The Hoarding of International Reserves: It's a neighborly day in Asia

Yin-Wong Cheung
XingWang Qian
Eli Remolona

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ABSTRACT

To explain why Asian countries seem to have been hoarding international reserves, especially since the 1997 crisis, we consider various regional neighborhood effects. One such effect is that of "catching up with the Joneses" as documented by Cheung and Qian (2009). We revisit that effect by analyzing several refinements of it. We also consider the fear of the kind of contagion that the crisis-hit countries saw in 1997. Finally, we look at the possibility of a regional financial cycle, in which the conditions that led to the crisis might have been correlated across countries. We find that refining the Joneses effect to take account of trade links strengthens its power to explain the build-up of reserves. We also observe that a country that finds itself more vulnerable than its regional neighbors would tend to accumulate more reserves. Finally, we find that a common regional factor related to current-account balances spurs further reserve accumulation. Contrary to previous analyses, our results suggest that only a couple of Asian countries have been holding excessive reserves. Some were actually holding less reserves than would be optimal in the presence of neighborhood effects.

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Correspondence Addresses:
Yin-Wong Cheung: Hung Hing Ying Chair Professor of International Economics, City University of Hong Kong, yicheung@cityu.edu.hk
XingWang Qian: Associate Professor, SUNY Buffalo State, qianx@buffalostate.edu
Eli Remolona: Chief Representative for Asia and the Pacific, BIS, eli.remolona@bis.org.

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1. Introduction

The Asian financial crisis in 1997 was a momentous event for the region. In the five crisis-hit countries of Indonesia, Malaysia, the Philippines, Thailand and South Korea, the crisis brought to a halt a decade of remarkable growth (e.g., Moreno, Pasadilla and Remolona, 1998). The crisis ensued in July 1997 and the next few months saw capital outflows, currency depreciation and stock market collapse in the crisis countries. Within the year, these countries all found themselves in deep recessions.

One lesson the five countries drew from the crisis was the insurance benefits of adequate reserves. On the eve of the crisis in June 1997, the five held varying levels of international reserves, ranging from 5.9% of GDP for Korea to 24.6% of GDP for Malaysia. In the face of capital outflows, these reserves quickly proved inadequate. Within six months, South Korea had lost 33% of its reserves, the Philippines 23% and Indonesia 18%. Once they had recovered from the crisis, the five countries embarked on an unprecedented accumulation of reserves. In June 1997, the five countries together held reserves amounting to 10.7% of GDP. By December 2006, they had jacked this ratio up to 24.2%. Other countries seem to have drawn the same lesson. The world's total international reserves increased steadily from US$ 1.6 trillion in 1997 to US$ 10.9 trillion in 2015.

Even though both theory and experience suggest that international reserves can reduce the probability of a financial crisis and thus mitigate output loss, they can be costly to hoard (Rodrick, 2006). Hence, there is an optimal level of reserves beyond which the insurance gains no longer justify the costs. However, there is little consensus on what this optimal level is, and determining it remains a challenging task. In much of the literature, the amounts of reserves held by Asian countries are seen as excessive.

The demand for international reserves can be driven by precautionary and non-precautionary motives. The precautionary motive would typically be about being able to cover import financing and external debt payments in the face of changing levels of international reserves (Frenkel, 1974;

Frenkel and Jovanovic, 1981).[1] The Greenspan-Guidotti rule, for example, says that developing economies should hold sufficient international reserves to cover a year of short-term external debt payments (Greenspan, 1999).[2] The precautionary motive has been extended to include the role of reserves as a self-insurance policy to avoid sudden stops, financial instability and crisis-induced output losses.[3] In Krugman's (1979) model of balance-of-payments crises, the money supply plays an important role, in which episodes of capital flight lead investors to exchange their money holdings for dollar reserves held by the central bank. Jeanne and Ranciere (2011) have consolidated all these considerations into a formula for the optimal level of reserves.

In the case of the non-precautionary motive, Dooley, Folkerts-Landau and Garber (2005) argue that for some East Asian economies, reserve accumulation was driven by a mercantilist development strategy. In this view, a development strategy that is based on export-led growth would require an undervalued currency, and this would lead as a by-product to a build-up of reserves. While Dellate and Fouquau (2012) and Bar-Ilan and Marion (2009) find evidence of the mercantilist motive of reserve accumulation, Aizenman and Lee (2007) find that it has little significance in explaining the rise of international reserves in the post-crisis era.

The literature on the precautionary motive explains reserve accumulation as behaviour that depends only on factors specific to the economy in question. This overlooks a salient feature of the 1997 Asian crisis, which is that it was a region-wide phenomenon. An exception to this is Cheung and Qian (2009), who revive the "catching up with the Joneses" effect observed by Machlup (1966). The effect says that a country's demand for international reserves will depend on how much its neighbours hold. In the way Cheung and Qian model the "Joneses effect," an implicit regional rivalry gives rise to a competitive hoarding mechanism, which boosts international reserves to level's not explained by traditional precautionary factors. By maintaining higher reserve levels than its neighbours, a country may avoid being the first one in the region to be

1 Grubel (1971) provides a survey of the pre-1970 studies. Flood and Marion (2002) and Aizenman and Genberg (2012), for example, discuss recent developments.

2 The rule follows from the former Federal Reserve Chairman Alan Greenspan's comments on the former Deputy Minister of Finance of Argentina Pablo Guidotti's insight on the role of external debts.

3 See, for example, Aizenman, et al. (2007), Aizenman, Chinn, and Ito (2010), de Beaufort Wijnholds and Kapteyn (2001), Lee (2004), and Obstfeld, Shambaugh, and Taylor (2010).

attacked by currency speculators and thus give itself time to shore up its defences. Empirical support for such a Joneses effect has now been reported by Aizenman, et al. (2015), Bird and Mandilaras (2010), Cheung and Sengupta (2011), and Pontines and Li (2011).

The regional nature of the 1997 Asian crisis was evidently not lost to the countries themselves. It was apparent that something connected the five countries in the crisis. Whatever that something was recognized to be, it would have affected reserve accumulation behaviour. For one thing, it may have reinforced the Joneses effect. Another connection among the countries would be the contagion they all saw during the crisis. Indeed, Glick and Rose (1999) show that this connection has some bases in fact. The fear of contagion may have led to the build-up in reserves by Asian countries in the period since the crisis, and not just by the five hit by the crisis. Other countries in the region, namely China, India, Japan, Singapore and Taiwan, also built up their reserves aggressively. As a group, the ten economies together accounted for 39% of total global international reserves in 1997 and 59% in 2015. Indeed the importance of the fear of contagion in Asia is demonstrated by the Chiang Mai Initiative Multilateralization (CMIM), a $240 billion group effort by the 13 members of ASEAN+3 to pool their reserves.[4]

In the literature, the actions of these countries are often characterized as excessive hoarding behaviour.[5] But this literature has not taken into account the possibility that these countries were behaving in part to guard themselves against contagion from their neighbours. Indeed, it may also have been the case that a regional financial cycle gave rise to the conditions that led to the crisis. These conditions would have been correlated across countries in the region. A sense of these correlations could also have been what motivated the countries in the region to build-up their reserves so aggressively as a group.

In this paper, we consider various neighborhood effects in an effort to explain why Asian countries have accumulated so much international reserves. One such effect is that of "catching up with the

[4] The European Stability Mechanism (ESM) is an even bigger regional financial assistance mechanism. It has a maximum lending facility of EUR500 billion to assist 19 member states. The difference is that ESM financing does not involve foreign currencies.

[5] See, for example, Aizenman and Marion (2003), Calvo, et al. (2013), Delatte and Fouquau (2012), Gosselin and Parent (2005), International Monetary Fund (2011), Jeanne and Ranciere (2011), and Park and Estrada (2009).

Joneses." This paper revisits that effect by analyzing several refinements of it. These refinements include a quadratic version of the variable to investigate a possible levelling off of the Joneses effect. Other refinements including weighting schemes that take account of economic links between neighboring countries in the region. We also look at the fear of contagion by examining whether measures of the vulnerability of neighboring countries affects a given country's accumulation of reserves. Finally, we investigate the possibility that the conditions that led to the crisis were correlated across countries in a kind of regional financial cycle. We carry out this investigation by extracting common economic factors and analyzing their effects on the accumulation of reserves.

We focus on 10 Asian countries. These include the five that were hit by the Asian crisis and five others that have been identified in the literature as having hoarded reserves excessively. Figure 1 shows the rise in the levels of reserves of these 10 economies. To facilitate comparison, reserves are normalized as ratios to GDP. By this measure, Singapore and Taiwan stand out as the two economies that had been most aggressive in building up their reserves.[6] By 2009, the group as a whole held reserves amounting to 40% of their combined GDP. This ratio has since levelled off but it still was 37% in 2015. Figure 1 suggests that the ratio international reserves to GDP has not been growing without bound; even the bound can be economy-specific. Indeed, with decreasing (net) marginal benefit of holding international reserves, the incentive to follow the Joneses is likely to be diminishing beyond certain level. To assess this behaviour, we consider a quadratic Joneses effect variable. The diminishing marginal effect implies a concave Joneses effect.

We uncover interesting results. We find a significant quadratic Joneses effect, indicating a levelling off of that effect. Moreover, we find that a Joneses variable that is constructed with weights based on trade links outperforms the unweighted version. In considering the fear of contagion, we find that when an economy finds its current-account position to be weak relative to the position of others in the region, it tends to increase its own holdings of international reserves. Finally, we find that a common regional factor related to current-account balances spurs further reserve accumulation. Contrary to previous analysis, our results suggest that only a couple of Asian

[6] High ratios of reserves to GDP are also observed in some non-Asian economies; an extreme case is Switzerland, which had international reserves greater than its GDP in 2016.

countries have been holding excessive reserves. Some were actually holding less reserves than optimal in the presence of neighborhood effects.

2. Empirical results

2.1 Basic Specification

Our empirical exercise is based on annual data from 10 Asian economies, namely China, India, Indonesia, Japan, South Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand. The five economies that were severely affected by the 1997 financial crisis are Indonesia, South Korea, Malaysia, the Philippines, and Thailand. The other five economies escaped the worst of the crisis but they are often identified in the literature as having accumulated an excess of international reserves. The sample period runs from 1980 to 2015.

The demand for international reserves is first investigated using the regression equations

$$Y_{it} = \mathrm{c} + X'_{it-1}\alpha + \delta J_{i,t-1} + \varepsilon_{it}, \qquad (1)$$

where *i* and *t* are the economy and time indexes. Y_{it} is the ratio of international reserves to GDP, and X_{it} is the vector containing the traditional economic determinants of demand for international reserves and crisis dummy variables. Data on international reserves are normalized with GDP to facilitate comparison across economies of different sizes. The economic variables in the X_{it} vector are a) the *per capita* GDP in logarithms, b) the average propensity to import given by the imports to GDP ratio, c) the exchange rate volatility measured by the standard deviation of monthly exchange rate data, d) the volatility of international reserve holding measured by the standard deviation of monthly data on international reserves, and e) the financial openness variable given by the sum of absolute values of capital inflow and outflow divided by GDP.[7]

[7] These canonical determinants are considered in, for example, Lane and Burke (2001), de Beaufort Wijnholds and Kapteyn (2001), Flood and Marion (2002), Aizenman and Marion (2003).

In addition, X_{it} contains the 1997 Asian Financial Crisis and the 2008 Global Financial Crisis dummy variables and their interaction terms with the Joneses variable defined in the next paragraph. Information on the definitions and sources of these variables and those used in the subsequent analyses are given in the data Appendix A.

The keeping-up-with-the-Joneses effect is represented by $J_{i,t}$, which we henceforth call the "Joneses variable" for brevity. Cheung and Qian (2009) elaborates Mrs Machlup'sWardrobe metaphor (Machlup, 1966) for demand for international reserves, and note that the build-up of international reserves depends on the behavior of neighboring economies. Feldstein (1999) and Fischer (1999), for example, acutely point out that economies with a higher level of international reserves survived the East Asian financial crisis better than those with a lower level. Thus, a relatively high level of international reserves may diffuse the speculative pressure and alleviate the cost of an attack on an economy when a financial crisis is developing in the neighborhood. Following Cheung and Qian (2009), we define J_{it} as

$$J_{i,t} = (\text{N-1})^{-1} \sum_{j \neq i} w_{ijt} Y_{jt}, \forall w_{ijt} \equiv 1 \qquad (2)$$

or the average of the international reserves/GDP ratios of all the other economies in the sample; that is, each economy contributes to the Joneses variable with the same weight. Later, we will consider a few alternative formulations of this variable.

The explanatory variables are lagged one period to alleviate potential endogeneity issues. We estimate (1) using the panel data regression technique that includes fixed effects and controls for cross-sectional and AR(1) serial correlation. The results are presented in Table 1.

Consistent with the literature on the precautionary motive for holding reserves, we find the variables representing the propensity to import and the volatility of reserves volatility to be statistically significant with the theoretical correct signs. The more a country tends to import and the more volatile its reserves, the higher the level of reserves it tends to hold.

The Joneses variable is statistically significant in all the representations given in Table 1. An economy's demand for international reserves is positively affected by the reserves held by others in the region. This interdependence is in accord with the Joneses effect reported for Asian economies in previous studies based on alternative sample periods.[8] In the presence of these economic variables and the Joneses variable, the crisis dummy variables and the related interaction terms are insignificant; indicating that the two crisis events do not offer marginal explanatory power.[9] In passing, we note that, the model's explanatory power, as given by the adjusted R^2 estimate, drops from slightly above 65% to 59.5% when the Joneses variable is excluded from the specification.

Figure 1 shows that the holdings of international reserves level off in the latter part of the sample period. To investigate this potential nonlinearity, we consider the following equation for the demand for international reserves:

$$Y_{it} = \mathrm{c} + X'_{it-1}\alpha + \delta J_{i,t-1} + \delta_1 J^2_{i,t-1} + \varepsilon_{it}, \qquad (3)$$

which is equation (1) augmented with a squared Joneses variable. The results from estimating (3) confirm the presence of levelling off effects; in Table 2, the squared Joneses variable is statistically significant with a negative coefficient. The coefficient estimates indicate that, on the average, the Joneses effect is concave – the marginal effect of "the Joneses" is diminishing and, other things equal, an economy's reserves reach maximum when the Joneses are at the level of 0.49 of reserves to GDP ratio. That is, the empirical implicit rivalry motive in international reserves among Asian economies is not constant and it has an upper bound – while the reserve level rises with that of the Joneses', it declines beyond a threshold value of 0.49.

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[8] See, for example, Aizenman, et al. (2015), Bird and Mandilaras (2010), Cheung and Sengupta (2011), and Pontines and Li (2011).

[9] We also considered an alternative dummy variable given by $\mathrm{I}(2009 \leq year \leq 2010)$, and found this dummy variable and its interaction with the Joneses variable are statistically significant. However, the presence of this dummy variable and the interaction term does not materially affect the reported linear and quadratic Joneses effects (and other variables). Further, the turning points of the reserve holdings of these economies usually do not match the periods represented by these dummy variables. Thus, we elected not to include them in the subsequent analyses.

The inclusion of the quadratic Joneses term marginally improves the overall explanatory power as indicated by the adjusted R^2 estimate, but does not materially affect the statistically significance of other right-hand-side variables. Specifically, the propensity to import and the volatility of international reserves retain their significance with similar coefficient estimates while the other variables including the crisis-related variables keep being insignificant. Given their insignificance, we drop these crisis-related variables from the subsequent tables.

In addition to the specifications in Tables 1 and 2, we explored a few other alternatives. For instance, we shortened the sample to the period of 1980 to 2004, the sample period considered in Cheung and Qian (2009). Here the squared Joneses variable is insignificant, although it has a coefficient estimate of similar magnitude. Apparently, the longer sample period allows the data to reveal the significance of the quadratic term. Further, we found that a cubic Joneses variable is insignificant.

Consistent with Krugman (1979), some recent studies viewed the money supply as a proxy for potential capital flight by domestic residents and the potential drain on international reserves (Calvo, 1996; de Beaufort Wijnholds and Kapteyn, 2001; Obstfeld, et al., 2010).[10] To assess the effect of the money supply, we used M2 normalized by GDP. In addition to the money stock variable, we considered the role of the VIX index, which can be interpreted a proxy for a global fear factor that follows a global financial cycle (Rey, 2015). When we added these two variables to (1) and (2), we found that both the normalized money stock variable and the VIX variable are statistically insignificant. These results are presented in Appendix B for easy references.[11] Thus, these two variables are not included in the subsequent analyses.

2.2 Alternative Joneses Variables

2.2.1 Trade-Intensity-Based Joneses Variable

[10] In some earlier studies, the link between international reserves and money is motivated by the monetary interpretation of balance of payments: see, for example, Courchene and Youssef (1967) and Johnson (1958).

[11] Due to data availability, the regressions involving the normal money stock and VIX variables entail have sample sizes different from those in Tables 1 and 2.

The Joneses variable in the previous subsection implicitly assumes the international reserve holdings of neighboring economies have the same effect on the targeted economy. The formulation ignores the possibility that the interdependence of hoarding behavior can be affected by the strength of economic tie between economies. For instance, trade is conceived a main conduit for financial contagion (Forbes, 2004; Glick and Rose, 1999). If an economy has a close trade tie with a neighbor, it shall assign a high weight to this neighbor in forming its Joneses variable. In view of this, we construct a trade-intensity-based Joneses variable, $J_{i,t}^{T}$

$$J_{i,t}^{T} = \sum_{j \neq i} w_{ijt} Y_{jt}, \; w_{ijt} \equiv (\text{Trade Intensity})_{ij,t} / \sum_{j \neq i} (\text{Trade Intensity})_{ij,t}, \qquad (4)$$

where $(\text{Trade Intensity})_{ij,t}$ is the trade intensity between economies i and j, and is given by their trade volume (sum of imports and exports, $(\text{imports} + \text{exports})_{ij,t}$) normalized by their GDPs ($GDP_{i,t} + GDP_{j,t}$). That is, the higher the relative trade intensity, the larger contribution to the Joneses variables, and a bigger influence on reserves hoarding behavior.

The estimation of equation (3) with the trade-intensity-based Joneses variable, $J_{i,t}^{T}$, in place of $J_{i,t}$ is presented under column [1] of Table 3. Both the level and square of the trade-intensity-based Joneses variable are significant. Again the negative quadratic form implies a concave Joneses effect that reaches a maximum when the Joneses variable has a value of 0.66. Comparing to the results in Table 2, the interdependent hoarding behavior, when trade interactions are taken into consideration, is more prominent and the marginal rate of Joneses effect is more persistent (the rate of diminish is -0.16 v.s. -0.29); thus, it takes a larger Joneses variable to realize the maximal reserves level. In addition, the use of the trade-intensity-based Joneses variable offers a slightly better explanatory power (column [1] of Table 2).

2.2.2 Contagion

In contemplating its reaction to its neighbor's hoarding behavior, an economy is likely to assign a high weight to a neighbor who is prone to a crisis. Since worsening current account balance, increasing debt burden, and excessively loose monetary conditions are warnings of a crisis, we

construct three alternative Joneses variables incorporating these factors separately. Specifically, these Joneses variables are given by

$$J^{CA}_{i,t} = \sum_{j \neq i} w_{ijt} Y_{jt}, \; w_{ijt} \equiv (1+\text{CAB}_{j,t}/\text{GDP}_{j,t})^{-1} / \sum_{j \neq i} (1+\text{CAB}_{j,t}/\text{GDP}_{j,t})^{-1} \quad (5)$$

$$J^{D}_{i,t} = \sum_{j \neq i} w_{ijt} Y_{jt}, \; w_{ijt} \equiv [(\text{Debt}_{j,t} + \text{OI}_{j,t})/\text{GDP}_{j,t}] / \sum_{j \neq i} (\text{Debt}_{j,t} + \text{OI}_{j,t})/\text{GDP}_{j,t} \quad (6)$$

and

$$J^{M}_{i,t} = \sum_{j \neq i} w_{ijt} Y_{jt}, \; w_{ijt} \equiv [\text{M2}_{j,t}/\text{GDP}_{j,t}] / \sum_{j \neq i} \text{M2}_{j,t}/\text{GDP}_{j,t} \quad (7)$$

where CAB is the current account balance, the debt variable comprises the stock of portfolio debt liability (Debt) and the stock of other investment liability (OI),[12] and M2 is the broad money supply figure. In essence, these alternative Joneses variables assign a larger weight to a neighbor economy that is more prone to a crisis as signaled by one of these indicators. The variable $J^{CA}_{i,t}$ assigns a larger weight to a neighbor who has a worse current account, $J^{D}_{i,t}$ to a neighbor who is deeper in debts, and $J^{M}_{i,t}$ to a neighbor who has a higher level of money supply.

Columns [2], [3], and [4] present the results of estimating (3) with these three alternative Joneses variables. Note that data for constructing the weights are not available for all the economies in all time periods. The results show that these Joneses variables themselves are individually significant but their squared terms are not. The use of these alternative Joneses variables does not qualitatively change the coefficient estimates of other right-hand-side variables.

In comparing the results in Table 3, we recognize that these four variants of Joneses variables ($J^{T}_{i,t}$, $J^{CA}_{i,t}$, $J^{D}_{i,t}$, $J^{M}_{i,t}$) are quite closely related. Their correlation coefficient estimates are in the range of 0.88 to 0.99; indicating that they tend to move in tandem (Appendix C). Including them in the same regression, thus, suffers the multicollinearity problem that leads to inappropriate

12 See Lane and Milessi-Ferretti (2007).

inferences. Taking both statistical and economic considerations into account, we opt to stick with the trade-intensity-based Joneses variable, $J_{i,t}^{T}$, in the subsequent analyses.[13, 14]

2.3 Relative vulnerability

Economies with weak international positions are vulnerable to speculative attack that can lead to a crisis. Relative to neighboring economies, the likelihood of getting an attack is high for a weak economy. At the same time, speculators are more likely to attack an economy that has less ability to defend itself. International reserves are a recognized ammunition that can fend off the impacts of speculative attack and adverse capital flows, and the level of international reserve holding is a barometer of an economy's ability to defend. Thus, it is plausible that a weak economy mitigates the chance of a crisis with a high level of international reserves. In view of this, we stipulate that, say, when an economy's current account position is worse than its neighbors, it is more vulnerable to speculative attack, consequently a crisis, and it tends to increase its hoarding of international reserves to reduce the odd. To account for this effect, we include a relative current account balance variable to the empirical demand for international reserve equation:

$$Y_{it} = \mathrm{c} + X_{it-1}^{'}\,\alpha + \delta\, J_{i,t-1}^{T} + \delta_1\, J_{i,t-1}^{T2} + \beta\, R_{i,t-1}^{CA} + \varepsilon_{it}\,, \tag{8}$$

and

$$R_{i,t}^{CA} = (1+\text{average}[\text{CAB}_{j\neq i,t}/\text{GDP}_{j\neq i,t}])/\,(1+\text{CAB}_{i,t}/\text{GDP}_{i,t}), \tag{9}$$

where average[.] is the average operator. A large value of the $R_{i,t}^{CA}$ ratio implies economy i's current account position is relatively weak.

The marginal effect of relative current account balance variable is given under column [1] of Table 4. The relative current account balance variable is statistically significant with the expected

[13] Our choice is mainly based on the observation that trade activity is the main conduit of shock propagation and the transmission of crisis (Forbes, 2004). Also, the adjusted r-squares estimates in Table 3 are not directly comparable because these regression equations have different numbers of observations.

[14] When the Joneses variable is defined by the economy with either the lowest CAB/GDP ratio or the highest M2/GDP ratio, the results are qualitatively similar to those in Table 3, but with smaller adjusted R^2 estimates. The regression with the Joneses variable defined by the economy with the highest DEBT/GDP ratio yields an insignificant Joneses effect and a smaller adjusted R^2 estimate. These results are available upon request.

positive sign, though the improvement in overall explanatory power is quite small. Besides current account balance, the external debt level and the monetary conditions are the other two indicators the market considers. Along a similar vein, we devise the relative debt and relative money supply ratios

$$R^{D}_{i,t} = \text{average}[(\text{Debt}_{j\neq i,t} + \text{OI}_{j\neq i,t})/\text{GDP}_{j\neq i,t}]/[(\text{Debt}_{i,t} + \text{OI}_{i,t})/\text{GDP}_{i,t}], \quad (10)$$

and

$$R^{M}_{i,t} = \text{average}[\text{M2}_{j\neq i,t}/\text{GDP}_{j\neq i,t}]/(\text{M2}_{i,t}/\text{GDP}_{i,t}). \quad (11)$$

The smaller the $R^{D}_{i,t}$ (or $R^{M}_{i,t}$) the more likely the economy is susceptible to a crisis. The results of estimating (8) with $R^{CA}_{i,t}$ replaced with either $R^{D}_{i,t}$ or $R^{M}_{i,t}$ are presented in Table 4 under columns [2] and [3], separately. Either $R^{D}_{i,t}$ or $R^{M}_{i,t}$ garners a negative coefficient estimate; the economy tends to increase its holding of international reserves when it is more prone to crisis. Nevertheless, neither effect is statistically significant.

Among the three indicators, only the relative current account balance displays a statistically impact on the hoarding of international reserves.[15]

In passing, we note that the notions of trade-intensity-based Joneses, contagion, and relative vulnerability are derived from the economic variables, say, trade and money supply, which are closely related to the usual perceived effects of precautionary motive and financial stability on hoarding of international reserves. In addition to the direct effects of these economic factors, our exercise considers these factors relative to other economies, and assesses the marginal effects of these relative factors on international reserve hoarding behavior (via the Joneses channel). In some sense, we include a relative perspective of these economic factors in analyzing hoarding of international reserves.

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[15] We considered an alternative version of $R^{CA}_{i,t}$, $R^{D}_{i,t}$ and $R^{M}_{i,t}$ that are based on minimum CAB/GDP, maximum debt/GDP, and maximum M2/GDP rather than the averages. These alternative variables do not improve the regression results and, thus, not discussed here. These results are available upon request.

2.4 Common economic factors

Rey (2015) has argued for a global financial cycle, in which capital flows, asset prices and credit growth move together. This cycle is not necessarily aligned with country-specific macroeconomic conditions. Could a common economic cycle at the regional level drive the international reserve hoarding behavior of an economy?[16] And, if it does, will it affect the Joneses effect? To answer these questions, we extract economic factors that countries in the region have in common and see whether these factors can help explain reserve accumulation. We add these factors to our Joneses equation:

$$Y_{it} = \mathrm{c} + X'_{it-1}\,\alpha + \delta\, J^{T}_{i,t-1} + \delta_1\, J^{T2}_{i,t-1} + \gamma\, CF_{i,t-1} + \varepsilon_{it}, \qquad (12)$$

where $CF_{i,t-1}$ is a common economic factor. For that common factor, we consider either a common economic growth variable ($CF^{G}_{i,t-1}$), a common current account balance variable ($CF^{CA}_{i,t-1}$), or a common financial account balance variable ($CF^{F}_{i,t-1}$).[17]

Results in Table 5 show that the common current account balance variable ($CF^{CA}_{i,t-1}$) is the only statistically significant common economic factor. It improves slightly the overall explanatory power with a positive impact on the holding of international reserves, but does not materially affect the significance of other variables; especially the Joneses variables. That is, the observed Joneses effect is unlikely a proxy for the significant common current account balance effect, which may be related to a common mercantilist incentive factor.

To round up the results we have had so far, we present in Table 6 the regression results based on significant explanatory variables in Tables 4 and 5. Besides the two traditional economic and two Joneses variables, the hoarding of international reserves is affected by the relative current account

[16] The use of VIX as a proxy for the global financial cycle is discussed at the end of the Section 2.1.

[17] For each economic variable, the first (largest) principal component of data from the 10 economies is taken as the proxy of the common factor.

position and the common current account balance. Apparently, the relative current account position and the common current account balance represent different components of the information on current account balances. Indeed, they have a relative small correlation coefficient estimate of 0.15. The significance of these two variables is unlikely attributed to their comovement pattern, if any. It is also of interest to note that these two current account related variables, though statistically significant, only very marginally enhance the overall explanatory power indicated by the adjusted R^2 estimate.

3. Additional Analysis

After considering a few other ways to specify the Joneses variables, we assess the explanatory power of Joneses variables relative to other determining factors, and compare our model's (in-sample) predictions with the corresponding ones offered by the International Monetary Fund (IMF).

As noted earlier, our sample of economies are heterogeneous. Specifically, five economies, namely, Indonesia, Korea, Malaysia, the Philippines, and Thailand were severely inflicted during 1997 Financial Crisis. The other five economies, on the other hand, are in general considered less crisis-prone. For convenience, and without any prejudicial connotation, we label the former group the weak-five and the latter one the strong-five.

In Table 7, we assess the Joneses effect when the Joneses variable is derived from international reserves held by the weak-five or the strong-five. Specifically, the weak-five Joneses variable is given by

$$J_{i,t}^{T,W} = \sum_{j=Indonesia,\ Korea,\ Malaysia,\ Philippines,\ Thailand} w_{ijt} Y_{jt}, \qquad (13)$$

and the weights w_{ijt}'s are given by the relative trade intensity as defined in (4). If economy j is one of these five economies, the Joneses variable is defined by the international reserves of the other four economies. The strong-five Joneses variable $J_{i,t}^{T,S}$ is defined in a similar manner.

If we focus only on its linear effects, the choice of a weak-five or the strong-five Joneses variables give qualitatively similar Joneses effects (Column [1]'s under "weak-five" and "strong-five,"

Table 7). The situation is a bit different if quadratic effects are allowed for. Only $J_{i,t}^{T,S}$, but not $J_{i,t}^{T,W}$ gives statistically significant quadratic Joneses effect (Column [2]'s, Table 7). That is, the nonlinear Joneses effects in the previous tables are likely driven by the strong-five element of the Joneses variable. Compared with the weak-five Joneses variables, the adjusted R^2 estimates indicate the strong-five Joneses variable better explains the hoarding of international reserves. The difference in performance deserve further investigation, which is beyond the scope of the current study.[18] Nevertheless, it is noted that the performance of the specification that includes the strong-five Joneses variable is no better than the corresponding specification in Table 3 (Column [1]). That is, the information contents of the weak-five and strong-five do not overlap completely; including both groups in the Joneses variable enhances the explanatory power.

Next, we consider a Joneses variable that incorporates the notion of a common lender effect (a measurement proxy for regional financial cycle), which describes a crisis transmission mechanism via bank lending. The effect amplifies contagion because economies are likely to experience a credit squeeze when the common lender they share with a crisis-inflicted economy scales back and withdraws its lending in face of crisis-related losses.[19] To capture the common lender effect, we construct the Joneses variable, $J_i^{T,CL}$,

$$J_{i,t}^{T,CL} = \sum_{j \neq i} w_{ijt} Y_{jt}, \; w_{ijt} \equiv \mathrm{B3_{jt}/TL3_t}, \tag{14}$$

where $\mathrm{B3_{jt}}$ is economy j's borrowings from top 3 foreign bank lenders in the region and $\mathrm{TL3_t}$ the total lending of top 3 foreign banks to these ten economies.[20] The borrowing and lending data are from the Bank for International Settlements.[21]

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[18] One possible reason, though we do not have a strong view, is that deviations from these less crisis-prone economies can be seen as a barometer of vulnerability.

[19] See, for example, Van Rijckeghem and Weder (2001; 2003).

[20] These three top foreign banks, in the period of 1983 to 2015, accounted for an average of 45% of annual total lending to the ten Asian economies in our sample.

[21] It is pointed out that BIS international bank lending data and liabilities data (debt + OI) may be inter-related. For the current exercise, the variables derived from these two data series – which are heterogeneous across economies – are constructed with different principles. Indeed, these two variables have a correlation coefficient estimate of 10.5%; indicating that they are quite dis-similar. The effects of these two variables captures different, rather than same, economic forces.

The results pertaining to the common lender Joneses effect are presented in Table 8. There is only limited empirical evidence on the relevance of $J_{i,t}^{T,CL}$ – the linear term is only marginally significant (with a p-value of 10.8%) in the presence of the quadratic term. The adjusted R^2 estimates in Table 8, at the same time, indicate the specifications with the common lender Joneses variables do not perform better than other forms of Joneses variables.

To what extent does the Joneses variable explain the observed level of international reserves? To shed some light on this question, we consider specification (3) in Table 6, and re-write as

$$Y_{it} = \hat{c} + X_{it-1}^{'} \hat{\alpha} + \hat{\delta} J_{i,t-1}^{T} + \widehat{\delta_1} J_{i,t-1}^{T2} + \hat{\beta} R_{i,t-1}^{CA} + \hat{\gamma} CF_{i,t-1}^{CA} + \widehat{\varepsilon_{i,t}}, \qquad (15)$$

where "$\widehat{\ }$" indicates an estimate. Note that (15) includes only significant explanatory variables. The shares of explained international reserves are: a) canonical economic variables (imports propensity and reserves volatility), $X_{it-1}^{'} \hat{\alpha}$, b) Joneses variables, $\hat{\delta} J_{i,t-1}^{T} + \widehat{\delta_1} J_{i,t-1}^{T2}$, and c) the relative and common current account variables, $\hat{\beta} R_{i,t-1}^{CA} + \hat{\gamma} CF_{i,t-1}^{CA}$. The estimated error term $\widehat{\varepsilon_{i,t}}$ gives the estimated excessive (or insufficient) amount of hoarding.

Figure 2 plots these components. With the exception of Singapore, the Joneses component in general accounts for a large share of explained international reserves. The two canonical economic variables contribute to the second largest share, followed by the two current account variables. That is, within the selected empirical framework, the Joneses variables play an important role in explaining the observed level of international reserves. In the case of Singapore, the share of its international reserves explained by the imports propensity and reserves volatility is larger than those of the Joneses effect and the two current account variables.

To assess the over- and under-hoarding behavior, we plot in Figure 3, for each economy in our sample, the predicted values of international reserves and their 95% confidence intervals from our model. Among these economies, our results indicate that, throughout the sample period, Singapore and Taiwan are the two economies that hoard an excessive level of international reserves; that is,

$\widehat{\varepsilon_{i,t}}$ >0 and the actual holdings are noticeably larger than the corresponding predicted values. The magnitude of over-hoarding is, for most time periods, large relative to individual explained components.

Somewhat surprisingly, China does not exhibit a consistently positive gap between the actual and predicted values. The estimation result indicates no strong evidence that China consistently hoards an excessive level of international reserves. The result is in contrast with the usual assertion that China has accumulated too much international reserves from its massive trade surplus and capital inflows (Calvo, Izquierdo, Loo-Kung, 2013; Jeanne and Ranciere, 2011).

Thailand is another economy that has the predicted and actual levels of reserve holdings that are largely comparable during the sample period. Malaysia, in the recent years, has shown a widened gap between the predicted and actual amounts of reserve holdings that is suggestive of under-hoarding in, say, 2014 and 2015.

The remaining five economies in our sample held less international reserves than our model's predictions. It is quite unexpected that Japan and India, two of the ten economies with the largest international reserve holdings, are deemed to hold reserve assets in amounts that fall short of the model's predictions.

How do our estimates of excessive hoarding compare with that of others? Acknowledging the challenge of determining the appropriate level of international reserves; especially in view of the rapid increase of global international reserves in the last two decades, IMF has proposed new frameworks beyond the traditional economic model considered in, say, IMF (2003) to assess reserve adequacy. The on-going efforts which are documented in IMF (2011a, 2011b, 2013, 2015, and 2016) generate reserve adequacy metrics to assess an economy's need for international reserves in adverse situations.

Figure 4 plots the predicted values and adequacy ranges of international reserves from the IMF reserve adequacy metric and the corresponding actual level of holdings.[22] Note that the IMF

[22] These IMF data are downloaded from http://www.imf.org/external/datamapper/ARA/index.html.

predictions are on the level of international reserves and not on the international reserves to GDP ratio. Also, predictions on Japan, Singapore and Taiwan are not available.

There are similarities and differences between our model predictions and the IMF figures. For instance, both sets of predictions indicate no (strong) evidence that China hoards an excessive amount of international reserves during the sample period, and point to the likely under-hoarding experienced by Malaysia in the recent years. Indonesia and Korea display a small degree of under-hoarding. On the other hand, the IMF Assessing Reserve Adequacy gauge indicates that the Philippines and Thailand are over-hoarding, and India is holding an appropriate level of international reserves.

Admittedly, our empirical specifications are relative simple compared with the IMF framework, which considers a large sample of economies with different economic characteristics and a wide spectrum of determining factors including precautionary and non-precautionary factors (IMF, 2015). The results of our specifications, however, offer an alternative perspective on assessing observed levels of international reserves for economies exhibiting (implicit) rivalry hoarding behaviour. Though IMF (2011) points out that about 40% of reserve managers surveyed across the world include a "peer comparison" element in assessing reserve adequacy, "peer comparison" factors are not explicitly incorporated in the reserve adequacy metric. As long as the perceived adequacy level is influenced by levels of reserves held by neighbouring economies, the actual holding is likely to be subject to neighbourhood effects. The explicit inclusion of "Joneses" factor offers a simple way to incorporate neighbourhood or peer comparison effects, and to assess reserve adequacy.

4. Concluding Remarks

Why have Asian countries been accumulating international reserves so aggressively? By most measures, they seem to have been hoarding reserves excessively. To explain this behavior, we consider various regional neighborhood effects. One such neighborhood effect is that of "catching up with the Joneses" as documented by Cheung and Qian (2009), and we revisit that effect by analyzing several refinements of it. We also consider the fear of contagion, in which contagion takes the form of what hit the region in 1997. Finally, we look at the possibility that the conditions

that led to the crisis were correlated across countries in a kind of regional financial cycle. We find that refining the Joneses effect to take account of trade links strengthens its power to explain the build-up of reserves. We also observe that a country that finds itself vulnerable relative to its regional neighbors would accumulate more reserves. Finally, we find that a common factor related to current-account balances spurs further reserve accumulation.

Compared to the literature that fails to account for neighborhood effects, the predictions of our model lead to a different list of countries that are deemed to be holding excessive amounts of international reserves. Our model suggests that Singapore and Taiwan have indeed been holding excessive amounts of reserves. Most notably, however, the model suggests that China's reserves have been only adequate and not excessive. This is true also of Thailand. Malaysia, however, seems to have been holding less than the adequate amount.

Our analyses illustrate the roles of several regional neighborhood effects including competitive hoarding behavior, fear of contagion and relative vulnerability in determining the observed interdependence of international reserve holdings of selected Asian economies. Conceivably, the interdependence of international reserve holdings can be a consequence of any mechanism such as learning or psychological factors that lead to competitive hoarding behavior. Further, the neighborhood effect can be experienced by economies with similar economic conditions in different regions. Thus, future studies can exploit alternative reasons underlying competitive hoarding and inter-regional behaviors to shed additional insights into the neighborhood effect.

Appendix A: Definition of variables

IRGDP: the ratio of international reserves (excluding gold) over GDP (current US Dollar); Source: World Bank Development Indicators. (y_{jt})

Joneses: the Joneses effect, measured by the average of international reserve/GDP in nine other Asian economies, [$J_{it} = \sum_{j \neq i} w_{ijt} y_{jt}$, $\forall w_{ijt} = 1$]. Source: WDI.

Joneses_trd: an alternative measurement for Joneses factor. It is a weighted average of all other countries' international reserves; with the weights given by trade intensity (bilateral trade volume over GDPs of two countries) [$J_{it} = \sum_{j \neq i} w_{ijt} y_{jt}$, w_{ijt} = [(imports + exports)$_{ij,t}$/(GDP$_{i,t}$ +GDP$_{j,t}$)] / $\sum_{j \neq i}$ (imports + exports)$_{ij,t}$/(GDP$_{i,t}$ +GDP$_{j,t}$). Source: Direction of trade statistics and WDI.

GDPpc: GDP per capita in constant USD and logarithm value; Source: WDI.

Imp: the propensity of imports, measured by imports/GDP; Source: WDI.

ErV: exchange rate volatility, measured by the S.D. of monthly period average exchange rate; Source: IMF IFS.

IrV: international reserves volatility, measured by the S.D. of monthly international reserves; Source: IMF IFS.

KAopenness: capital account openness, measured by gross capital count inflows and outflows over GDP ratio; Source: IMF IFS

M2/GDP: the detrend data of M2 (broad money) to GDP ratio, calculated as the cyclical component after Hodrick-Prescott filter. Source: IMF IFS and authors' calculation.

VIX: the implied volatility index of S&P 500. Source: CBOE.

J_cntg_cab: an alternative measurement of Joneses effect based on the possible contagious effect from neighbors' current account crisis. It is a weighted average of all other economies' reserves/GDP. The weights matrix is comprised of the *reverse* of the share of current account balance (CAB) in GDP of all other economies [w_{ijt} = (1+CAB$_{j,t}$/GDP$_{j,t}$)$^{-1}$ / $\sum_{j \neq i}$ (1+CAB$_{j,t}$/GDP$_{j,t}$)$^{-1}$]. A high weight indicates high probability of current account crisis. The weights are multiplied by their corresponding economies' reserves/GDP to calculate the alternative Joneses effect [$J_{it} = \sum_{j \neq i} w_{ijt} y_{jt}$,]. Source: WDI.

J_cntg_debt: an alternative measurement of Joneses effect based on the possible contagious effect from neighbors' financial crisis due to over-borrowing and external drain. It is a weighted average of all other economies' reserves/GDP. The weights matrix comprises the ratio of portfolio debt liability (stock) and other investment liability (stock) to GDP of all other economies [w_{ijt} = [(Debt$_{j,t}$ + OI$_{j,t}$)/GDP$_{j,t}$] / $\sum_{j \neq i}$ (Debt$_{j,t}$ + OI$_{j,t}$)/GDP$_{j,t}$]. A high weight indicates high probability of financial crisis. The weights are multiplied by their corresponding economies' reserves/GDP to calculate the alternative Joneses effect [$J_{it} = \sum_{j \neq i} w_{ijt} y_{jt}$,]. Source: Lane and Milesi-Ferretti, EWN II data.

J_cntg_M2: an alternative measurement of Joneses effect based on the possible contagious effect from neighbors' financial crisis due to credit over-supply and internal drain. It is a weighted average of all other economies' international reserves. The weights matrix comprises the ratio of M2 (broad money) to GDP of all other economies [w_{ijt} = [$M2_{j,t}/GDP_{j,t}$] / $\sum_{j\neq i}$ $M2_{j,t}/GDP_{j,t}$]. A high weight indicates high probability of bank run crisis and capital flight. The weights are multiplied by their corresponding economies' reserves/GDP to calculate the alternative Joneses effect [$J_{it} = \sum_{j\neq i} w_{ijt} y_{jt}$,]. Source: WDI.

Vlnr_Cab: a proxy measurement for possibility current account crisis relative to other economies, measured by the ratio of the average of all other economies' CAB/GDP to current economy's CAB/GDP; $Cc_{it} = [1 + average(CAB_{j\neq i,t}/GDP_{j\neq i,t})]/(1 + CAB_{i,t}/GDP_{i,t})$.

Vlnr_Debt: a proxy measurement for possibility financial crisis (external drain) relative to other economies, measured by the ratio of the average of all other economies' Portfolio debt and Other investment liability over GDP to current economics's; $Dc_{it} = average[(Debt_{j\neq i,t} + OI_{j\neq i,t})/GDP_{j\neq i,t}]/[(Debt_{j\neq i,t} + OI_{i,t})/GDP_{i,t}]$.

Vlnr_M2: a proxy measurement for possibility bank run crisis and capital flight (internal drain) relative to other economies, measured by the ratio of the average of all other economies' M2/GDP to current economy's M2/GDP; $Mc_{it} = average(M2_{j\neq i,t}/GDP_{j\neq i,t})/(M2_{i,t}/GDP_{i,t})$.

GDPG_comm: the common growth among 10 Asian economies ($CF^{G}_{i,t-1}$). The data are deduced from 10 economies' GDP growth data using Principal Component Analysis (PCA) to extract data information from the first component.

Cab_comm: the common development of current account balance among 10 Asian economies ($CF^{CA}_{i,t-1}$). The data are deduced from 10 economies' current account balance data using Principal Component Analysis (PCA) to extract data information from the first component.

Fab_comm: the common development among financial account balance among 10 Asian economies ($CF^{F}_{i,t-1}$). The data are deduced from 10 economies' net financial account balance data using Principal Component Analysis (PCA) to extract data information from the first component.

Afc97: a time dummy variable for 1997 East Asia financial crisis. $I(1996 \leq year \leq 1999) = 1$, otherwise 0.

Gfc08: a time dummy variable for 2008 global financial crisis.$I(2007 \leq year \leq 2009) = 1$, otherwise 0.

Appendix B: Some Additional Regression Results

This appendix presents results of estimating (1) and (2) in the text with M2/GDP and VIX as additional explanatory variables. The effective numbers of observations in these Tables are different from those in Tables 1 and 2 because data on money stock and VIX are not available for the entire sample period.

Table B1: Linear "Joneses" effects on international reserves (with M2/GDP)

	[1]	[2]	[3]	[4]
Joneses	0.594***	0.557***	0.601***	0.576***
	(0.077)	(0.063)	(0.076)	(0.064)
GDPpc	0.017	0.022	0.017	0.020
	(0.014)	(0.013)	(0.013)	(0.013)
Imp	0.209***	0.215***	0.181**	0.187***
	(0.057)	(0.056)	(0.056)	(0.056)
ErV	0.001	0.002	0.001	0.002
	(0.003)	(0.003)	(0.003)	(0.003)
IrV	0.011***	0.011***	0.011***	0.011***
	(0.002)	(0.002)	(0.002)	(0.002)
KAopenness	0.027	0.028*	0.023	0.023
	(0.015)	(0.015)	(0.017)	(0.017)
M2/GDP	0.017	0.020	0.025	0.028
	(0.036)	(0.036)	(0.034)	(0.034)
Afc97		0.004		0.021
		(0.060)		(0.062)
Joneses*Afc97		-0.091		-0.159
		(0.234)		(0.241)
Gfc08			0.423	0.417
			(0.255)	(0.259)
Joneses*Gfc08			-1.086	-1.073
			(0.651)	(0.662)
Constant	-0.147	-0.178*	-0.135	-0.156*
	(0.082)	(0.080)	(0.079)	(0.076)
Adj. R-Square	0.682	0.682	0.686	0.686
Obs.	341	341	341	341

Note: The table reports results of panel data fixed effect regression controlling for cross-sectional correlation and AR(1) serial correlation. Robust errors are in the parentheses. Dependent variable is the reserves/GDP ratio. All independent variables are lagged one period. Country sample comprises 10 East Asia economies – CHN, IDN, IND, JPN, KOR, MYS, PHL, SGP, THA, TWN (1980 – 2015). "***", "**", and "*" denotes 1%, 5%, and 10% level of significance.

Table B2: Non-Linear "Joneses" effects on international reserves (with M2/GDP)

	[1]	[2]	[3]	[4]
Joneses	1.261***	1.317***	1.206***	1.272***
	(0.250)	(0.249)	(0.245)	(0.244)
Joneses^2	-1.173**	-1.352***	-1.069**	-1.246**
	(0.387)	(0.411)	(0.378)	(0.401)
GDPpc	0.012	0.017	0.013	0.016
	(0.014)	(0.014)	(0.013)	(0.014)
Imp	0.196***	0.203***	0.173***	0.180***
	(0.051)	(0.049)	(0.052)	(0.050)
ErV	0.001	0.002	0.001	0.002
	(0.003)	(0.003)	(0.003)	(0.003)
IrV	0.013***	0.012***	0.012***	0.012***
	(0.002)	(0.002)	(0.002)	(0.002)
KAopenness	0.022	0.023	0.019	0.019
	(0.015)	(0.015)	(0.016)	(0.017)
M2/GDP	0.001	0.004	0.011	0.013
	(0.034)	(0.034)	(0.031)	(0.031)
Afc97		0.034		0.046
		(0.064)		(0.065)
Joneses*Afc97		-0.268		-0.309
		(0.255)		(0.260)
Gfc08			0.360	0.344
			(0.241)	(0.244)
Joneses*Gfc08			-0.921	-0.883
			(0.615)	(0.624)
Constant	-0.181*	-0.224**	-0.168*	-0.202**
	(0.084)	(0.086)	(0.082)	(0.085)
Adj. R-Square	0.689	0.691	0.692	0.693
Obs.	341	341	341	341

Note: The table reports results of panel data fixed effect regression controlling for cross-sectional correlation and AR(1) serial correlation. Robust errors are in the parentheses. Dependent variable is the reserves/GDP ratio. All independent variables are lagged one period. Country sample comprises 10 East Asia economies – CHN, IDN, IND, JPN, KOR, MYS, PHL, SGP, THA, TWN (1980 – 2015). "***", "**", and "*" denotes 1%, 5%, and 10% level of significance.

Table B3: Linear "Joneses" effects on international reserves (with M2/GDP and VIX)

	[1]	[2]	[3]	[4]
Joneses	0.718***	0.693***	0.729***	0.719***
	(0.080)	(0.060)	(0.082)	(0.065)
GDPpc	-0.015	-0.013	-0.016	-0.016
	(0.012)	(0.010)	(0.012)	(0.011)
Imp	0.262***	0.266***	0.232***	0.235***
	(0.042)	(0.041)	(0.046)	(0.046)
ErV	0.002	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)
IrV	0.014***	0.013***	0.014***	0.014***
	(0.002)	(0.002)	(0.002)	(0.002)
KAopenness	0.010	0.010	0.008	0.008
	(0.014)	(0.014)	(0.016)	(0.016)
M2/GDP	0.019	0.022	0.026	0.029
	(0.039)	(0.040)	(0.035)	(0.036)
VIX	0.011	0.014	0.010	0.013
	(0.013)	(0.014)	(0.012)	(0.013)
Afc97		0.030		0.045
		(0.074)		(0.074)
Joneses*Afc97		-0.194		-0.251
		(0.300)		(0.298)
Gfc08			0.286	0.294
			(0.191)	(0.191)
Joneses*Gfc08			-0.745	-0.770
			(0.496)	(0.497)
Constant	0.036	0.019	0.058	0.05
	(0.091)	(0.090)	(0.091)	(0.091)
Adj. R-Square	0.616	0.615	0.617	0.615
Obs.	260	260	260	260

Note: The table reports results of panel data fixed effect regression controlling for cross-sectional correlation and AR(1) serial correlation. Robust errors are in the parentheses. Dependent variable is the reserves/GDP ratio. All independent variables are lagged one period. Country sample comprises 10 East Asia economies – CHN, IDN, IND, JPN, KOR, MYS, PHL, SGP, THA, TWN (1990 – 2015). "***", "**", and "*" denotes 1%, 5%, and 10% level of significance.

Table B4: Non-linear "Joneses" effects on international reserves (with M2/GDP and VIX)

	[1]	[2]	[3]	[4]
Joneses	1.586***	1.794***	1.527***	1.761***
	(0.444)	(0.341)	(0.449)	(0.349)
Joneses^2	-1.454*	-1.788***	-1.337*	-1.697**
	(0.649)	(0.533)	(0.655)	(0.542)
GDPpc	-0.012	-0.014	-0.013	-0.016
	(0.013)	(0.012)	(0.013)	(0.013)
Imp	0.223***	0.217***	0.201***	0.194***
	(0.054)	(0.052)	(0.058)	(0.058)
ErV	0.002	0.002	0.002	0.003
	(0.002)	(0.002)	(0.002)	(0.002)
IrV	0.014***	0.014***	0.014***	0.014***
	(0.002)	(0.002)	(0.002)	(0.002)
KAopenness	0.007	0.006	0.006	0.004
	(0.016)	(0.015)	(0.017)	(0.016)
M2/GDP	0.005	0.009	0.011	0.014
	(0.037)	(0.037)	(0.034)	(0.034)
VIX	0.011	0.012	0.010	0.012
	(0.014)	(0.015)	(0.013)	(0.014)
Afc97		0.098		0.107
		(0.076)		(0.077)
Joneses*Afc97		-0.494		-0.528
		(0.308)		(0.311)
Gfc08			0.237	0.252
			(0.183)	(0.182)
Joneses*Gfc08			-0.618	-0.663
			(0.475)	(0.470)
Constant	-0.086	-0.099	-0.059	-0.069
	(0.099)	(0.111)	(0.098)	(0.116)
Adj. R-Square	0.622	0.623	0.622	0.623
Obs.	260	260	260	260

Note: The table reports results of panel data fixed effect regression controlling for cross-sectional correlation and AR(1) serial correlation. Robust errors are in the parentheses. Dependent variable is the reserves/GDP ratio. All independent variables are lagged one period. Country sample comprises 10 East Asia economies – CHN, IDN, IND, JPN, KOR, MYS, PHL, SGP, THA, TWN (1990 – 2015). "***", "**", and "*" denotes 1%, 5%, and 10% level of significance.

Appendix C: Correlation Coefficient Estimates

	Joneses	*Joneses_trd*	*J_cntg_cab*	*J_cntg_debt*	*J_cntg_m2*	*Vlnr_Cab*	*Vlnr_Fab*	*Vlnr_M2*	*GDPG_comm*	*Cab_comm*	*Fab_comm*
Joneses	1										
Joneses_trd	0.9199	1									
J_cntg_cab	0.9692	0.922	1								
J_cntg_debt	0.8995	0.8826	0.9561	1							
J_cntg_m2	0.9631	0.9154	0.9954	0.9376	1						
Vlnr_Cab	0.1583	0.1339	0.1611	0.1323	0.1622	1					
Vlnr_Fab	0.0743	0.026	0.0493	0.0661	0.0461	0.0123	1				
Vlnr_M2	-0.032	-0.0876	-0.0363	-0.0525	-0.0355	0.0045	0.0085	1			
GDPG_comm	-0.3792	-0.3601	-0.3931	-0.4621	-0.3598	-0.1142	-0.0808	0.0442	1		
Cab_comm	0.8848	0.8451	0.9143	0.845	0.9233	0.1495	0.0613	-0.0072	-0.3846	1	
Fab_comm	0.8822	0.8452	0.9109	0.8518	0.9083	0.1447	0.0442	-0.001	-0.3769	0.9628	1

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Table 1: Linear "Joneses" effects on international reserves

	[1]	[2]	[3]	[4]
Joneses	0.578***	0.536***	0.588***	0.561***
	(0.086)	(0.074)	(0.083)	(0.071)
GDPpc	0.027	0.033	0.026	0.030
	(0.020)	(0.020)	(0.019)	(0.019)
Imp	0.180**	0.187**	0.150**	0.156**
	(0.064)	(0.063)	(0.064)	(0.063)
ErV	0.001	0.002	0.001	0.002
	(0.003)	(0.003)	(0.003)	(0.003)
IrV	0.010***	0.010***	0.010***	0.010***
	(0.003)	(0.003)	(0.003)	(0.003)
KAopenness	0.026	0.027*	0.021	0.022
	(0.014)	(0.015)	(0.016)	(0.017)
Afc97		-0.010		0.009
		(0.060)		(0.062)
Joneses*Afc97		-0.032		-0.104
		(0.232)		(0.240)
Gfc08			0.472	0.462
			(0.265)	(0.268)
Joneses*Gfc08			-1.217	-1.195
			(0.676)	(0.685)
Constant	-0.205	-0.240*	-0.187	-0.211
	(0.128)	(0.129)	(0.119)	(0.118)
AIC	-834.65	-832.09	-837.38	-836.40
BIC	-811.53	-801.28	-806.56	-801.73
Adj. R-Square	0.653	0.652	0.657	0.656
Obs.	348	348	348	348

Note: The table reports results of panel data fixed effect regression controlling for cross-sectional correlation and AR(1) serial correlation. Robust errors are in the parentheses. Dependent variable is the reserves/GDP ratio. All independent variables are lagged one period. Country sample comprises 10 East Asia economies – CHN, IDN, IND, JPN, KOR, MYS, PHL, SGP, THA, TWN (1980 – 2015). "***", "**", and "*" denotes 1%, 5%, and 10% level of significance.

Table 2: Non-linear "Joneses" effects on international reserves

	[1]	[2]	[3]	[4]
Joneses	1.403***	1.457***	1.348***	1.412***
	(0.285)	(0.288)	(0.285)	(0.287)
Joneses^2	-1.445**	-1.630**	-1.339**	-1.520**
	(0.495)	(0.529)	(0.488)	(0.519)
GDPpc	0.019	0.025	0.019	0.023
	(0.018)	(0.019)	(0.017)	(0.018)
Imp	0.166**	0.175***	0.141**	0.150**
	(0.056)	(0.054)	(0.058)	(0.055)
ErV	0.001	0.002	0.001	0.002
	(0.003)	(0.003)	(0.003)	(0.003)
IrV	0.012***	0.012***	0.012***	0.012***
	(0.002)	(0.002)	(0.002)	(0.002)
KAopenness	0.021	0.021	0.017	0.018
	(0.014)	(0.015)	(0.016)	(0.016)
Afc97		0.031		0.043
		(0.064)		(0.065)
Joneses*Afc97		-0.262		-0.302
		(0.257)		(0.262)
Gfc08			0.387	0.368
			(0.246)	(0.248)
Joneses*Gfc08			-0.991	-0.943
			(0.628)	(0.635)
Constant	-0.232*	-0.279*	-0.216	-0.253*
	(0.124)	(0.131)	(0.119)	(0.126)
AIC	-845.02	-845.03	-845.96	-845.34
BIC	-818.05	-810.36	-811.30	-814.67
Adj. R-Square	0.664	0.665	0.667	0.668
Obs.	348	348	348	348

Note: The table reports results of panel data fixed effect regression controlling for cross-sectional correlation and AR(1) serial correlation. Robust errors are in the parentheses. Dependent variable is the reserves/GDP ratio. All independent variables are lagged one period. Country sample comprises 10 East Asia economies – CHN, IDN, IND, JPN, KOR, MYS, PHL, SGP, THA, TWN (1980 – 2015). "***", "**", and "*" denotes 1%, 5%, and 10% level of significance.

Table 3: Non-linear "Joneses" effects – Alternative measures of the "Joneses"

	[1]	[2]	[3]	[4]
Joneses_trd	1.067***			
	(0.260)			
Joneses_trd^2	-0.803*			
	(0.371)			
J_cntg_cab		1.130***		
		(0.274)		
J_cntg_cab^2		-0.612		
		(0.449)		
J_cntg_debt			0.742***	
			(0.221)	
J_cntg_debt^2			-0.343	
			(0.286)	
J_cntg_M2				1.023***
				(0.246)
J_cntg_M2^2				-0.586
				(0.352)
GDPpc	0.014	-0.009	0.008	0.011
	(0.019)	(0.014)	(0.014)	(0.016)
Imp	0.146**	0.210***	0.129**	0.160**
	(0.055)	(0.042)	(0.053)	(0.061)
ErV	-0.001	0.000	-0.002	0.001
	(0.003)	(0.003)	(0.003)	(0.003)
IrV	0.009***	0.012***	0.012***	0.010***
	(0.002)	(0.002)	(0.003)	(0.002)
KAopenness	0.022	0.018	0.011	0.022
	(0.014)	(0.014)	(0.011)	(0.014)
Constant	-0.137	-0.011	-0.076	-0.149
	(0.125)	-0.101	-0.093	-0.105
AIC	-854.07	-864.61	-870.43	-860.43
BIC	-827.10	-838.02	-843.64	-833.64
Adj. R-Square	0.673	0.701	0.697	0.690
Obs.	348	330	339	348

Note: The table reports results of panel data fixed effect regression controlling for cross-sectional correlation and AR(1) serial correlation. Dependent variable is the reserves/GDP ratio. All independent variables are lagged one period. See the text for definitions of the alternative measures of the Joneses variable. Country sample comprises 10 East Asia economies – CHN, IDN, IND, JPN, KOR, MYS, PHL, SGP, THA, TWN (1980 – 2015). "***", "**", and "*" denotes 1%, 5%, and 10% level of significance.

Table 4: Effects of the Trade-Intensity-Based Joneses Variable *and* Relative Vulnerability

	[1]	[2]	[3]
Joneses_trd	1.069***	1.069***	1.083***
	(0.260)	(0.260)	(0.261)
Joneses_trd^2	-0.825*	-0.825*	-0.847**
	(0.369)	(0.369)	(0.372)
GDPpc	0.013	0.013	0.014
	(0.019)	(0.019)	(0.019)
Imp	0.151**	0.151**	0.146**
	(0.056)	(0.057)	(0.057)
ErV	-0.001	-0.001	-0.001
	(0.003)	(0.003)	(0.003)
IrV	0.010***	0.010***	0.009***
	(0.002)	(0.002)	(0.002)
KAopenness	0.023	0.023	0.023
	(0.014)	(0.014)	(0.014)
Vlnr_Cab	0.049**	0.049**	0.049**
	(0.020)	(0.020)	(0.020)
Vlnr_Fab		-0.001	-0.002
		(0.015)	(0.015)
Vlnr_M2			-0.010
			(0.009)
Constant	-0.137	-0.137	-0.138
	(0.126)	(0.126)	(0.127)
Adj. R-Square	0.674	0.673	0.674
Obs.	348	348	348

Note: The table reports results of panel data fixed effect regression controlling for cross-sectional correlation and AR(1) serial correlation. Robust errors are in the parentheses. Dependent variable is the reserves/GDP ratio. See the text for definitions of the relative vulnerability variables. All independent variables are lagged one period. Country sample comprises 10 East Asia economies – CHN, IDN, IND, JPN, KOR, MYS, PHL, SGP, THA, TWN (1980 – 2015). "***", "**", and "*" denotes 1%, 5%, and 10% level of significance.

Table 5: Effects of the Trade-Intensity-Based Joneses Variable *and* Common Factors

	[1]	[2]	[3]
Joneses_trd	1.011***	1.139***	1.138***
	(0.250)	(0.264)	(0.274)
Joneses_trd^2	-0.759*	-1.265**	-1.242**
	(0.371)	(0.390)	(0.408)
GDPpc	0.013	0.004	-0.001
	(0.018)	(0.020)	(0.025)
Imp	0.146**	0.153**	0.190***
	(0.055)	(0.055)	(0.047)
ErV	-0.003	-0.002	-0.002
	(0.004)	(0.003)	(0.003)
IrV	0.009***	0.010***	0.010***
	(0.002)	(0.002)	(0.003)
KAopenness	0.022*	0.021	0.018
	(0.012)	(0.013)	(0.013)
GDPG_comm	-0.005	-0.004	-0.004
	(0.003)	(0.003)	(0.003)
Cab_comm		0.011**	0.014
		(0.005)	(0.010)
Fab_comm			-0.003
			(0.010)
Constant	-0.122	-0.038	-0.021
	(0.121)	(0.133)	(0.181)
Adj. R-Square	0.679	0.683	0.691
Obs.	348	348	339

Note: The table reports results of panel data fixed effect regression controlling for cross-sectional correlation and AR(1) serial correlation. Robust errors are in the parentheses. Dependent variable is the reserves/GDP ratio. See the text for definitions of the common factor variables. All independent variables are lagged one period. Country sample comprises 10 East Asia economies – CHN, IDN, IND, JPN, KOR, MYS, PHL, SGP, THA, TWN (1980 – 2015). "***", "**", and "*" denotes 1%, 5%, and 10% level of significance.

Table 6: Effects of the Trade-Intensity-Based Joneses Variable, Relative Vulnerability, *and* Common Factors

	[1]	[2]	[3]
Joneses_trd	1.228***	1.242***	1.275***
	(0.238)	(0.247)	(0.240)
Joneses_trd^2	-0.945**	-0.992**	-1.501***
	(0.360)	(0.373)	(0.366)
Imp	0.133*	0.139*	0.151**
	(0.063)	(0.064)	(0.061)
IrV	0.010***	0.011***	0.010***
	(0.002)	(0.002)	(0.002)
Vlnr_Cab		0.049*	0.046**
		(0.022)	(0.019)
Cab_comm			0.014**
			(0.005)
Constant	-0.047	-0.049	-0.019
	(0.027)	(0.027)	(0.031)
Adj. R-Square	0.671	0.670	0.678
Obs.	348	348	339

Note: The table reports results of panel data fixed effect regression controlling for cross-sectional correlation and AR(1) serial correlation. Robust errors are in the parentheses. Dependent variable is the reserves/GDP ratio. See the text for definitions of the relative vulnerability and common factor variables. All independent variables are lagged one period. Country sample comprises 10 East Asia economies – CHN, IDN, IND, JPN, KOR, MYS, PHL, SGP, THA, TWN (1980 – 2015). "***", "**", and "*" denotes 1%, 5%, and 10% level of significance.

Table 7: Joneses effects based on weak and strong Joneses (trade/GDP weighted)

	"weak-five"		**"strong-five"**	
	[1]	**[2]**	**[1]**	**[2]**
Joneses_trd	0.532***	0.535	0.447***	0.799***
	(0.100)	(0.323)	(0.066)	(0.204)
Joneses_trd^2		-0.006		-0.531*
		(0.838)		(0.278)
GDPpc	0.043**	0.043**	0.032	0.025
	(0.019)	(0.018)	(0.020)	(0.018)
Imp	0.212**	0.212**	0.164**	0.151**
	(0.073)	(0.073)	(0.062)	(0.057)
ErV	0.000	0.000	0.000	0.000
	(0.004)	(0.004)	(0.003)	(0.003)
IrV	0.010***	0.010***	0.009***	0.009***
	(0.003)	(0.003)	(0.003)	(0.002)
KAopenness	0.026*	0.026*	0.025	0.023
	(0.014)	(0.013)	(0.015)	(0.015)
Constant	-0.302**	-0.302**	-0.211	-0.198
	(0.127)	(0.131)	(0.131)	(0.122)
Adj. R-Squares	0.639	0.637	0.651	0.655
Obs.	348	348	348	348

Note: The table reports results of panel data fixed effect regression controlling for cross-sectional correlation and AR(1) serial correlation. Robust errors are in the parentheses. Dependent variable is the reserves/GDP ratio. See the text for definitions of the weak-five and strong-five Joneses variables. All independent variables are lagged one period. Country sample comprises 10 East Asia economies – CHN, IDN, IND, JPN, KOR, MYS, PHL, SGP, THA, TWN (1980 – 2015). "***", "**", and "*" denotes 1%, 5%, and 10% level of significance.

Table 8: Effects of Common Lender based Joneses Variable

	[1]	[2]
Joneses_Commlender	-0.026	0.274
	(0.065)	(0.154)
Joneses_ Commlender ^2		-0.544*
		(0.282)
GDPpc	0.080***	0.079***
	(0.012)	(0.011)
Imp	0.366***	0.361***
	(0.045)	(0.042)
ErV	0.003*	0.003
	(0.002)	(0.002)
IrV	0.011***	0.011***
	(0.003)	(0.003)
KAopenness	0.029**	0.027*
	(0.013)	(0.013)
Constant	-0.564***	-0.581***
	(0.098)	(0.090)
Adj. R-Square	0.595	0.610
Obs.	330	330

Note: The table reports results of panel data fixed effect regression controlling for cross-sectional correlation and AR(1) serial correlation. Robust errors are in the parentheses. Dependent variable is the reserves/GDP ratio. See the text for definitions of the common lender based Joneses variable. All independent variables are lagged one period. Country sample comprises 10 East Asia economies – CHN, IDN, IND, JPN, KOR, MYS, PHL, SGP, THA, TWN (1980 – 2015). "***", "**", and "*" denotes 1%, 5%, and 10% level of significance.

Figure 1: The ratios of international reserves to GDP: 10 Asian Economies

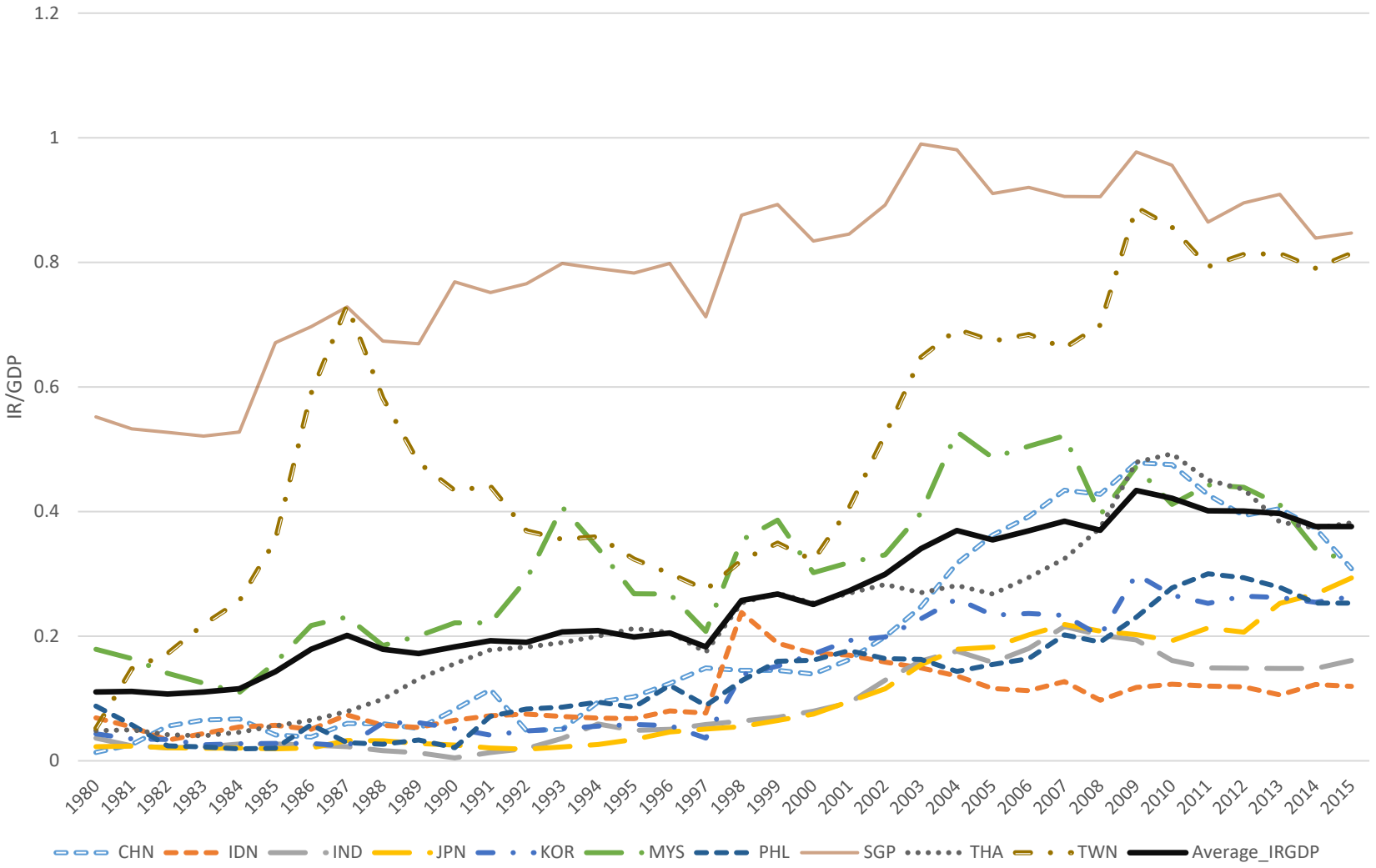
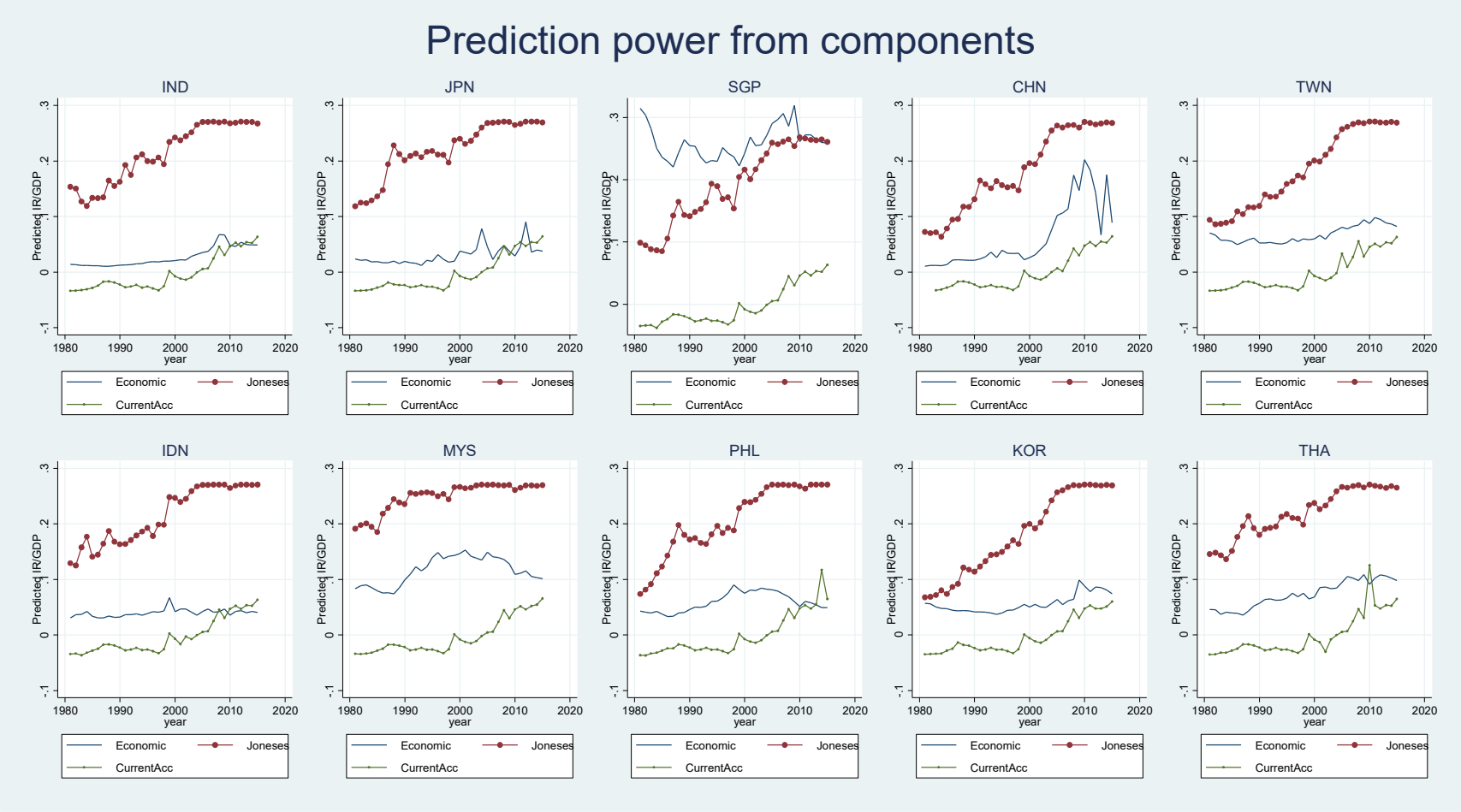
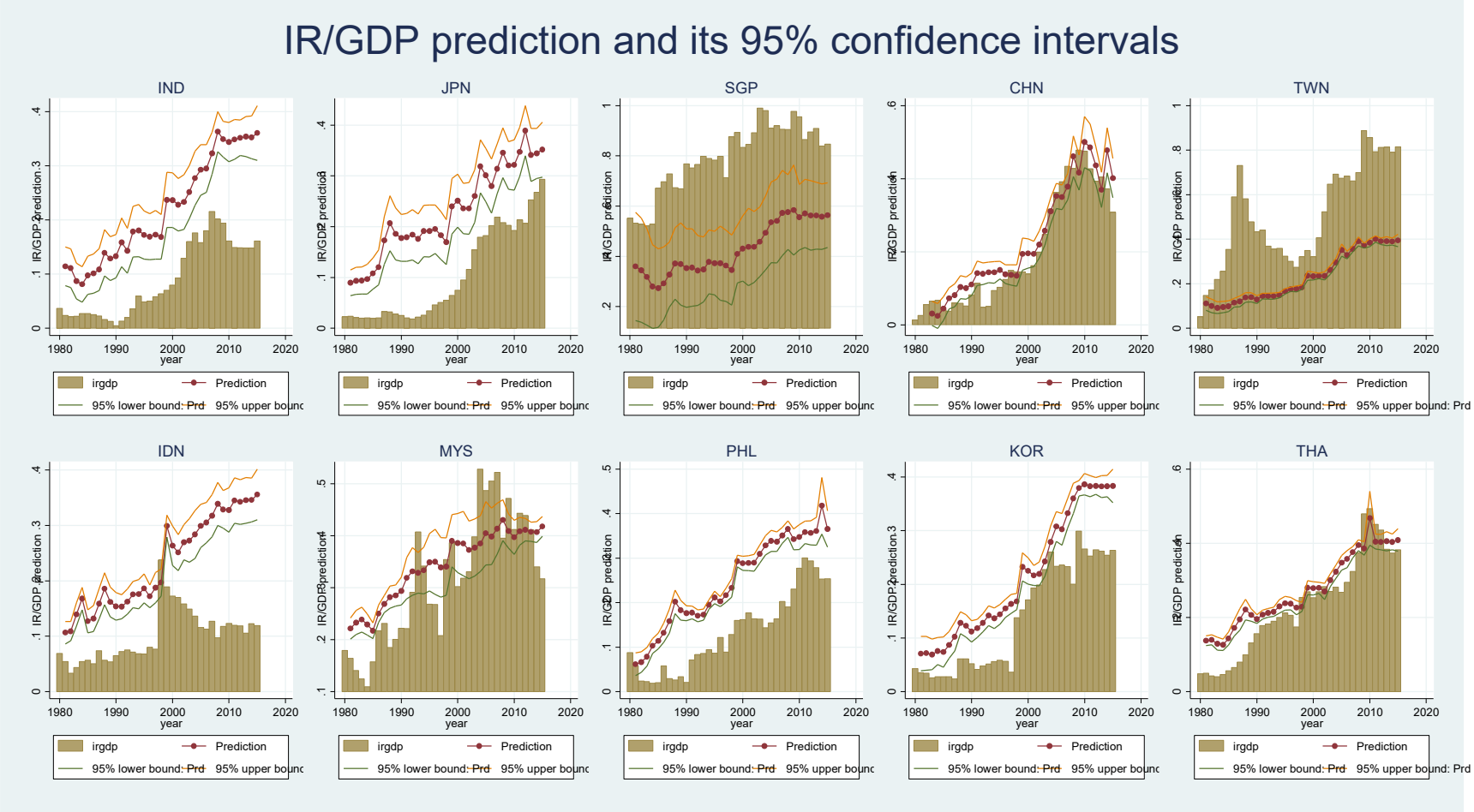


Figure 2: International reserves explained by different explanatory components



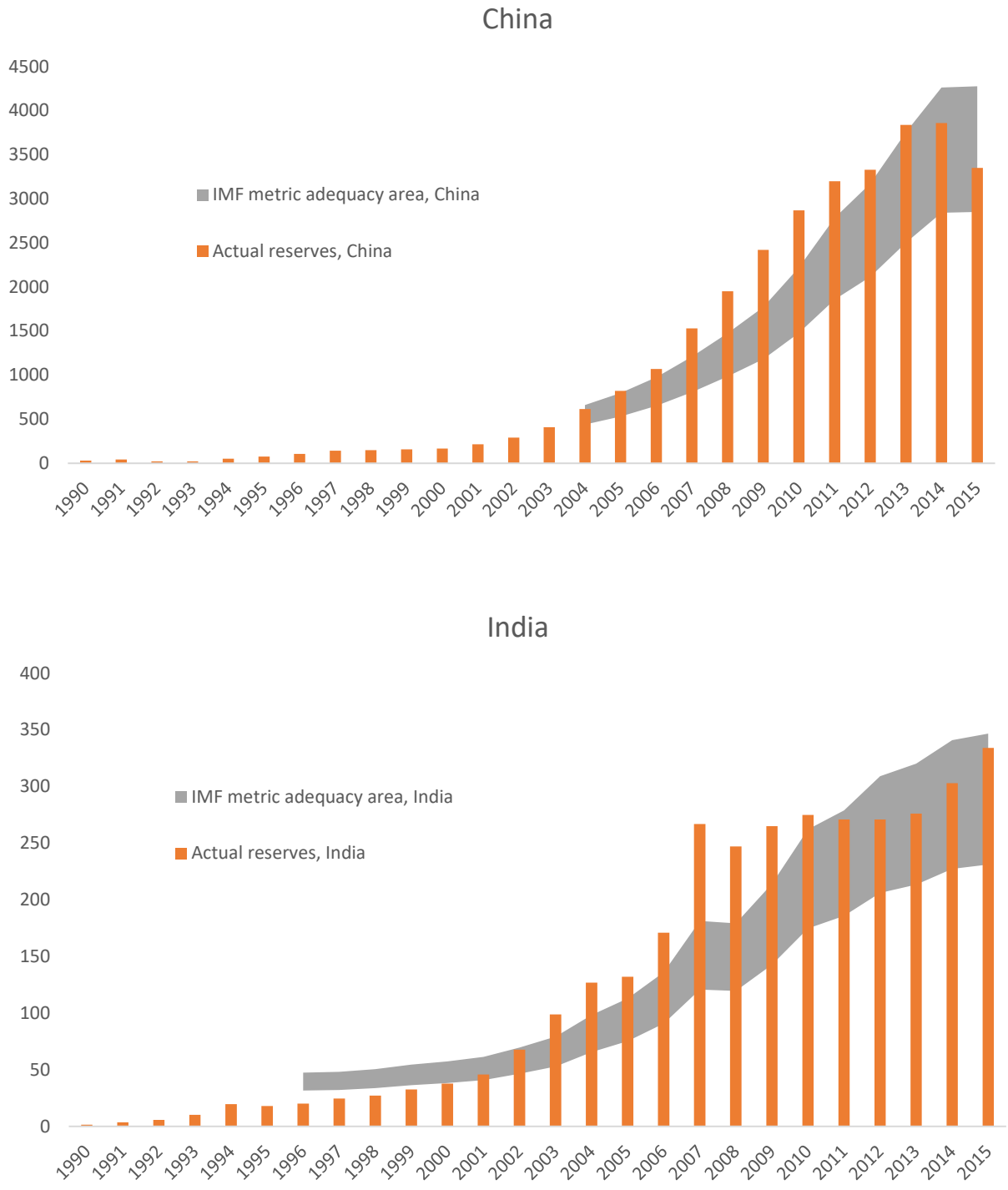
Notes: The IR/GDP ratio explained by three regression components in equation (15) in the text. These three components are economic variables (imports propensity and reserves volatility), Joneses variables (Joneses and Joneses^2), and current account variables (the relative risk of current account crisis and common movement in current account among 10 Asian economies).

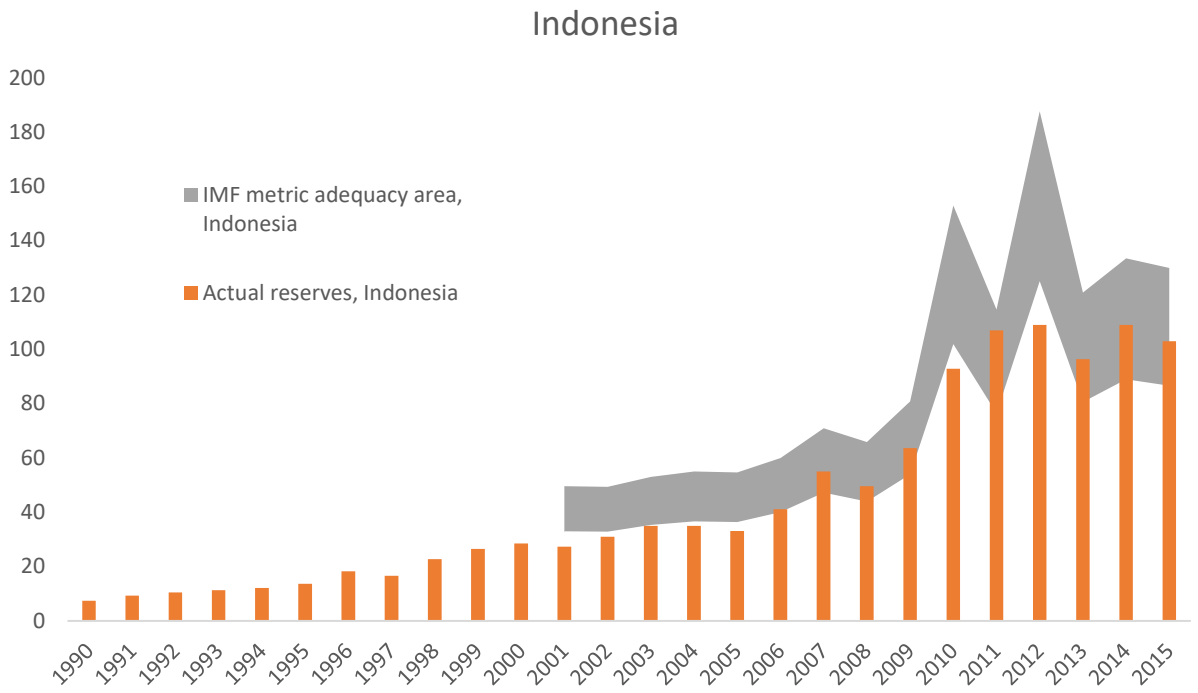
Figure 3: The comparison of IR/GDP and its prediction with 95% confidence intervals



Notes: The IR/GDP predications and their 95% confidence intervals derived from equation (15) in the text. “irgdp” labels the actual IR/GDP ratio.

Figure 4: The IMF ARA metric prediction and the adequacy range, and the actual holdings of international reserves (Billions USD)




Indonesia
IMF metric adequacy area, Indonesia
Actual reserves, Indonesia
200
180
160
140
120
100
80
60
40
20
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1990
1991
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1993
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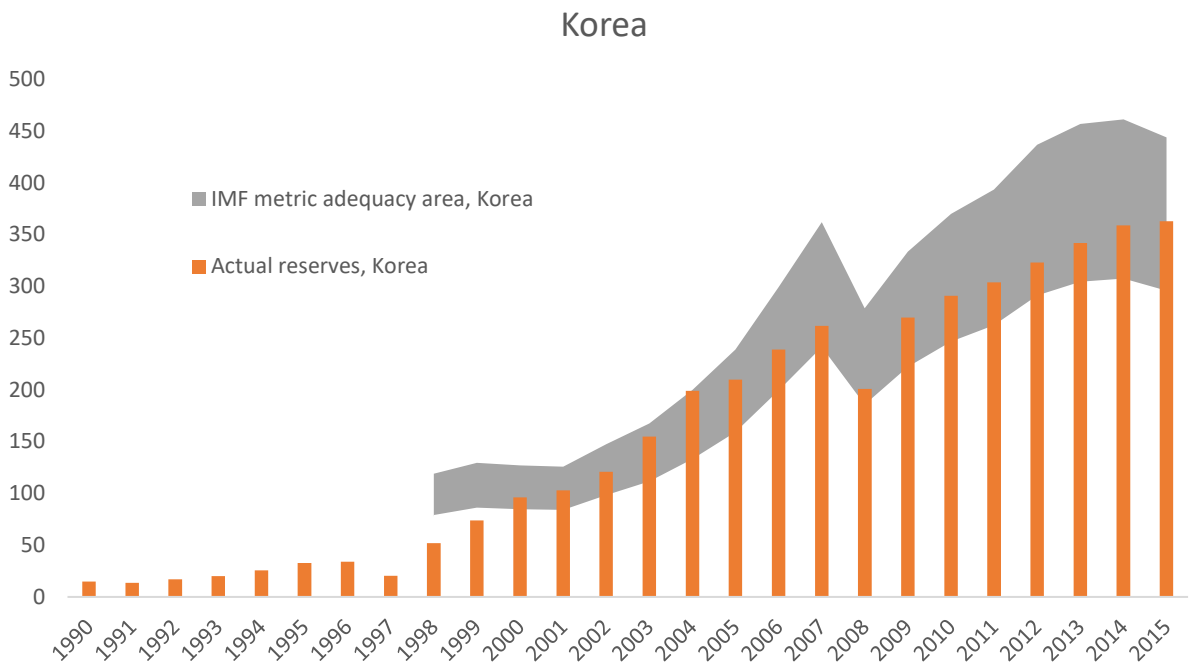
Korea
IMF metric adequacy area, Korea
Actual reserves, Korea
500
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400
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250
200
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2014
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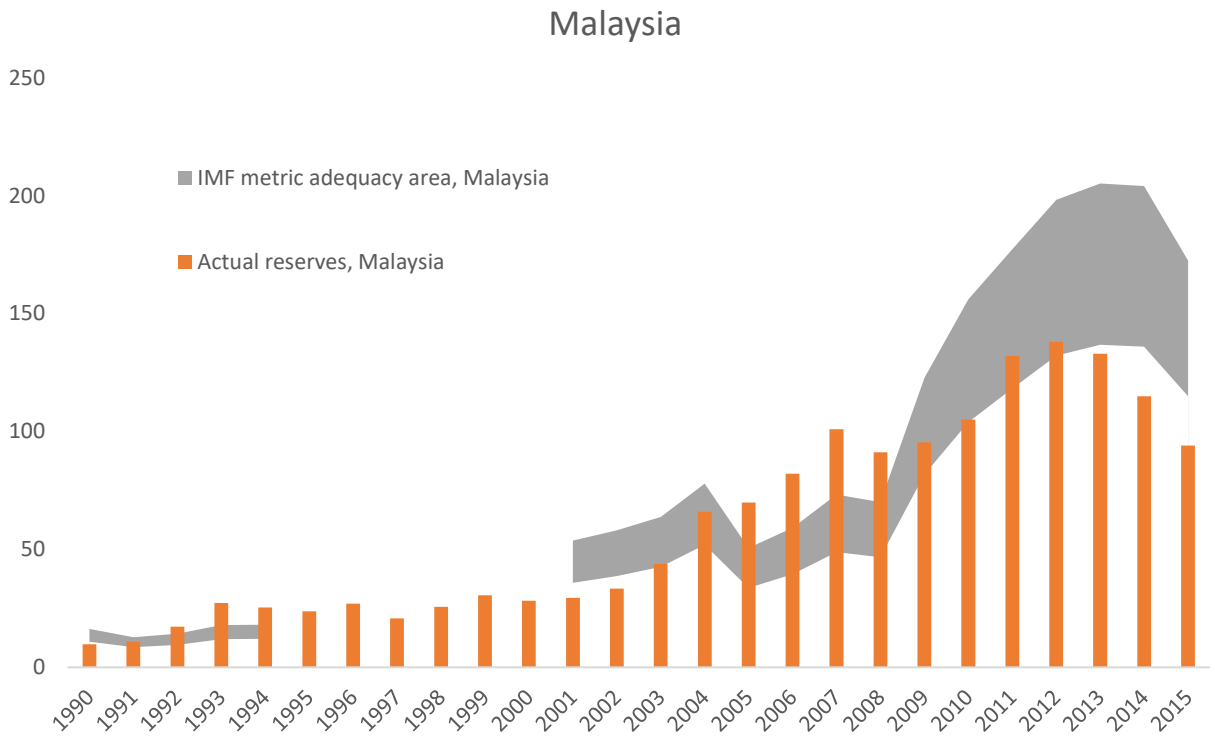
Malaysia
250
200
150
100
50
0
IMF metric adequacy area, Malaysia
Actual reserves, Malaysia
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
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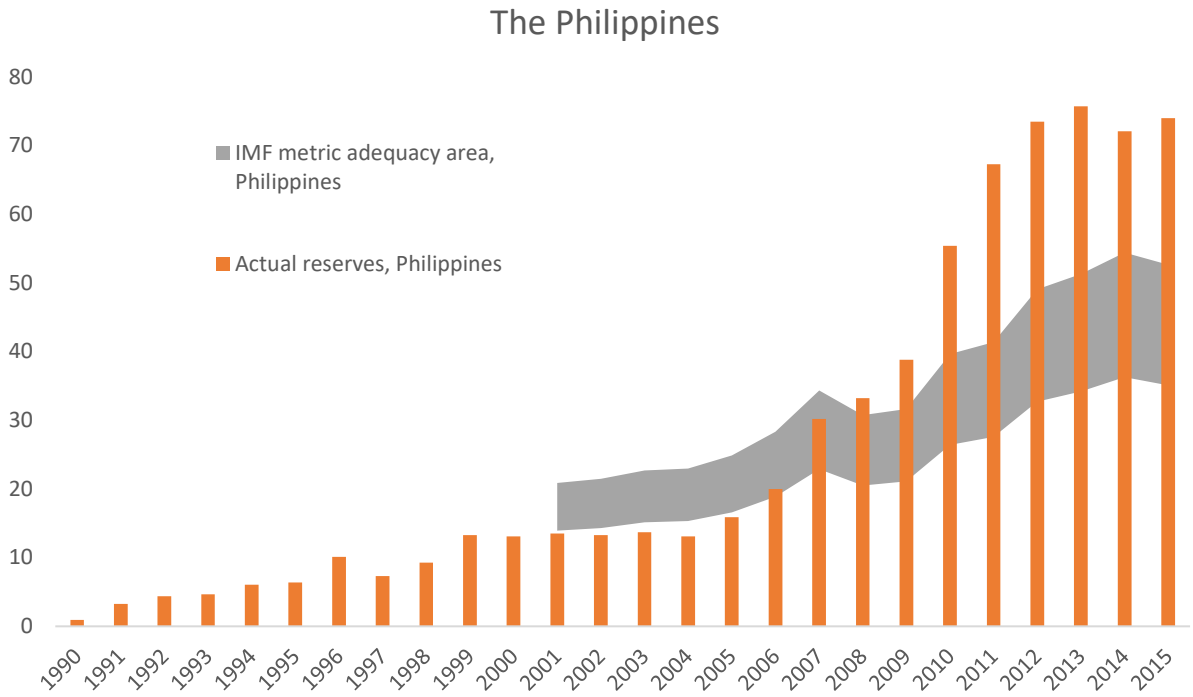
2008
2009
2010
2011
2012
2013
2014
2015


The Philippines
80
70
60
50
40
30
20
10
0
IMF metric adequacy area, Philippines
Actual reserves, Philippines
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
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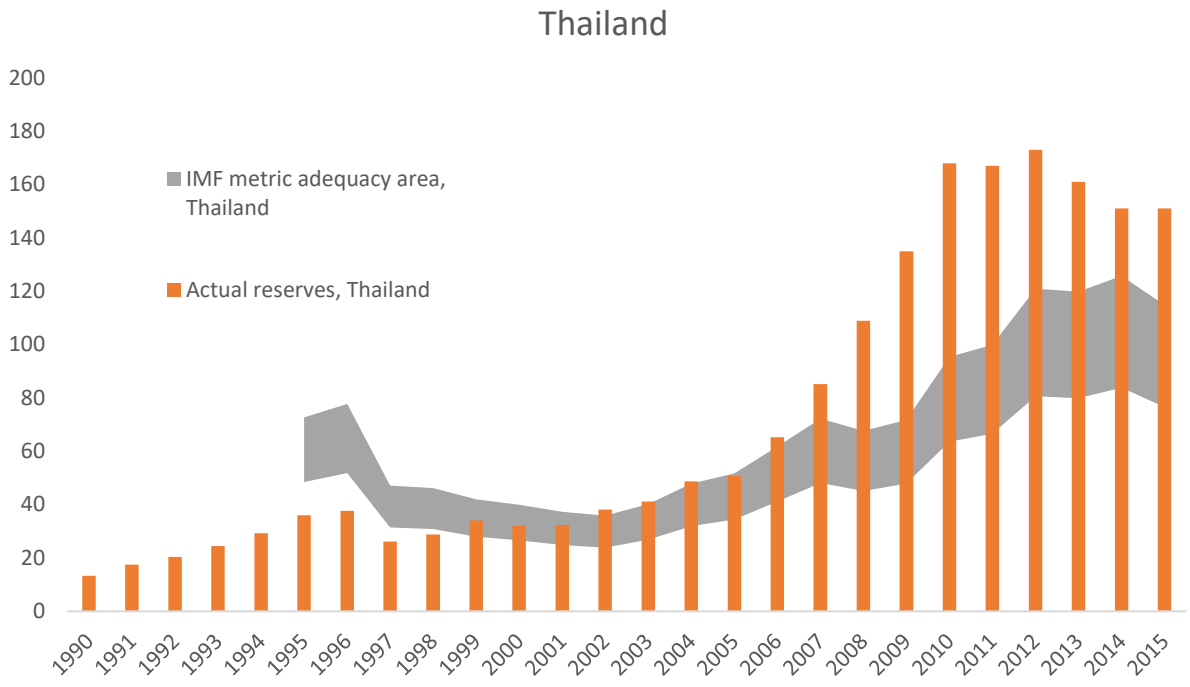
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015


Thailand
200
180
160
140
120
100
80
60
40
20
0
IMF metric adequacy area, Thailand
Actual reserves, Thailand
1990
1991
1992
1993
1994
1995
1996
1997
1998
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2015