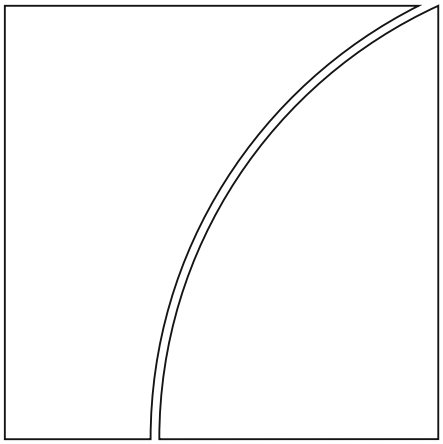

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by Andrew J Filardo and Pierre L Siklos

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Prolonged reserves accumulation, credit booms, asset prices and monetary policy in Asia[1]

Andrew J Filardo[2] and Pierre L Siklos[3]

Abstract

This paper examines past evidence of prolonged periods of foreign exchange reserves accumulation in the Asia-Pacific region. One empirical challenge is to identify periods of reserve accumulation that are sufficiently large and persistent to be categorised as prolonged. Several proxies for prolonged episodes are considered, including a newly proposed one based on a factor model. We then identify the key macrofinancial determinants of prolonged reserve accumulation. Two broad conclusions emerge from the stylised facts and the econometric evidence. First, the best protection against costly reserves accumulation is a more flexible exchange rate. Second, the necessity of accumulating reserves as a bulwark against goods price inflation is misplaced. Instead, there is a strong link between asset price movements and the likelihood of accumulating foreign exchange reserves that are costly. Policy implications are also drawn.

Keywords: foreign exchange reserves accumulation, monetary and financial stability

JEL classification: F41, F32, E44, D52

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1. Introduction

Explaining the motives for holding foreign exchange reserves continues to attract considerable research. There is, of course, a vast literature on the determinants of reserves holdings. The topic has garnered more attention in the past decade thanks in part to the prominence of China in international economic affairs and the seemingly concerted efforts by emerging markets more generally to accumulate vast amounts of foreign exchange reserves over time.[4] The G20's agenda, which includes reforms to the current international monetary system, has also raised awareness about foreign exchange management practices. Our interest is in investigating the determinants of the accumulation of international reserves over prolonged periods of time.

The Economist (2010) refers to a "monsoon" to describe recent patterns of reserve accumulation, particularly among emerging market economies. Graph 1 reveals an upward trend in the levels of foreign exchange reserves-to-GDP ratio, beginning in the 1990s, in nine of the 12 economies in the Asia-Pacific region that are examined in the present paper. Indeed, by the end of the sample in 2010, reserves exceeded 40% of real GDP in six of 12 economies shown (China, Hong Kong SAR, Malaysia, Singapore and Thailand) while the 20% threshold was reached in four other countries (India, Japan, Korea and the Philippines). Therefore, by any metric, holdings of foreign exchange reserves are sizeable. For example, Jeanne and Rancière (2011) conclude that international reserves holdings that exceed 10% of GDP are not optimal, at least in terms of the precautionary motive. With the exception of Australia and, at times, New Zealand, this level is easily surpassed in all of the other countries of the Asia-Pacific considered in this study.

Graph 1 also highlights the period of the Asian Financial Crisis (AFC; 1997–98) and the Global Financial Crisis (hereafter GFC; dates vary, see Dominguez, Hashimoto and Ito (2012, Table 3)). Reserves as a percentage of GDP rose slightly in India and Indonesia, and more so in the Philippines, Singapore, Thailand, Australia and New Zealand. Only China, Malaysia and Japan experienced modest declines. Visual comparisons with the AFC suggest a similar pattern with the exception of China and Korea, which saw increases, while volatility characterises the behaviour of reserves accumulation in Thailand and New Zealand. Australia's reserves holdings reveal a large drop before the GFC, followed by a resumption of the trend that began in the mid-1990s. The sharp depreciation of the Australian dollar assisted by an equally large fall in the Reserve Bank's policy rate likely contributed to this development.

Beyond the rise in levels of foreign exchange reserves holdings is the more intriguing observation of the incidence of episodes of prolonged reserves accumulation (PRA). This is the focus of the present study. These episodes are

[4] The large accumulation of foreign exchange reserves has also been seen beyond emerging markets. The Swiss National Bank in 2011 set a floor on the EUR/CHF exchange rate at 1.20 in view of the "…acute threat to the Swiss economy …" posed by the massive overvaluation of the Swiss franc." (see press releases of the Swiss National Bank, 6 September 2011, www.snb.ch). The Czech National Bank followed suit in late 2013 with its decision to use the exchange rate as an additional monetary policy instrument, https://www.cnb.cz/miranda2/export/sites/www.cnb.cz/en/monetary_policy/bank_board_minutes/2013/download/tk_07sz2013_aj.pdf. For the specific example of China, see Bonatti and Fracasso (2013).

broadly defined as taking place when the rise in foreign exchange reserves persistently exceeds some metric that proxies a trend in reserves holdings. There is no consensus on the precise meaning of the PRA concept. As a result, several proxies have been proposed in the literature. Moreover, it is apparent that the phenomenon examined in this paper is asymmetric, as one clearly observes a tendency towards the accumulation of reserves with fewer instances of reversals.[5] This phenomenon has already been observed by some (eg Blanchard, Faruqee and Dias (2010); Aizenman and Sun (2010)) and it has been argued that such an outcome also stems from the desire to hold a sufficiently large stocks of reserves to ward off future speculative attacks (eg Dominguez, Hashimoto and Ito (2012)).

Table 1 illustrates the phenomenon by listing episodes when the rolling three-year centred moving average of year-on-year changes in the reserves-to-GDP ratio proxy is positive in the Asia-Pacific economies in our sample.[6] Certain episodes reflect the impact of the AFC on economies such as Hong Kong SAR and the Philippines. Elsewhere, the moving average proxy remains permanently positive, again in the aftermath of the Asian crisis of 1997–98 in countries such as Indonesia, Korea and Singapore. Finally, there is widespread reaction to the financial crisis of 2008–09 as evidenced by the reserves build-up in Hong Kong, Malaysia, Thailand, India, Australia and New Zealand. Interestingly, there is almost no overlap between the episodes of PRA and so-called "sudden stops" wherein a sharp reversal in capital flows takes place (see eg Jeanne and Rancière (2011) and Durdu et al (2009).

Strikingly, the literature provides little guidance to explain why such episodes emerge. Whereas the early literature in this area (eg Heller (1966), Frenkel and Jovanovich (1981)) sought to determine optimal levels of foreign exchange reserves, either based on the precautionary motive, or by relying on principles of inventory management, research in recent years has shifted to asking why it became increasingly attractive for some central banks to accumulate reserves particularly when many evinced a tendency to adopt more flexible exchange rate regimes, occasionally alongside a form of inflation targeting.

Clearly, policymakers believe that this behaviour can pose economic risks, especially in emerging markets (eg IEO (2012), Filardo and Grenville (2012), Mohanty and Turner (2006), and Genberg et al (2005)). More recently, Obstfeld (2011) has highlighted the fiscal implications arising from the accumulation of foreign exchange reserves. Moreover, sterilisation is likely imperfect (for the experience of emerging markets, see eg Lavigne (2008), Disyatat and Galati (2005), and Siklos (2000)), while other macroeconomic indicators such as credit growth and asset price developments, albeit useful, provide noisy signals. Therefore, the fact that Hong Kong, Singapore and China have reserves holdings that approach their

[5] The asymmetry in the behaviour of reserves accumulation is also reflected in the observation that central banks in emerging markets tend to respond more aggressively to prevent exchange rate appreciations but are less reluctant to stop depreciations (see eg Pontines and Rajan (2011)).

[6] Other metrics are considered and evaluated below (see also the Appendix). The sample is the same as depicted in Graph 1.

annual GDP levels (see Graph 1) has macroeconomic implications that are, as yet, not well understood.[7]

Since we do not yet fully understand the consequences of attempts at persistent reserves accumulation, the present paper begins with some stylised facts and considers the role played by macroeconomic, financial and institutional factors in determining the likelihood of observing the phenomenon of PRA.[8] To be more precise, we ask whether there are robust determinants for the probability of observing PRA episodes. We also touch on the question whether changes in the central bank's balance sheet resulting from prolonged interventions are reflected in the balance sheet of the private sector (eg housing prices, equity prices, growth in domestic credit).

We provide a simple motivation for our empirical analysis by appealing to the usefulness of having multiple instruments when there is more than one monetary policy objective. Relatively fast-growing emerging markets, particularly ones in Asia, have opted for a macroeconomic policy geared towards two objectives, namely exchange rate stability and domestic economic stability. To achieve these aims, as required by Tinbergen's principle,[9] two policy instruments have been deployed, namely a policy rate (or a related monetary policy instrument such as changes in bank reserves requirements) and prolonged foreign exchange reserves accumulation.

The rest of the paper is organised as follows. In the following section we summarise the relevant literature. The data are described in Section 3 and some stylised facts are also provided. The econometric specifications as well as the empirical evidence are discussed in Section 4. The paper concludes with some policy implications and suggestions for further research.

2. Relevant literature

Recent research on the foreign exchange holdings practices of central banks typically identifies two principal motives.[10] They are: a precautionary desire to

[7] Nevertheless, these developments reflect persistent imbalances at the global level that would translate into an "…intensification of pressures on international monetary, financial and trading systems" (Haldane 2010).

[8] We do not address the issue whether this kind of behaviour represents a deliberate choice by policymakers in the economies considered or a failure to suitably cooperate in managing international economic conditions. Also not considered are the financial costs of holding and managing such reserves, especially in an era of historically low yields, and the forgone opportunities from not investing these funds in more profitable, if not more productive, endeavours. See, for example, Filardo and Grenville (2012) for a discussion of the implications of foreign exchange reserves and the accumulation of "lazy assets" on central bank balance sheets (ie low-yielding returns in relation to available alternative asset holdings).

[9] Namely, that the number of policy instruments should be at least as large as the number of policy objectives.

[10] Concerns over the foreign exchange reserves practices of some countries sometimes rest on the concept of the "impossible trinity", also called the policy trilemma, wherein domestic policymaking is constrained by the degree of capital mobility, the ability to set a domestic interest or policy rate, and the choice of exchange rate regimes.

provide adequate foreign exchange reserves in case an economic shock might otherwise precipitate a crisis (eg Aizenman and Marion (2003)); and a mercantilist view, revived by those who believe that the original Bretton Woods exchange rate system lived on in a fashion after its demise in the early 1970s, as a system that enabled some countries to protect their export markets (eg Dooley et al (2004)). More recently, a financial stability motive which is essentially a variant of the precautionary motive, wherein any threats to financial instability following the onset of a financial crisis can be prevented by ensuring that a sufficiently large "buffer stock" of reserves is available (eg Jeanne and Rancière (2006)).

As previously stated, all of these motives have implications for the decision as to what level of foreign exchange reserves is appropriate. Nevertheless, to the extent that the relevant economic shocks favouring one or more of these motives are persistent, these motives serve as the basis for prolonging the period over which reserves are accumulated. All of the foregoing explanations also presuppose that economic fundamentals are at work to explain the reserves holdings practices of central banks. Steiner (2013b) argues that the incidence of financial crises also prompts the ramping up of foreign exchange reserves holdings.[11] Steiner (2013b) highlights that foreign exchange reserves accumulation results partly from a "fear of capital mobility". As a result, at least in the short run, large reserves hold out the possibility of overcoming the restrictions imposed by the impossible trinity. Similarly, the willingness of policymakers to rely on capital controls is thought to impact the ability of central banks to effectively sterilise them since, at least in emerging markets, domestic and foreign assets are not perfect substitutes (see eg Bayoumi and Saborowski 2014).

Each one of the foregoing explanations gives rise to a variety of intervention practices in foreign exchange markets beyond sterilising foreign exchange transactions. For example, Aizenman and Hutchison (2010) report that, during the crisis which engulfed the world economy in 2008–09, the emerging markets they examined allowed the exchange rate to bear much of the adjustment over the alternative of allowing foreign exchange reserves to be depleted. Hence, this is tantamount to evidence of a shift from a fear of floating to a fear of losing reserves (also see Aizenman and Sun (2009)). Graph 1 does seem to provide some graphical support for this view.[12]

Empirically based attempts to establish whether foreign exchange holdings exceed some level deemed adequate, but not necessarily optimal, generally rely on the benchmark known as the Greenspan-Guidotti or G-G rule (Greenspan (1999),

[11] In a related vein, Steiner (2014) calibrates a reserves holding model to suggest the potential for the hoarding of reserves on a global scale to potentially trigger a financial crisis. Hence, the very phenomenon such practices were intended to prevent can actually become more likely. Likewise, the decision to accumulate foreign exchange reserves creates a kind of demonstration effect that leads others to follow suit. The "keeping up with the Joneses" phenomenon has also been supported empirically (see eg Pontines and Yongqiang (2011)).

[12] In related work, Aizenman, Lee and Sushko (2010) also point out that the fear of losing reserves may well have been exacerbated by the fact that, unlike many industrial economies, emerging market economies did not have access to the swap lines with the US Fed. These swap lines were meant to alleviate the apparent shortage of US dollars. The countries in our sample that made use of this facility were Japan, Korea and Singapore. See Dominguez, Hashimoto and Ito (2012). As a result, financial factors played a far greater role during the latest crisis than when the world economy was in the Great Moderation era.

Guidotti et al (2004)): a level of reserves equal to short-term external debt with a maturity of up to one year ought to provide adequate protection against an economic shock that threatens the external position of the domestic economy.[13] Why such a rule would apply to economies that either do not borrow from abroad, or do so modestly, is unclear. Nevertheless, the rule does indicate a level of concern about insuring against adverse capital outflows. Moreover, since so many countries exceed this rule, often by a wide margin (see eg ECB (2006)), the practice of accumulating large quantities of foreign exchange holdings is regarded as something of a puzzle.

It is worth underscoring the fact that there is no agreement about how broadly the G-G rule, or some variant, is applicable across emerging markets. For example, while the September 2003 *World Economic Outlook* (IMF (2003)) recommended that Asian economies cut back on their policy of building up foreign exchange reserves, the data in Graph 1 suggest that most countries did not heed their advice. Blanchard and Milesi-Ferretti (2011) argue that reserves holdings which appear excessive may simply reflect the role played by capital controls that limit the ability of domestic residents to acquire foreign financial assets. However, if this interpretation is correct, then periods of prolonged reserves accumulation may reflect persistent imbalances between savings and investment. Indeed, financial imbalances are believed by some to have contributed to the recent US housing bubble as well as providing the necessary fuel for its subsequent bust (Bernanke et al (2011)). IEO (2012), which reviews the policy positions of the IMF, criticises the international agency for advocating policies that "…stressed the symptom of problems rather than the underlying causes…" (op cit, p v) and by proposing levels of reserves adequacy that fail to consider country-specific factors and needs.

The empirical literature resorts to a fairly broad array of economic determinants to econometrically explain foreign exchange reserves holdings (see eg Dominguez, Hashimoto and Ito (2011), Dominguez (2010), Hashimoto and Ito (2007), Aizenman and Lee (2005) and CGFS (2009)). Typically, the focus has been on the short run, although a few studies have also considered whether determinants of reserves holdings and the quantities of foreign exchange reserves held are attracted to each other, in a statistical sense, thereby raising the possibility that there are also long-run determinants of foreign exchange reserves holdings (eg Gosselin and Parent (2005). Many of these determinants are the same as those that appear in short-run studies of the determinants of foreign exchange reserves. Variables believed to influence reserves holdings run the gamut from the exchange rate regime to the state of domestic fiscal policy. Only recently have studies begun to consider the implications of recurring financial crises on reserves behaviour (eg Gourinchas, Rey and Govillot (2010)).

As seen from Table 1, introduced earlier, there are frequent episodes during which reserves accumulate for an extended period of time. However, there is little empirical guidance about whether this phenomenon can be linked to economic fundamentals (ie output and inflation performance, the behaviour of asset prices and so on). This is surprising. Poole (1992), for example, documents how the Plaza-

[13] Jeanne and Rancière (2006) specify a model with the aim of quantifying the size of foreign exchange reserves holdings needed to satisfy precautionary motives. They conclude that the G-G rule is plausible under certain circumstances and, hence, they provide a theoretical rationale for this type of rule.

Louvre Accords of 1985–87 impacted the US economy as well as the economies of the United Kingdom, Germany and Japan.[14] This resulted in a sharp and prolonged change in the foreign exchange reserves holdings in all of these countries that lasted several years (op cit, Graph 3). As a result, the real economic implications for the United States were clear to Poole: "This classic monetary-policy cycle was accompanied by a classic cycle in real activity. Industrial production first rose in response to higher money growth and then fell as inflation rose and money growth declined" (op cit, p. 75). Just as important, there were real economic effects in the other major economies as well. Indeed, Frankel's exhaustive survey (Frankel (2010)) does not allude to this phenomenon, apparent in several emerging market economies, preferring instead to highlight disagreements over whether amassing foreign exchange reserves can largely be explained by precautionary or mercantilist motives.

3. Data and stylised facts

In what follows we examine data at the quarterly sampling frequency for 12 economies in the Asia-Pacific region. For some key variables (eg GDP) the raw data are only available at this sampling frequency. Indeed, in a few cases, data are available only at the semiannual or annual frequencies (eg capital mobility index, some property price data). When the raw data are not available at the quarterly frequency, linear interpolation is employed to create series at the quarterly frequency.

The economies in the data set are as follows: Australia, China, Hong Kong SAR, India, Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippines, Singapore and Thailand. The sample periods over which various econometric specifications are estimated vary owing to differences in data availability and coverage. In addition, as the motives for holding reserves may well have evolved over time (see eg Obstfeld (2011)), we also provide estimates for different country groupings for samples that begin in the 1960s, 1970s and 1980s. These are also partly motivated by data availability.

It is well known that there exist several ways to measure foreign exchange reserves adequacy, including reserves-to-GDP, reserves-to-imports, or reserves-to-short-term external debt. All are intended to capture an economy's ability to withstand economic shocks operating through their balance of payments.[15] Moreover, the theoretical literature provides no convincing argument to support

[14] Indeed, the origins of the Japan's "lost decade" may well have been triggered in part because of the appreciation of the yen that followed these two agreements. See, however, IMF (2011, Box 1.4) for a different interpretation.

[15] Another measure that is occasionally used is the ratio of foreign exchange reserves to some monetary aggregate. A practical difficulty with this measure is that monetary aggregates are frequently redefined or contain some discontinuities.

one measure over another. More often than not, analysts rely on the reserves-to-GDP proxy because it is also the indicator available for the longest span of time.[16]

As we are interested in changes in foreign exchange reserves holdings over time, Graph 2 plots two proxies that serve as the basis for evaluating PRA episodes. They are: a rolling three-year centred moving average of changes in the reserves-to-GDP ratio and deviations in H-P filtered reserves-to-GDP ratio measure.[17] There is clearly evidence of prolonged rises and declines in changes in foreign exchange reserves holding relative to some trend, relying on either proxy. Nevertheless, the PRA phenomenon is especially apparent when the moving average proxy is considered. Of course, several proxies for PRA have been proposed in the literature. Detken and Smets (2004) use a proxy that is similar to the moving average proxy defined above. Mendoza and Terrones (2008), Alessi and Detken (2010), Adalid and Detken (2007), Borio and Lowe (2002) and Gourinchas, Velde and Landerretche (2001) all employ variants of the H-P filtered proxy also included among the candidates that proxy PRA.[18]

Next, Table 2 provides some evidence on the incidence of PRA episodes considered sizeable or "painful" in terms of their overlap with business cycle and asset price cycle-related contractions. It should be noted that our proxies are new (also see, footnote 15 above). We follow the approach for selecting business cycle contractions of the "sizeable" and "painful" varieties defined by Edwards (2007). These are labelled ES and EP, respectively. Sizeable foreign exchange reserves accumulation episodes take place when the reserves-to-GDP measure rises (or falls) by 3% or more. This threshold implies that Australia, Japan, New Zealand and the Philippines experienced no such events. Since the threshold is somewhat *ad hoc*, the table also shows the case when the threshold is instead set at ± 2%. Given that the threshold applies to data at the quarterly frequency, even a 2% threshold arguably represents a sizeable change in the reserves-to-GDP ratio. In addition, since the resulting proxy is based on a three-year centred moving average (see Graph 2), it seems reasonable to refer to them as PRA episodes. It is also worth highlighting, as shown in Table 2, that foreign exchange reserves change in an asymmetric manner with relatively few examples of sharp declines in reserves. Malaysia and Singapore experience drops in reserves-to-GDP that are greater than 2–3% over the sample considered. Australia experiences a sharp drop in reserves holdings but it is too brief to be recorded as sizeable. We will use the ES proxy as a benchmark of sorts against which we can compare our results that rely on alternative PRA indicators.

We then consider the joint occurrences of PRA episodes together with contractions in business cycles and asset prices. "Painful" episodes are ones where the moving average of reserves-to-GDP ratio exceeds +3% and there are two consecutive quarters of negative output gaps ("painful" output gap), or real per capita real GDP growth is negative ("painful" real per capita). Two separate definitions of business cycle contractions are employed. First, we again follow

[16] It is important to note that the variable we seek to explain is based on a classification such as the one shown in Table 1 and not the series shown in Graph 1. Plots of various proxies of the PRA proxy are relegated to the Appendix.

[17] A smoothing parameter of 100000 is applied to the data shown in Graph 1.

[18] The Appendix to the paper provides more precise details about the construction of PRA proxies not emphasised here.

Edwards (2007), by defining a fall in real per capita income or two consecutive periods of decline in the per capita output gap to represent business cycle contractions. We also consider the juxtaposition of PRAs with episodes of growth recessions based on the Economic Cycle Research Institute's dating of such events (www.businesscycle.com). Focusing on sizeable PRA episodes (defined on the basis of a 3% threshold) and on "painful" PRA episodes (defined as decreasing real per capita income events), half the economies in the sample experience PRA episodes that are both sizeable and "painful".[19] The number of economies with the joint occurrences rises to seven when relying on the output gap indicator while only two economies experience both PRAs and growth rate recessions, namely China and Korea.

Now consider the combination of PRAs with "busts" in asset prices, where these are proxied by housing and equity prices. For this purpose we adopt the Mishkin and White (2003) definition of a "crash" in asset prices as taking place whenever there is a 20% or more fall in equity prices on an annual basis. As seen in Table 2 these kinds of episode emerge in most of the economies in our sample as frequently as some of the other costly events considered. Continuing in the same vein, we ask whether there is some synchronicity in PRA episodes and costly output and asset price changes. This is evaluated by estimating the concordance index, due to Harding and Pagan (2002), between PRAs and large negative movements in equity prices and output relying on the Mishkin and White metric. The results are shown in Table 3 for both the full sample and a sample when either the Great Moderation prevails or when globalisation is believed to take hold (1986–2007). If PRAs were perfectly synchronised with either one of the paired variables, the index would be equal to one; a zero value for the index is indicative of a countercyclical relationship between the series. Synchronicity is enhanced during the globalisation period while stock price downturns or large negative output gaps are most highly synchronised for China, Hong Kong, Malaysia, Singapore and Thailand.

The stylised facts considered so far do suggest that real and financial links exist with the accumulation of international reserves. In the following section we explore these via econometric estimation.

4. Econometric specifications and empirical results

Since we have identified PRA episodes using a wide variety of definitions that have been used in the literature (ie moving average, H-P filter, sizeable (ES), "painful" (EP)) we now provide some econometric estimates of the likelihood that selected macroeconomic and financial factors will contribute to such events. A dummy variable is created set equal to 1 in any quarter when a PRA episode has been identified and zero elsewhere. Probit estimation under these circumstances is appropriate. As indicated earlier, our focus initially is on the ES and moving average proxies (labelled RESACC), although new indicators are also introduced below. Define PRA_{it} as episodes of prolonged reserves accumulation, such that

[19] If we consider a 2% threshold then eight of 12 economies experience both a PRA and an economic contraction defined in terms of changes in real per capita GDP.

$$PRA_{it} = \begin{cases} = 1 \text{ if } r_{it}^{*} > 0 \\ = 0, \text{ otherwise} \end{cases} \tag{1.1}$$

where PRA_{it}^{*} is an unobserved latent variable, estimated in the manner described below, while PRA_{it} is the observed proxy and set equal to 0 or 1, and r_{it}^{*} is the moving average reserves-to-GDP ratio indicator defined earlier. Next, we posit that PRA is a linear function of a vector of macroeconomic and institutional variables, denoted by Ω_{it}, to be discussed below. The estimated specification is then written

$$PRA_{it}^{*} = \Omega_{it}\beta^{'} + \eta_{it} \tag{1.2}$$

where the index *i* identifies the country and η_{it} is a residual term assumed to satisfy the usual properties.[20] Various proxies define PRA. By way of a benchmark we consider whether foreign exchange holdings are sizeable (ES), following Edwards. Next, we consider the three-year rolling centred moving average proxy (RESACC). Others are introduced below.

As discussed previously, there is no unique or consensus measure of PRA. An alternative which, to our knowledge, has yet to be considered in the literature is to construct estimates of PRA based on a factor model where we restrict the number of factors to two since the literature suggests that two principal motives for the accumulation of foreign exchange reserves exist, namely the self-insurance/financial stability and mercantilist motives. In this case the dependent variable in equation (1.2) is replaced with one derived from estimating

$$\mathbf{Y}_{it} - \boldsymbol{\mu} = \Phi\mathbf{F}_{it} + \varepsilon_{it} \tag{1.3}$$

where **Y** is the vector of observables, namely 10 different proxies for PRA,[21] Φ are the factor loadings, that is, the relative weight of each PRA proxy in constructing the two factors representing PRA (results not shown), **F** is the common factor(s) while the idiosyncratic contribution of each PRA proxy is summarised by ε. The first factor is assumed to represent the self-insurance motive since the PRA proxies are positively related to each other. If each one of the proxies reflects the self-insurance motive for holding foreign exchange reserves, then all of the proxies should increase (or fall) arising out of a need to forestall a surge in the demand for reserves following some negative economic shock.

The second factor is assumed to capture the mercantilist motive. A priori we do not know how strong the mercantilist motive is. Hence, depending on the central bank and the particular construction of the PRA, some policymakers may well respond to developments in external accounts by accumulating foreign exchange

[20] We also considered one-period lags for all of the variables that displayed some persistence. However, all of our conclusions are unaffected by this change. Hence, the results reported below omit lags.

[21] Details of the construction of these proxies are relegated to the Appendix. An earlier version of this paper (Filardo and Siklos (2013)) also provides the details. In addition to the proxies proposed by Edwards (2007; ES, EP), the moving average indicator defined above is also included, as are the proxies of Mendoza and Terrones (2008), Alessi and Detken (2010), Adalid and Detken (2007), Borio and Lowe (2001), Detken and Smets (2004), Calvo, Izquierdo and Mejia (2004), Gourinchas, Velde and Landerretche (2001), Helbling (2005), and Mishkin and White (2003).

reserves. Alternatively, existing levels of foreign exchange reserves could serve as a buffer stock against temporary shocks to be subsequently rebuilt. Hence, there is no reason, *a priori*, for the PRA proxies to be positively related to each other as domestic considerations will dictate the sign of the factor loadings. The resulting scores define PRA. Since these scores are not bounded in the [0,1] interval we can estimate this version of equation (1.2) via OLS.[22]

Turning to the potential determinants of PRA (ie Ω_{it}) the existing literature offers a large variety of candidates to choose from. They include: a measure of capital account openness developed by Chinn and Ito (2008), measures of exchange rate regime flexibility created by Levy-Yeyati and Sturzenegger (2005), or the alternative classification proposed by Reinhart and Rogoff (2004),[23] the rate of change in the nominal exchange rate, inflation, real per capita GDP growth or, as an alternative, the output gap and foreign direct investment (FDI).

A series of "gap" indicators for asset prices is also considered. The gaps were estimated by applying an H-P filter with a large smoothing parameter (λ=100,000). The justification for this choice is the same one used earlier to construct some of the proxies for the PRA indicator. The methodology used to generate the gaps were previously defined and were applied to domestic credit, equity returns, foreign direct investment, real property prices and the M2 money stock measure. The rate of change in the WTI (West Texas Intermediate) oil price index is added to account for the role of commodity prices in influencing the desire to hold foreign exchange reserves. As a proxy for uncertainty and the role this might play in influencing the choice to engage in a prolonged period of foreign exchange reserves accumulation, we also added the VIX.[24] Finally, to account for the possible role of the "global" financial crisis, we also consider interaction terms with the financial variables in Ω_{it}, namely gaps in credit, real estate prices, foreign direct investment and M2. To conserve space we only present the essential results and note how robust these are to small changes in the estimated specifications.

The global financial crisis defined as a (0, 1) dummy variable. The chronology of Dominguez, Hashimoto and Ito (2012), developed for each one of the countries in our data set, is used to define the GFC dummy. We also include a common date (see Graph 1) for the period of the Asian Financial Crisis.

Generally, speaking, one expects the following relationship between the determinants listed above and PRA. A flexible exchange rate regime (ERRFC) would make it less likely for one to observe PRA episodes. In principle, the nominal exchange rate should adjust to prevent any sudden depletion (or surge) in foreign exchange reserves. A similar argument would apply to explaining why greater capital account openness (KAOPEN) would reduce the need to continue accumulating foreign reserves. Note, however, that if the self-insurance motive

[22] It is conceivable that some of the determinants of PRA are endogenous. However, experimentation also suggests that instrument quality is a potential concern, making instrumental variable estimation (eg GMM) unreliable under the circumstances.

[23] In the results discussed below we rely on the so-called fine classification created by Reinhart and Rogoff (2004).

[24] The VIX is a widely used indicator of short-term expected volatility in equity markets derived from options on the S&P 500 index.

alone predominates, then fears of capital outflows may well reverse the sign of such a relationship. Similarly, greater uncertainty, proxied by a rise in the VIX, might well lead the authorities to favour the accumulation of foreign exchange reserves. It should be noted, however, that, since the VIX evaluates uncertainty in US financial markets, this need not translate into greater uncertainty either globally or in the Asia-Pacific region. As reported in Burdekin and Siklos (2011; also see references therein), equity markets in the Asia-Pacific and the United States were far from being coupled over much of the sample considered in this study.

A rise in inflation (INFL) ought to result in a depreciation of the domestic currency, thereby raising the value of existing reserves and possibly leading to a decline in the likelihood that the monetary authorities will continue accumulating reserves.[25] Similar arguments apply to the influence of the various asset price gaps (CREDGAP, credit gap; STMKGAP, stock market gap; RPPGAP, real estate price gap; M2GAP, gap in the M2 money stock measure) on the probability that foreign exchange reserves holdings will rise. Finally, since the market for oil is denominated in US dollars, a rise in its price (WTI) would lead to an enhanced desire to hold greater reserves, possibly as a hedge. Finally, again depending on the ability and willingness of the authorities to engage in sterilisation, FDI flows can also contribute, positively or negatively, to changing international reserves holdings.

Estimates provided in Tables 4 and 5 reveal that the statistical significance of the determinants of PRA is robust across various definitions considered. In particular, greater capital account mobility as well as more exchange rate flexibility reduces the likelihood of accumulating additional foreign exchange reserves – with one notable exception, namely when the self-insurance motive is the factor that drives PRAs. Next, a significant positive determinant of the desire to accumulate reserves is the VIX proxy for financial uncertainty as a determinant of the mercantilist motive but not when the self-insurance motive is considered. Similarly, higher oil prices are associated with a greater propensity to hold reserves. One effect of the GFC comes from the interaction between excessive credit growth, that is, a positive credit-to-GDP gap and the GFC dummy. The GFC also seems to play a slightly larger role in the mercantilist explanation of build-ups of reserves through the relaxation of credit growth in crisis conditions. Finally, it is generally found that domestic inflation reduces the desire to engage in PRA as does a booming economy, proxied here by a positive output gap. There is some evidence that foreign direct investment during the crisis tempers the willingness to accumulate foreign exchange reserves as well as some indications that real estate and equity market prices also significantly impact PRA. However, the results are sensitive to the particular specification and, hence, cannot be considered robust.

An interesting result concerns the separate impact of the factors meant to proxy the self-insurance and mercantilist motives on the likelihood of PRA. For example, a floating exchange rate reduces the probability of engaging in PRA when this is assumed to be driven by the self-insurance motive. This is consistent with the view that exchange rate flexibility acts as a substitute for the need to accumulate foreign exchange reserves. In contrast, if PRA is defined by the mercantilist motive then a floating exchange rate does not contribute reserves holdings. In particular,

[25] A referee points out that if sterilisation fails, and the accumulation of foreign exchange reserves becomes inflationary, a mercantilist policy can backfire. In this case the coefficient will also be negative.

depending on the strength of pass-through effects, a floating exchange rate need not completely insulate the domestic economy from external shocks. Furthermore, a credit boom raises the likelihood of a PRA when the self-insurance/financial stability motive is considered but the mercantilist motive leads to a reduction in the same probability. The negative response to a credit boom when the mercantilist motive predominates reflects the fact that this explanation focuses on trade in goods and services while ignoring external financial flows that are likely to be built up during a credit boom.[26]

Table 5 complements results shown in Table 4 by presenting evidence for different sample periods and country groupings.[27] Some of the country groupings are dictated by data availability and are easily identified in each table. Hence, data since the 1960s are used to generate estimates of equation (1.2) for Australia, Japan, Korea, New Zealand and Singapore, while data for the next group of economies, consisting of Hong Kong, Malaysia. Philippines and Thailand begin sometime during the 1970s. The final group of countries, which includes China, Indonesia and India, relies on a sample that begins in the 1980s. This particular way of organising the data also influences data availability for some of the determinants of PRA (ie Ω_{it}).

For the most part, the signs reported in Table 4 carry over to the estimates shown in Table 5. However, it is interesting to consider whether some economies are more prone than others, on average, to engage in PRA. Of course, some of the results are more robust to the PRA proxy employed than others. Nevertheless, on balance, Hong Kong is prone to engaging in PRA, while China, Indonesia and India are less prone, on average, to be involved in this kind of activity. Although the result for China may appear at first glance to be surprising, the period of PRA is a relatively recent one, as both Graphs 1 and 2 suggest. In other words, the Chinese experience is sufficiently brief to suggest that PRA is not yet a firm feature of the landscape that explains the country's reserves holding behaviour.[28]

5. Conclusions

This study has considered the determinants and implications of the accumulation of foreign exchange reserves that has been evident in most Asia-Pacific economies for well over a decade. The following conclusions emerge based on the stylised facts

[26] Hence, the interaction of a credit boom and a financial crisis raises the likelihood of a PRA as a partial response to the central bank's desire to reduce the fallout from such an event. However, this is partially offset, according to the mercantilist motive, by a desire to reduce foreign exchange holdings (hence, the negative CREDGAP coefficient) in order to stem the pressure from an appreciating currency. Interaction effects alone are shown for the CRISES dummy (=1 during the Asian [1997Q1 – 1998Q4] and Global Financial Crises [dates vary by country; see above]). The CRISES dummy alone is highly insignificant when added. An illustration of the results is relegated to the Appendix. Space constraints also prevent a discussion of the marginal effects associate with each determinant.

[27] A referee suggested that we consider a pooled regression. We did try this and while the results for the determinants of interest remain broadly similar, idiosyncrasies, in reserves accumulation behaviour (eg see Table 1) argue against conditioning on fixed effects.

[28] Moreover, one should not confuse the size of reserves holdings with the degree to which these might be excessive according to the metrics used in this study.

and the econometric evidence presented in this study. First, data suggest that reserves accumulation is less likely under flexible exchange rates and capital mobility. Second, there is a clear and robust trade-off between output and the accumulation of foreign exchange reserves. Third, the necessity of accumulating reserves as a bulwark against goods price inflation is not evident from the results. Fourth, while above-trend economic growth serves to lessen the desire to hold reserves, the opposite is true in response to commodity price movements and economic uncertainty as proxied by the VIX. Finally, there is also a previously under-explored link between asset price movements and the likelihood of accumulating foreign exchange reserves for prolonged periods.

Turning to the implications, policies pursued by several Asian economies to accumulate these reserves are potentially economically costly (eg Rodrik (2006), Bianchi, Hatchondo and Martinez (2012), Filardo and Grenville (2012)), especially when assuming that the returns on international reserves remain relatively low. While it is difficult to establish a direct link between prolonged reserves accumulation and their macroeconomic impact it is worthwhile asking about the implications of these episodes for the financial sector. A plausible scenario involves banks loading up on government securities, that is, acquiring sovereign debt with a low risk weighting and low returns. In particular, such policies lead banks to accumulate low yielding (ie "lazy") assets (eg government securities), which may entail exchange rate risk, not to mention the risk of capital losses when interest rates rise. Of course, a possible reaction of banks, depending upon the quality of the regulatory environment, is to move up the risk curve as they seek to maintain stable asset or equity returns. In either case, the accumulation of foreign exchange reserves has the potential to influence financial markets and, thereby, impact macroeconomic performance via distortions in the credit allocation process. Unfortunately, the necessary data to investigate the effects of growing foreign exchange reserves holdings on bank performance are hard to come by. Nevertheless, based on data from Bankscope for China, Hong Kong, South Korea and Thailand, we find that the Global Financial Crisis and the downward shift in yield curves, have reduced bank asset returns, consistent with the "lazy" assets hypothesis (results not shown). Moreover, there is also some evidence that reserves accumulation has a positive effect on asset returns, which is consistent with the notion that such policies may well lead banks to also take on more risky assets.

An important drawback with the existing metrics for foreign exchange reserves is that the metrics fall short of accounting for a range of economic and financial stability costs arising during long periods of significant reserve accumulation. Accordingly, we propose a new metric that takes advantage of the information content of the various indicators of the intensity with which foreign exchange reserves are held; we estimated factor models based on all the proxies for reserves accumulation considered in this study and we conclude that this approach broadly supports our conclusions. At least two other important extensions also await. First, it may be useful to adopt the treatment effect view of the link between exchange rate regimes and reserves accumulation. Second, we need to more carefully deal with the possible endogeneity of some of the regressors. The shortage of good instruments is a challenge that remains difficult to overcome.

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Episodes of prolonged reserves accumulation, 1960–2010 Table 1

Economy	Sample	Episodes	Duration	% of sample
Australia	1960.4-2010.2	1961.2-1962.1	2	40.3
		1963.4	1	
		1971.1-1974.1	13	
		1982.2-1986.2	15	
		1986.4-1991.4	21	
		1999.4	1	
		2000.4	1	
		2001.2-2001.3	2	
		2003.2-2004.2	5	
		2004.4	1	
		2005.2	1	
		2005.4-2010.1	18	
China	1980.4-2010.2	2003.2-2008.4	23	22.7
		2009.2-2010.1	4	
Hong Kong	1990.4-2010.2	1997.3-1998.1	3	10.1
		2009.2-2010.2	5	
Indonesia	1980.4-2010.2	1997.3-2010.1	51	42.9
India	1980.4-2010.2	1994.1-1995.1	5	26.9
		2002.1-2005.3	14	
		2006.2	1	
		2007.1	1	
		2007.3-2010.1	11	
Japan	1960.1-2010.2	1971.3-1972.2	4	21.8
		1972.4	1	
		2000.3-2010.1	39	
Korea	1960.4-2010.2	1998.2-2010.1	48	24.2
Malaysia	1980.4-2010.2	1992.3	1	21.8
		1993.3-1994.3	5	
		1999.2	1	
		2004.1-2005.4	8	
		2006.2	1	
		2007.2	1	
		2008.1-2010.1	9	
New Zealand	1980.4-2010.1	1983.1	1	17.8
		1984.4	1	
		1986.3-1987.2	4	
		2005.4-2008.3	12	
		2009.1-2009.2	2	
		2010.1	1	
Philippines	1973.1-2010.2	1991.2	1	41.3
		1991.4-1992.1	2	
		1992.3-1994.3	9	
		1996.2-1997.1	4	
		1997.3	1	
		1998.2-1998.3	2	
		1999.1-2001.2	10	
		2002.1-2010.1	33	
Singapore	1975.4-2010.2	1985.4-1986.4	5	54.7
		1992.3-2010.1	71	
Thailand	1980.4-2010.2	2008.1	1	6.7
		2008.4-2010.2	7	

Note: The sample represents the period for which the reserves data are available. The column labelled "episodes" represents the samples when the three-year year-on-year moving average of reserves-to-GDP ratio is positive. Duration is measured in quarters while the % of sample is the number of quarters as a percent of the total number of observations when the moving average measure exceeds zero.

Incidence of sizeable and painful episodes of prolonged reserves accumulation, 1960–2010

Table 2

Economy	Foreign Exchange Reserves				Real GDP				Painful equity (1)	Painful Equity (2)
	Sizeable increase 3%	Sizeable increase 2%	Sizeable decrease -3%	Sizeable decrease -2%	Painful real per capita (1)	Painful real per capita (2)	Painful output gap	Painful Growth		
AU	0	0	0	0	0	0	0	0	0	0
CN	19	38	0	0	0	0	12	6	3	8
HK	32	45	0	0	11	14	14	0	6	7
ID	10	12	0	0	6	6	4	0	5	5
IN	3	14	0	0	0	0	1	0	0	1
JAP	0	13	0	0	0	0	0	0	0	2
KR	9	16	0	0	2	4	5	4	2	8
MY	34	42	5	10	5	5	17	0	7	7
NZ	0	9	0	0	0	2	0	0	0	0
PH	0	14	0	0	0	8	0	0	0	3
SG	29	43	5	16	9	13	20	0	5	8
TH	7	23	0	0	1	2	0	0	1	2

Notes: the figures in the table refer to the number of quarters consistent with episodes as defined in the text. The definitions of "sizeable" and "painful" follow those of Edwards (2007). For foreign exchange reserves a "sizeable" change represents a quarter when the three-year moving average of reserves-to-GDP exceeds the threshold shown above. For output and asset prices the "painful" episodes are ones where the moving average of reserves-to-GDP ratio exceeds +3% and there are two consecutive quarters of negative output gaps ("painful" output gap), or real per capita real GDP growth is negative ("painful" real per capita). "Painful" equity periods are defined as ones where the three-year moving average of reserves growth exceeds either 3% (1) or 2% (2) and the rate of change in stock prices exceeds –20%. "Painful" growth are the number of quarters when there is a growth recession combined with sizeable reserves accumulation. See the appendix for the country code details. A smoothing parameter of 1600 is used to estimate the output gap.

Synchronicity of prolonged reserves accumulation and costly equity or output gap cycles, 1960–2010

Table 3

Economy	Sizeable vs Equity (2) Full	Sizeable vs Equity (3) Global	Sizeable vs Equity (4) Full	Sizeable vs Output (5) Global	Sizeable vs Output (6) Full	Sizeable vs Output (7) Full
AU	.09	.03	.09	.05	.07	.07
CN	.18	.36	.13	.34	.16	.09
HK	.23	.40	.18	.39	.30	.27
ID	.12	.20	.11	.15	.07	.07
IN	.13	.27	.09	.16	.07	.03
JP	.17	.32	.13	.16	.08	.03
KR	.11	.22	.14	.14	.21	.22
MY	.24	.43	.20	.42	.20	.17
NZ	.13	.19	.08	.15	.10	.05
PH	.18	.26	.14	.19	.16	.12
SG	.20	.34	.16	.35	.22	.19
TH	.18	.36	.11	.31	.16	.09

Note: Sizeable in columns (2), (3), (5) and (6) refers to the foreign exchange reserves variable defined in defined in Table 2, column (2). Sizeable in columns (4) and (7) refers to the foreign exchange reserves variable defined in defined in Table 2, column (3). Equity refers to the painful equity variable (1) also defined in Table 2. Output refers to a binary variable created by setting output equal to 1 whenever the output gap is –2% or greater. Synchronicity refers to the coincident index of Harding and Pagan (2002) between two series α and β defined as: $\frac{1}{N}\sum_{t=1}^{T}\{\alpha_t\beta_t+(1-\alpha_t)(1-\beta_t)\}$ where $\alpha,\beta=\begin{cases}0\\1\end{cases}$ are binary variables such that α =1 whenever the economy in question is in a PRA episode, and $\beta=0$ whenever the output gap is –2% or larger or the economy in question is in a painful equity drop period.

Probit and factor model estimates of the likelihood of episodes of prolonged foreign exchange reserves accumulation, 1960–2010

Dependent variable: Proxy for PRA, ES (Edwards – Sizeable) Table 4 (1)

Variable	Coeff.	SE	z–Stat	Prob.
C	–0.63	0.28	–2.20	0.03
KAOPEN	–0.14	0.07	–2.16	0.03
CREDGAP	–0.73	0.64	–1.15	0.25
CREDGAP*CRISES	4.15	1.06	3.91	0.00
STMKGAP	–0.37	0.35	–1.06	0.29
FDIGAP	0.12	0.07	1.80	0.07
FDIGAP*CRISES	–0.24	0.19	–1.24	0.21
RPPGAP	–0.02	0.01	–2.59	0.01
RPPGAP*CRISES	0.02	0.02	1.12	0.26
INFL	0.02	0.01	1.30	0.19
M2GAP	–0.00	0.00	–0.44	0.66
M2GAP*CRISES	–0.00	0.01	–0.17	0.86
PCRGDPGAP	–0.06	0.03	–1.76	0.08
ERRFC	–0.17	0.02	–8.33	0.00
VIX	0.04	0.01	3.55	0.00
DLWTI	0.01	0.00	3.09	0.00
McFadden R-squared	0.33			
LR statistic	153.94			
Prob(LR statistic)	0.00			
Obs with Dep=0	494		Total obs	575
Obs with Dep=1	81			

Probit and factor model estimates of the likelihood of episodes of prolonged foreign exchange reserves accumulation, 1960–2010

Dependent variable: Proxy for PRA three-year centred moving average, RESACC Table 4 (2)

Variable	Coeff.	SE	z–Stat	Prob.
C	0.19	0.25	0.76	0.45
KAOPEN	–0.38	0.06	–6.40	0.00
CREDGAP	2.00	0.50	3.96	0.00
CREDGAP*CRISES	5.41	1.04	5.19	0.00
STMKGAP	–0.62	0.28	–2.21	0.03
FDIGAP	–0.03	0.05	–0.62	0.54
FDIGAP*CRISES	–0.37	0.18	–2.09	0.04
RPPGAP	0.01	0.01	2.13	0.03
RPPGAP*CRISES	–0.00	0.01	–0.18	0.85
INFL	–0.25	0.03	–9.45	0.00
M2GAP	–0.00	0.00	–0.69	0.49
M2GAP*CRISES	–0.02	0.01	–2.41	0.02
PCRGDPGAP	–0.07	0.03	–2.10	0.04
ERRFC	0.06	0.02	3.20	0.00
VIX	0.02	0.01	2.75	0.01
WTI	0.01	0.00	2.17	0.03
McFadden R-squared	0.27			
LR statistic	214.37			
Prob(LR statistic)	0.00			
Obs with Dep=0	277		Total obs	581
Obs with Dep=1	304			

Probit and factor model estimates of the likelihood of episodes of prolonged foreign exchange reserves accumulation, 1960–2010

Dependent variable: Proxy for PRA

Table 4 (3)

	Factor 1: self-insurance motive				Factor 2 Mercantilist motive			
Variable	Coeff.	SE	t-Stat	Prob.	Coeff.	SE	t-Stat	Prob.
C	–0.50	0.15	–3.43	0.00	0.17	0.15	1.15	0.25
KAOPEN	0.05	0.03	1.87	0.06	–0.07	0.03	–2.33	0.02
CREDGAP	0.55	0.22	2.48	0.01	0.49	0.23	2.13	0.03
CREDGAP*CRISES	–0.03	0.41	–0.06	0.95	1.86	0.43	4.36	0.00
STMKGAP	–0.07	0.15	–0.46	0.65	–0.51	0.16	–3.25	0.00
FDIGAP	–0.02	0.03	–0.64	0.53	–0.00	0.03	–0.10	0.92
FDIGAP*CRISES	–0.14	0.10	–1.51	0.13	–0.10	0.10	–1.06	0.29
RPPGAP	–0.00	0.00	–0.45	0.65	0.00	0.00	1.53	0.13
RPPGAP*CRISES	–0.01	0.01	–1.85	0.07	0.01	0.01	1.03	0.31
INFL	–0.01	0.01	–2.10	0.04	–0.05	0.01	–6.97	0.00
M2GAP	–0.00	0.00	–0.19	0.85	–0.00	0.00	–0.66	0.51
M2GAP*CRISES	–0.00	0.00	–0.90	0.37	–0.01	0.00	–2.27	0.02
PCRGDPGAP	–0.01	0.02	–0.41	0.68	–0.03	0.02	–1.75	0.08
ERRFC	0.05	0.01	5.57	0.00	–0.00	0.01	–0.27	0.79
VIX	–0.00	0.01	–0.84	0.40	0.02	0.01	2.59	0.01
WTI	–0.00	0.00	–1.32	0.19	0.00	0.00	2.50	0.01
R-squared	0.13				0.21			
Log likelihood	–553.17				9.00			
F-statistic	4.99				0.00			
Prob(F-statistic)	0.00							

Note: All specifications were estimated via probit via maximum likelihood except when factors are used as the dependent variable in which case panel OLS is used. Data are quarterly. KAOPEN is the index of capital account openness, CREDGAP is the domestic credit gap, STMKGAP is the gap in equity market prices, FDIGAD is the gad in foreign direct investment, RPPGAP is the gap in real property prices, INFL is CPI inflation, M2GAP is the gap in the M2 money stock measure, PCRGDPGAP is the output gap measured in terms of real per capita income, VIX is the proxy for uncertainty, and ERRFC is the Reinhart-Rogoff exchange rate regime indicator. WTI is the rate of change in West Texas Intermediate oil price, CRISES is a 0,1 dummy for the Global Financial Crisis. Different dates may apply to the individual countries in the data set. See Dominguez, Hashimoto and Ito (2012) for the dates.

Further probit and factor model estimates of the likelihood of episodes of prolonged foreign exchange reserves accumulation, data since 1960

Dependent variable: Factor self-insurance motive

Included observations: 668 after adjustments

Table 5 (1)

Variable	Coeff.	SE	t-Stat	Prob.
CREDGAP	–0.92	0.38	–2.45	0.01
INFL	–0.07	0.01	–6.94	0.00
ERRFC	–0.10	0.02	–5.98	0.00
Australia	1.57	0.23	6.95	0.00
Japan	1.83	0.23	7.90	0.00
Korea	1.09	0.22	5.07	0.00
New Zealand	2.14	0.26	8.24	0.00
Singapore	0.90	0.23	3.93	0.00
R-squared	0.17			

Further probit and factor model estimates of the likelihood of episodes of prolonged foreign exchange reserves accumulation, data since 1970

Dependent variable: Factor 1 self-insurance motive

Included observations: 264 after adjustments

Table 5 (2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INFL	0.00	0.01	0.05	0.96
KAOPEN	–0.30	0.20	–1.50	0.14
CREDGDPGAP	–0.75	0.37	–2.04	0.04
FDIGAP	–0.01	0.04	–0.21	0.83
Hong Kong	0.38	0.54	0.70	0.48
Malaysia	0.37	0.22	1.67	0.10
Philippines	–0.13	0.18	–0.72	0.47
Thailand	–0.27	0.15	–1.75	0.08
R-squared	0.06			

Further probit and factor model estimates of the likelihood of episodes of prolonged foreign exchange reserves accumulation, data since 1980s

Dependent variable: Factor self-insurance motive

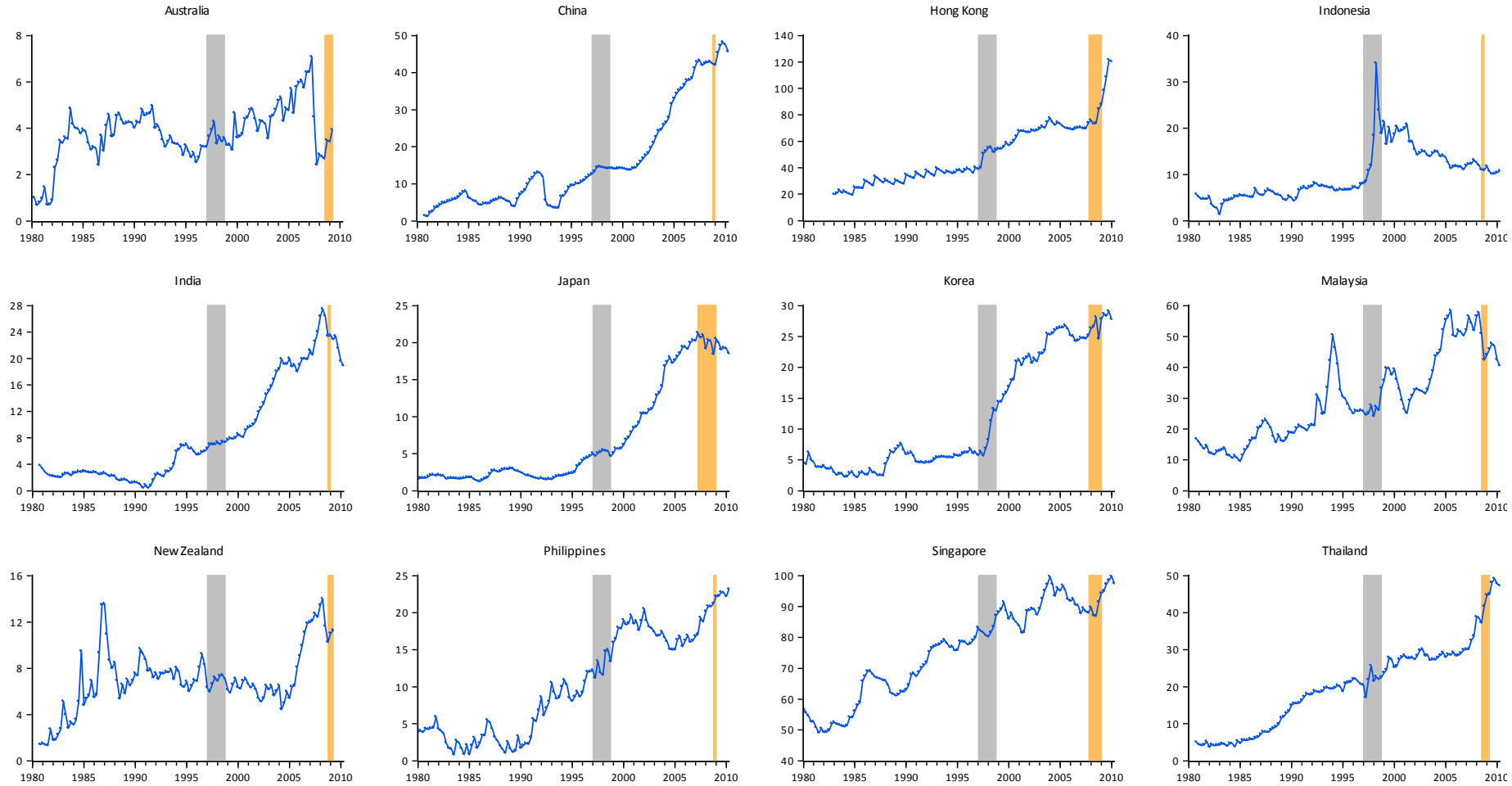
Included observations: 211 after adjustments

Table 5 (3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INFL	0.01	0.01	1.06	0.29
KAOPEN	–0.77	0.51	–1.50	0.14
ERRFC	0.07	0.10	0.69	0.49
CREDGDPGAP	2.80	0.49	5.70	0.00
FDIGAP	–0.10	0.03	–3.88	0.00
China	–0.32	0.40	–0.79	0.43
Indonesia	0.25	1.78	0.14	0.89
India	–1.64	0.39	–4.18	0.00
R-squared	0.33			

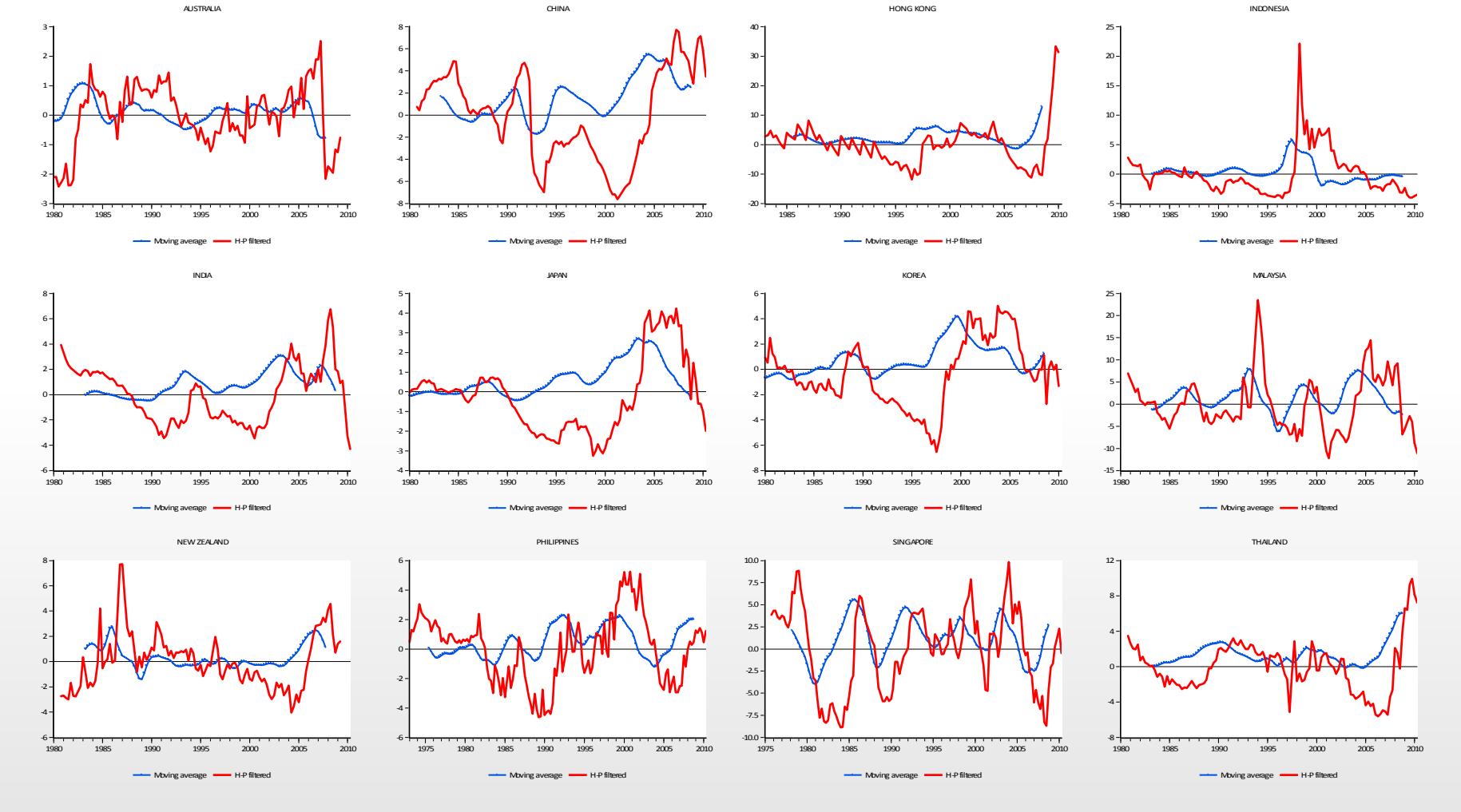
Note: See notes to Table 4. Only the self-insurance factor results are shown. Results for the mercantilist factor are available on request

Graph 1 Reserves-to-GDP ratios, 1980–2010



Note: The vertical axis is in percent. Data are quarterly.

Graph 2 Moving average and H-P filtered reserves holdings, 1980–2010



Note: The moving average is over a three-year horizon for the annual change (ie *t* less *t-4* in the reserves-to-GDP ratio (see Graph 1). For the H-P filtered series a smoothing parameter of 100,000 is applied to the reserves-to-GDP ratio series.