence on this matter is, however, not as clear cut as the underlying theory might predict. Often, when testing for a significant effect of volatility on savings, inflation that diverges from average values is used to proxy for volatility. Interestingly, work published before the East Asian financial crisis, when savings rates were lower altogether, finds negative (Dayal-Gulati and Thimann, 1997) or negligible (Corbo and Schmidt-Hebbel, 1991) effects of volatility on East Asian savings rates, whereas work published after the crisis finds positive coefficients (Loayza, Schmidt-Hebbel, and Serven, 2000).

Similar to its citizens, governments of emerging markets often rely on substantial savings rates to insure themselves against volatility and crises. For governing bodies in emerging markets, crises in the form of sudden stops to foreign investment and lending as well as capital flight can wreak many forms of havoc. During the 1997 East Asian financial crisis, the combined net capital flows of Indonesia, Malaysia, Thailand, Korea and the Philippines reversed from an inflow of $93 billion in 1996 to an outflow of $12 billion in 1997 (Radelet and Sachs, 1998). According to Radelet and Sachs (1998) a pressing issue in the development to the crisis was a ratio of debt to foreign exchange reserves above one, meaning that once foreign lending decreases, foreign creditors will withdraw their capital quickly, knowing that foreign reserves do not suffice to repay everyone. A higher government savings rate, allowing for greater accumulation of foreign exchange reserves, could therefore increase creditor confidence and help prevent sudden capital flow reversals. Indeed, after the financial crisis of 1997, East Asian countries started accumulating large amounts of foreign exchange reserves as insurance against capital outflows. In part, this was done by lending to the private sector and using the returns to buy U.S. dollar denominated securities, which in turn stimulated domestic savings (Bernanke, 2005). Even if outflows did reoccur, countries could then draw from their reserves and help prevent a complete standstill from lack of capital.

While there is sparse empirical evidence in support of a positive relationship between economic volatility and private savings among East Asian emerging markets, data shows that gross domestic savings continued to increase in most East Asian countries upon recovery from the 1997 crisis. Additionally, the majority of savings increases denominated in U.S. dollar were retained in international reserves during the early 2000s and post financial crisis (Dooley, 2005), leading to believe that governments, so to speak, "learned their lesson" and increased savings as a safeguard to capital flight.

Financial Markets and Institutions

The second contending driver of savings rates is the state of financial markets and institutions in East Asia. Financial markets, more specifically, the state of financial development is analyzed first. There are two different views on how the state of financial development impacts savings. The conventional view argues that "financial deepening could induce more saving through more depth and sophistication of the financial system" (Chinn and Ito, 2009, pg.121). The opposing view claims that in countries with more financially developed markets, less people rely on precautionary savings, consequently depressing the savings rate (Chinn and Ito, 2009). Theoretically, the latter reasoning helps explain high savings rates in East Asian emerging markets according to Bernanke (2005) as well as Chinn and Ito (2009). Given that financial markets are less developed throughout East Asia, the willingness of the private sector to invest in domestic markets is low, as a result of little confidence in the market. Therefore, people prefer to save their income rather than invest it.

There is limited empirical research on financial development and savings solely focused on East Asian emerging markets. However, results published by Chinn and Ito (2009) show that for emerging markets in East Asia and Pacific (excluding China), financial development is associated with a decline in savings, thereby supporting the view that less developed markets are an explanation for high savings. The credibility of this relationship is reinforced by the authors' use of proxies for multiple forms of financial development such as market size, openness, efficiency, level of activity, and access to credit. Conversely, using a dataset of 16 emerging markets including India, Indonesia, Korea, and Malaysia, Bonser-Neal and Dewenter (1999) find that stock markets size and liquidity have a significant positive effect on savings in Korea and Malaysia, whereas results for India and Indonesia are insignificant. In summary, the argument that less financially developed markets have contributed to higher savings in East Asian emerging markets is supported by empirical evidence, while some studies show this is not the case for all countries.

Along with financial markets, basic institutions such as social security and legal systems set the underlying parameters for economic and financial decisions. Before touching on any relationship between institutions and savings, it is important to clarify the state of these institutions in East Asia and with what goals they were first implemented. First, social security and welfare systems. Most “pay-as-you-go” or “funded” social security systems in East Asia were introduced in the 1950s (Datta and Shome, 1981). During that time, government-lead development defined most economies, meaning that expenditures on anything besides growth targeting was minimized. As a result, welfare and social security systems simply did not reflect the same values as those put in place by developed countries more devoted to maximizing social welfare. Furthermore, non-democratic regimes meant that these institutions were established by authoritarian elites instead of labor unions and democratic elections, as in developed countries (Goodman and White, 1998). The East Asian legal environment shares similar traits in that the law is framed to protect government policy goals. “Therefore, East Asian legalism is characterized by *rule through law rather than the rule of law*” (Jayasuriya, 2007, pg.2).

If pensions or welfare prove unreliable, this may well affect the manner of savings. For one, pensions help ensure stable income for the elderly, who would otherwise need to rely on personal or other peoples’ savings when they stop working. Therefore, theory predicts that in the case of no or limited social security, households should save more of their income to smooth consumption during old age. Time series estimates and ordinary least squares regressions by Datta and Shome (1981) show no significant negative effect of social security on household savings in five East Asian emerging markets. This evidence supports the idea that households are reluctant to lower their savings rates despite existing social security, possibly because they do not fully trust in it. An untrusty legal environment may also affect incentives to save by jeopardizing property rights or allowing for high levels of corruption. Consequently, households my refrain from investing in real estate or financial markets if returns cannot be guaranteed from a legal perspective, thereby raising savings (Chinn and Ito, 2009). Empirical evidence by Chinn and Ito (2009) shows that a more developed legal environment in East Asia is indeed associated with a lower savings rate, the more developed the financial market is.

Demographic Effects

The life-cycle hypothesis proposed by Modigliani and Brumburg (1954) is the premise for most research focused on the relationship between demographic factors and savings rates in East Asia. Throughout their lifetime, individuals follow three stages of savings that are driven by consumption smoothing. During young and old age, individuals are not yet or no longer part of the working population, meaning that income is low. Consequently, savings are also low because most income is consumed. During the productive working years (ages 15-64), income is often much higher which allows individuals to save more and prepare for retirement. Therefore, the life-cycle hypothesis predicts that a country's savings rate will partly depend on its dependency ratio i.e. the proportion of young and old dependents to those in the working population. More specifically, a low dependency ratio drives up private savings because a higher proportion of the population is of working age and can afford to save a part of its income (Kim and Lee, 2007). Similarly, public savings should increase as the dependency ratio decreases. This is primarily because a higher proportion of working individuals will increase government tax revenue. Furthermore, institutions such as social security are under less financial pressure if the proportion of dependents decreases. Thus, lower dependency ratios should theoretically allow both governments and households to save more, *ceteris paribus* (Kim and Lee, 2007). However, in order to assess whether the life-cycle hypothesis can indeed help explain high savings in East Asia, the corresponding demographic data must be understood.

Figures 8 and 9 show how age dependency ratios of East Asian emerging markets and advanced economies have developed over time. While there is a common negative trend for most economies in both country groups, East Asian ratios are higher to begin with. Looking at the first recorded observation in 1960, East Asian age dependency ratios range between 76.6 and 100.5. For the same year, advanced economy age dependency ratios range between 49.1 and 70.7. This discrepancy is further reiterated in figure 10, which visually compares average dependency ratios of both country groups over time. The East Asian average dependency ratio exceeded that of advanced economies by more than 20 percentage points up to 1974. Over time, this difference continued to shrink, amounting to 10.5% in 1988, until the average dependency ratio of advanced economies began exceeding that of Eastern Asia by the year of 2000 ("The World Bank Open Data", 2020).

Having established that East Asia was characterized by a relatively high, but nevertheless decreasing, average dependency ratio throughout the mid 1900s up until the early 2000s, the question arises whether this helps explain the development of savings rates in the region. Solely based on the underlying theory of the lifecycle hypothesis, the observed decline in the average dependency ratio should reflect an increase in the average savings rate because the working population increases relative to the non-working population (Kim and Lee, 2007). This does in fact hold when looking at the data (see figure 2). Therefore, the lifecycle hypothesis can theoretically explain the increasing savings rates in East Asia.

Very few empirical studies of the above-mentioned theory are specific to East Asia alone, since most papers utilize large datasets with countries from all over the globe. Consequently, the extent to which this paper can compare empirical evidence of demographic effects on savings in East Asia is limited by the amount of existing literature. Nevertheless, Kim and Lee (2007) give evidence in support of the lifecycle hypothesis using data from 10 East Asian countries. By means of vector autoregressions and impulse response functions they find a significant negative response of savings rate to a shock in dependency ratio.[3] This negative response is predominantly attributed to falling government rather than private savings. At the same time, elderly dependency ratios[4] have a greater negative impact on savings than youth dependency ratios[5]. Based on this evidence, Kim and Lee (2007) believe that the proportion of old dependents is a predominant driver of savings rates in East Asia. This is because a) shocks to elderly dependency ratios exhibit higher persistence than shocks to youth dependency ratios and b) shocks to elderly dependency ratios directly affect government savings via social security and, therefore, have a greater impact on overall savings than youth dependency ratios.

Looking at China alone, Modigliani and Cao (2004) provide further evidence in support of the lifecycle hypothesis. Their paper uses China's one-child policy, implemented in the late 1970s, to investigate the effects of decreasing dependency ratios on savings rates. Ordinary least squares time series regressions show that the resulting decline of the youth dependency ratio led to an increase in savings rates of over 10%. Next to one-child policy, the Chinese government also aimed to decrease the financial dependency of the elderly population on their working families by encouraging individuals to accrue their own savings from early on. While this second strategy did not physically decrease the ratio of old dependents to the working population, it had a very similar effect and increased savings by an additional 10% according to Modigliani and Cao (2004).

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[3] This negative response of savings to a shock in dependency ratio does not imply that savings rates in East Asia are actually falling. A negative response merely provides empirical evidence of the inverse relationship between savings rates and dependency ratios in East Asia i.e. savings fall as dependency ratios rise and *visa versa.*

[4] The ratio of those aged 75+ to working population (Modigliani and Cao, 2004).

[5] The ratio of those aged 15 and below to working population (Modigliani and Cao, 2004).

Oil Price Increases

Next to emerging markets in Eastern Asia there is another group of economies that have especially high gross domestic savings rates compared to advanced economies, namely oil exporting economies. Figure 3 illustrates the behavior of gross domestic savings rates from five Middle Eastern oil exporting economies over time, with figure 4 depicting the average savings rate in the region. In oil exporting economies, average savings rates are not only much higher than in advanced economies but also far more volatile. The mean average savings rate for oil exporting economies is 46.6%, while that of advanced economies is 21.2%. Furthermore, the standard deviation of average savings rates is 12.5 for oil exporting economies and only 1.1 for advanced economies. To understand why savings are so much more volatile in oil exporting economies, one must first understand where these savings come from and how these economies primarily accumulate income. Of course, the answer is oil, more specifically, oil rents.[6]

In all five countries selected countries, governments hold the rights to all oil reserves and their respective revenues. This means that the state is free to choose whether oil rents are consumed or saved. Naturally, an adverse shock to oil rents will limit the government's capacity to save, since there are simply less available funds (Basher and Fachin, 2013). Furthermore, the degree to which a shock to oil rents will affect savings is partly determined by a country's dependency on oil revenues, measured by oil rents as a percentage of GDP. Given that the average oil rent as a percentage of GDP for all five economies has a mean of 28.1%, oil rents should, theoretically, have a substantial impact on how much these economies are able to save. Indeed, a purely graphical comparison of oil rents and savings rates reveals that the two follow very similar trends for Saudi Arabia, Brunei, and Oman (See figure 12).

Having established that oil rents may affect the government's capacity to save in oil exporting economies, the volatility and magnitude of savings rates in these countries can now be addressed. It is well-known that crude oil prices are amongst the most volatile commodity prices on earth (see figure 13). As oil rents are a function of world prices, volatility of the world price should theoretically affect oil rents and thereby a country's capacity to save *ceteris paribus*. In short, highly volatile oil prices may be one possible explanation of why gross

[6] "Oil rents are the difference between the value of crude oil production at world prices and total costs of production" (World Bank, 2011).

domestic savings rates of oil exporting economies tend to be more volatile than those of more diversified advanced economies (Barnett and Ossowski, 2002). As for the drastically higher savings rates amongst oil exporting economies compared to advanced economies, two explanations have gained popularity. First, highly volatile oil rents induce so-called consumption smoothing such that precautionary savings rates are very high during favorable oil price shocks in order to finance adverse price shocks (Barnett and Ossowski, 2002) (Cherif and Hasanov, 2013) (Van der Ploeg, 2010). Second, strong oil price increases during the early 2000s have simply increased oil rents by more than government expenditure, causing savings rates to surge higher amongst oil exporters than advanced economies (Bernanke, 2005) (Bernanke, 2007).

Savings Rates and Global Imbalances

So far, this paper has detailed a variety of explanations as to why savings rates in East Asian emerging markets and oil exporting economies tend to be higher than in advanced economies. What follows is an analysis of the effects high savings rates in these two country groups can have on real interest rates in advanced economies. However, before this relationship can be empirically tested, the theoretical mechanisms behind it must be described in order to understand how and why savings rates in one country may affect real interest rates in another. The first step in this process involves understanding the connection between high savings rates and global imbalances, also known as 'savings glut theory' – a term famously coined by American economist and Chair of the Federal Reserve, Ben Bernanke. The following section is dedicated to this topic. Thereafter, the relationship between savings rates and real interest rates can be explored via these global imbalances.

Regardless of whether the savings rates in one country are considered relatively high or low, the savings themselves must not remain within the country's borders. For example, if a government decides not to invest all of its accumulated savings at home, it could lend the excess savings over investment to another foreign country. On the flipside, if domestic savings do not suffice to cover domestic investment demands, the home country could borrow from abroad to bridge the gap. The point of this example is that differences between domestic savings and domestic investment can determine whether a country is a net borrower or a net lender to international capital markets (Bernanke, 2005).

In the case that a country is a net lender to international capital markets, capital outflows will exceed capital inflows, resulting in downward pressure on the exchange rate.[7] What follows is that a country's exports become cheaper and imports from abroad become more expensive, thereby pushing the current account towards a surplus as net exports increase. Through the same channel, a net borrower on international capital markets will have capital inflows that exceed capital outflows, resulting in upward pressure on the exchange rate. This will make exports more expensive and imports from abroad cheaper, pushing the net borrower's current account into deficit (Feldstein, 2008) (International Monetary Fund, 2019). Therefore, the difference between domestic savings and domestic investment is equal to net exports. Moreover, if these differences are sustained and large enough, they may well lead to global current account imbalances (Bernanke, 2005).

The 1997 East Asian financial crisis marked a turning point for global imbalances according to Bernanke (2005). As previously mentioned, East Asia relied heavily on capital inflows during the early 1990s with a ratio of debt to foreign exchange reserves exceeding one (Radelet and Sachs, 1998). Indeed, the region was a net importer of capital during that time. After the crisis, however, the situation reversed and East Asia became a net exporter on international capital markets. Domestic investment shrank dramatically as governments sought to avoid another crisis and insured themselves against capital flight with foreign exchange reserves. This meant that East Asian savings were used to buy large amounts of foreign currencies and foreign currency denominated assets, especially in U.S. dollars. These capital outflows put downward pressure on the exchange rate, made East Asian exports more competitive and boosted the current account. By creating a model of the 1997 East Asian financial crisis, Gruber and Kamin (2007) find statistically significant evidence that East Asian current account surpluses are indeed associated with the crisis. That being said, insurance against crises was not the only motivation behind increasing domestic savings relative to investment in East Asia. Export-led growth strategies also involved increasing capital outflows in the hope of tapping into foreign demand with relatively cheaper exports (Bernanke, 2005).

By virtue of simple trade accounting, it is known that sustained current account surpluses in one region of the globe must be accompanied by sustained deficits in another. In other words, with East Asia becoming a net exporter after the crisis in 1997, someone else

[7] This downward pressure comes from the fact that lending to foreign countries increases the supply of domestic currency on the foreign exchange market. As the supply of a currency increases, the "price" of a currency falls.

must be becoming a net importer. These net importers turned out to be advanced economies with developed financial and legal systems. When accumulating foreign reserves, it was in the best interest of East Asian economies to buy currencies and financial assets from countries that could guarantee reliable property rights, political stability, and well-organized financial systems (Bernanke, 2005). Correspondingly, the U.S. and euro area experienced large capital in-flows between the early-2000s and the financial crisis of 2008 (Carvalho and Fidora, 2015). At the same time, current account balances of the U.S., U.K, France, and Italy fell into deficit (World Bank, 2020).

According to Bernanke (2005), there were two key links between capital flows and current account deficits in advanced economies. First, capital in-flows boosted stock-market fortunes in advanced economies and thereby people's propensity to buy imports from abroad. Second, savings declined relative to investment as households in advanced economies became overly confident from stock-market fortunes, no longer feeling an urge to save. Using panel regressions and fixed effects analysis, Gruber and Kamin (2007) show that, indeed, higher financial development and more stable government institutions were associated with decreasing current account surpluses in the United States. This evidence supports the claim of Bernanke (2005) that advanced economies attracted East Asian capital flows due to better institutions.

Around the same time that East Asian economies were accumulating large amounts of foreign reserves and pursuing export-led growth strategies, the price of crude oil began a major rise at the beginning of the 21st century. As a result, the value of crude oil imports dramatically increased in advanced economies. In the U.S., the value of oil imports increased by approximately $110 billion over the course of 8 years from 1996 to 2004 (Gruber and Kamin, 2007). In the E.U., the value of oil imports increased by approximately $53 billion over the course of 4 years from 2001 to 2004 ("EU crude oil imports and supply cost - Energy European Commission", 2020). At the same time, savings rates among oil exporters increased and current accounts rose into surplus (World Bank, 2020). Although both Bernanke (2005) and Gruber and Kamin (2007) do not attribute rising oil prices as a dominant cause to rising current account deficits in advanced economies, the latter do find a small and positive significant effect of oil price on the U.S. deficit during 1997 to 2003.

Naturally, this paper realizes that financial capital flows from East Asia and oil price increases were not the sole reasons for current account deficits in advanced economies. The main objective of this particular section was simply to explain and evaluate evidence of how high savings rates in East Asia and oil exporting economies could contribute to current account surpluses within these regions, and by doing so, to deficits in advanced economies. Having now explained the channels through which savings can affect global imbalances, the final part of our theoretical analysis can begin. This final part is devoted understanding how high savings rates and global imbalances interact with interest rates in advanced economies.

Global Imbalances and Real Interest Rates

One significantly debated and far-reaching implication of this high propensity to save in East Asian emerging markets and oil exporting economies is a declining real interest rate in advanced economies. The underlying argument is that current account surpluses brought about by higher savings relative to investment need to be balanced by lower surpluses or deficits elsewhere in the world. Therefore, "saving rates [in advanced economies] had to fall relative to investment, and current account deficits had to emerge as counterparts to the developing countries' surpluses. This adjustment could be achieved only by declines in real interest rates" (Bernanke, 2007, pg.3). Bernanke's explanation may seem fairly obvious from a theoretical accounting standpoint; however, from a practical standpoint it may seem abstract to believe that interest rates simply fall to balance-out current account surpluses elsewhere in the world. Empirical literature on this topic offers a more practical explanation focused on financial capital flows. The main idea is that as accumulated savings from East Asia and oil exporters flow into advanced economies, the supply of loanable funds increases, thereby lowering the real interest rate in that country (Dooley, Folkerts-Landau and Garber, 2005).

Looking at the data alone, foreign bond holdings amounted to around 2% of GDP for both the U.S. and euro area in the year 2000. By 2006 this figure rose to 7% of GDP in the U.S. and 6% of GDP in the euro area (Carvalho and Fidora, 2015). During the same period, the U.S. real interest rate decreased from 6.8% to 2.9%, while the average interest rate of Germany, France, and Italy decreased from 6.8% to 3.5% (World Bank, 2020). Warnock and Warnock (2009) investigate the effect of foreign financial in-flows on U.S. long-term interest rates using a vector error correction model. Their results show that in the absence of foreign bond accumulation, long-term interest rates would be 0.8% higher in the U.S., *ceteris paribus*.

Carvalho and Fidora (2015) investigate the same relationship within the euro area, showing that a rise in foreign bond accumulation related to a 1.55% decrease in long-term interest rates. While both papers mention the importance of capital in-flows from East Asia, only Warnock and Warnock (2009) specifically test for the effect of in-flows from this exact region, which are estimated to depress U.S. long-term rates by 0.38%. This means that Carvalho and Fidora (2015) simply estimate the aggregate effects of capital flows into the euro area and not from East Asia specifically. Additionally, both papers do not estimate the effect of capital in-flows from oil exporting economies.

Motivated by the ambition to specifically investigate the degree to which high savings rates in East Asia and oil exporting economies may affect real interest rates in advanced economies, this paper now proceeds to outlining the empirical methods required for such an analysis. Unlike both papers mentioned above, the analysis does not involve capital in-flows but estimates the direct effect of savings rates on real interest rates. While investigating a relationship as such may seem somewhat far-fetched at first, the hope is that the explanations given thus far help paint a relatively credible picture of how savings rates can affect real interest rates and thereby justify the relevance of the following analysis.

Methodology

A vector autoregressive (VAR) model will be used to empirically analyze the relationship between savings rates in both East Asian emerging markets as well as oil exporting countries and real interest rates in advanced economies. VAR models are widely used in forecasting, while also exhibiting traits that lend themselves to economic analysis. By testing the extent to which current values of an endogenous variable can be explained by lagged values of another endogenous variable, the nature of economic mechanisms can be described (Luetkepohl, 2011). The VAR models will be accompanied by impulse response functions (IRF) along with Granger causality tests. The following section will give a more detailed description of the applied methodology and is structured into five subsections, namely 1) nature of trends 2) model selection and specification 3) impulse response function 4) Granger causality 5) diagnostic tests.

1) Nature of Trends

When working with time series data, it is important to identify and understand the trend components of the variables. There exist so-called stochastic and deterministic trend components in a group of time series variables denoted by y_t. It can be assumed that

$y_t = \alpha_t + x_t$,

where α_t denotes the deterministic component and x_t denotes the stochastic component. A deterministic trend can be described as a non-random function of time, which increases or decreases with a specific value, meaning it has a predetermined constant trend. A stochastic trend, on the other hand, is a random function of time and does not exhibit a constant trend (Athanasopoulos and Hyndman, 2018). Deterministic trends do not lend themselves to forecasting, meaning they should be avoided in VAR models. Similarly, VAR models are not intended to include stochastic trends (Enders, 2015) (Ooms, 1994) (Luetkepohl, 2011). Therefore, the nature of existing trends must first be verified before any further analysis is conducted.

Figures 2, 4, and 7 illustrate that both savings and real interest rates do not have a constant slope. Rather, the behavior of savings and real interest rate resembles a random walk with a drift. From a graphical perspective, it seems the data follows a stochastic trend rather than a deterministic trend. Another indicator of stochastic processes, also known as non-stationarity, is a slowly diminishing autocorrelation (Enders, 2015). Indeed, this is observed in most correlograms of savings and real interest rates. Finally, an augmented Dickey-Fuller (ADF) test is applied to determine whether non-stationarity can be verified empirically. The null-hypothesis of the ADF test states that the time series is non-stationary and can be rejected if the test statistic is significant at 5%. Before running the test, the optimal lag length is chosen using the Akaike Information Criterion (AIC), where the lag length with the lowest AIC is selected. Additionally, it is specified whether the tested series is trending or the mean lies around zero. The results displayed in tables 6 and 7, show that all variables are I(1) (integrated of order one), meaning they have a unit root and are only stationary in their 1st differences. Therefore, all non-stationary variables need to be transformed into stationary variables to be included in the VAR model. This can be done through a technique known as "differencing", whereby the series is converted into its 1st differences. VAR models specified in first differences still lend themselves to hypothesis tests using t or F-statistics (Enders, 2015). Finally, an ADF test is run on the differenced data to show that it is stationary (see tables 8 and 9)

2) Model Selection and Specification

Before going into any details on how VAR models are specified, it is important to understand the econometric reasoning that justifies their application. Quite commonly, impact evaluation assumes at least one exogenous variable and one endogenous variable, such as in an ordinary least squares (OLS) regression. In macroeconomics, however, exogenous variables tend to be sparse, given that the sheer number of interdependent factors within an economy make it difficult for the value of one such factor to be independent of others in the model. Consequently, savings rates cannot simply be assumed to be exogenous in the context of this paper, implying that empirical methods in need of exogeneity fall away. A VAR model assumes all variables as endogenous, that is, their values are partly determined by other variables in the model (Enders, 2015). In that respect, the VAR model lends itself to the econometric analysis of this paper and is specified as follows.

$$Y_t = \gamma_0 + \sum_{i=1}^{k} \delta\, Y_{t-i} + \sum_{j=1}^{k} \beta\, X_{t-i} + \varepsilon_t \tag{1.1}$$

$$X_t = \eta_0 + \sum_{i=1}^{k} \beta\, X_{t-i} + \sum_{j=1}^{k} \delta\, Y_{t-i} + \tau_t \tag{1.2}$$

The two series Y_t and X_t are treated symmetrically, meaning that Y_t can be impacted by current and past values of X_t and X_t can be impacted by current and past values of Y_t. Additionally, the current and lagged values of the variable on the left-hand-side of the equations is included in a VAR model as well. The optimal lags of X_t and Y_t in both 1.1 and 1.2 are given by k. Constants are denoted by γ_0 and η_0, while the error terms are ε_t and τ_t. This paper utilizes an unrestricted VAR model where all variables are included in each equation. Once again, the optimal lags are determined by the lowest AIC.

3) Impulse Response Function

VAR models obtain coefficients through estimated variances and covariances, meaning that interpretation of coefficients is not always as straightforward and should be conducted appropriately. A tool often used to interpret macroeconomic VAR models is the impulse response function (IRF). The idea behind an IRF is to simulate a shock in one variable and test whether this shock is transmitted to the other variable along a given time frame using the VAR model. Empirically, the IRF will model a one standard deviation shock to the error term of savings, which will affect the current and future value of savings. Since VAR models are symmetric and there are two regression equations, a shock to savings may affect the current and future values of real interest rate as well. Therefore, an IRF can estimate the expected future values of real interest rates in response to a shock in savings (Pesaran and Shin, 1998).

4) Granger Causality

A Granger causality test will be used to determine whether lagged values of savings rates have any explanatory power over current values of real interest rates. If this is the case, savings is said to Granger cause real interest rates, meaning that the prediction of interest rates is improved by including past values of savings. The null hypothesis states that there is no Granger causality and can be rejected if the *p*-value of the *F*-test is less than 0.05. The VAR framework lends itself to testing for Granger causality, requiring a simple post estimation command in STATA. Therefore, the number of lags is already determined when estimating the unrestricted VAR model using the AIC.

5) Diagnostic Tests

Finally, diagnostic tests are run to check for residual autocorrelation and normally distributed disturbances. Residual autocorrelation by itself does not lead to biased forecasts, yet it is a sign that not all information is accounted for and that forecasts could be improved by re-specifying the model (Athanasopoulos and Hyndman, 2018). The Lagrange multiplier (LM) test will be used to check for autocorrelation in the residuals of each VAR model. The null hypothesis states that there is no residual autocorrelation for the specified number of lags. If the resulting p-value at any lag order is less than 0.05, the null hypothesis is rejected and the model suffers from residual autocorrelation at that lag.

If the normality assumption does not hold and disturbances in the model do not follow a normal distribution, hypothesis testing may prove unreliable in small samples. Given that the dataset used in this paper is relatively small, tests for normality should be performed. The Jarque-Bera test is one available method with a null hypothesis of normally distributed disturbances. If the p-value of the Jarque-Bera statistic is less than 0.05, the null hypothesis is rejected and the model does not satisfy the assumption of normality (Jarque and Bera, 1987).

Data

All time-series data is acquired from The World Bank National Accounts Database of world development indicators. Gross domestic savings as a percentage of GDP and real interest rates are the two main data series used. Gross domestic savings is chosen because it includes household, private and public sector savings. Both savings and real interest rates are assumed to be partially endogenous, as they may be affected by each other or by variables not included in the model. Observations run through the years of 1970-2018, with some countries having fewer observations due to unavailable data. Table 5 shows all countries included in the dataset.

Other data series used but not included in empirical models are age dependency ratios of East Asian emerging markets and advanced economies, oil rents as a percentage of GDP of oil exporting economies and the spot crude oil price. These datasets are also obtained from The World Bank National Accounts Database of world development indicators with the exception of the spot crude oil price which was acquired from the database of the Federal Reserve Bank of St. Louis.

To be included in the list of East Asian emerging markets, a country must a) belong to Eastern or South-Eastern Asia according to the United Nations Statistics Division and b) must be listed on the Morgan Stanley Capital International (MSCI) Emerging Markets Asia Index. To be included in the list of oil exporting economies, a country's average annual oil rents, as a percentage of GDP, must be in excess of 10% (see figure 11). Apart from the selected countries, many others would qualify as oil exporting economies in this respect; however, limited data on savings rates has restricted the dataset to five countries. Advanced economies were chosen in line with the Group of Seven (G7) list of major industrial nations with the exception of Japan. While Japan presently exhibits traits of an advanced economy, it could have arguably been classified as an emerging market a few decades ago. Given that observations in the dataset span back to the 1970s, Japan was deliberately excluded to avoid confusion.

As mentioned in the methodology, all data on gross domestic savings and real interest rates are transformed into their first differences to ensure stationarity. In practice, this entails subtracting the previous year's value from every observation. The resulting series yields the changes in savings and interest rate from one period to the next. Three separate series of

VARs are run using this differenced data. Initially, a VAR is estimated for each country separately. This means that every advanced economy is paired up with each oil exporting economy and each East Asian emerging market to estimate separate VARs of real interest rate on savings rate. In total, 84 individual VARs are estimated in this first series.[8]

Following these individual estimates, the relationship is analyzed on an aggregate level in the second series of VARs. This is done by first computing the average real interest rate in advanced economies as well as the average savings rates in both East Asian emerging markets and oil exporting economies. VARs are simply estimated using these averages. The third series of VARs is run using average savings rates weighted by GDP per capita and average real interest rates. The table below gives a complete overview of the three series of VARs analysis.

Overview of the different VAR models used.

VAR Model 1

$$\boldsymbol{real\ interest\ rate_t = \gamma_0 + \sum_{i=1}^{k} \delta\, real\ interest\ rate_{t-i} + \sum_{j=1}^{k} \beta\, savings\ rate_{t-i} + \varepsilon_t}$$

VAR Model 2

$$\boldsymbol{avg.real\ interest\ rate_t = \gamma_0 + \sum_{i=1}^{k} \delta\, avg.real\ interest\ rate_{t-i} + \sum_{j=1}^{k} \beta\, avg.savings\ rate_{t-i} + \varepsilon_t}$$

VAR Model 3

$$\boldsymbol{avg.real\ interest\ rate_t = \gamma_0 + \sum_{i=1}^{k} \delta\, avg.real\ interest\ rate_{t-i} + \sum_{j=1}^{k} \beta\, weighted\ avg.savings\ rate_{t-i} + \varepsilon_t}$$

Results

Impulse Response Function – Model 1

The estimated impulse response functions (IRF) of model 1 show that interest rates in advanced economies do not respond uniformly to shocks in savings rates throughout East Asian emerging markets and oil exporting economies. More specifically, around half the expected future values of real interest rates decreased in response to a shock in savings, while the other half increased. In total, 24 IRFs were significant. Out of this total, 16 IRFs were in

[8] $6_{advanced\ economies} \times (9_{East\ Asian\ EMs} + 5_{oil\ exp.economies}) = 84$ VARs

response to savings shocks in East Asia and 8 were in response to savings shocks in oil exporting countries. Tables 12 and 13 show the breakdown of positive and negative responses of real interest rates. Half of the responses to an East Asian savings shock showed a decline in the real interest rates of advanced economies, while the other half showed an increase. Regarding oil exporting economies, 3 out of 5 IRFs showed a decline in the real interest rates of advanced economies in response to a savings shock. In total, a higher number of net positive responses were observed in the real interest rates of advanced economies in response to shocks of savings rates in all countries.

Most significant responses of real interest rate to a shock in savings are observed in lags one and two. This indicates that the effect of shocks tends to die out within the first two periods and, in most cases, does not propagate down a longer time frame. In response to a shock in East Asian savings the maximum significant lag of real interest rates is four. In response to a shock in oil exporter savings, the maximum significant lag of real interest rates is two. Figure 14 is one example of an IRF and shows the response of real interest rate in the U.S. to a one standard deviation shock in the Hong Kong savings rate. The shaded grey area shows the 95% confidence interval of the impulse response. This means that there is 95% probability that actual value will fall within this interval. If the 95% confidence interval contains zero, the results cannot be statistically significant, given that zero would be a possible actual value. Therefore, whenever the shaded grey area contains zero, the impulse response for that period is not significant. Still looking at figure 14, lags 3 and 4 are statistically significant and can be interpreted as follows. A one standard deviation shock to savings rate is associated with a significant decrease in real interest rate in period three followed by a significant increase in real interest rate in period 4. These two significant responses show a net decrease in the U.S. real interest rate, as the increase in lag 4 is not enough to offset the decrease in the previous period. Figure 15 shows the significant impulse response of Canadian real interest rates to a shock in Omani savings. There is a significant increase in real interest rate within periods 1 and 2 as a result of a one standard deviation shock in savings, after which the effect becomes insignificant

Granger Causality Model – 1

Results from significant Granger causality tests can be observed in tables 14 and 15. The left most column gives the country whose savings rate is used in the test, while the column immediately to the right gives the country whose interest rate is used in the test. Therefore, the first row in table 7 displays results from the granger causality test between Indonesian savings and Canadian real interest rate. The null hypothesis stating that savings does not Granger cause interest rates can be rejected because the *p*-value is less than 0.05. Hence, the test concludes that savings Granger-causes interest rates. However, the null hypothesis that interest rates Granger-cause savings cannot be rejected, since the *p*-value exceeds 0.05. Consequently, it can be concluded that there is unidirectional Granger causality from Indonesian savings to Canadian real interest rates.

The direction of all significant Granger causality tests is well summarized in table 16. There where 18 cases in which savings Granger caused interest rates, 13 cases in which interest rates Granger caused savings, and 6 cases of mutual Granger causality. In total, 84 tests were conducted, meaning that 28.6% of all tests showed evidence that savings in East Asia and oil exporting economies Granger-caused real interest rates in advanced economies. Looking at the break-down by region, East Asian savings Granger caused interest rates in 29.6% of cases, while savings in oil exporting economies Granger caused interest rates in 26.7% of cases.

Impulse Response Function – Model 2

Model 2 estimates two VARs of average savings rates on average real interest rates (see table 17). The first VAR uses average East Asian savings rates, while the second uses average oil exporter savings rates. Figures 16 and 17 show the two corresponding IRFs. A one standard deviation shock to the average savings rate in East Asia is associated with a significant increase in the average real interest rate amongst advanced economies. The significant lags are 2 and 3, after which the results become insignificant. A one standard deviation shock to the average savings rate of oil exporting economies is associated with a significant decrease in the average real interest rate amongst advanced economies. The significant decrease occurs in lag 3.

Granger Causality – Model 2

Results of granger causality tests for model 2 are given in table 18. The null hypothesis that average savings rates do not granger cause average real interest rates of advanced economies can be rejected for both East Asian emerging markets and oil exporting economies at a significance level of 0.05. This indicates that the prediction of average real interest rates is improved by including past values of average savings rates. However, there is no evidence of granger causality in the other direction at a significance level of 0.05.

Impulse Response Function – Model 3

Model 3 estimates two VARs of average savings rates weighted by GDP per capita on average real interest rates (see table 19). The first VAR uses weighted average East Asian savings, while the second uses weighted average oil exporter savings. The two corresponding IRFs are shown in figures 18 and 19. A one standard deviation shock to the weighted average savings rate in East Asia is associated with a significant increase in the average real interest rate amongst advanced economies. The significant lags are 2 and 3, after which the results become insignificant. A one standard deviation shock to the weighted average savings rate of oil exporting economies is associated with a significant decrease in the average real interest rate amongst advanced economies. The significant decrease occurs in lag 3.

Granger Causality – Model 3

Results of granger causality tests for model 3 are given in table 20. The null hypothesis that weighted average savings rates do not granger cause average real interest rates of advanced economies can be rejected for both East Asian emerging markets and oil exporting economies at a significance level of 0.05. This indicates that the prediction of average real interest rates is improved by including past values of weighted average savings rates, thus savings rates granger-cause real interest rates. There is no evidence of granger causality in the other direction at a significance level of 0.05. However, at a significance level of 0.1, average real interest rates in advanced economies granger-cause weighted average savings in East Asia. Therefore, one case of mutual granger causality exists at the significance level of 0.1 in model 3.

Diagnostic Tests and Empirical Limitations – All Models

Evidence of residual autocorrelation can only be observed in model 1 (see table 21 and 22). P-values of the test statistic for the Lagrange-multiplier test fall below 0.05 in five separate VARs within model 1. In these five cases, the null hypothesis of no residual autocorrelation for the specified number of lags is rejected. Finding evidence of residual autocorrelation does not immediately imply biased forecasts, yet it is an indicator of possible model misspecification. More specifically, the model may suffer from unaccounted information, meaning that forecasts could be improved by re-specifying the model and possibly adding previously omitted variables (Athanasopoulos and Hyndman, 2018) (Hatemi-J, 2004).

In addition to residual autocorrelation, evidence of non-normally distributed disturbances can also only be found in model 1 (see table 21 and 22). P-values of the test statistic for the Jarque-Bera test fall below 0.05 in three separate VARs within model 1. In these three cases, the null hypothesis of normally distributed disturbances is rejected, hence the individual VARs do not satisfy the assumption of normality. According to Jarque and Bera (1987), non-normality may be cause to misleading t and F-tests and thereby invalid conclusions. Given that hypothesis testing in the form of Granger causality and Lagrange-multiplier tests is important to the empirical findings of this paper, non-normally distributed disturbances are indeed reason for concern.

Even though diagnostic tests for models 2 and 3 do not yield any evidence of residual autocorrelation or non-normally distributed disturbances (see tables 23 and 24), they are, of course, still subject to limitations. Primarily, it must be remembered that VARs assume endogeneity of all included variables. This means that one should avoid directly interpreting the estimated coefficients of VARs. Not only do all included variables potentially impact each other, but variables entirely outside of the model may have an impact as well (Athanasopoulos and Hyndman, 2018) (Luetkepohl, 2013). Therefore, it is difficult to quantify the magnitude of one variable's relationship with another as would be done in a simple OLS regression by looking at coefficients. As a result, the empirical methods used in this paper may seem further from reality than others, given that the relationship between savings rate and real interest rate is investigated through hypothetical shocks and not through coefficients that, arguably, paint a more precise picture.

As with many empirical methods, the problem of potentially omitted variables leading to bias is no exception here. This issue is especially relevant to the interpretation of IRFs. In the case that key variables are not included, the so-called "impulse responses" will not solely be the result of shocks to variables included in the system. Therefore, it would be misleading to interpret the change in the response variable as being solely caused by a shock to other variables in the system. That being said, predictions using IRFs can still be valid even in the case of omitted variable bias. (Lütkepohl, 2005).

Finally, the distinction between Granger causality and an actual causal relationship must be clarified. Granger causality from x to y simply implies that the prediction of y is improved by including past values x. However, there could exist a separate variable z that impacts y and is correlated with x, causing x to pick up part of the effect of the external variable z, leading to omitted variable bias. Consequently, Granger causality should not be interpreted as actual causality. In addition, Granger causality tests can be sensitive to how data is measured. More specifically, if average annual savings rates Granger-cause average annual interest rates, this does not automatically imply that the same holds for monthly or quarterly data. Therefore, the results found by this paper may be influenced by the frequency with which data is collected and must not be overinterpreted (Lütkepohl, 2005).

Discussion and Conclusion

Conclusion

This paper sets out to investigate whether high savings rates in East Asian emerging markets and oil exporting economies contributed to falling real interest rates in advanced economies. The findings do not suggest that high savings rates in East Asian emerging markets have contributed to falling real interest rates in advanced economies. In fact, shocks to East Asian savings are associated with a significant increase in average real interest rate amongst advanced economies. Nonetheless, there is significant unidirectional Granger causality from savings rate to average real interest rate. These results hold for average savings rate and average savings rate weighted by GDP per capita. On an individual country level, the number of positive and negative responses of real interest rate to a shock in East Asian savings are equal, meaning that no definitive relationship can be derived. However, diagnostic tests show evidence of residual autocorrelation and non-normally distributed disturbances at the individual country level.

Looking at oil exporting economies, the results are consistent with the hypothesis that high savings rates have contributed to falling interest rates in advanced economies. Positive shocks to the savings rate of oil exporting economies is associated with a significant decrease in the average real interest rate in advanced economies. In addition, the past values of savings rates are useful at explaining present values of real interest rates in advanced economies. These results hold for average savings rate and average savings rate weighted by GDP per capita for oil exporting countries. On an individual country level, the number of positive to negative responses of real interest rate to a shock in oil exporter savings is 5 to 3 respectively. However, diagnostic tests show evidence of residual autocorrelation and non-normally distributed disturbances at the individual country level.

While there is evidence that a positive savings shock in oil exporting economies is associated with a decrease in real interest rate in advanced economies, the conducted research is much too simplistic and prone to omitted variable bias to infer any causation. Nevertheless, the nearly identical results of models 2 and 3 for both IRFs and Granger causality tests give confidence towards some robustness of the results, since shocks to average and weighted average savings seem to invoke very similar responses in average real interest rates. Additionally, the results from Granger causality tests are a reasonably strong indication that reverse causality from real interest rate to savings rate can be ruled out at a 5% significance level amongst VARs using averaged data. At the very least, this paper shows that past values of savings rates amongst East Asian emerging markets and oil exporting economies have some predictive power over current values of real interest rates in advanced economies.

There are a few implications of the discussed results. For one, if savings rates in East Asia and oil exporting economies have some explanatory power over real interest rates in advanced economies, then it could be worth investigating whether the same holds for other factors that go along with high savings rates in these regions. Perhaps the question of whether an emerging market is net lender or borrower on international capital markets is a useful question to ask when it comes to forecasting interest rates in advanced economies. Possibly, it is worth the effort to look beyond the borders of an economy more often when trying to forecast interest rates in general.

Recommendations for Future Research

Besides impulse response functions and tests for Granger causality, there is one other tool that lends itself to interpreting the output of VARs. Forecast error variance decomposition (FEVD) estimates the dependence of a certain time series on external versus internal shocks, i.e. do shocks to variables in the system have a greater impact than shocks of the variable itself? With the help of this method, the degree of exogeneity can be determined along a given time horizon. FEVD could complement the research of this paper by estimating the percentage of movements in real interest rate that can be explained by shocks to the savings rate. If the percentage is high, this would be an indicator of strong endogeneity amongst real interest rate (Enders, 2015) (Lütkepohl, 2005).

One limitation of VAR is that it cannot estimate long-run relationships between variables. In order to estimate a long-run equilibrium between savings rates and real interest rates, both variables need to be cointegrated, that is, there must exist a stable long-run relationship between the two. If cointegration does exist, a vector error correction model (VECM) is able to capture the long-run effect, also known as the error correction term, which indicates how much real interest rate would adjusts per period if a disequilibrium exists between savings rate and real interest rate (Luetkepohl, 2005) (Nkoro and Uko, 2016). Finding evidence in support of (or not in support of) cointegration would give a deeper understanding of the relationship between savings rates and real interest rates. Testing for cointegration and possibly estimating a VECM allows for long-run analysis that would not be possible using VARs alone.

Finally, it is possible to extend the research of this paper using the same empirical methods. As detailed in previous sections, capital flows into advanced economies as well as reserve accumulation of emerging markets and oil exporting countries may affect global imbalances and real interest rates in advanced economies. Including these variables in VAR analysis would allow for a comparison of IRFs to gauge whether a shock in capital flows or reserve accumulation has a larger impact on real interest rates than a shock in savings rate. Consequently, this could lead to a more precise understanding of what drives real interest rates in advanced economies. The main reason for omitting these control variables was unavailability or incompleteness of country-specific data. Therefore, further research would involve creating variables that proxy for capital inflows and reserve accumulation and making sure that these are available for all countries in the dataset.

Appendix

Table 1

Summary statistics of savings rates by country

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Indonesia	49	27.29	5.65	10.63	35.52
India	49	22.52	7.95	9.76	34.38
Malaysia	49	35.93	6.70	20.18	48.67
Korea Rep.	49	32.51	6.49	14.40	41.62
Thailand	49	29.32	5.68	18.75	37.45
Singapore	49	44.28	9.12	21.02	54.52
Philippines	49	19.36	4.95	13.76	28.56
Hong Kong	49	30.71	3.67	21.78	37.97
China	49	40.71	5.68	32.58	51.71
Saudi Arabia	49	40.27	16.34	10.38	80.66
Bahrain	39	39.04	10.45	17.06	56.29
Qatar	25	61.18	12.19	35.63	75.55
Oman	49	40.65	11.21	16.23	67.79
Brunei	40	58.45	16.64	29.87	86.29
Germany	49	24.26	2.48	19.18	28.12
Canada	49	22.99	2.03	17.58	26.38
France	49	23.26	2.21	20.54	28.87
U.S.	49	19.89	2.40	15.06	24.25
U.K.	49	14.64	2.06	9.01	18.92
Italy	49	22.33	1.86	18.72	26.08

Table 2

Summary statistics of average savings and average savings rate weighted by GDP by region

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
East Asia	49	31.40	4.01	20.93	36.64
Oil Exporters	40	46.57	12.53	24.07	70.90
Weighted East Asia	49	32.95	19.68	4.97	69.10
Weighted Oil Exporter	49	43.84	15.72	20.38	76.24

Table 3

Summary statistics of real interest rates by country

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
U.S.	49	3.92	2.43	-1.28	8.59
U.K.	45	1.36	3.81	-12.17	6.44
Canada	30	4.93	2.54	1.79	11.65
Germany	48	3.54	2.98	-4.24	10.30
France	39	6.30	2.40	2.41	10.13
Italy	46	4.09	2.73	-3.30	7.85

Table 4

Summary statistics of average real interest rate in advanced economies

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Advanced Economies	44	3.29	2.61	-4.57	7.6

Table 5

Countries included in the dataset

East Asian Emerging Markets	Oil Exporting Economies	Advanced Economies
Indonesia	Saudi Arabia	U.S.
Philippines	Bahrain	U.K.
Malaysia	Qatar	Canada
Korea Rep.	Oman	Germany
Thailand	Brunei	France
Singapore		Italy
India		
Hong Kong		
China		

Table 6

Results of the augmented Dickey Fuller test for a unit root in gross domestic savings rates.

Variable	Test Statistic	Specified lags	Order of Integration
Indonesia	-2.257(t)	4	*I(1)*
India	-1.178(t)	1	*I(1)*
Malaysia	-1.243(t)	1	*I(1)*
Korea Rep.	-1.749(t)	3	*I(1)*
Thailand	-1.696(t)	2	*I(1)*
Singapore	-2.488(t)	2	*I(1)*
Philippines	-1.787(t)	1	*I(1)*
Hong Kong	-1.031(t)	1	*I(1)*
China	-2.338(t)	2	*I(1)*
Saudi Arabia	-1.872(t)	1	*I(1)*
Bahrain	-1.982	1	*I(1)*
Qatar	-1.722(t)	1	*I(1)*
Oman	-2.713(t)	1	*I(1)*
Brunei	-0.805(t)	1	*I(1)*
Avg. East Asian savings rate	-2.412(t)	1	*I(1)*
Weighted Avg. East Asian savings rate	-2.715(t)	1	*I(1)*

Notes:

1. (t) denotes that a trend term was included

*2. * denotes that the null hypothesis of non-stationarity can be rejected at a 5% significance level.*

Table 7

Results of the augmented Dickey Fuller test for a unit root in real interest rates.

Variable	Test Statistic	Specified lags	Order of Integration
U.S.	-2.320	1	*I(1)*
U.K.	-2.141	1	*I(1)*
Canada	-1.985	1	*I(1)*
Germany	-3.117(t)	1	*I(1)*
France	-1.243(t)	1	*I(1)*
Italy	-3.205(t)	1	*I(1)*
Avg. real interest rate advanced economies	-1.252(t)	1	*I(1)*

Notes:

1. (t) denotes that a trend term was included

*2. * denotes that the null hypothesis of non-stationarity can be rejected at a 5% significance level.*

Table 8

Results of the augmented Dickey Fuller test for a unit root in gross domestic savings rates using data in first differences.

Variable	**Test Statistic**	**Specified lags**	**Order of Integration**
Indonesia	-5.007*	3	*I(0)*
India	-4.105*	1	*I(0)*
Malaysia	-6.268*	1	*I(0)*
Korea Rep.	-3.986*	2	*I(0)*
Thailand	-4.122*	1	*I(0)*
Singapore	-4.152*	1	*I(0)*
Philippines	-6.054*	1	*I(0)*
Hong Kong	-6.517*	1	*I(0)*
China	-4.190*	1	*I(0)*
Saudi Arabia	-4.552*	1	*I(0)*
Bahrain	-4.561*	1	*I(0)*
Qatar	-3.360*	1	*I(0)*
Oman	-6.483*	1	*I(0)*
Brunei	-4.143*	1	*I(0)*
Avg. East Asian savings rate	-5.479*	1	*I(0)*
Weighted Avg. East Asian savings rate	-5.847*	1	*I(0)*

Notes:

1. (t) denotes that a trend term was included

*2. * denotes that the null hypothesis of non-stationarity can be rejected at a 5% significance level.*

Table 9

Results of the augmented Dickey Fuller test for a unit root in real interest rates using data in first differences.

Variable	Test Statistic	Specified lags	Order of Integration
U.S.	-4.668*	1	*I(0)*
U.K.	-5.536*	1	*I(0)*
Canada	-5.845*	1	*I(0)*
Germany	-4.603*	1	*I(0)*
France	-3.756*	2	*I(0)*
Italy	-5.547*	2	*I(0)*
Avg. Real interest rate advanced economies	-4.087*	1	*I(0)*

Notes:

1. (t) denotes that a trend term was included

*2. * denotes that the null hypothesis of non-stationarity can be rejected at a 5% significance level.*

Table 10

Significant results from VAR Model 1 of savings rates in East Asia on real interest rates in advanced economies

East Asian EM	Advanced Economy	Lag 1	Lag 2	Lag 3	Lag 4
Indonesia	Canada	0.243*** (0.093)	0.110 (0.092)	-	-
India	Germany	-0.350** (0.176)	0.257 (0.180)	-	-
Malaysia	Germany	-0.113 (0.085)	0.237*** (0.070)	-	-
Malaysia	France	0.015 (0.060)	-0.123** (0.060)	0.091 (0.060)	-
Malaysia	UK	-0.266** (0.133)	-	-	-
Rep. of Korea	Canada	-0.405*** (0.151)	0.343** (0.154)	-	-
Rep. of Korea	France	0.121 (0.090)	-0.171** (0.085)	-0.021 (0.083)	0.334*** (0.086)
Thailand	France	0.311*** (0.117)	-0.158 (0.115)	0.182* (0.112)	0.024 (0.104)
Singapore	US	0.226** (0.100)	-	-	-
Singapore	Germany	0.207** (0.099)	-	-	-
Singapore	Italy	0.222** (0.113)	-	-	-
Philippines	France	0.012 (0.105)	-0.230** (0.099)	-	-
Philippines	Italy	-0.408** (0.160)	-0.155 (0.154)	-	-
Hong Kong	US	-0.134 (0.103)	0.201** (0.093)	-0.336*** (0.089)	0.178** (0.088)
China	Germany	-0.351** (0.147)	-	-	-

*p-value<0.1, **p-value<0.05, ***p-value<0.01

Table 11

Significant results from VAR Model 1 of savings rates in oil exporting economies on real interest rates in advanced economies.

Oil Exporting Economy	Advanced Economy	Constant	Lag 1	Lag 2
Saudi Arabia	France	0.014 (0.168)	-0.062** (0.024)	-
Saudi Arabia	UK	-0.029 (0.389)	-0.127** (0.057)	-
Bahrain	Canada	-0.179 (0.328)	0.112* (0.060)	-
Bahrain	Italy	-0.114 (0.211)	-0.106*** (0.039)	-
Oman	Canada	0.175 (0.278)	0.133*** (0.040)	0.097** (0.045)
Oman	UK	0.004 (0.373)	-0.057 (0.055)	0.152*** (0.054)
Brunei	Canada	-0.131 (0.326)	0.170*** (0.063)	0.024 (0.065)
Brunei	Italy	-0.307 (0.189)	-0.050 (0.036)	0.058* (0.031)

*p-value<0.1, **p-value<0.05, ***p-value<0.01

Table 12

Sign of significant responses in real interest rate in advanced economies to a one standard deviation shock in savings rate in East Asia for Model 1.

	Net Negative Response	Net Positive Response
Advanced Economies	**Number of Cases**	**Number of Cases**
US	1	1
Canada	1	1
Germany	2	2
France	2	2
UK	1	0
Italy	1	2
ALL	8	8

Table 13

Sign of significant responses in real interest rate in advanced economies to a one standard deviation shock in savings rate in oil exporting economies for Model 1.

	Net Negative Response	**Net Positive Response**
Advanced Economies	**Number of Cases**	**Number of Cases**
US	0	0
Canada	0	3
Germany	0	0
France	1	0
UK	1	1
Italy	1	1
ALL	3	5

Table 14

Significant Granger causality tests between savings rate in East Asia and real interest rate in advanced economies using VAR Model 1.

		H_o: Savings does not cause Interest rates	H_o: Interest rate does not cause savings
East Asian EM	**Advanced Economy**	**p-value**	**p-value**
Indonesia	Canada	0.025	0.118
Indonesia	Germany	0.538	0.048
India	US	0.497	0.004
India	Canada	0.889	0.007
India	Germany	0.043	0.631
India	UK	0.161	0.006
Malaysia	Germany	0.001	0.000
Malaysia	France	0.050	0.578
Malaysia	UK	0.046	0.954
Rep. of Korea	US	0.416	0.028
Rep. of Korea	Canada	0.007	0.918
Rep. of Korea	France	0.000	0.283
Thailand	France	0.041	0.003
Singapore	US	0.025	0.106
Singapore	Germany	0.037	0.219
Singapore	Italy	0.049	0.195
Philippines	Germany	0.705	0.048
Philippines	France	0.045	0.137
Philippines	Italy	0.031	0.001
Hong Kong	US	0.001	0.001
Hong Kong	Germany	0.644	0.012
Hong Kong	France	0.111	0.038
Hong Kong	UK	0.829	0.036
Hong Kong	Italy	0.444	0.002
China	Germany	0.017	0.645
China	France	0.272	0.007

Notes:
A p-value less than 0.05 indicates that the null hypothesis of no Granger causality is rejected.

Table 15

Significant Granger causality tests between savings rate in oil exporting economies and real interest rate in advanced economies using VAR Model 1.

		H_o: Savings does not cause Interest rates	**H_o: Interest rate does not cause savings**
Oil Exporting Economy	**Advanced Economy**	**p-value**	**p-value**
Saudi Arabia	Germany	0.113	0.009
Saudi Arabia	France	0.010	0.592
Saudi Arabia	UK	0.025	0.294
Bahrain	Canada	0.049	0.744
Bahrain	Italy	0.002	0.354
Qatar	Italy	0.558	0.004
Oman	Canada	0.000	0.312
Oman	UK	0.005	0.036
Brunei	Canada	0.022	0.144
Brunei	Italy	0.044	0.002

Notes:
A p-value less than 0.05 indicates that the null hypothesis of no Granger causality is rejected.

Table 16

Direction of significant Granger causality tests by region for Model 1.

	Savings Granger Causes Interest Rates	**Interest Rate Granger Causes Savings**	**Mutual Granger Causality**	
Countries	**Number of Cases**	**Number of Cases**	**Number of Cases**	**Total Number of Tests**
East Asia	12	11	4	54
Oil Exporting Economies	6	2	2	30
ALL	18	13	6	84

Table 17

Results from VAR Model 2 of average savings rates on real interest rates in advanced economies.

Average Savings Rate	**Average Real Interest Rate**	**Constant**	**Lag 1**	**Lag 2**	**Lag 3**	**Lag 4**
East Asian EMs	Advanced Economies	-0.383*** (0.130)	0.162 (0.116)	0.275** (0.116)	0.226* (0.124)	-
Oil Exporting Economies	Advanced Economies	-0.299* (0.171)	0.040 (0.026)	0.008 (0.028)	-0.058** (0.027)	0.010 (0.029)

*p-value<0.1, **p-value<0.05, ***p-value<0.01

Table 18

Granger causality tests from VAR Model 2 of average savings rates on real interest rates in advanced economies.

Average Savings Rate	**Average Real Interest Rate**	**H_o: Savings does not cause Interest rates p-value**	**H_o: Interest rate does not cause savings p-value**
East Asian EMs	Advanced Economies	0.022	0.134
Oil Exporting Economies	Advanced Economies	0.037	0.929

Notes:

1. *A p-value less than 0.05 indicates that the null hypothesis of no Granger causality is rejected.*

Table 19

Results from VAR Model 3 of average savings rates weighted by GDP per capita on real interest rates in advanced economies.

Weighted Average Savings Rate	**Average Real Interest Rate**	**Constant**	**Lag 1**	**Lag 2**	**Lag 3**
East Asian EMs	Advanced Economies	-0.443** (0.178)	0.086 (0.060)	0.134** (0.061)	-
Oil Exporting Economies	Advanced Economies	-0.219 (0.157)	0.019* (0.011)	0.002 (0.011)	-0.024** (0.011)

*p-value<0.1, **p-value<0.05, ***p-value<0.01

Table 20

Granger causality tests from VAR Model 3 of average savings rates weighted by GDP per capita on real interest rates in advanced economies.

Weighted Average Savings Rate	Average Real Interest Rate	H_o: Savings does not cause Interest rates p-value	H_o: Interest rate does not cause savings p-value
East Asian EMs	Advanced Economies	0.024	0.052
Oil Exporting Economies	Advanced Economies	0.021	0.932

Notes:

1. *A p-value less than 0.05 indicates that the null hypothesis of no Granger causality is rejected.*

Table 21

Results from diagnostic tests on significant VAR Model 1 of savings rates in East Asia on real interest rates in advanced economies.

		Lagrange-Multiplier Test				Jarque-Bera Test
East Asian EM	**Advanced Economy**	**p-value Lag 1**	**p-value Lag 2**	**p-value Lag 3**	**p-value Lag 4**	**p-value**
Indonesia	Canada	0.541	0.595	-	-	0.333
India	Germany	**0.007**	0.693	-	-	0.293
Malaysia	Germany	0.606	0.431	-	-	0.599
Malaysia	France	0.380	0.432	**0.011**	-	0.889
Malaysia	UK	0.280	-	-	-	0.235
Rep. of Korea	Canada	0.350	0.153	-	-	0.795
Rep. of Korea	France	0.112	0.300	**0.01**	**0.053**	0.724
Thailand	France	0.111	0.342	0.211	0.720	0.847
Singapore	US	0.532	-	-	-	0.956
Singapore	Germany	0.538	-	-	-	**0.006**
Singapore	Italy	0.155	-	-	-	**0.000**
Philippines	France	0.230	0.952	-	-	0.591
Philippines	Italy	0.465	0.328	-	-	0.436
Hong Kong	US	0.493	**0.04**	0.218	0.550	0.533
China	Germany	0.853	-	-	-	0.212

Notes:

1. *For the LM test a p-value less than 0.05 indicates that the null hypothesis of no residual autocorrelation is rejected.*
2. *For the JB test a p-value less than 0.05 indicates that the null hypothesis of normally distributed disturbances is rejected.*

Table 22

Results from diagnostic tests on significant VAR Model 1 of savings rates in oil exporting economies on real interest rates in advanced economies.

		Lagrange-Multiplier Test				Jarque-Bera Test
Oil Exporting Country	**Advanced Economy**	**p-value Lag 1**	**p-value Lag 2**	**p-value Lag 3**	**p-value Lag 4**	**p-value**
Saudi Arabia	France	0.111	-	-	-	0.948
Saudi Arabia	UK	0.246	-	-	-	0.473
Bahrain	Canada	0.360	-	-	-	**0.004**
Bahrain	Italy	**0.001**	-	-	-	0.422
Oman	Canada	0.294	0.714	-	-	0.310
Oman	UK	0.836	0.203	-	-	0.297
Brunei	Canada	0.876	0.247	-	-	0.973
Brunei	Italy	0.748	0.672	-	-	0.406

Notes:

1. *For the LM test a p-value less than 0.05 indicates that the null hypothesis of no residual autocorrelation is rejected.*
2. *For the JB test a p-value less than 0.05 indicates that the null hypothesis of normally distributed disturbances is rejected.*

Table 23

Diagnostic tests from VAR Model 2 of average savings rates on real interest rates in advanced economies.

		Lagrange-Multiplier Test				Jarque-Bera Test
Average Savings Rate	**Average Real Interest Rate**	**p-value Lag 1**	**p-value Lag 2**	**p-value Lag 3**	**p-value Lag 4**	**p-value**
East Asian EMs	Advanced Economies	0.854	0.365	0.432	-	0.661
Oil Exporting Economies	Advanced Economies	0.549	0.342	0.823	0.363	0.975

Notes:

1. *For the LM test a p-value less than 0.05 indicates that the null hypothesis of no residual autocorrelation is rejected.*
2. *For the JB test a p-value less than 0.05 indicates that the null hypothesis of normally distributed disturbances is rejected.*

Table 24

Diagnostic tests from VAR Model 3 of average savings rates weighted by GDP per capita on real interest rates in advanced economies.

		Lagrange-Multiplier Test				Jarque-Bera Test
Weighted Average Savings Rate	**Average Real Interest Rate**	**p-value Lag 1**	**p-value Lag 2**	**p-value Lag 3**	**p-value Lag 4**	**p-value**
East Asian EMs	Advanced Economies	0.693	0.569	-	-	0.275
Oil Exporting Economies	Advanced Economies	0.762	0.458	0.522	-	0.810

Notes:

1. *For the LM test a p-value less than 0.05 indicates that the null hypothesis of no residual autocorrelation is rejected.*
2. *For the JB test a p-value less than 0.05 indicates that the null hypothesis of normally distributed disturbances is rejected.*

Figure 1

Savings Rates of East Asian Emerging Markets

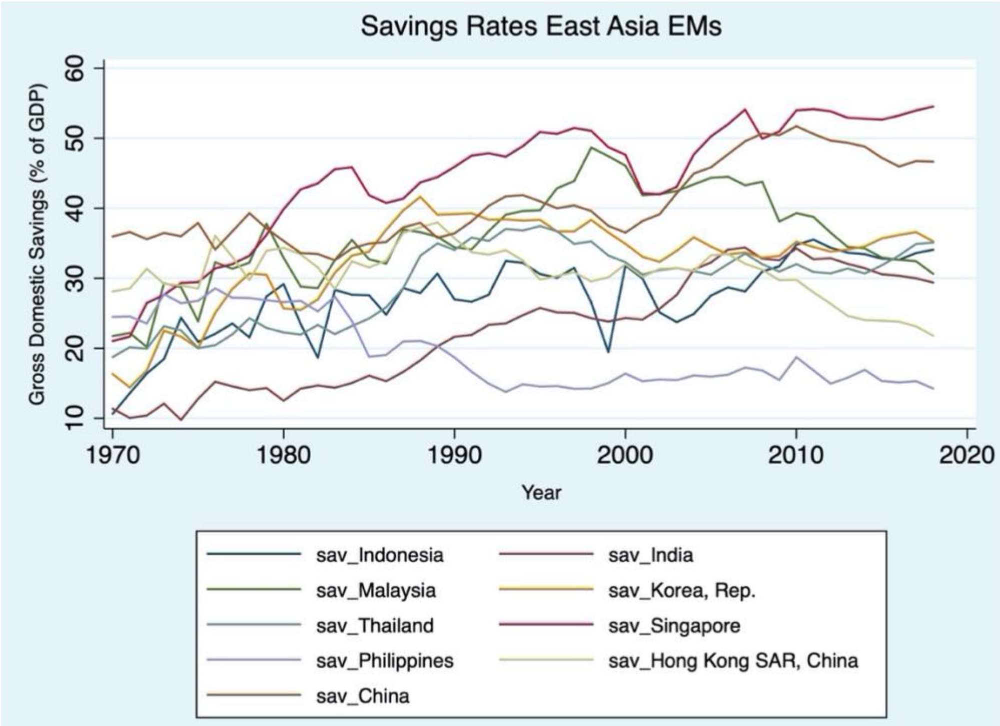


Figure 2

Average Savings Rate of East Asian Emerging Markets

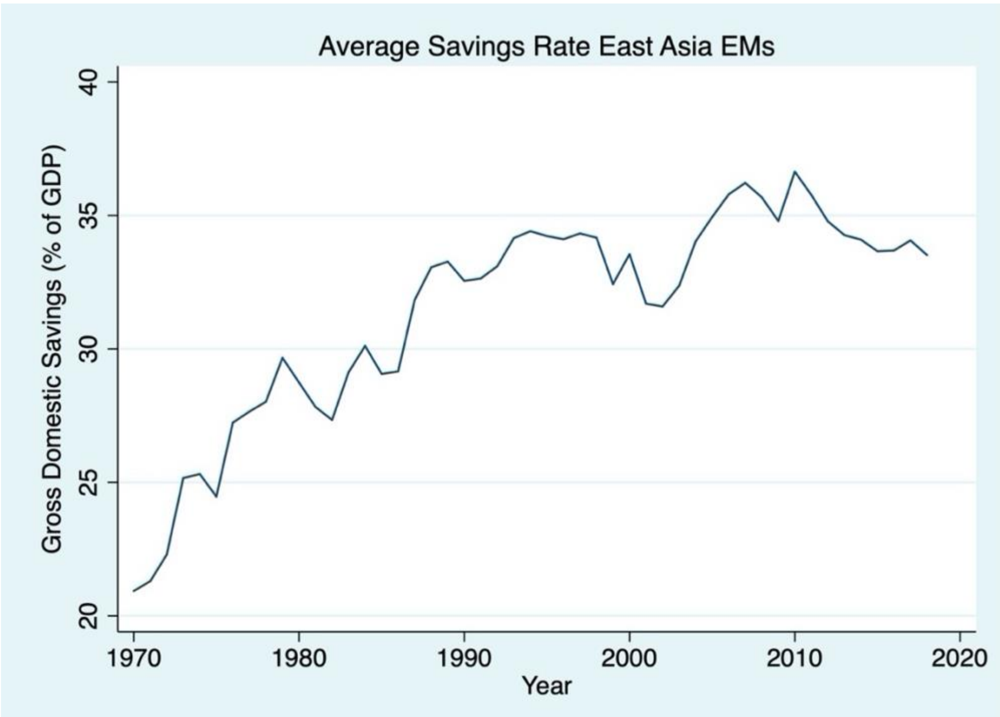


Figure 3

Savings Rates of Oil Exporting Economies

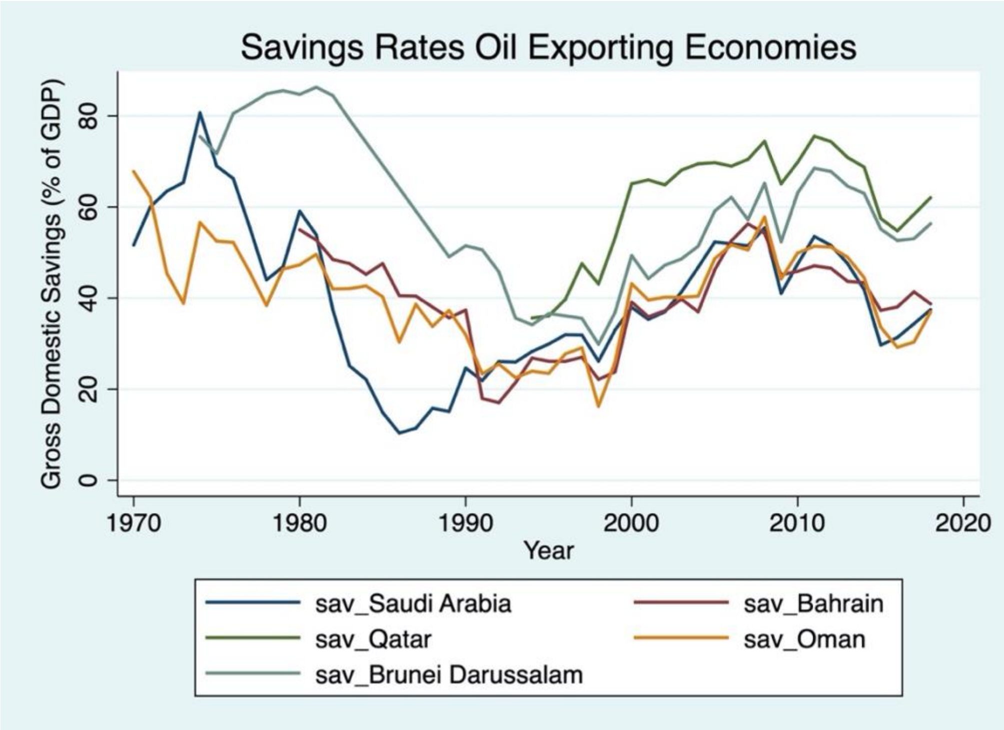


Figure 4

Average Savings Rate of Oil Exporting Economies

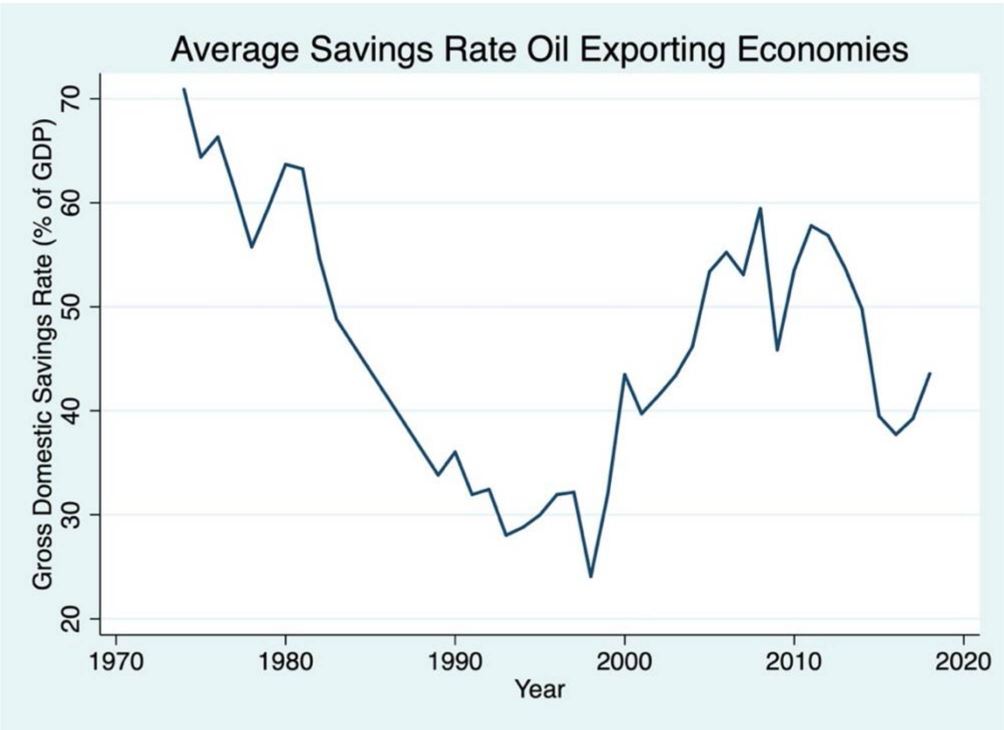


Figure 5

Savings Rates of Advanced Economies

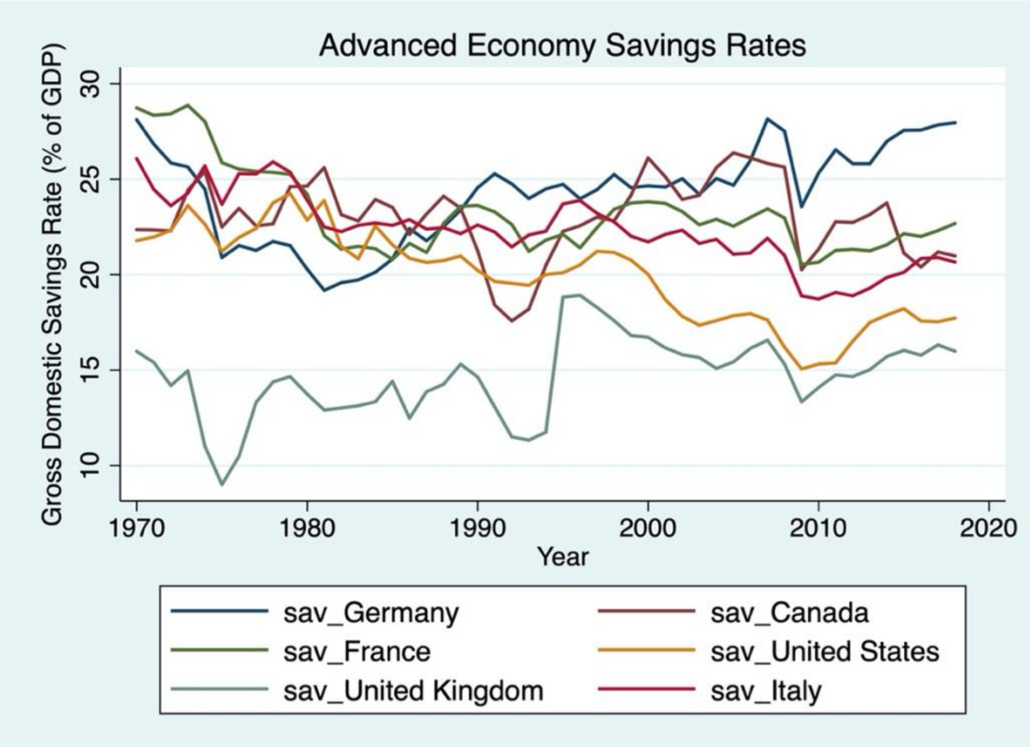


Figure 6

Comparison of Average Savings Rates

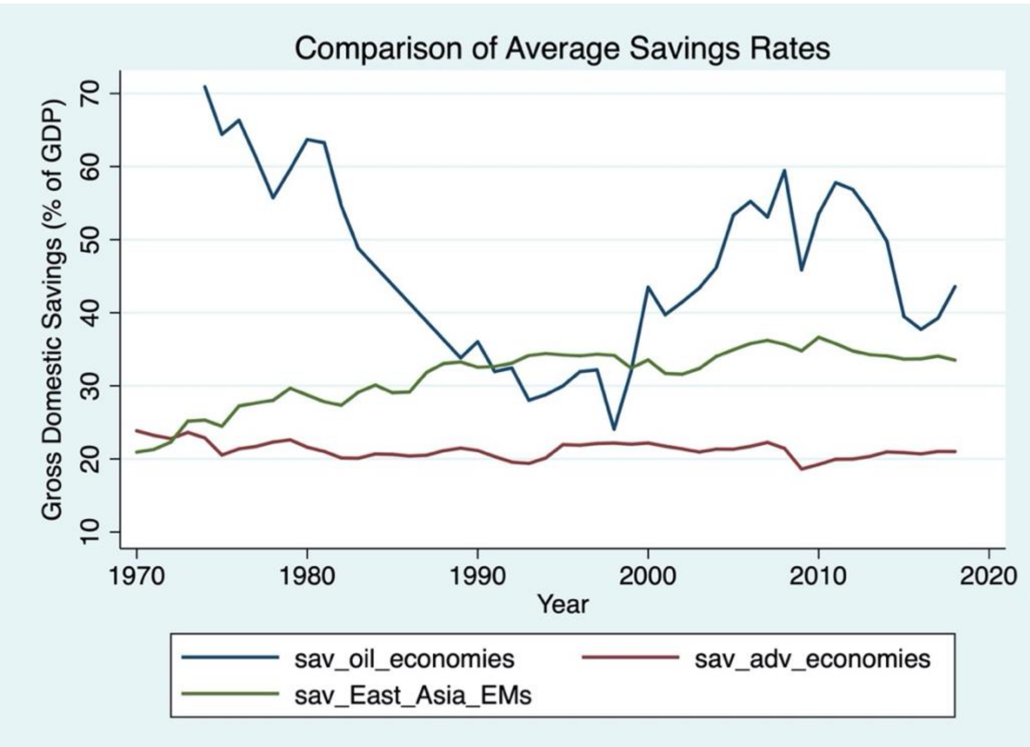


Figure 7

Average real interest rates among advanced economies

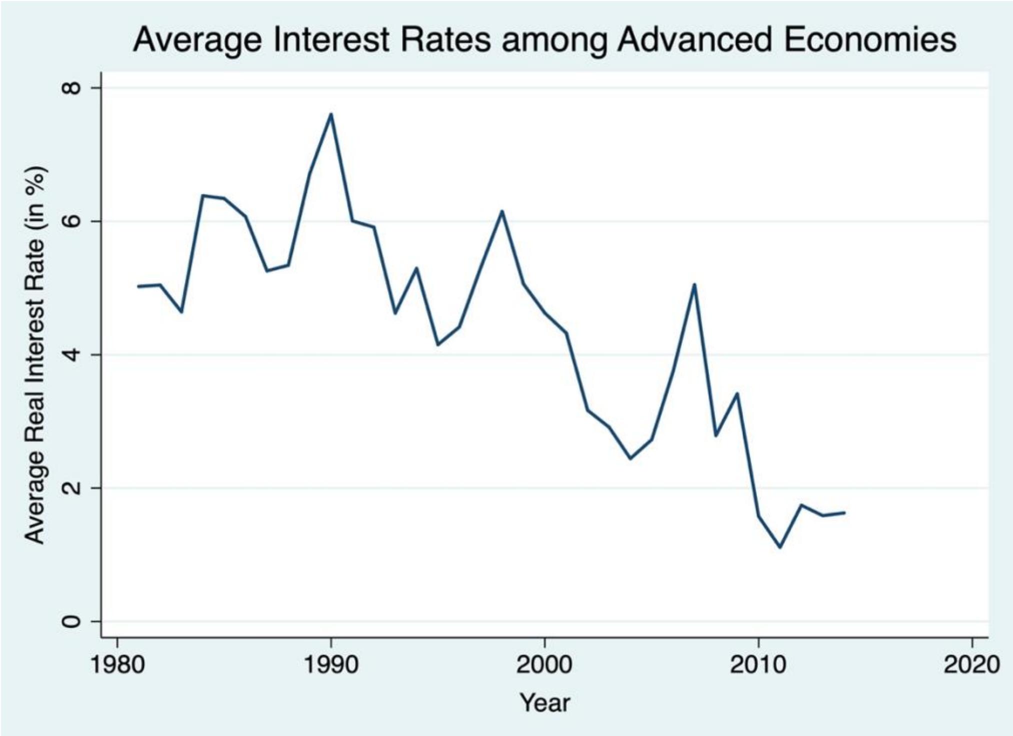


Figure 8

Age dependency ratios among advanced economies

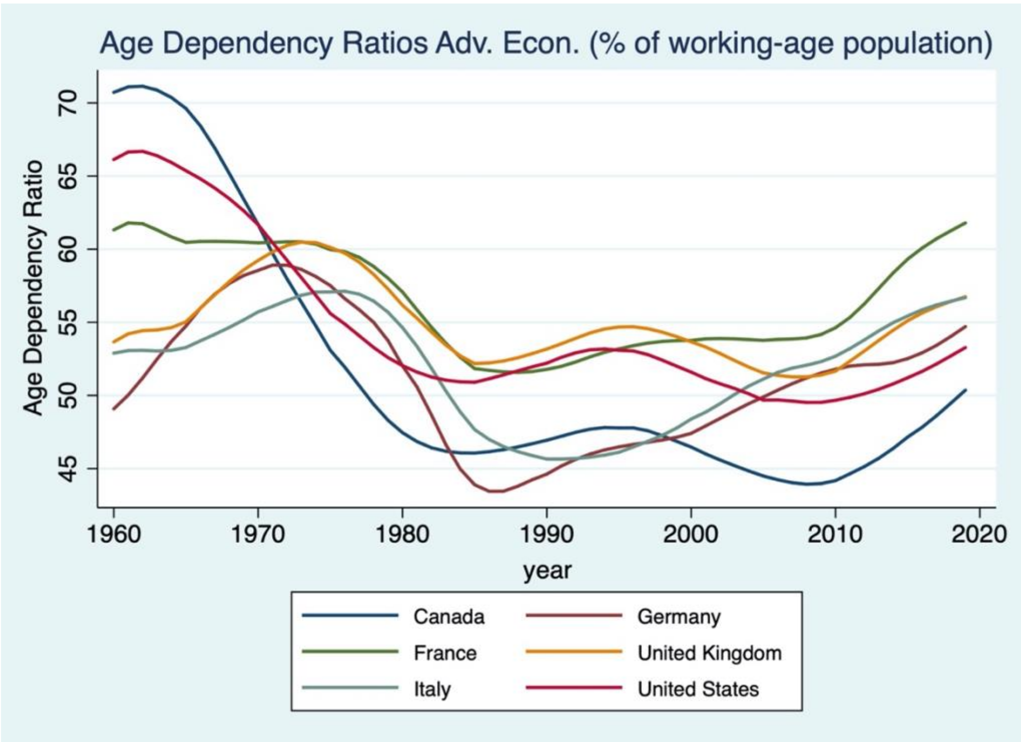


Figure 9

Age dependency ratios among East Asian emerging markets

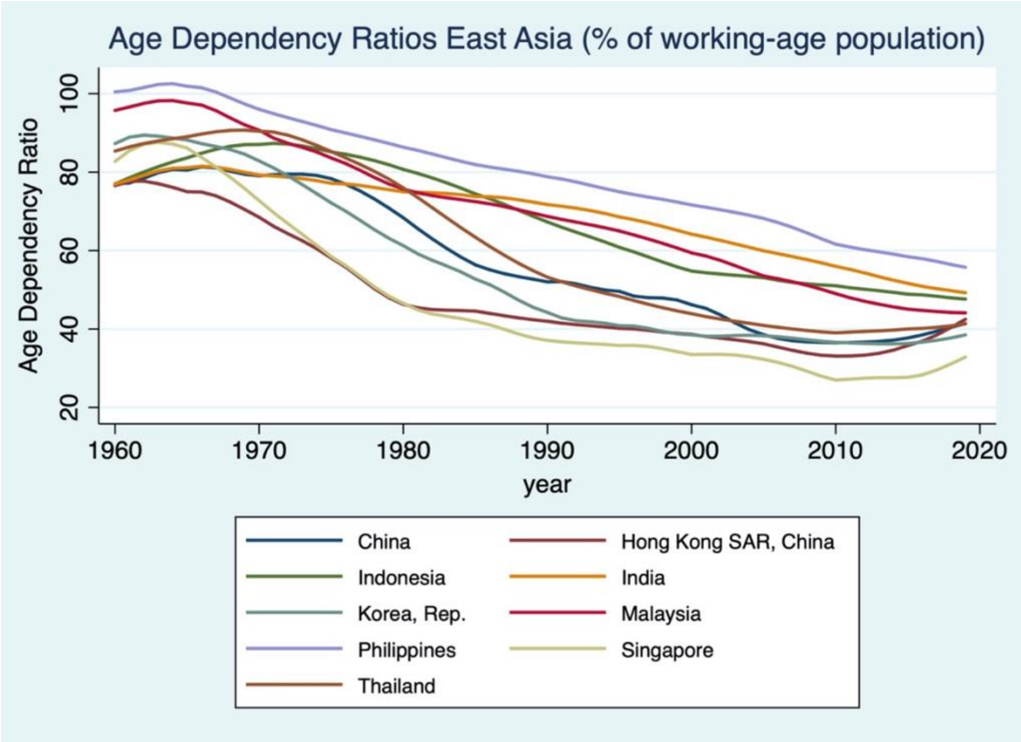


Figure 10

Comparison of average age dependency ratios amongst East Asia and advanced economies

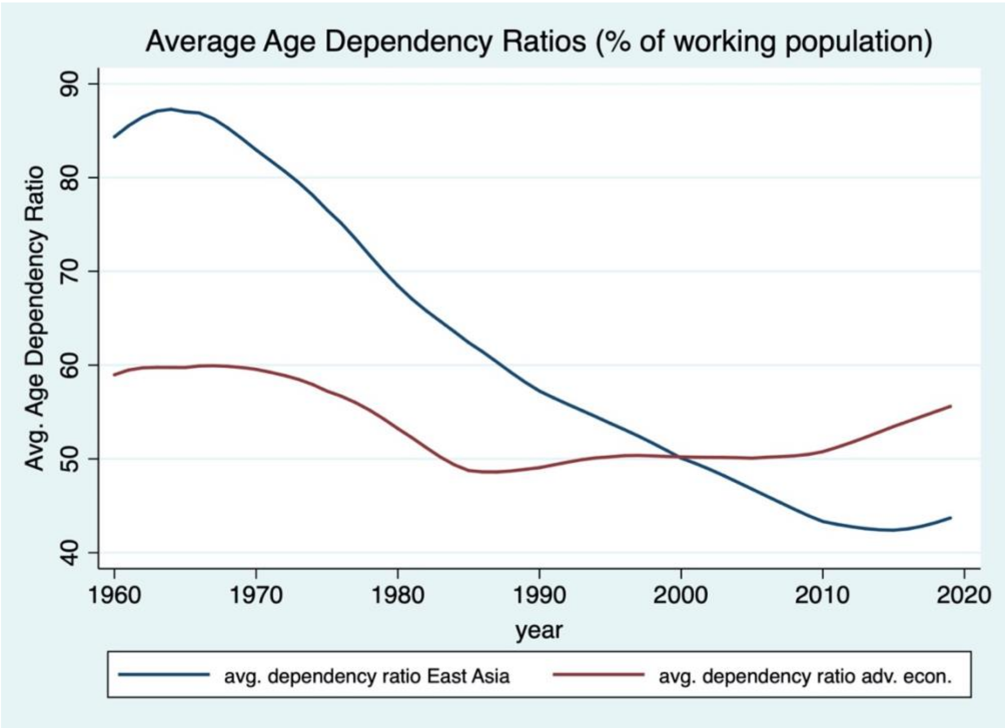


Figure 11

Oil rents as a percentage of GDP

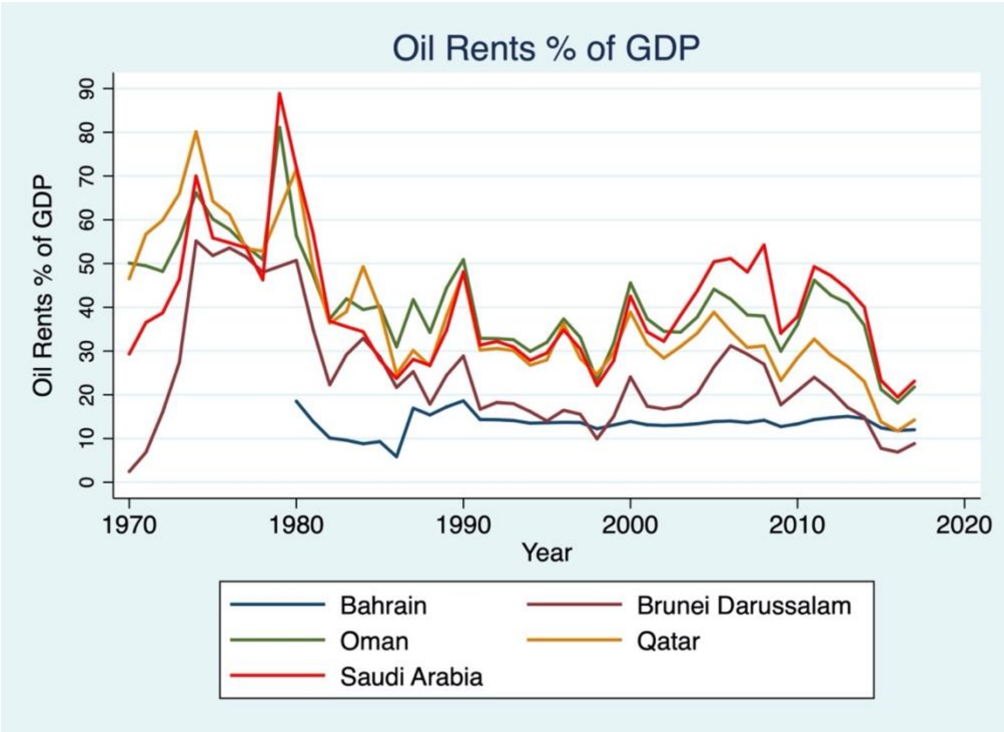


Figure 12

Comparison of oil rents as a % of GDP and savings rates as a % of GDP over time.

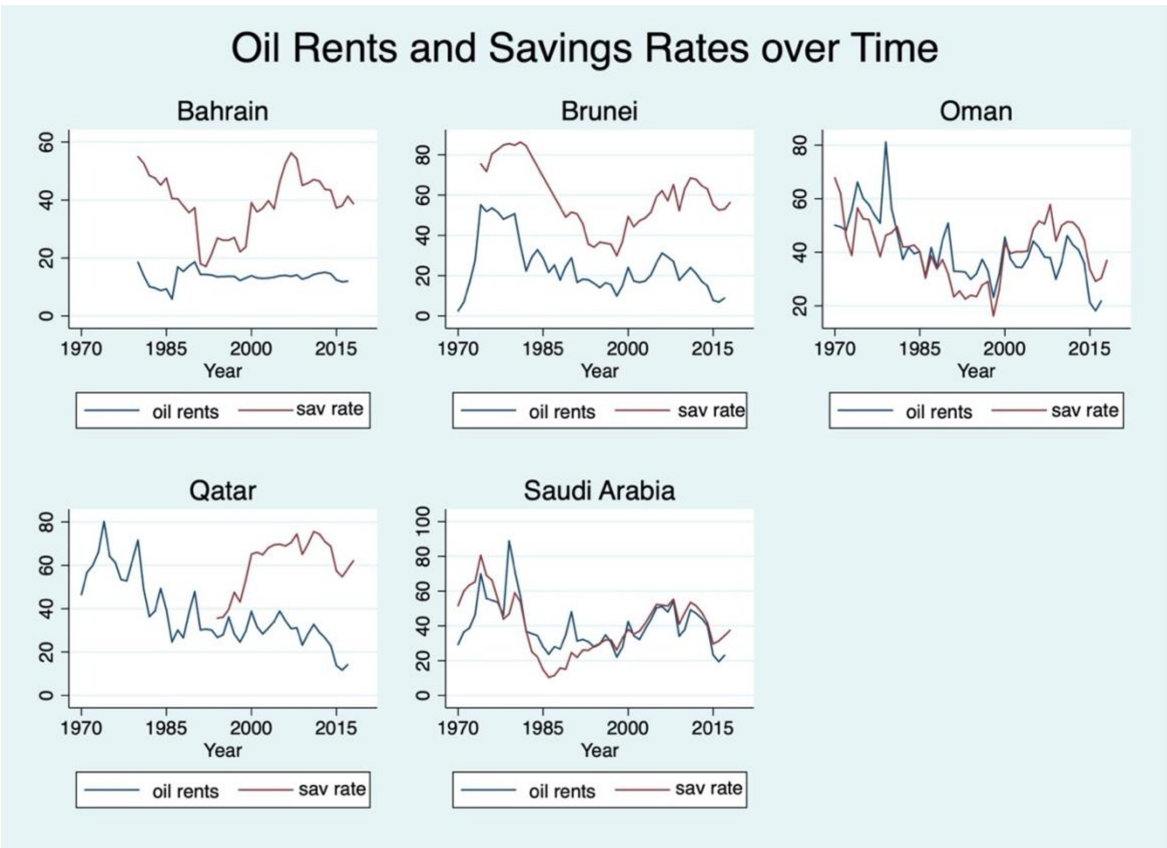


Figure 13

Monthly spot crude oil price measured in U.S. Dollars per barrel

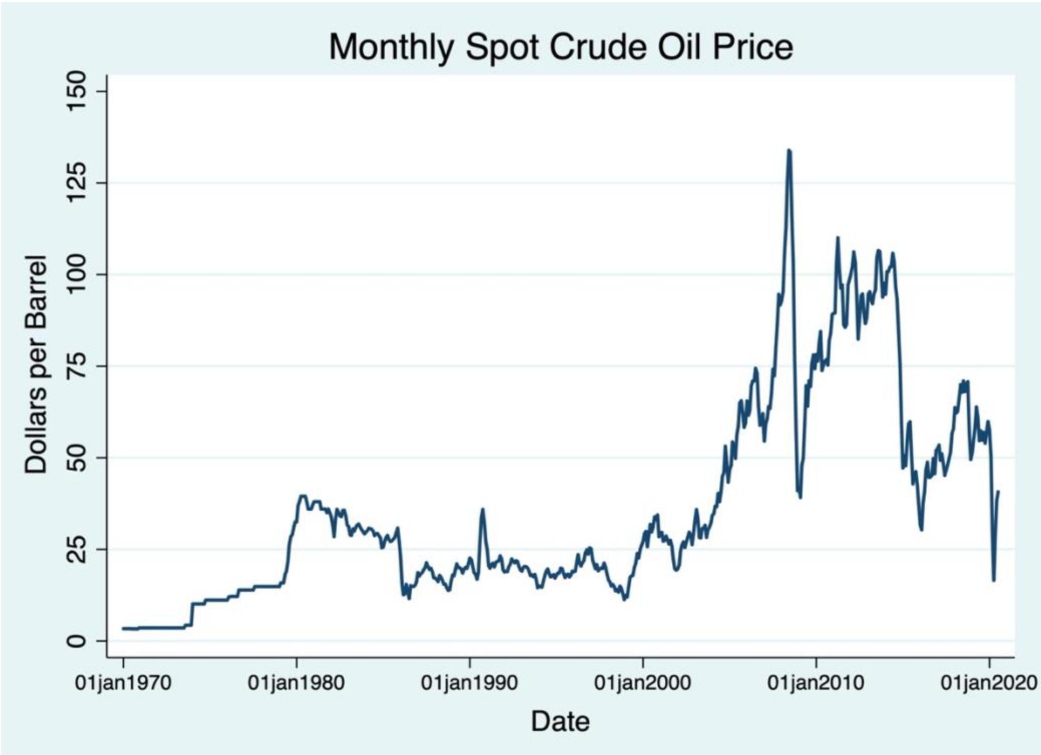


Figure 14

Graph of impulse response function with Hong Kong savings rate as impulse variable and U.S. real interest rate as response variable from model 1

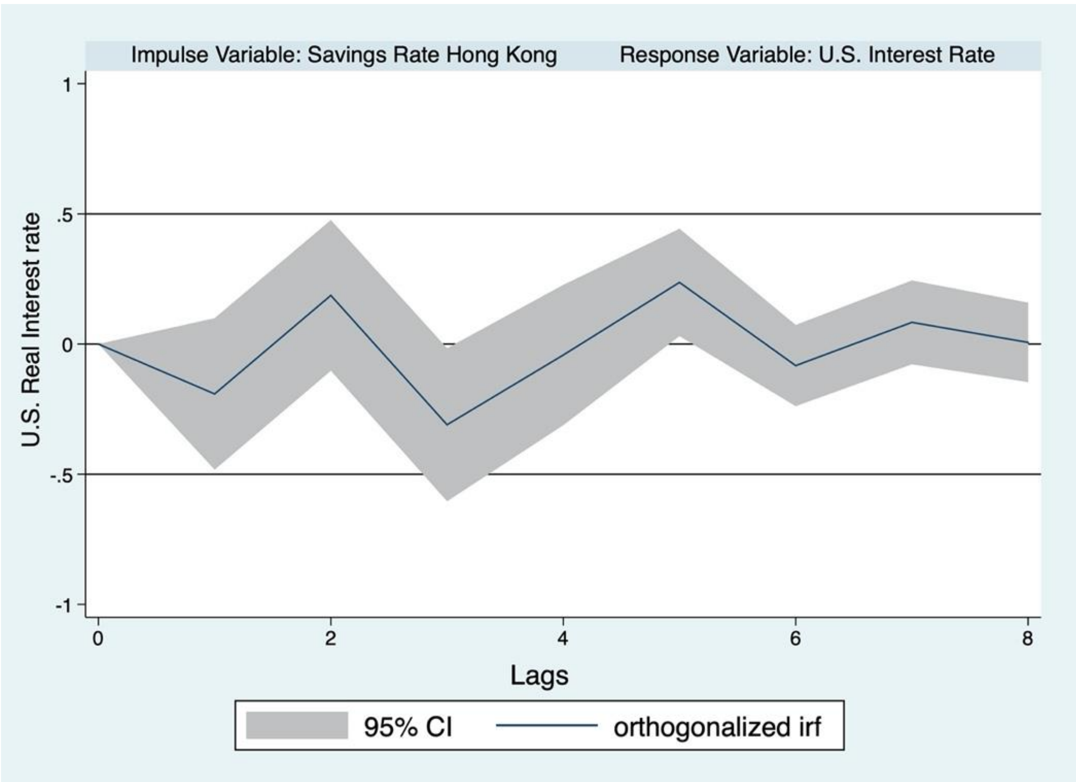


Figure 15

Graph of impulse response function with Omani savings rate as impulse variable and Canadian real interest rate as response variable from model 1

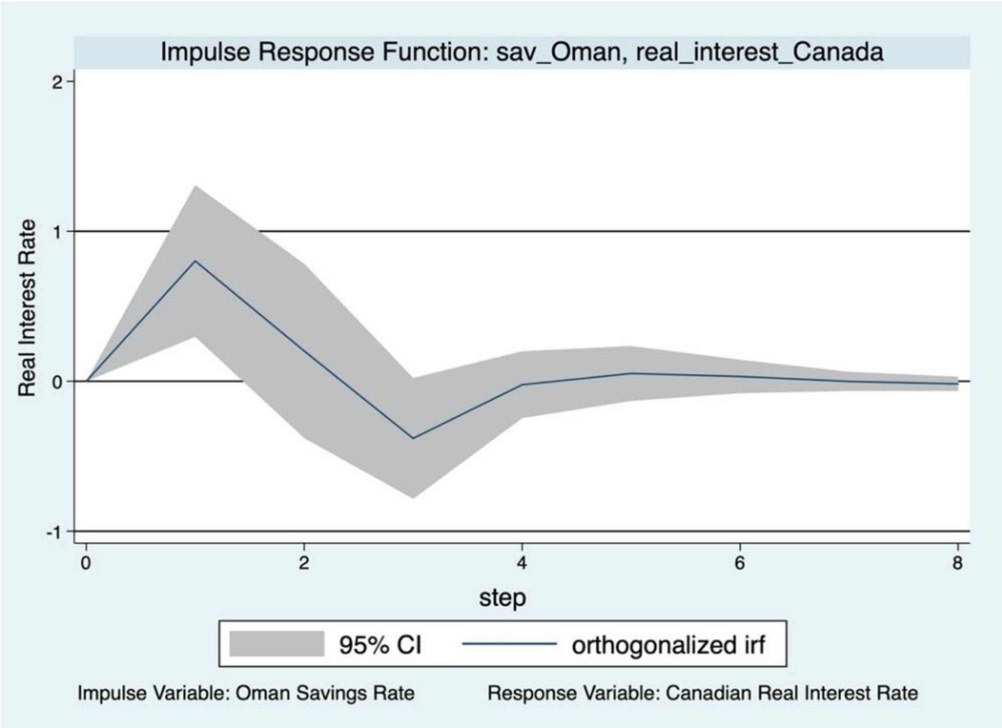


Figure 16

Graph of impulse response function with average East Asian savings as impulse variable and average advanced economy real interest rate as the response variable from model 2

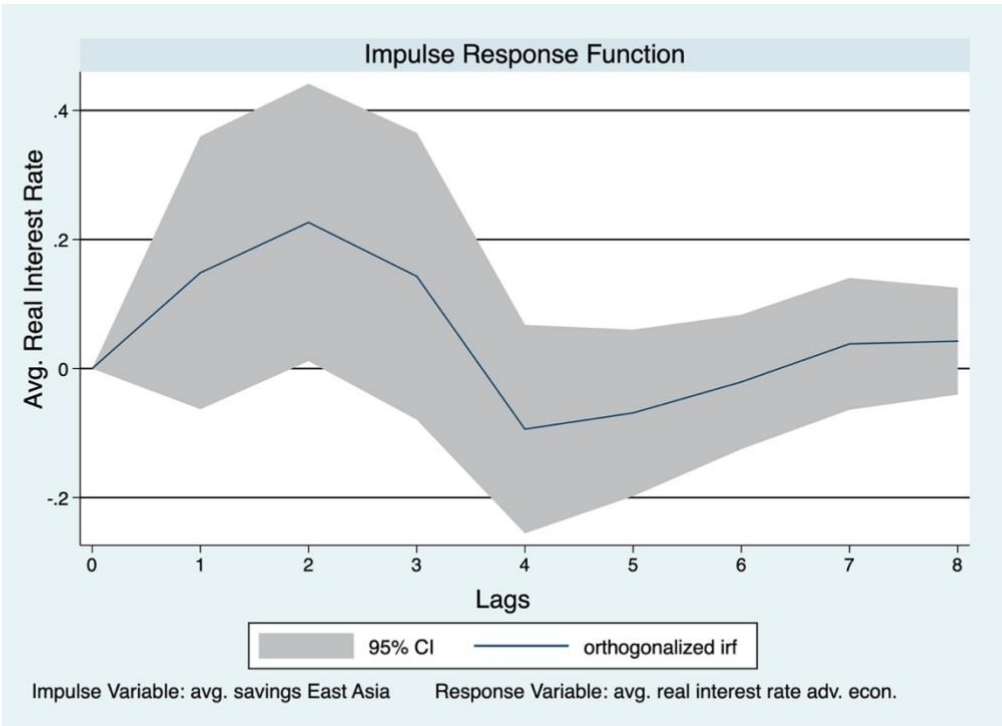


Figure 17

Graph of impulse response function with average oil exporter savings as impulse variable and average advanced economy real interest rate as the response variable from model 2

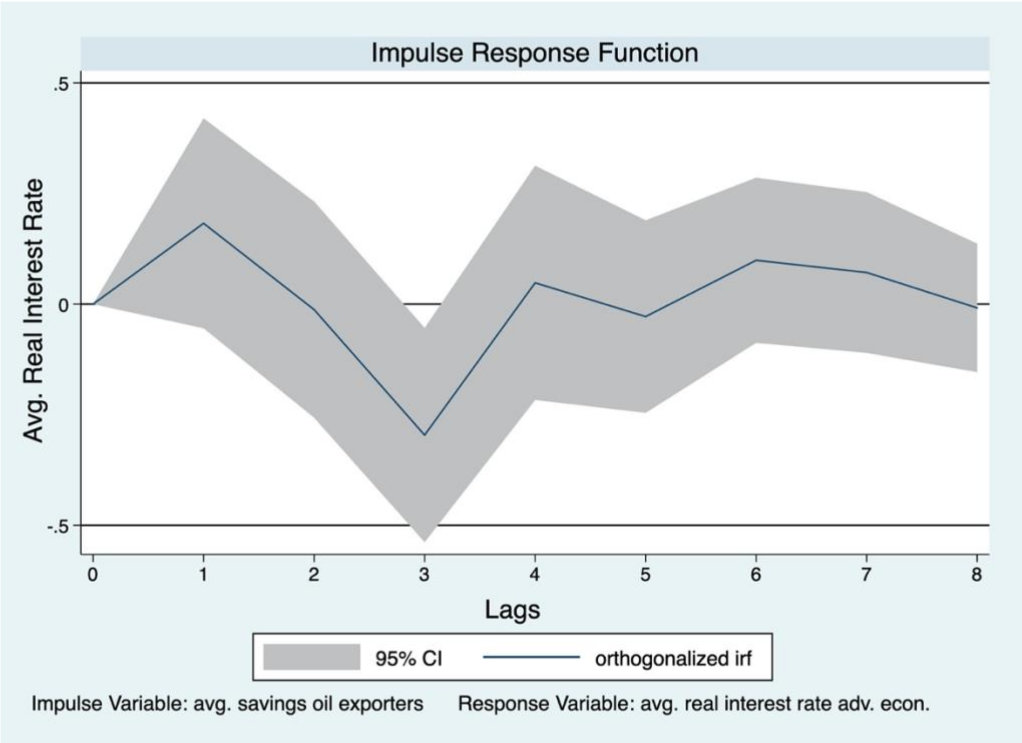


Figure 18

Graph of impulse response function with weighted average East Asian savings as impulse variable and average advanced economy real interest rate as the response variable from model 3

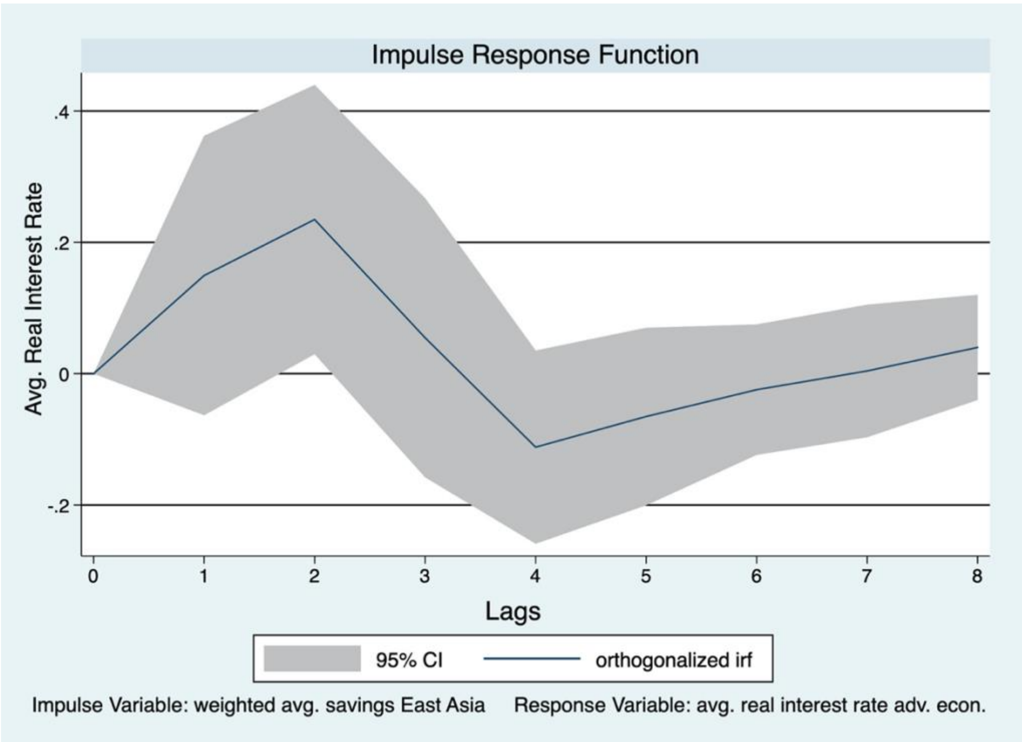
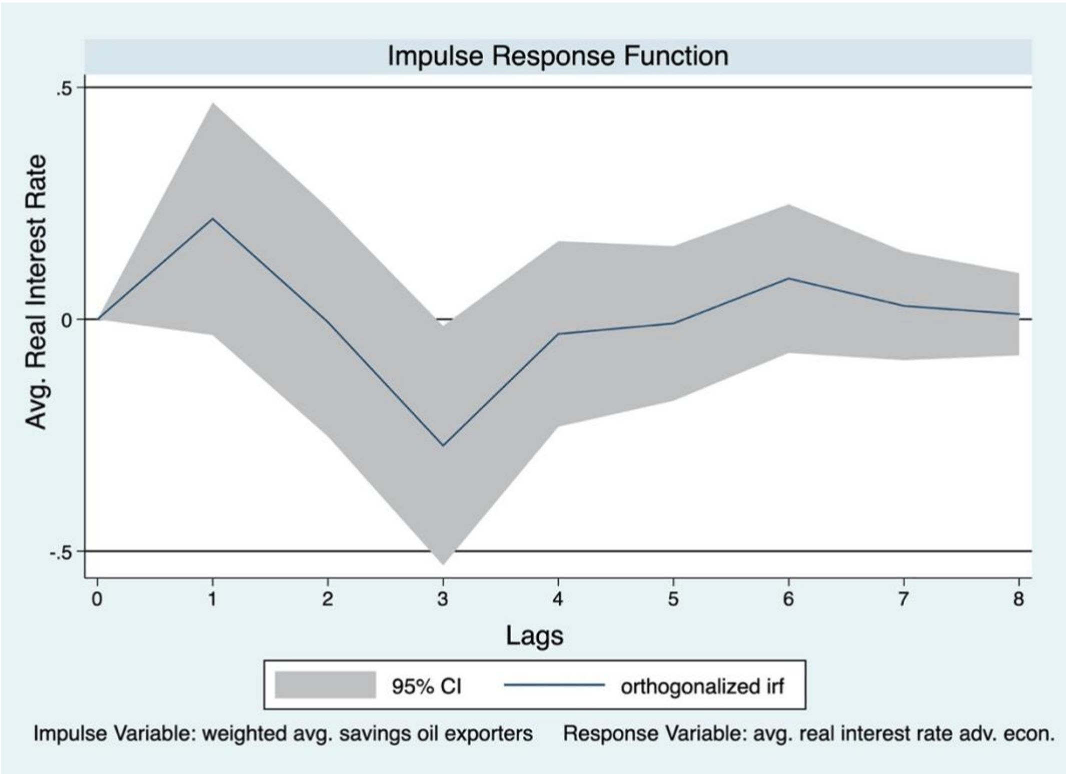


Figure 19

Graph of impulse response function with weighted average oil exporter savings as impulse variable and average advanced economy real interest rate as the response variable from model 3



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