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Estimating the Demand for Reserve Assets Across Diverse Groups of Countries

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Estimating the Demand for Reserve Assets Across Diverse Groups of Countries[1]

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Abstract

This paper takes a fresh look at the determinants of reserves holding with the aim of highlighting similarities and differences in the motives for holding reserves among emerging markets (EMs), advanced economies (AEs), and low-income countries (LICs). We apply two panel estimation techniques: fixed effects (FE) and common correlated effects pooled mean group (CCEPMG). FE regression results suggest that precautionary savings motives, both current account- and capital account-related, are generally the most important determinants of reserves holding across country groups and that their importance has increased for AEs and LICs since the global financial crisis while receding for EMs. Mercantilist motives matter mostly for EMs. Intertemporal motives have been gaining importance everywhere over time. The CCEPMG results confirm the importance of precautionary motives and suggest that current account motives matter only for EMs and LICs and capital account motives matter for all groups while being more important for EMs in both the short- and long runs. The CCEPMG results also point to the importance of taking into account unobserved common factors that affect coefficient estimates and the dynamic process through which reserves adjust to changes. At about 0.6, the speed of adjustment to the long-run equilibrium implies that more than half of the gap between actual and desired reserves holding is closed within a year.

JEL Classification Numbers: C23, E58, F31, G01

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I. INTRODUCTION

In the recent decades, the amount of reserve assets held by countries' monetary authorities has been rising all over the world, and so has researchers' interest in the topic. The pace of reserve accumulation has been more rapid for emerging markets (EMs), and in particular East Asian countries. A large literature has tried to determine the optimal amount of reserves or to explain the actual amounts held by countries. But so far, the literature has been mostly focused on EMs, sometimes downplaying the importance of holding adequate reserves for advanced economies (AEs) and low-income countries (LICs).[2]

The literature puts forth a number of arguments to rationalize the greater focus on reserves holding in EMs relative to the remaining two country groups.[3] It suggests that the EMs country group has both the need to hold reserves, facing frequent balance of payments disruptions, and the means to acquire reserves in international markets. For countries in the AEs group, it is argued that their external position is too large to be insurable, and that they do not have the need to hold a large amount of reserves in the first place because not only are their trade and capital flows more stable but also their financial markets are more liquid. Moreover, these countries can rely upon other forms of insurance, for example swap lines.[4] For LICs, it is argued that they have limited access to financial markets and that the balance of payments risks that they face are therefore different in nature from those of EMs.

While the literature implicitly assumes that existing models relate mostly to EMs and are of only limited relevance to AEs and LICs, we take a different standpoint for two main reasons. First, as illustrated in Figure 1, AEs and LICs are not different from EMs when it comes to the trend of reserves holding. Second, both AEs and LICs can benefit from holding adequate reserves, making it important to understand what drives their demand for reserves assets. For AEs, while episodes of market dysfunction are less frequent and of shorter duration than in EMs, they can have very disruptive effects on macroeconomic performance. For LICs, reserves can help smooth disruptions to domestic demand associated with the volatility of export proceeds and other external flows. Indeed, many LICs that are now characterized as frontier markets have been accumulating reserves since the early 2000s. Against this background, we argue that it does make sense to apply models developed for EMs also to AEs and LICs.[5] This is what we do in this paper.

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[2] This holds for empirical contributions, e.g. Aizenman and Marion (2003), Sula (2011), Delatte and Fouquau (2012) and Ghosh et al. (2012, 2014) as well as for theoretical contributions, e.g. Jeanne (2007) and Jeanne and Rancière (2011). An exception is Ghosh and Ostry, (1997), who calibrate an intertemporal savings model for reserves to three advanced economies. Some empirical papers have considered various country groups jointly, but have not attempted to assess whether the same type of model is appropriate for all (e.g. Aizenman and Lee, 2007, Bastourre et al., 2009, Obstfeld et al., 2010). Normative approaches like reserve adequacy metrics have been developed primarily for EMs (see e.g. Wijnholds and Kaptejn (2001), IMF (2011, 2013, 2015), and Mwase (2012) for not only EMs but also small island nations).

[3] The arguments summarized in this paragraph are based mostly on IMF (2011), where additional information and references can be found.

[4] Some of the AEs are reserve issuers themselves, and hence the traditional motives of reserves holding do not apply to them. We exclude those countries from our analysis.

[5] Recently, some empirical analyses on reserves adequacy have included LICs into their focus (see IMF, 2011, and references therein), but most journal articles still focus exclusively on EMs.

Our aim is to investigate the determinants of the demand for reserves and highlight possible similarities and differences in the motives for reserves holding across the three country groups, and to see how these motives have evolved over time, using various econometric specifications. Our empirical approach considers the fact that countries are very heterogeneous, both across and within groups.

Our econometric strategy is twofold. First, we carry out static panel data estimations, which include country fixed effects to capture time-invariant country specific factors. We compare estimation results both for the complete sample period of 1980–2014, and for three sub-periods to find out how the motives for reserves holding have been affected by the experiences of two severe crises, the Asian crisis and the global financial crisis. Second, we apply a relatively new estimation technique, common correlated effects pooled mean group (CCEPMG) estimation, that allows for addressing the heterogeneity of the countries included in the sample and other issues that have a bearing on the robustness of the estimates. In particular, CCEPMG estimation takes into account the possible existence of common unobserved factors that affect reserves accumulation while not being captured by explanatory variables included in the model, the cross-sectional dependence in the regressions' residuals, and also the fact that reserves are likely to adjust to changes in the explanatory variables through a dynamic process. To take into account the role of the dynamic process, the CCEPMG methodology, unlike fixed effects, makes a clear distinction between the short-run and the long-run impacts of the explanatory variables. It allows for the slope parameters to differ in the short-run, while assuming convergence in the long-run.

We make at least three important contributions to the literature. First, we consider new explanatory variables for reserves holding. In particular, in addition to the standard variables analyzed in previous studies, we investigate intertemporal savings motives by including a measure of the change in the age dependency ratio, and also analyze whether an economic crisis situation (as proxied in this study by participation in an IMF program, especially for advanced and emerging market economies) makes a difference to reserves holding. Second, in the fixed-effects regressions, we test for and address cross-sectional dependence and serial correlation, which the previous literature on the determinants of reserves has been silent upon. Third, to the best of our knowledge, we are the first to apply the CCEPMG estimation technique to the analysis of reserves holding, thereby separating short-run from long-run determinants of reserves accumulation.

Our findings are in line with the existing literature but also novel. In the fixed effects regressions, we find that precautionary savings motives, related both to the current account and to the capital account, are the most important determinants of reserves holding across country groups. The evidence suggests that precautionary motives have been gaining in importance for AEs and LICs in recent years, while for EMs it is the opposite. Mercantilist motives are found to be significant only for EMs. Intertemporal savings motives have, over time, become more and more important in all country groups. The evidence for the role of other factors, such as the opportunity cost of reserves is less clear-cut.

The CCEPMG regressions confirm the importance of precautionary savings motives and reveal important differences across country groups. The evidence suggests that precautionary motives are less important in the long run for AEs than for EMs and LICs. In particular, variables relating to the current account are found to be either not significant determinants of reserves holding in AEs or to have smaller coefficients relative to EMs and LICs when statistically

significant. The same applies to variables relating to the capital account, which seem to matter more for EMs followed by LICs. The CCEPMG estimations, unlike the fixed effects, do not suggest that mercantilist motives unambiguously play an important role for reserves holding in EMs, as they are (borderline) significant for the full sample and for EMs together with AEs. The speed of adjustment to the long-run equilibrium is around 0.6, implying that more than half of the gap between actual and desired reserves holding is closed within a year.

The remainder of the paper is structured as follows: Section II discusses the determinants of reserves holding considered in the existing literature and introduces some new explanatory variables. It also discusses the findings of the existing literature. Section III presents the data and describes the variables in the dataset and the classification of countries into the three different groups. Section IV introduces the econometric model and estimation technique. Section V presents the regression results, first for fixed effects, then for CCEPMG estimation. Section VI contains some robustness checks, and Section VII concludes.

II. Standard and New Determinants of Reserves holding

There are many different approaches to assessing reserve adequacy: theoretical and empirical, positive and normative. Our approach is positive as we try to empirically explain reported reserve assets holding in regression analyses. In doing so, we follow a large literature that regresses reserves holding, mostly relative to GDP, on a set of explanatory variables which economic theory and previous empirical analyses suggest have an effect on the demand for reserves.

Precautionary motives have traditionally been the focus of the literature on the determinants of reserve assets holding. When a country experiences (temporary) balance of payments pressures, reserve assets can provide liquidity to meet external liabilities. Adverse shocks may affect the current account, through for instance a deterioration in the terms of trade. They may also affect the capital account, such as in the case of sudden stops, capital flights, or ad hoc borrowing constraints. Under those circumstances, reserves can be used to finance imports or to meet the external obligations of the sovereign or the banking system.

Several papers investigate and find support for precautionary motives for holding reserves. Aizenman and Marion (2003) is one of the first papers to provide empirical evidence that precautionary motives related to the current account matter for reserve accumulation by developing countries, with a particular focus on East Asian countries. Aizenman and Lee (2007) confirm these findings and also include a variable related to the capital account, which they find to be a significant determinant of reserves. Others have since confirmed these findings (Bastourre et al. (2009), Obstfeld et al. (2010), Ghosh et al. (2012), and Ghosh et al. (2014)). In their analysis, Obstfeld et al. (2010) further investigate the role of self-insurance against capital account vulnerabilities by including additional variables measuring financial stability. They find that their model is better able to explain reserves holding than a model focusing exclusively on the current account. Sula (2011) finds in a quantile regression that precautionary motives matter more for countries with a low stock of reserves relative to GDP. Ghosh et al. (2012) confirm this for precautionary demand against current account shocks, but not for capital account shocks.

Mercantilist motives are another reason for accumulating reserves that the literature has analyzed. The literature suggests that, by building up reserves and keeping the exchange rate

artificially undervalued, a country can strengthen its export sector at the expense of its trading partners. Aizenman and Lee (2007) find that mercantilist motives are statistically significant, but economically negligible determinants of reserves holding. Ghosh et al. (2012) provide evidence that mercantilism has been becoming more important after the Asian crisis, which is confirmed by Delatte and Fouquau (2012) in a framework allowing for time-varying coefficients. Ghosh et al. (2014) find that, for the Asia Pacific RIM countries[6], mercantilism matters more than elsewhere though it accounts only for a small fraction of the observed rise in reserves holding.

The existing (theoretical and empirical) literature is inconclusive regarding the impact of the exchange rate regime on reserves holding. From a pure theoretical standpoint, countries with a fixed exchange rate regime have a greater need for foreign currency reserves relative to their peers with more flexible regimes to maintain the peg and defend it against speculative attacks. But some researchers such as Calvo and Mishkin (2003) argue that even countries with a floating exchange rate must be concerned about possible runs on their currencies, and many of them therefore choose to "float with a large life jacket". Empirical evidence on the role of the exchange rate regime for reserves holding is also mixed. Bastourre et al. (2009) find that countries with a pegged exchange rate regime hold significantly less reserves than do countries with a floating regime. In contrast, Obstfeld et al. (2010) find that countries with pegged exchange rates hold significantly more reserves, whereas in Ghosh et al. (2012, 2014), the peg dummy is mostly insignificant. Sula (2011) suggests that countries with a floating regime hold less reserves, but the coefficient is significant only up to the 50th percentile. Overall, the role of the exchange rate regime in driving reserves holding is not clear-cut.

The cost of holding reserves and income per capita are two other determinants of reserves used in the literature. Holding reserves is costly because of foregone investment opportunities with higher yield and because of the need for sterilization. Accordingly, central banks are expected to perform a cost-benefit analysis when accumulating reserves. This intuition is confirmed by Bastourre et al (2009). Income per capita is a level of development indicator, meant to capture the size of international transactions. It is expected that, ceteris paribus, richer economies will hold larger reserve buffers. In line with expectations, the coefficient on GDP per capita is mostly found to be positive (Aizenman and Marion, 2003, Bastourre et al, 2009, Obstfeld et al, 2010, Sula, 2011, Ghosh et al., 2012, 2014).

Adding to the motives discussed above, we consider two other determinants of reserves accumulation: saving for future generations and having a program with the IMF. Saving for future generations has been stated in a survey of central bankers (IMF, 2013) as an important motive for reserves holding but has, so far, not been taken into account in empirical studies. Considering that many economies (not only advanced) face declining birth rates and increasing longevity, there is reason to believe that the intertemporal motive has been gaining importance over the past several years. Projected changes in the demographic structure of the population should induce governments and central banks to save to protect living standards when dependency ratios are expected to rise in the future. Some countries, in particular exporters of natural resources, use sovereign wealth funds as a separate savings vehicle for intertemporal savings and intergenerational consumption smoothing and sometimes report the resources

[6] The Asian countries bordering the Pacific Ocean.

accumulated in these funds as part of the official reserves. This provides an argument for including intertemporal motives among the determinants of reserves holding.

Having a program with the IMF can be a relevant indicator of reserves holding as strengthening reserves buffers is a quite standard feature of IMF program design. The IMF indeed encourages its member countries to hold adequate reserves. It is important to note, however, that the simple IMF program dummy that we use is not just an indicator of the effect of the program on official reserves, but is also likely a proxy for the omitted characteristics of the crisis itself facing the country having a program and of any persistent post-crisis risk aversion that would have occurred independent of IMF intervention.

Over the past decade, IMF staff have developed metrics to help gauge countries' reserve adequacy (IMF 2011, 2013, 2015). These metrics take account of how reserve needs vary across different types of economies based on external vulnerabilities they face and other country-specific institutional and structural characteristics, such as their exchange rate regime and openness of their capital accounts. This reinforces the need to analyze the determinants of the demand for reserve assets separately for different groups of countries based on their income levels and other economic characteristics.

III. DATA

Our dataset contains annual data for 133 countries from 1980 to 2014. The choice of the countries and years in the sample is first and foremost determined by the availability of data. We do not include observations prior to 1980 because, during the Bretton Woods system of fixed exchange rates and in the immediate aftermath, reserve accumulation is likely to have been governed by different motives than what is captured by our model. Further, we drop countries that are reserve currency issuers[7]. These countries do not have a strong need to hold reserves. The list of countries is in the Appendix. Due to varying data coverage, the panel is highly unbalanced. We do not have reason to believe that missing observations are missing non-randomly.

The regressions presented below are based not only on the full sample period, but also on subsets of the sample constructed by dividing the sample into sub-periods or according to income-based country groups. We use the sub-periods 1980–1997, 1998–2006 and 2007–2014, considering two major financial crisis episodes as cut-off points: the Asian crisis and the global financial crisis. We conjecture that it could be possible that both have changed the motives for reserves holding, as they may have brought to light certain vulnerabilities that were previously not insured against, as suggested by some studies. For example, Aizenman and Lee (2007) argue that the Asian crisis induced a hoarding of reserve assets by affected countries, whereas Ghosh et al. (2012) show that capital account precautionary motives strengthened during the years following the Asian crisis. By looking at sub-periods separately, we can determine whether these effects are present in our three country groups as well. Also, we can find out whether the explanatory power of the model has changed over time. As indicated above, some of our regressions are based on income-specific country groups.

[7] Reserve currencies are the US Dollar, the British Pound, the Euro (prior to 1999, the Deutschmark and the French Franc), and the Japanese Yen.

A. Country Groups

For the purpose of this study, it is crucial to classify the three country groups accurately. We rely on the classification used in the IMF's World Economic Outlook (WEO) and take into account possible changes in countries' circumstances during our sample period. In particular, we adopt time-varying classifications to reflect the fact that a country's economic structure and performance relative to the rest of the world may have changed over time, prompting for instance a reclassification of a country from EM to AE. The complete list of countries and their time-varying classifications can be found in the Appendix. Of the 133 countries in the sample, there are 22 AEs (five of them classified as EMs during part of the sample period), 49 LICs (of which six were sometimes classified as EMs), and 73 EMs.

WEO classifies countries into AEs and emerging and developing countries (EMDCs) based on criteria reflecting not only countries' income levels, but also aspects of their economic and financial development. The three main criteria are: (1) the level of per capita income, (2) export diversification – which leads to the exclusion of rich Middle East oil exporters as oil accounts for about 70 percent of their exports, and (3) the degree of integration into global financial markets. Countries that do not make the list of AEs based on these criteria are EMDCs. Within this group, those that meet the eligibility criteria for access to concessional finance from the IMF's Poverty Reduction and Growth Trust (PRGT) — if their per capita income is below a certain threshold level and, additionally, if they do not have access to international financial markets on a durable and substantial basis — are classified as LICs. The EMs form the residual group of countries. The list of PRGT-eligible countries is reviewed biannually.

B. Variables

The dependent variable in the regressions is the logarithm of the stock of reserves in percent of GDP, which is regressed on several determinants of reserves holding. We use the standard definition of reserves as outlined in the IMF Balance of Payments Manual: reserves include holdings of monetary gold, special drawing rights, reserves of IMF members held by the IMF, and holdings of foreign exchange assets (consisting of currency and deposits and securities) under the control of monetary authorities. As explanatory variables, we use proxies for the motives for holding reserves and other determinants of reserve accumulation discussed in Section II.

The proxies for the precautionary demand for reserves reflect countries' need to insure against adverse current account as well as capital account shocks. As indicators of exposure to current account shocks, we use the logarithm of imports in percent of GDP and the volatility of the terms of trade. Our volatility measure is computed as the five-year relative standard deviation of the terms of trade index for goods and services, lagged by one year in order to avoid possible endogeneity.[8] As the data contain some outliers, we winsorize the variable at the 1st and 99th percentiles.

[8] The relative standard deviation is more suited for comparison across time than the standard deviation because it normalizes the standard deviation by the (absolute value of) the mean.

(continued…)

In order to capture the precautionary demand for reserves for the purpose of insuring against capital account shocks, we use three indicators. First, we use capital flows, measured as net portfolio investment flows (debt and equity inflows less outflows) in percent of GDP, which is informative about how much a country would be affected by a sudden drain of financial resources from the rest of the world.[9] Second, we include the volatility of capital inflows, measured as the five-year relative standard deviation of capital inflows, lagged by one year. The volatility of capital flows is defined in the same way as the volatility of the terms of trade and this variable is also winsorized at the 1st and 99th percentiles. Third, we include broad money (M2) in percent of GDP, which captures the risk of residents withdrawing their deposits from domestic financial institutions. In particular, the higher the liabilities of the banking system, the larger the risk of capital flight by depositors and the higher the potential need for bank support during a capital account crisis. While these three variables do not form an exhaustive list of indicators of risks relating to the capital account, they are the main ones that drive precautionary accumulation of reserves to insure against capital account shocks.[10] For all these variables, theory predicts that we should find a positive effect on reserves.

Mercantilist motives can be captured through the impact of the deviation of the real exchange rate (RER) from its fundamental value and, to some extent, the fear of appreciation assessed through the de facto exchange rate regime[11]. Following Aizenman and Lee (2007), the deviation of the RER from fundamentals is constructed as the residual of a regression of the national price level on the PPP-based real per capita income of the country relative to the United States. If the residual is negative (positive), the real exchange rate is undervalued (overvalued) relative to its fundamental PPP value. A negative coefficient on this variable can be interpreted as evidence for a mercantilist motive (the more undervalued a currency, the higher the reserves). We also use the de facto exchange rate regime as an indicator of whether reserve accumulation is partly for the purpose of exchange rate stabilization. We distinguish between three regime types: A hard peg, a soft peg, and a (managed or independent) float. A higher value means a more flexible exchange rate.[12]

The opportunity cost of reserves is also used as an explanatory variable, notwithstanding the difficulties associated with its measurement, as pointed out for example by Rodrik (2006) and Yeyati (2008). There is no single measure or indicator that could be used to approximate the cost of reserves for all countries under all circumstances.[13] Not only does the use of various

[9] We do not include foreign direct investments, because these are usually longer-term investments and not withdrawn as fast.

[10] Some papers also include short-term debt as a determinant of precautionary holding of reserve assets related capital account vulnerabilities as this is the type of capital is subject to easy reversal. However, data for short-term debt is not available for most AEs, precluding its use in our regressions.

[11] More sophisticated measures for mercantilist motives have been proposed by Ghosh et al (2012, 2014), but unfortunately, the required data is not available for our full sample.

[12] This indicator compresses the more nuanced official IMF exchange rate classification. Our primary data source is the IMF, but for the earlier years of our sample (pre-1985) we use the dataset compiled by Reinhart and Rogoff (2004).

[13] Estimates of the cost of reserves generally comprise one of two main components: the foregone return on an alternative use to which the reserves could have been allocated, or the cost of issuing securities for liquidity sterilization less the return on reserves (Hauner, 2005). The choice of indicators to be used for each component

(continued…)

measures depend on country-specific circumstances, but also the possibility of reverse causality is an important caveat to bear in mind. In particular, a higher level of reserves may decrease the cost of sovereign borrowing because the sovereign risk premium reflects the probability of default, which may be negatively associated with the level of reserves. In light of these obstacles, most studies revert to simple measures of the costs of reserves, acknowledging their shortcomings. We follow Ghosh et al. (2012, 2014) in using the spread between returns on domestic and US financial assets of the same maturity. For AEs, we use primarily spreads on short-term government bond yields; for the other countries, we use spreads on T-bill rates, the lending rate, or the money market rate, depending on data availability. The variable is defined as the logarithm of 1 plus the cost of reserves. We will later check the robustness of our findings to an alternative definition of the opportunity cost of reserves.

Three additional variables are included. To measure the intertemporal motive for reserves holding, we use the age dependency ratio – the population younger than 15 and older than 64 in percent of the population aged 15–64 years. We take the difference of this measure between period t+20 and period t. The t+20 value is either the actual future value, if within the sample period, or a forecast by the United Nations. To assess the impact of an IMF program on reserves holding, we introduce a dummy that takes the value of one when a country borrows from the Fund as part of an IMF program. If the original level of reserves is lower than recommended by the IMF (2011) metric, participation in an IMF program would likely lead to an increase in reserves. As an additional control, we add GDP per capita, measured in real terms. A complete list of variable definitions and data sources can be found in the Appendix, Tables A1 and A2.

C. Stylized Facts

As mentioned in the introduction, EMs, AEs and LICs are not very different when it comes to reserves holding (Figure 1). According to three measures of reserves holding —Reserves-to-GDP, reserves-to-broad money, and reserves-to-imports — differences between the three country groups are marginal. In particular, relative to GDP, reserves in EMs, AEs and LICs follow a similar trend: they have been rising from about 1.5 percent of GDP to around 3 percent of GDP from 1980 until 2014. Relative to imports, the three country groups have started to diverge only in recent years, but still follow a similar trend. By contrast, relative to broad money, AEs had been holding less reserves in the past, but started to converge to the other groups since the global financial crisis. In real terms, we can also observe a similar trend

as well as the relevance of the components themselves depend on country-specific circumstances, including the adequacy of reserves, the alternative use of reserves, and the level of the exchange rate compared to its fundamentals (IMF, 2016). In this vein, Calvo (1991) indicates for instance that when a country has a relatively low level of reserves, alternatives to reserves accumulation are less relevant whereas the quasi-fiscal cost of sterilizing the liquidity injection associated with reserves accumulation can be high. Rodrik (2006) suggests to consider private foreign borrowing costs because reserves are acquired for the purpose of insuring private sector borrowing abroad. He argues that the central bank's domestic government bonds sold in the process of sterilization are ultimately bought by the private sector, so that this transaction nets out. The problem is that neither private borrowing costs nor the return on capital are easy to quantify, in particular for LICs.

(continued…)

throughout most of the sample period, though AEs have recently surpassed the other two groups.[14]

When it comes to the determinants of reserves holding, the summary statistics show that the three country groups have some distinctive differences (Table A3). For instance, AEs have, on average, a larger broad money-to-GDP compared with EMs and LICs, but the standard deviation is lower. LICs, on the other hand, are characterized by large volatilities of both the terms of trade and capital inflows. Mercantilism seems, on average, absent in AEs while present in EMs and LICs, with LICs surprisingly having more undervalued exchange rates than EMs. Strong differences between AEs on the one hand, and EMs and LICs on the other, can also be observed in the changes in age dependency ratios over the next 20 years. Unsurprisingly, this measure is positive for AEs but negative for EMs and LICs, reflecting the fact that the share of working-age individuals is, on average, growing during the sample period for LICs and EMs but decreasing for AEs. The cost of reserves is, as expected, much lower in AEs than in EMs and LICs. EMs have the highest standard deviation of the cost of reserves.

Next, we take a look at the correlations between reserves and the explanatory variables (Table A4). The signs of the correlations generally conform with expectations, with a few surprises. Among the indicators of precautionary current account and capital account motives for holding reserves, our reserves measure is most strongly correlated with imports and M2. This is not surprising, because both variables are well-established determinants of reserves holding and play a key role in reserve adequacy metrics like the one suggested by IMF (2011). Another variable that has a positive and relatively high correlation with reserves is the change in the age dependency ratio over the next 20 years. This suggests that countries with a shrinking working-age population hold more reserves, and provides an argument for using changes in age dependency ratios as a determinant of reserves holding. The volatility of the terms of trade is negatively correlated with reserves, which is quite surprising.

There is a negative and statistically significant correlation between reserves and participation in an IMF program. This does not necessarily mean that participation in an IMF program induces countries to hold fewer reserves. Countries that participate in an IMF program might have had a lower level of reserves to start with, reflecting a weak macroeconomic and financial situation, which led them to request financial assistance from the Fund. Our analysis in Section V will provide more clarity on this issue.

D. Cross-sectional dependence and serial correlation

A concern with macroeconomic panel data that have cross section and time dimensions is the potential existence of serial correlation and cross-sectional dependence of the error terms. Should these exist, the estimates of fixed effects regressions continue to be consistent, but the standard errors are biased and need to be corrected. We test for cross-sectional dependence using the post-estimation test proposed by Pesaran (2004) for the full sample and for EMs where $N > T$, and the Lagrange multiplier test of Breusch and Pagan (1980) for the AEs and LICs where $T > N$. Test statistics are reported in Table A5. The null hypothesis of no cross-

[14] The large depletion of reserves of LICs in 2010 is driven largely by India and disappears when India is excluded.

sectional dependence is strongly rejected, both for the full sample and for the sub-samples. To test for serial correlation, we use a test suggested by Wooldridge (2002) and Drukker (2003). The test statistic indicates that there is serial correlation as well. Our regressions take these results into account.

IV. Econometric Model and Methodology

A. Fixed Effects Estimation

We start with a simple panel data estimation equation,

$$y_{it} = \alpha_i + \beta' x_{it} + \varepsilon_{it}$$

where $i = 1, \dots, N$ is the country dimension and $t = 1, \dots, T$ is the time dimension of the panel. y_{it} represents the dependent variable and x_{it} is a $k \times 1$ vector of explanatory variables, with β the vector of coefficients. α_i is a country fixed effects dummy and ε_{it} is an iid error term. This fixed-effects formulation is the most common in the literature on panel data estimation and is based on the idea that there are country-specific time-invariant effects that might create a bias in β if not controlled for. It can also be used to take into account group-specific characteristics in a single regression. In our case, fixed effects are particularly important when we include all three country groups in a regression as countries in the full sample are very heterogeneous.[15] As we find evidence of both cross-sectional dependence and serial correlation in our sample, we need to correct the standard errors in the fixed effects regression. For this, we use the estimator proposed by Driscoll and Kraay (1998) in the regressions, which addresses both types of correlations of the error terms.

Fixed effects estimation serves three other important roles in our analysis. First, it allows us to compare our results with those presented in other empirical papers estimating the demand for reserve assets. Second, it allows us to estimate the model separately for different sub-periods and country groups, since there is no stringent requirement for T, the length of the time series of the countries, or N, the number of countries, to be large. Third, it represents a natural benchmark against which we will compare the findings from the more complex CCEPMG estimation discussed in the next subsection.

However, there are two major shortcomings associated with the use of fixed effects estimation for the analysis of the determinants of reserves holding. First, the estimation assumes that the relationship between the dependent variable and the explanatory variables is static. In other words, reserves holding adjust instantaneously to changes in any of the explanatory variables. This assumption is unrealistic because in reaction to changes in explanatory variables, a central bank is likely to adjust its stock of reserves over several periods. Bastourre et al. (2009) have shown that disregarding the dynamic element creates a bias in the results. Second, the standard fixed effects model imposes that the relationship between the explanatory variables and the dependent variable is the same across all countries in the regression. While this assumption might be justified in the long-run, in the short run the adjustment process is likely to be

[15] In the case of reserve assets, we would for example expect countries that are fuel or commodity exporters or offshore financial centers to hold more reserves than others, everything else equal.

heterogeneous across countries. Against this background, the second part of our analysis will feature an estimation technique, the CCEPMG, that takes into account the fact that reserves go through an adjustment process and that this process can be heterogeneous across countries.

B. CCEPMG Estimation

The CCEPMG estimation addresses the concerns of possible cross-sectional heterogeneity and correlation by marrying two different econometric techniques that have found widespread application over the past several years. The first is the pooled mean group (PMG) estimation, going back to Pesaran, Shin and Smith (1999) which imposes the restriction of long-run parameter homogeneity while allowing for unrestricted short-run parameter heterogeneity across cross sectional units. The second is Pesaran's (2006) common correlated effects estimator, which is suitable for situations in which the effects of the unobserved common factors on cross-sectional units differ. Consider a dynamic estimation equation

$$y_{it} = \alpha_i + \lambda_i y_{i,t-1} + \beta_{1i}{}' x_{it} + \beta_{2i}{}' x_{i,t-1} + \varepsilon_{it}$$

with

$$\varepsilon_{it} = \gamma_i{}' f_t + u_{it}$$

where u_{it} is iid. Note the three additions relative to the static estimation equation: First, the coefficients are individual-specific (subscript i). Second, there is a dynamic element: both y_{it} and x_{it} are included in lagged terms in the equation.[16] Third, there is a $m \times 1$ vector of unobserved time-specific common factors, f_t, with loadings γ_i. f_t is allowed to be correlated with the regressors x_{it}. If not controlled for, the unobserved factor may therefore bias the vectors of coefficient estimates $\hat{\beta}_{1i}$ and $\hat{\beta}_{2i}$. Pesaran (2006) shows for a static panel data setting that including the cross-sectional averages of both dependent and independent variables in the regression will eliminate the bias if N is sufficiently large. For dynamic panel data models, Chudik and Pesaran (2015) show that the same principle applies when including contemporaneous cross-sectional averages and a sufficient number of lags. We refer the reader to Appendix B for details. Our estimation equation takes the form

$$y_{it} = \alpha_i + \lambda_i y_{i,t-1} + \beta_{1i}{}' x_{it} + \beta_{2i}{}' x_{i,t-1} + \beta_{3i}{}' \bar{z}_t + \beta_{4i} \bar{z}_{t-1} + e_{it},$$

where $\bar{z}_t = (\bar{y}_t, \bar{x}_t{}')'$ is a $k+1$ vector of simple cross-sectional averages and e_{it} is a composite error term. This equation can be re-formulated into an error-correction model[17] of type

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[16] The fact that we include only one lag throughout the paper is due to the limited sample size. In general, more lags can be included.

[17] Error correction models of this sort are often estimated when there is panel cointegration. While our motive for applying CCEPMG is different – we use it to assess to what extent coefficients are homogeneous or heterogeneous across countries – it is worth mentioning that CCEPMG estimation is applicable to both stationary and non-stationary data (see de Calvacanti et al., 2015, and on PMG more generally, Pesaran, 2015). In fact, an advantage of this technique is that it allows us to ignore the order of integration of the variables. For CCE, Kapetanios et al (2011) show that cross-sectional averages continue to correct for the bias introduced by the presence of unobserved common factors when these factors are non-stationary.

$$\Delta y_{it} = \alpha_i + \phi_i\left(y_{i,t-1} - \theta_{1i}{}'x_{it-1} - \theta_{2i}{}'\bar{z}_{t-1}\right) + \beta_{1i}{}'\Delta x_{it} + \beta_{3i}{}'\Delta\bar{z}_t + \varepsilon_{it}$$

where $\phi_i = -(1-\lambda_i)$ is the speed of adjustment, and $\theta_{1i} = \frac{1}{1-\lambda_i}(\beta_{1i} + \beta_{2i})$ and $\theta_{2i} = \frac{1}{1-\lambda_i}(\beta_{3i} + \beta_{4i})$ are the long-run coefficients. β_{1i} and β_{3i} are the short-run coefficients. This is the equation we are going to estimate.

The advantage of the error correction formulation is that it allows for applying different assumptions on the short- and long-run coefficients. In particular, the short-run coefficients can be allowed to be individual-specific while restricting long-run coefficients to be common for all individuals, $\theta_{1i} = \theta_{1j} = \theta_1$ and $\theta_{2i} = \theta_{2j} = \theta_2$. This is the principle of the CCEPMG estimator, an augmented pooled mean group estimator (Chudik et al, 2015; de Calvalcanti et al, 2015). In contrast, the CCEMG estimator, an augmented mean group estimator, works with the assumption that both short- and long-run coefficients are individual-specific. The CCEMG estimator is consistent, whereas CCEPMG is both efficient and consistent if the assumption of homogeneity of the long-run slopes is correct. The assumption can be tested using a Hausman test.

As the estimation procedure requires a large T to fit the model separately for each cross section, we will include in the regressions only countries where the number of observations is at least 25. This reduces our dataset to 28 countries: 16 EMs, seven AEs and three LICs, and two countries that graduated from being EM to AE during the sample period[18]. In order to get consistent estimates for the small country groups of AEs and LICs, we carry out regressions jointly for EMs and AEs, and also jointly for EMs and LICs. In comparing the estimated coefficients to those that result from a regression using only the EM group, we can determine whether AEs and LICs are different from EMs. Additionally, we present results for the full sample.

In light of the inclusion of lags in the set of explanatory variables, the number of variables included has to be very limited relative to that of those included in the FE regressions to have meaningful degrees of freedom. Accordingly, we include a set of variables that captures the main motives for reserve accumulation discussed above, while reducing the number of controls within each motive. Imports, M2, and changes in age dependency ratios or cost of reserves are included in the long-run as we believe that these variables are likely to affect reserves holding in the long run.[19] Consistent with the CCEPMG methodology, changes in these variables are also included in the short-run equation. In addition, and following the academic literature's suggestion that mercantilist motives for building up reserves tend to be operative only in the short-term, we also include the price level deviation in the short-run equation only. As an

[18] Included in the regressions are: Argentina, Brazil, Chile, Columbia, Guatemala, Indonesia, Kuwait, Mexico, Malaysia, Panama, Philippines, Swaziland, Seychelles, Thailand, Tunisia and South Africa (EMs), Australia, Canada, Switzerland, Denmark, Iceland, Norway and Sweden (AEs), Bolivia, Kenya and St. Lucia (LICs) and Israel and Korea, which were reclassified from EM to AE in 1997.

[19] Based on the presumption that the cost of reserves and age dependency can have long run effects on reserves holding, we considered CCEPMG regressions including one or the other in light of the limited degrees of freedom. Regressions with age dependency have been retained as they perform better than those with cost of reserves.

(continued…)

additional short-run variable we also include a zero-one dummy to control for whether the country had program with the IMF during the year.

In order to control for unobserved time-varying factors, we include cross-sectional averages of those variables that we believe are highly correlated across countries.[20] In particular, reserves, M2 and imports are likely to be affected by global as well as by domestic factors and developments, and their cross-sectional averages are included in the regressions. The cross-sectional average of changes in age dependency ratios is also included, more for consistency in the use of the CCEPMG methodology than for the belief that it is affected by global factors.

V. Regression Results

A. Fixed Effects Regressions

The full sample

The regression results for the full set of countries (Table 1a) suggest that, on average, richer countries in general hold more reserves, but this changes rather abruptly in the 2007–2014 sub-period, where the coefficient on GDP per capita turns negative while staying significant. Possibly, this can be explained by some rich countries having run down their reserves in response to balance of payments shocks.

Precautionary motives seem to matter in a way consistent with economic theory, but their importance for reserve accumulation appears to have changed over time. The coefficients on imports, the volatility of capital inflows and M2 are all positive and statistically significant for the regressions over the entire sample period 1980–2014. However, precautionary motives relating to current account variables seem to have been losing importance over time as reflected by the decline in the estimated elasticity for imports from 0.73 (highly significant) over the period 1980–1997 to 0.30 (non significant) over the period 2007–2014. In contrast, for precautionary savings relating to capital account variables, patterns differ across indicators. Capital inflows and the volatility of capital inflows are significant prior to 2007 but not afterwards, whereas the importance of M2 appears to have been growing over time, from being insignificant in 1980-1997 to having an estimated elasticity of 0.85 in the 2007–2014 sub-period. Since M2 is often associated with the risk of capital flight by residents in the case of a banking crisis, it could be that, since the beginning of the global financial crisis, which revealed vulnerabilities in the banking systems of many countries, central banks have been paying more attention to the banking sector and to the risk of residents withdrawing their domestic bank deposits and converting them into foreign currency.

There is no evidence that the deviation of the actual exchange rate from its equilibrium or the exchange rate regime itself play roles consistent with the relevant hypotheses for the determination of reserves holding. For the entire sample of countries, the coefficient on *pl_deviation,* an indicator of mercantilist motives for reserves holding*,* is not statistically significant over the complete sample period as well as for all three sub-periods. The results on the exchange rate regime are somewhat inconclusive. For 2007–2014, the coefficient has the

[20] For the sake of brevity, the coefficient estimates for the cross-sectional means are not shown in Tables 2 and 7, but are available from the authors on request.

expected sign, but the estimated coefficient for the 1998–2006 sub-period is counter-intuitive. Switching from a hard peg to a soft peg, or from a soft peg to a float, is associated with an increase in reserves of around 9 percent in 1998–2006.

There is evidence that intertemporal motives and the cost of reserves are significant determinants of reserves holding while participation in an IMF program is not. Intertemporal motives have a positive and significant impact for the whole sample period and for 2007–2014. Indeed, from a global perspective, saving for future generations seems to have become important only recently. This could be due to the fact that population aging has recently been picking up speed in many regions of the world. Also, even though in many countries the age dependency ratio has been exhibiting an upward trend for some decades, this topic has come to the center of public debate only recently. An increase in the opportunity cost of reserves is shown to decrease the amount of reserves held. The coefficient on this variable is always negative, and it is significant in 1998–2006 and over the full sample period. Finally, participation in an IMF program does not seem to have a significant effect on the level of reserves relative to GDP.

The EMs subgroup sample

The fixed effects results for the subgroup of EMs (Table 1b) show a number of important differences with regard to the full sample. First, motives related to the capital account seem to be relatively less important in EMs. The coefficients on capital inflows and on the volatility of capital inflows are generally smaller and often not significant, whereas the coefficient on M2 is not significant for the full sample. In the sub-period samples, the coefficient on M2 has about the same size as in the full sample in 1998–2006 and gets smaller in the last sub-period. For current account motives, no clear picture emerges. The volatility of the terms of trade exhibits a significant positive effect in 1998–2006, but in the same sub-period, the coefficient on imports is (counter-intuitively) negative after having been not only positive and highly significant in the 1980–1997 sub-period, but also the largest among the three country groups.

Second, mercantilist motives clearly seem to matter in EMs: The coefficient on *pl_deviation* is negative and significant for the whole sample period and for the 1998–2006 sub-period. The coefficient can be interpreted as a one-unit increase in *pl_deviation* leading to a decline in the reserves to GDP ratio of around 25 percentage points. As shown in the summary statistics, the average value of *pl_deviation* for EMs is -0.08, with a standard deviation of 0.17. An increase by one unit is therefore a very large change. Economically, mercantilism does not seem to make a big difference for reserves holding. This finding is consistent with previous studies like Aizenman and Lee (2007) and Ghosh et al. (2012, 2014).

Third, intertemporal savings motives also seem to be more pronounced and consistent in the EM group than in the full sample. The coefficient on the change in the age dependency ratio is positive and significant throughout all eight regressions. What is more, the coefficient grows monotonically over time. This means that the intertemporal savings motive is becoming an increasingly important determinant of reserve assets. Given that population aging and fertility decline are likely to proceed at an even faster speed in the future, it should be expected that this motive for holding reserves would likely gain even more relevance in the future.

The AEs subgroup sample

For the AEs subgroup the empirical evidence on precautionary motives is mixed (Table 1c). Imports and M2 have positive coefficients as would be expected, and the coefficients are economically large. But the coefficients on capital inflows and volatility of the terms of trade are negative and significant (though both only at the 10 percent-level in column (1)) and therefore counterintuitive. The volatility of capital inflows does not seem to matter. When considering the sub-periods separately, the counterintuitive negative coefficients disappear, but evidence for precautionary savings motives is generally weak in 1980-2006; only capital inflows are significant for this sub-period. Moreover, the coefficient on M2 only becomes highly significant and economically large in the period following the global financial crisis, perhaps the outcome of weaknesses in the banking systems of many AEs coming to the fore during the crisis. The volatility of the terms of trade also becomes a significant determinant of reserves only since the global financial crisis.

While mercantilist considerations do not seem to play a role in the determination of reserves for AEs, the importance of most of the other explanatory variables varies across the sub-periods. Mercantilist motives are not significant in either the entire sample or the sub-periods. The cost of reserves is statistically significant and negative only in the last sub-period from 2007–2014. Spreads between short-term U.S. bond yields relative to bonds issued by other AEs were, on average, small during the great moderation, but increased during the crisis. Hence, following the crisis, the cost of holding reserves suddenly became costlier for AEs and impacted negatively on their reserves holding. The findings on the exchange rate regime are again inconclusive, while the coefficient on GDP per capita shows the same trend as for the EM subgroup. The change in the age dependency ratio has a negative significant coefficient for the 1980–1997 sub-period, while gradually turning positive over the course of the subsequent two sub-periods. Again, we could interpret this finding as an indication that central banks are gradually starting to react to the projected aging of their populations.

The coefficient on the IMF program dummy needs to be interpreted with caution considering that only two AEs participated in IMF programs during the sample period. South Korea had a program during 1997–2000 and Iceland during 2008–2011.[21] It seems that the program participation led Iceland to increase its reserves, everything else equal, but had no effect on Korea (see columns (7) and (8) of table 1c).

Finally, it is noteworthy that the overall model fit for the AE sample improves significantly in the third sub-period. While hardly any of the coefficients are significant in 1980–1997 and in 1998–2006, the model seems to be very successful in explaining reserves holding in 2007–2014. Apparently, (non-reserve currency issuing) AEs have started to behave more in line with what economic theory would predict since the outbreak of the global financial crisis. Therefore, we are able to put into perspective the findings of Aizenman and Lee (2007), which is the only study we are aware of that undertakes a direct comparison of AEs and EMs. While they find

[21] As noted earlier, countries issuing reserve currencies are not included in our sample. Accordingly, euro area countries that have had IMF programs in the aftermath of the global financial crisis are excluded from our sample the year their euro area membership started.

that, for their sample period of 1980–2000, their model works better for EMs than for AEs, we can add that this finding may no longer prevail.

The LICs subgroup sample

Over the full sample period, the model performs well for the LICs subgroup (Table 1d). In particular, all precautionary variables are significant at least at the 5 percent level and have the expected signs in columns (1) and (5), indicating that both current and capital account vulnerabilities induce LICs to hold more reserves. In contrast to EMs and AEs, the two volatility measures are shown to play an important role, both over the whole sample period and in the 1980–1997 sub-period. This seems understandable: LICs have, on average, the highest volatilities both of capital inflows and of the terms of trade, and therefore need to insure against the associated vulnerabilities – particularly given their relatively limited access to international capital markets.

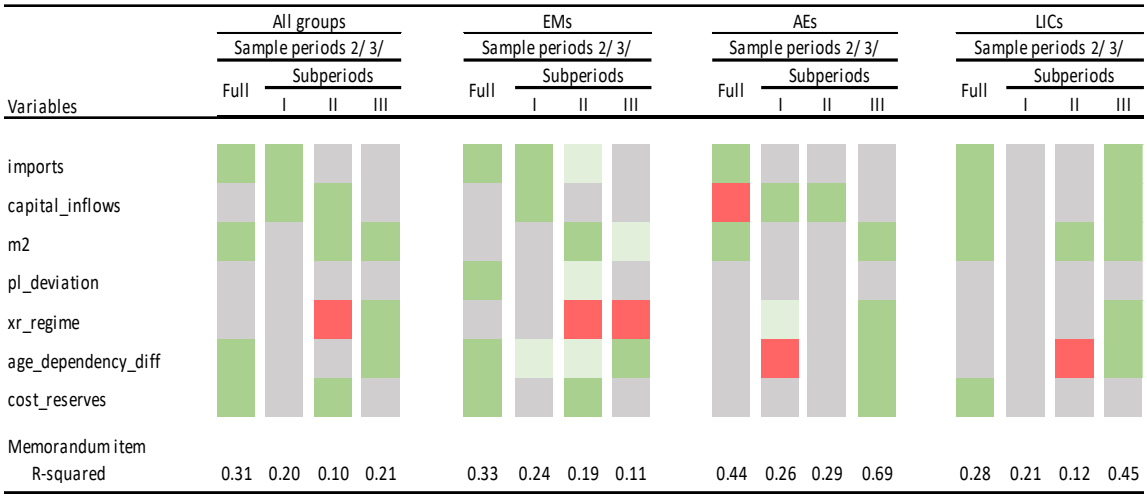
For the full sample period, the cost of reserves has a negative and significant impact on reserves while mercantilist motives are not significant. While it is expected that cost of reserves should matter strongly for LICs, because of foregone investment opportunities with much higher yields, the measurement issues mentioned in Section II might prevent capturing this motive accurately. Having the largest negative coefficient for LICs, followed by EMs and AEs when comparing columns (1) or columns (5) across Tables 1b, 1c and 1d, our measure of the cost of reserves thus seems to do a good job as a determinant of reserves holding. As in the case of AEs, there is no evidence that mercantilist considerations play a role in the determination of reserves holding in LICs. The coefficient of *pl_deviation* is not statistically significant, whether for the entire sample period or for the sub-periods. Thus, it seems that exchange rate undervaluation is pertinent for reserves holding only in the case of EMs.

Considering the sub-periods separately, it is notable that the impacts of several of the explanatory variables on reserves are significant only in the last sub-period, 2007–2014. These variables include some associated with precautionary motives (imports and capital flows), as well as the dummies for the exchange rate regime and for participation in an IMF program. Projected changes in the age dependency ratio are also positive significant only recently, while negative and significant in 1998–2006. Apart from the factors discussed above, an additional consideration relevant for LICs is that saving for future generations is most likely a less pressing priority. Our results could thus reflect the reality that societies can only "afford" to take the needs of future generations into account once they have reached a certain level of economic development and once reserves have risen to a level where other motives are adequately taken care of.

As was the case for AEs, the results confirm the relevance of the model for LICs, with the model fit increasing significantly in the last sub-period of the sample (Text Figure below). The relevance of the model, together with the fact that it performs much better since 2007 for both AEs and LICs, is a very important finding of our study that lends support to our conjecture and should further motivate future research on reserves holding to have a broader scope, not focusing just on EMs.

Text Figure 1. Summary of fixed effects regression results, full sample and sub-periods [1/]

Text Figure. Summary of FE regression results, full sample and sub-periods



Memorandum item	All groups				EMs				AEs				LICs			
R-squared	0.31	0.20	0.10	0.21	0.33	0.24	0.19	0.11	0.44	0.26	0.29	0.69	0.28	0.21	0.12	0.45

1/ Full regression results are in tables 1a, 1b, 1c, and 1d, for all groups, EMs, AEs, and LICs, respectively.

2/ Full sample is for 1980-2014 while sub-periods I, II, and III cover the periods 1980-1997, 1998-2007, and 2008-2014, respectively

3/ Color codes: dark green is for coefficients that have expected signs and are statistically significant at the one and five percents levels; light green is used when coefficients have expected signs and are significant only at the 10 percent level; red is for coefficients that are statistically significant with counterintuitive signs; and grey is for non-statistically significant coefficients.

B. CCEPMG Regressions

We now complement the findings from the fixed effects estimation with results obtained when applying the more sophisticated CCEPMG regressions. Table 2 shows regression results for the full sample (columns (1) and (2)), the sample of EMs only (columns (3) and (4)), the EMs and AEs sample (columns (5) and (6)) and the EMs and LICs sample (columns (7) and (8)). Within each bloc, the first column contains results based on CCEMG estimation, whereas the second column displays CCEPMG estimation results. The Hausman test statistics do not reject the null hypothesis that there is no significant difference between the long-run coefficients of both sets of regressions, thus indicating that the CCEPMG estimates are both consistent and efficient. In what follows we therefore focus on the CCEPMG results.

The first thing to note is that the coefficient on the error correction term is always negative and highly significant, which means that there is convergence to the long-run equilibrium. The coefficient is around 0.65 for EMs only and 0.68 for EMs and LICs combined, implying that, for these subgroups, around 65 percent of the gap between the current level of reserves and the equilibrium level is closed within the course of a year. The error-correction coefficient is marginally smaller in the full sample and for the combined AEs and EMs sub-sample, at around 0.62. It seems that it takes central bankers in AEs slightly more time to adjust the stock of reserves to its long-run level.

We now compare the results of the CCEPMG with those obtained from fixed-effects regressions, noting as a word of caution, that the results from the two estimation techniques are not comparable one-to-one. This is in part because the sample composition changes

significantly. Across country groups, the number of countries included in the regressions is much smaller relative to the fixed effects estimation. In particular, the AEs and LICs subgroups include only very few countries, so that it is no longer possible to have regressions separately for LICs only or AEs only. We will address this issue further below.

The CCEPMG results overall confirm the importance of precautionary motives (relating to both the current and capital accounts) for the demand for reserves and the heterogeneous role of age dependency across country groups. Looking first at imports, the coefficient on imports is not statistically significant for EMs alone or tor the AEs and EMs subgroup, but highly significant for the total sample and for the LICs and EMs subgroup. This suggests that precautionary motives relating to the current account are of most importance for LICs. This result contrasts with the fixed effects regression results, which suggest that this motive is of highest relevance for AEs, followed by EMs and then LICs. The estimated long-run coefficients on M2 are, for all four samples, positive and significant statistically, broadly consistent with the findings from the fixed effects regressions. However, unlike with the fixed effects regression results for EMs where M2 is not significant, in the CCEPMG regressions the coefficient on M2 is positive and highly significant for the EMs only subgroup in both the short and long runs, confirming that capital flight concerns are also of relevance for them and motivate them to build up reserve buffers as an insurance against capital flight.

With regard to age dependency, for all groups together this variable is highly significant in the fixed effects regressions but not in the CCEPMG regressions. However, the two methodologies give consistent results for the subgroups. In particular, in the CCEPMG regressions, just like in the fixed effects regressions, the coefficient on age dependency is positive and significant for the EMs only subgroup and non-significant for other subgroups.

Mercantilist motives no longer seem to be significant for EMs. There is evidence for mercantilist motives in the CCEPMG regressions for the full sample, and only for the AEs and EMs subgroup (at the 10 percent statistical significance level). This stands in contrast with the finding of the fixed effects regressions that mercantilist motives are important for EMs and not for the full country sample or the other two country groups. It is relevant here to note that, due to the need to reduce the number of variables, the exchange rate regime is not included as an explanatory variable in either the short-run or the long-run in the CCE regressions (in contrast with the fixed effects regressions).

All in all, based on the signs and statistical significance of the estimated coefficients, the CCEPMG results confirm partly but not fully the insights of the fixed effects regressions, in that they highlight the importance of precautionary motives relating both to the current and capital accounts. They do, however, paint a slightly different picture of the relative importance of these motives across country groups. The findings on age dependency are generally consistent between the two estimation techniques, except for the full sample as noted above. Somewhat surprisingly, the mercantilist motive for holding reserves loses significance for the EMs only subgroup in the CCEPMG regressions, but is marginally of significance for the full sample of countries and for the AEs and EMs subgroup.

The comparison between CCEPMG and fixed-effects results would be more meaningful if the results are obtained from the same sample and the same regressors. As the EMs subgroup is the one with the highest number of countries in the CCEPMG regressions, we run a fixed effects regression for the 16 EMs countries included in the CCEPMG with regressors

restricted to the variables included in the long-run equation of the CCEPMG, as well as the two variables included in the short-run equations: pl_deviation and imf_program. All the variables included are highly significant and the regression has a much higher explanatory power than the one based on the full EMs sample and an expanded set of regressors. With regard to precautionary motives, the CCEPMG results confirm only capital account motives for both the short and long runs as noted above. In comparison to the fixed effects results, the coefficients differ significantly for all variables but M2 (Text table 1). This suggests not only that there exist unobserved common factors that significantly affect the impact of those variables on desired reserves holding, but also that making a distinction between short-run and long-run impacts is important.

Text Table 1. Fixed effect and CCEPMG results for EMs

Variables	Fixed effects coefficients	CCEPMG coefficients 1/	
		Long run	Short run 2/
imports	1.076***	0.108	0.0963
m2	0.353***	0.377***	0.376*
age_dependency_diff	0.0172***	0.0306**	0.101
pl_deviation	-0.641***		0.102
imf_program	-0.0981**		0.124
Constant	-2.711***		
Memo items			
Observations	548		528
Number of countries	16		16
R-squared	0.514		---

1/ From column (4) of Table 2.
2/ For imports, m2, and age_dependency diff, the short run coefficients are the coefficients of the first difference of each variable.

VI. Robustness Checks

In this section, we present some additional regressions to check how robust our findings are. We use alternative proxies for some of the explanatory variables or add new variables, and adjust the sample in one instance. The robustness checks are conducted for both the fixed effects and the CCEPMG regressions. In the comparisons, we refer to the regressions whose robustness we check as baseline regressions.

For the fixed effects regressions, the first robustness check, which consists of assessing how reserves holding is affected by global economic uncertainty suggests that the findings of the main regressions continue to hold. We include as an additional variable in the regression the VIX index, which measures market expectations of near term volatility based on stock index

option prices (Table 3). The VIX is available from 1990 onwards only, which is why Table 3 shows regression results for the full 1990–2014 sample period by country groups. In general, the results from Tables 1a-1d, columns (1), continue to hold. Slight changes in the size of the coefficients can be attributed partly to the adjusted time period. The VIX itself is, somewhat surprisingly, insignificant. This may be because other variables, in particular the cost of reserves and the variables capturing precautionary savings motives, already reflect the global economic climate to some extent.

The second robustness check, which consists of removing China from the sample of EMs also suggests that the results continue to hold (Table 4). China is a large emerging market economy that has accumulated substantial foreign exchange reserves over the past couple of decades. Some have argued that China has used strategic reserves policies to keep the renminbi artificially undervalued (see for example Goldstein and Lardy, 2006, Ferguson and Schularick, 2011, and references therein). Therefore, it could be mostly China driving the results for the group of EMs, and in particular the finding on mercantilist motives. If that were the case, our conclusions would not be valid for EMs taken as a group. In order to test this hypothesis, we repeat the fixed effects regressions for EMs excluding China for the complete sample period, for 1998–2006, and for 2007–2014.[22] As Table 4 shows, the EMs estimation results are almost unchanged when China is excluded. Neither the coefficient on *pl_deviation* nor any of the other coefficients change significantly. Therefore, we can safely conclude that the findings for the EM sub-sample are not being driven by China.

Using an alternative measure of the opportunity cost of reserves in a third robustness check also broadly confirms the results of our baseline fixed effects regressions (Table 5). As discussed above, the opportunity cost of reserves is difficult to measure, partly because the foregone investment opportunity for the central bank is likely to vary by country, depending for example on the country's access to international financial markets. An alternative to using the spread between domestic and US rates of return on financial assets of comparable maturity, as we have done in Section V, is to use the yield spread on US financial assets of different maturities. Therefore, we repeat the fixed effects regressions using as an alternative measure of the cost of reserves the difference in yield of a US 10-year government bond and a US 3-month Treasury bills. A similar measure has been used by Bastourre et al. (2009).

For the sake of space, we show the regressions for the full sample period for all groups, but presents sub-period results only for the sample including all countries. It can be seen that the alternative measure performs poorly. In particular, it is never significant in the full sample, and for the subgroups it is only significant in AEs – but with the wrong sign. It seems that this measure is not accurately capturing the cost of reserves. However, the main findings on the other explanatory factors continue to hold. This makes us confident that the cost of reserves measure employed in Section V is not erroneously picking up the effect of some other variable.

Results from the regression in which we use the volatility of exports instead of the volatility of the terms of trade as a proxy for current account shocks also confirm the robustness of our findings (Table 6). Some existing studies that use the volatility of exports include Aizenman and Marion (2003), Bastourre et al. (2009) and Ghosh et al. (2012, 2014). We use this alternative measure, defined analogously to the other volatility measures as the lagged five-

[22] China was already not included in the 1980-1997 regressions of Section V because of missing data.

year relative standard deviation of exports in percent of GDP, and repeat the estimations. As Table 6 shows, in the regressions including all countries the volatility of exports is insignificant except for the last time period, where it is negative significant. In the sub-sample regressions, it is insignificant for EMs and LICs but positive significant for AEs, a reversal of the counterintuitive negative and significant coefficient of the baseline regression for AEs.

A final robustness check for the fixed effects regressions, which consists of using an alternative *measure* of capital inflows to some extent confirms the findings of our baseline regressions with some changes on the intuitiveness of the coefficients of a few variables for some subgroups (Table 7). We follow some papers (e.g. Aizenman and Lee, 2007, Obstfeld et al., 2010) that use a de jure measure of capital account openness. While we believe that a measure of actual capital inflows more accurately captures the risks connected to the capital account, we can perform an additional robustness check of the results presented in Section V by replacing our *capital_inflows* variable with the Quinn (1997) index of de jure capital account openness.[23]

Table 7 shows the de jure capital account variable *ka_open* to be positively significant in nearly half of the specifications, as was *capital_inflows*However,there are some notable differences with the baseline results. For the EMs where both capital inflows and the volatility of capital inflows are not significant for the full period in Table 1b, they become positive and significant. For the AEs, the coefficient on *ka_open* is insignificant whereas in Table 1c, *capital_inflows* has a counterintuitive negative and significant coefficient. For LICs, volatility of terms of trade and capital inflows turn out not to be significant whereas in Table 1d they both have intuitive positive and significant coefficients. For all subgroups, the coefficients on the other variables change slightly. This, together with the mixed changes on the intuitiveness of certain variables, suggests using de facto capital inflows as in our baseline regressions seems more appropriate.

For the CCEPMG regression, the robustness check consists of replicating the results from Table 2 by either dropping the dummy for IMF program which is only marginally significant in Table 2 or replacing M2 with the volume of capital inflows as an indicator of capital account considerations. In the version excluding the dummy for an IMF program, the results change marginally (Table 8). In the version with the volume of capital flows in lieu of M2, some changes are worthy of note (Table 9). In particular, although precautionary motives continue to be of importance, the current account-related motive becomes more significant while the capital account-related motive becomes notably less important in magnitude while remaining statistically significant for the EMs only and EMs and LICs subgroups. This contrasts with the results of the baseline regression presented in Table 2, where the indicator of capital account motives is significant for all groups together as well as for all the subgroups.

There are also notable changes to the coefficients of the remaining variables. In particular, age dependency, which is significant only for the EMs only group in the long run, loses its long run significance for EMs and becomes statistically significant in the short run for the EMs only and EMs and LICs subgroups. The statistical significance for the long run shifts to the full sample group and to the EMs and LICs subgroups. The IMF program dummy loses its statistical significance for all groups. The speed of adjustment is lower in Tables 8 and 9 than

[23] This index is based on the IMF's Annual Report on Exchange Arrangements and Restrictions database and ranges from 0 (signifying a completely closed capital account) to 1 (completely open).

in Table 2 in all cases. All this suggests that M2, as a stock variable, probably captures the importance of precautionary motives relating to the capital account better than does capital inflows alone, which is a flow variable.

VII. CONCLUSION

In this paper, we have looked at the determinants of reserves holding from a new perspective: focusing not exclusively on EMs but comparing three country groups, EMs, AEs and LICs, over time and using two different estimation techniques. Particular attention was paid to the heterogeneity of the countries within and across groups, and to cross-sectional dependence and serial correlation. In fixed effects panel data regressions, we have shown that precautionary motives are important determinants for reserves holding in all three country groups. For EMs, they seem to have mattered more prior to 2007, with a shift from more emphasis on current account motives prior to the Asian crisis to capital account considerations after the crisis, confirming findings from previous studies such as Ghosh et al. (2012). For AEs and LICs, the role of precautionary motives has increased since the global financial crisis. Mercantilist motives seem to matter only for EMs, but with less importance in recent years. For all three groups, a newly introduced explanatory variable, the (projected) change in the age dependency ratio, is shown to have been gaining in importance over time. Overall, the model fit improves significantly for AEs and LICs in the period since the start of the global financial crisis relative to earlier periods, whereas the opposite seems to be the case for EMs.

Applying a novel estimation technique, CCEPMG estimation, we have taken a closer look at the (long-term) role of the different motives for reserves holding across groups and the potential role of unobserved common factors across countries. The results confirm the importance of precautionary motives for all country groups, but are less clear-cut when it comes to mercantilist motives for building up reserves and the importance (or otherwise) of age dependency. A more meaningful comparison between CCEPMG and fixed-effects results is based on results from regressions using the same regressors and the same sample. A comparison of results from a fixed effects regression covering only the 16 EMs countries included in the CCEPMG, with regressors restricted to those used in the CCEPMG reveals that the coefficients differ significantly for all variables but M2. This suggests that there exist unobserved common factors related to those variables and points to the importance of making a distinction between short-run and long-run impacts.

We conclude that it does make sense to use models initially developed for EMs to estimate the demand for reserves for AEs and LICs and to take into account the heterogeneity of countries and the impact of cross-sectional dependence when it is detected as in our analysis. It seems that these models have become fairly relevant in explaining reserves holding for AEs and LICs, as reflected by the increased explanatory power of the fixed effects regressions for the period since the start of the global financial crisis. Our CCEPMG results provide evidence that reserves are likely to adjust to changes through a dynamic process and that unobserved common factors affect some coefficient estimates. These findings should motivate future research on the determinants of reserves holding. They also have important implications for policymakers in all three country groups, that may be incentivized to apply empirical models like the ones used in our analysis more broadly.

REFERENCES

Aizenman, Joshua, and Jaewoo Lee, 2007, "International Reserves: Precautionary Versus Mercantilist Views, Theory and Evidence", *Open Economies Review*, Vol. 18, pp.191-214.

Aizenman, Joshua, and Nancy P. Marion, 2003, "The High Demand for International Reserves in the Far East: What Is Going On?", *Journal of the Japanese and International Economies*, Vol. 17, pp. 370-400.

Bastourre, Diego, Jorge Carrera and Javier Ibarlucia, 2009, "What is Driving Reserve Accumulation? A Dynamic Panel Data Approach", *Review of International Economics*, Vol. 17, pp. 861-877.

Breusch, Trevor S., and Adrian R. Pagan, 1980, "The Lagrange multiplier test and its application to model specification in econometrics, *Review of Economic Studies*, Vol. 47, pp. 239-253.

de Calvacanti, Tiago V., Kamiar Mohaddes and Mehdi Raissi, 2015, "Commodity price volatility and the sources of growth", *Journal of Applied Econometrics*, Vol. 30, pp. 857-873.

Calvo, Guillermo A., and Frederic S. Mishkin, 2003, "The Mirage of Exchange Rate Regimes for Emerging Market Economies", *Journal of Economic Perspectives*, Vol. 17, pp. 99-118.

Chudik, Alexander, Kamiar Mohaddes, M. Hashem Pesaran and Mehdi Raissi, 2015, "Long-Run Effects in Large Heterogeneous Panel Data Models with Cross-Sectionally Correlated Errors", Federal Reserve Bank of Dallas Working Paper No. 223.

Chudik, Alexander, and M. Hashem Pesaran, 2015, "Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors", *Journal of Econometrics*, Vol. 188, pp. 393-420.

Delatte, Anne-Laure, and Julien Fouquau, 2012, "What Drove the Massive Hoarding of International Reserves in Emerging Economies? A Time-varying Approach", *Review of International Economics*, Vol. 20, pp. 164-176.

Driscoll, John C. and Aart C. Kraay (1998), "Consistent covariance matrix estimation with spatially dependent panel data", *Review of Economics and Statistics*, Vol. 80, pp. 549-560.

Drukker, David M., 2003, "Testing for serial correlation in linear panel-data models, *Stata Journal*, Vol. 3, pp. 168-177.

Ferguson, Niall, and Moritz Schularick, 2011, "The End of Chimerica", *International Finance*, Vol. 14, pp. 1-26.

Ghosh, Atish R., and Jonathan D. Ostry, 1997, "Macroeconomic uncertainty, precautionary saving, and the current account", *Journal of Monetary Economics*, Vol. 40, pp. 121-139.

Ghosh, Atish R., Jonathan D. Ostry, and Charalambos G. Tsangarides, 2014, "Accounting for emerging market countries' international reserves: Are Pacific Rim countries different?", *Journal of International Money and Finance*, Vol. 49, pp. 52-82.

Ghosh, Atish R., Jonathan D. Ostry, and Charalambos G. Tsangarides, 2012, "Shifting Motives: Explaining the Buildup in Official Reserves in Emerging Markets since the 1980s", IMF Working Paper No. WP/12/34.

Goldstein, Morris, and Nicholas Lardy, 2006, "China's Exchange Rate Policy Dilemma", *American Economic Review*, Vol. 96, pp. 422-426.

International Monetary Fund, 2015, "Assessing Reserve Adequacy – Specific Proposals", IMF Policy Paper, April (Washington: International Monetary Fund).

International Monetary Fund, 2013, "Assessing Reserves Adequacy – Further Considerations", IMF Policy Paper, February (Washington: International Monetary Fund).

International Monetary Fund, 2011, "Assessing Reserves Adequacy", IMF Policy Paper, February (Washington: International Monetary Fund).

International Monetary Fund, 2016, "Guidance Note on the Assessment of Reserve Adequacy and Related Considerations", IMF Policy Paper, June (Washington: International Monetary Fund).

Jeanne, Olivier, 2007, "International Reserves in Emerging Market Countries: Too Much of a Good Thing?", *Brookings Papers on Economic Activity*, Vol. 2007, pp. 1-55.

Jeanne, Olivier, and Romain Rancière, 2011, "The Optimal Level of International Reserves for Emerging Market Countries: A New Formula and Some Applications", *Economic Journal*, Vol. 121, pp. 905-930.

Kapetanios, George, M. Hashem Pesaran and Takashi Yamagata, 2011, "Panels with non-stationary multifactor error structures", *Journal of Econometrics*, Vol. 160, pp. 326-348.

Obstfeld, Maurice, Jay C. Shambaugh and Alan M. Taylor, 2010, "Financial Stability, the Trilemma, and International Reserves", *American Economic Journal: Macroeconomics*, Vol. 2, pp. 57-94.

Nkunde, Mwase, 2012, "How Much Should I Hold? Reserve Adequacy in Emerging Markets and Small Islands", IMF Working Paper No. WP/12/205, (Washington: International Monetary Fund).

Pesaran, M. Hashem, 2015, "Time Series and Panel Data Econometrics", Oxford University Press, Oxford.

Pesaran, M. Hashem, 2006, "Estimation and inference in large heterogeneous panels with multifactor error structure", *Econometrica*, Vol. 74, pp. 967-1012.

Pesaran, M. Hashem, 2004, "General diagnostic tests for cross-section dependence in panels", CESifo Working Paper No. 1229.

Pesaran, M. Hashem, Yongcheol Shin and Ron P. Smith, 1999, "Pooled Mean Group Estimation of Dynamic Heterogeneous Panels, *Journal of the American Statistical Association*", Vol. 94, pp. 621-634.

Quinn, Dennis, 1997, "The Correlates of Change in International Financial Regulation", *American Political Science Review*, Vol. 91, pp. 531-551.

Reinhart, Carmen M., and Kenneth S. Rogoff, 2004, "The Modern History of Exchange Rate Arrangements: A Reinterpretation", *Quarterly Journal of Economics*, Vol. 119, pp. 1-48.

Rodrik, Dani, 2006, "The Social Cost of Foreign Exchange Reserves", *International Economic Journal*, Vol. 20, pp. 253-266.

Sula, Ozan, 2011, "Demand for international reserves in developing countries: A quantile regression approach", *Journal of International Money and Finance*, Vol. 30, pp. 764-777.

Yeyati, Eduardo Levy, 2008, "The cost of reserves", *Economics Letters*, Vol. 100, pp. 39-42.

Wijnholds, J. Onno de Beaufort, and Arend Kaptejn, 2001, "Reserve Adequacy in Emerging Market Economies", IMF Working Paper No. WP/01/143, (Washington: International Monetary Fund).

Wooldridge, Jeffrey M., 2002, "Econometric Analysis of Cross Section and Panel Data", MIT Press, Cambridge.

REGRESSION TABLES

Table 1a: Fixed effects regressions, all countries

VARIABLES	(1) all	(2) 1980-1997	(3) 1998-2006	(4) 2007-2014	(5) all	(6) 1980-1997	(7) 1998-2006	(8) 2007-2014
gdp_pc	0.429***	0.645***	0.752***	-0.839***	0.459***	0.703***	0.651***	-0.811***
	(0.144)	(0.161)	(0.0963)	(0.151)	(0.138)	(0.167)	(0.0926)	(0.156)
imports	0.570***	0.733***	-0.0695	0.341*	0.622***	0.726***	-0.0289	0.307
	(0.123)	(0.0996)	(0.0972)	(0.175)	(0.119)	(0.0926)	(0.0952)	(0.181)
volatility_tot	-0.197	0.0110	0.585	-0.172				
	(0.483)	(0.563)	(0.651)	(0.491)				
capital_inflows	-0.000799	0.0315***	0.00555*	0.00241	-0.00165	0.0266***	0.00457**	0.00269
	(0.00223)	(0.00661)	(0.00255)	(0.00175)	(0.00219)	(0.00578)	(0.00196)	(0.00177)
volatility_capital_inflows	0.00400**	0.00495	0.00501**	0.000876	0.00394**	0.00497	0.00450**	7.62e-05
	(0.00158)	(0.00373)	(0.00209)	(0.00163)	(0.00160)	(0.00385)	(0.00148)	(0.00119)
m2	0.409***	-0.118	0.574***	0.843***	0.383***	-0.131	0.573***	0.849***
	(0.108)	(0.124)	(0.0644)	(0.133)	(0.106)	(0.125)	(0.0581)	(0.152)
pl_deviation	-0.0869	-0.177	-0.183	0.0312				
	(0.146)	(0.130)	(0.215)	(0.193)				
xr_regime	0.0241	-0.0169	0.0925*	-0.0528***	0.0332	-0.00924	0.0943**	-0.0246**
	(0.0350)	(0.0726)	(0.0443)	(0.00778)	(0.0352)	(0.0684)	(0.0342)	(0.00992)
age_dependency_diff	0.0118***	0.00746	-0.00811	0.0288***	0.0101***	0.00817	-0.00720	0.0302***
	(0.00352)	(0.00738)	(0.00721)	(0.00184)	(0.00340)	(0.00696)	(0.00722)	(0.00300)
cost_reserves	-0.0853**	-0.0113	-0.871***	-0.344	-0.0824**	-0.0124	-0.812***	-0.253
	(0.0412)	(0.0208)	(0.178)	(0.575)	(0.0388)	(0.0184)	(0.178)	(0.495)
imf_program	-0.0162	-0.0850	0.0474	0.0681				
	(0.0417)	(0.0728)	(0.0994)	(0.0411)				
Constant	-4.813***	-5.518***	-6.031***	5.370***	-5.175***	-5.906***	-5.234***	5.155***
	(0.938)	(1.397)	(0.926)	(1.432)	(0.976)	(1.454)	(0.903)	(1.403)
Observations	2,011	569	738	704	2,165	626	801	738
R-squared	0.317	0.202	0.109	0.213	0.314	0.197	0.101	0.208
Number of countries	122	68	105	106	131	80	113	113

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1b: Fixed effects regressions, emerging markets

VARIABLES	(1) all	(2) 1980-1997	(3) 1998-2006	(4) 2007-2014	(5) all	(6) 1980-1997	(7) 1998-2006	(8) 2007-2014
gdp_pc	0.412***	0.561***	0.184	-0.558**	0.442***	0.617***	0.182	-0.568**
	(0.127)	(0.163)	(0.174)	(0.183)	(0.117)	(0.156)	(0.141)	(0.185)
imports	0.633***	0.797***	-0.289*	0.0709	0.634***	0.793***	-0.289*	0.0694
	(0.169)	(0.149)	(0.146)	(0.194)	(0.170)	(0.151)	(0.147)	(0.194)
volatility_tot	-0.739	-0.219	0.619*	-0.388	-0.744	-0.231	0.618*	-0.354
	(0.602)	(0.513)	(0.277)	(0.488)	(0.617)	(0.550)	(0.291)	(0.423)
capital_inflows	0.00317	0.0280***	0.00977	-0.000545	0.00330	0.0276***	0.00977	-0.000558
	(0.00352)	(0.00524)	(0.00700)	(0.00229)	(0.00354)	(0.00548)	(0.00691)	(0.00233)
volatility_capital_inflows	0.00205	0.00554	0.00323**	0.000924	0.00221	0.00531	0.00322***	0.000897
	(0.00239)	(0.00627)	(0.000965)	(0.00154)	(0.00242)	(0.00627)	(0.000944)	(0.00149)
m2	0.200	-0.222	0.607***	0.421*	0.203	-0.242	0.607***	0.418*
	(0.133)	(0.156)	(0.133)	(0.213)	(0.134)	(0.151)	(0.134)	(0.212)
pl_deviation	-0.254**	-0.762*	-0.279*	0.0651	-0.244**	-0.688	-0.279*	0.0595
	(0.119)	(0.399)	(0.135)	(0.407)	(0.117)	(0.401)	(0.135)	(0.415)
xr_regime	0.0494	-0.0808	0.140***	0.0552***	0.0487	-0.0769	0.140***	0.0550***
	(0.0389)	(0.0849)	(0.0234)	(0.0119)	(0.0393)	(0.0870)	(0.0246)	(0.0125)
age_dependency_diff	0.0130***	0.0111*	0.0144*	0.0288***	0.0125***	0.0125*	0.0144*	0.0293***
	(0.00341)	(0.00616)	(0.00729)	(0.00277)	(0.00347)	(0.00648)	(0.00674)	(0.00345)
cost_reserves	-0.0679**	-0.00265	-0.963***	0.222	-0.0698**	-0.00461	-0.963***	0.257
	(0.0329)	(0.0218)	(0.187)	(0.976)	(0.0320)	(0.0225)	(0.190)	(0.923)
imf_program	-0.0469	-0.109	0.00202	0.0123				
	(0.0456)	(0.0806)	(0.0666)	(0.0473)				
Constant	-4.064***	-4.308***	-0.456	5.662***	-4.352***	-4.695***	-0.437	5.759***
	(0.830)	(1.192)	(1.200)	(1.333)	(0.817)	(1.113)	(1.014)	(1.268)
Observations	1,190	345	437	408	1,190	345	437	408
R-squared	0.333	0.244	0.194	0.114	0.332	0.239	0.194	0.114
Number of countries	72	40	58	63	72	40	58	63

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1c: Fixed effects regressions, advanced economies

VARIABLES	(1) all	(2) 1980-1997	(3) 1998-2006	(4) 2007-2014	(5) all	(6) 1980-1997	(7) 1998-2006	(8) 2007-2014
gdp_pc	0.489	1.506***	1.974**	-1.883***	0.513	1.505***	0.744	-1.972***
	(0.544)	(0.491)	(0.655)	(0.469)	(0.462)	(0.456)	(0.433)	(0.418)
imports	0.710*	0.541	-0.248	-0.176	0.794**	0.377	0.152	-0.0802
	(0.367)	(0.322)	(0.188)	(0.542)	(0.312)	(0.370)	(0.132)	(0.420)
volatility_tot	-2.622*	-1.383	-0.0858	6.229**	-1.908*	-1.420	0.185	5.428***
	(1.299)	(1.464)	(0.665)	(1.798)	(1.125)	(1.645)	(0.671)	(1.025)
capital_inflows	-0.00361*	0.0334**	0.00507**	0.00505	-0.00418**	0.0301**	0.00377**	0.00457
	(0.00200)	(0.0155)	(0.00209)	(0.00468)	(0.00172)	(0.0141)	(0.00156)	(0.00446)
volatility_capital_inflows	-0.000176	-0.00106	-0.00236	-0.0257				
	(0.00159)	(0.00231)	(0.00210)	(0.0327)				
m2	0.888***	0.0792	0.183	3.062**	0.747***	0.187	0.180	2.962***
	(0.168)	(0.272)	(0.156)	(0.878)	(0.129)	(0.199)	(0.133)	(0.775)
pl_deviation	-0.0469	0.128	-0.0245	0.0647				
	(0.119)	(0.291)	(0.134)	(0.0965)				
xr_regime	-0.192	0.441*	0.0293	-0.538**	-0.157	0.404*	0.0259	-0.548***
	(0.119)	(0.227)	(0.0449)	(0.172)	(0.114)	(0.193)	(0.0478)	(0.156)
age_dependency_diff	-0.00815	-0.0442**	-0.0406**	0.0368*	-0.00840	-0.0431**	-0.00986	0.0330**
	(0.0115)	(0.0180)	(0.0160)	(0.0159)	(0.00938)	(0.0172)	(0.0127)	(0.0136)
cost_reserves	-0.288	1.754	1.398	-7.535**	0.708	-0.575	1.256	-7.229**
	(2.025)	(1.504)	(0.932)	(2.710)	(0.792)	(0.845)	(0.994)	(2.393)
imf_program	0.593**	0	-0.153	0.231***	0.502*	0	-0.192	0.249***
	(0.259)	(0)	(0.115)	(0.0533)	(0.250)	(0)	(0.119)	(0.0463)
Constant	-8.534	-17.26***	-17.74**	10.04	-8.604*	-16.85***	-6.557	11.16
	(5.379)	(4.487)	(6.424)	(6.796)	(4.672)	(4.573)	(4.671)	(5.977)
Observations	328	123	115	90	363	151	122	90
R-squared	0.423	0.309	0.328	0.693	0.435	0.264	0.286	0.690
Number of countries	21	17	19	14	22	19	20	14

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1d: Fixed effects regressions, low-income countries

VARIABLES	(1) all	(2) 1980-1997	(3) 1998-2006	(4) 2007-2014	(5) all	(6) 1980-1997	(7) 1998-2006	(8) 2007-2014
gdp_pc	0.333	1.366**	1.859*	-0.976***	0.371*	1.188***	1.746**	-0.955***
	(0.210)	(0.539)	(0.877)	(0.171)	(0.209)	(0.381)	(0.585)	(0.146)
imports	0.486***	0.274	-0.00112	0.459**	0.565***	0.356	0.00849	0.452**
	(0.119)	(0.315)	(0.314)	(0.137)	(0.116)	(0.216)	(0.327)	(0.137)
volatility_tot	1.355***	1.474*	0.177	-0.430	1.380***	1.500*	0.104	-0.392
	(0.456)	(0.752)	(1.334)	(0.723)	(0.479)	(0.734)	(1.174)	(0.639)
capital_inflows	0.0246**	0.0478	0.0281	0.0277**	0.0236**	0.0626	0.0267	0.0310***
	(0.0102)	(0.0710)	(0.0158)	(0.0101)	(0.00944)	(0.0818)	(0.0160)	(0.00865)
volatility_capital_inflows	0.00745**	0.00652*	0.00798	0.00432	0.00734**	0.00742**	0.00820	0.00434
	(0.00352)	(0.00329)	(0.00692)	(0.00279)	(0.00346)	(0.00338)	(0.00636)	(0.00268)
m2	0.742***	0.0529	1.506***	0.976***	0.687***	0.155	1.363***	0.978***
	(0.134)	(0.292)	(0.284)	(0.115)	(0.132)	(0.263)	(0.214)	(0.109)
pl_deviation	0.0104	-0.944	0.359	-0.0933				
	(0.326)	(1.154)	(0.671)	(0.0721)				
xr_regime	0.0591	-0.0590	0.0135	-0.0951**	0.0966	-0.0473	0.0674	-0.0867**
	(0.0697)	(0.0835)	(0.145)	(0.0362)	(0.0711)	(0.0801)	(0.106)	(0.0296)
age_dependency_diff	0.00648	0.00738	-0.0558**	0.0154**	0.00344	0.0118	-0.0536**	0.0191***
	(0.00612)	(0.0254)	(0.0193)	(0.00573)	(0.00595)	(0.0224)	(0.0165)	(0.00449)
cost_reserves	-1.168**	0.320	-0.717	-0.575	-1.213***	0.421	-0.858	-0.455
	(0.451)	(0.246)	(0.523)	(0.769)	(0.391)	(0.301)	(0.606)	(0.703)
imf_program	0.0177	-0.0682	0.0262	0.146***	0.0324	-0.0531	0.0254	0.142***
	(0.0927)	(0.108)	(0.328)	(0.0326)	(0.0775)	(0.0983)	(0.296)	(0.0289)
Constant	-4.439***	-8.175**	-16.59**	4.460**	-4.912***	-7.557***	-15.46***	4.348**
	(1.254)	(2.894)	(6.585)	(1.434)	(1.263)	(2.562)	(4.253)	(1.293)
Observations	493	101	186	206	515	103	197	215
R-squared	0.287	0.219	0.127	0.450	0.282	0.211	0.122	0.451
Number of countries	41	16	30	34	44	18	32	36

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2: CCEMG and CCEPMG regressions

VARIABLES	(1) all MG	(2) all PMG	(3) EMs MG	(4) EMs PMG	(5) AEs and EMs MG	(6) AEs and EMs PMG	(7) LICs and EMs MG	(8) LICs and EMs PMG
Error correction term								
ec	-0.659 ***	-0.623 ***	-0.641 ***	-0.647 ***	-0.67 ***	-0.624 ***	-0.714 ***	-0.682 ***
	(0.0493)	(0.0414)	(0.0794)	(0.0740)	(0.0623)	(0.0575)	(0.0654)	(0.0552)
Short run								
D.imports	0.144	0.111	0.234	0.0963	0.114	-0.112	0.374 **	0.339 **
	(0.206)	(0.183)	(0.209)	(0.171)	(0.202)	(0.181)	(0.175)	(0.138)
D.m2	0.363	0.212	0.456 **	0.376 *	0.437 ***	0.318 *	0.542 *	0.112
	(0.229)	(0.189)	(0.225)	(0.206)	(0.164)	(0.165)	(0.302)	(0.246)
D.age_dependency_diff	-0.0124	0.156	-0.00509	0.101	-0.0269	0.0295	0.128	0.175
	(0.0624)	(0.126)	(0.234)	(0.177)	(0.122)	(0.117)	(0.177)	(0.197)
pl_deviation	-0.158	-0.231 *	0.152	0.102	-0.204	-0.264 *	-0.125	-0.245
	(0.170)	(0.135)	(0.234)	(0.210)	(0.184)	(0.158)	(0.161)	(0.150)
imf_program	0.0734	0.103 *	0.0991	0.124	0.102	0.119 *	0.0659	0.113
	(0.0783)	(0.0604)	(0.109)	(0.0919)	(0.0659)	(0.0688)	(0.106)	(0.0752)
Long run								
L.imports	0.718	0.395 ***	0.394	0.108	1.103 **	-0.0834	0.0792	0.49 ***
	(0.540)	(0.131)	(0.533)	(0.160)	(0.534)	(0.141)	(0.613)	(0.139)
L.m2	0.209	0.208 *	0.735	0.377 ***	0.469 *	0.255 **	1.743 **	0.289 **
	(0.406)	(0.118)	(0.594)	(0.109)	(0.269)	(0.112)	(0.770)	(0.131)
L.age_dependency_diff	-0.0627	0.00460	-0.0418	0.0306 **	-0.0299	-0.00285	-0.0106	0.0155
	(0.0527)	(0.0123)	(0.0585)	(0.0138)	(0.0338)	(0.0130)	(0.0574)	(0.0118)
Constant	-1.732	-0.602	-6.477 *	-5.548	-3.213	-2.108	-3.625	-0.867
	(4.986)	(2.250)	(3.660)	(3.476)	(3.795)	(2.939)	(5.934)	(2.292)
Observations	935	935	528	528	828	828	635	635
Number of countries	28	28	16	16	25	25	19	19
aic	-842.7	-635.9	-421	-316.6	-782.6	-604	-530.2	-395.9
Chi2		1.157		1.160		3.606		2.352
Joint Haussman test p-value		0.763		0.763		0.307		0.503

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3: Fixed effects regressions, including VIX

VARIABLES	(1) Full sample	(2) EMs	(3) AEs	(4) LICs
gdp_pc	0.440***	0.497***	0.216	0.189
	(0.151)	(0.170)	(0.606)	(0.198)
Imports	0.420***	0.287*	0.662	0.535***
	(0.134)	(0.159)	(0.456)	(0.121)
volatility_tot	0.409	0.0314	-1.235	1.554***
	(0.287)	(0.353)	(1.273)	(0.372)
capital_inflows	-0.00172	0.000673	-0.00282*	0.0218**
	(0.00163)	(0.00197)	(0.00145)	(0.0102)
volatility_capital_inflows	0.00267	0.00116	-0.000432	0.00630*
	(0.00164)	(0.00239)	(0.00179)	(0.00334)
m2	0.400***	0.140	1.104***	0.830***
	(0.110)	(0.150)	(0.187)	(0.126)
pl_deviation	-0.0453	-0.228**	-0.194	0.0406
	(0.131)	(0.106)	(0.121)	(0.391)
xr_regime	0.00713	0.0393	-0.322***	0.00210
	(0.0363)	(0.0390)	(0.0987)	(0.0802)
age_dependency_diff	0.0103**	0.0138***	-0.00978	0.00163
	(0.00386)	(0.00324)	(0.0122)	(0.00787)
cost_reserves	-0.0643*	-0.0706**	-1.068	-1.982***
	(0.0358)	(0.0273)	(2.117)	(0.676)
imf_program	0.0361	0.0209	0.659***	0.0364
	(0.0379)	(0.0368)	(0.224)	(0.0910)
Vix	-0.000313	0.00154	-0.00461	-0.00413
	(0.00300)	(0.00287)	(0.00366)	(0.00636)
Constant	-4.259***	-3.282**	-5.959	-3.716**
	(1.070)	(1.286)	(5.474)	(1.344)
Observations	1,787	1,051	280	456
R-squared	0.228	0.221	0.445	0.267
Number of countries	119	71	21	39

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Fixed effects regressions, emerging markets excluding China

VARIABLES	(1) Full sample	(2) 1980-1997	(3) 1998-2006	(4) 2007-2014	(5) Full sample	(6) 1980-1997	(7) 1998-2006	(8) 2007-2014
gdp_pc	0.412***	0.561***	0.147	-0.506**	0.444***	0.617***	0.148	-0.516**
	(0.128)	(0.163)	(0.158)	(0.202)	(0.117)	(0.156)	(0.128)	(0.207)
imports	0.632***	0.797***	-0.309*	0.0635	0.632***	0.793***	-0.309*	0.0621
	(0.171)	(0.149)	(0.150)	(0.195)	(0.172)	(0.151)	(0.150)	(0.195)
volatility_tot	-0.735	-0.219	0.622*	-0.348	-0.740	-0.231	0.622*	-0.313
	(0.602)	(0.513)	(0.275)	(0.503)	(0.617)	(0.550)	(0.289)	(0.437)
capital_inflows	0.00317	0.0280***	0.00987	-0.000604	0.00330	0.0276***	0.00987	-0.000617
	(0.00352)	(0.00524)	(0.00701)	(0.00232)	(0.00354)	(0.00548)	(0.00692)	(0.00236)
volatility_capital_inflows	0.00205	0.00554	0.00321***	0.000941	0.00221	0.00531	0.00322***	0.000913
	(0.00240)	(0.00627)	(0.000934)	(0.00155)	(0.00243)	(0.00627)	(0.000912)	(0.00150)
m2	0.201	-0.222	0.617***	0.426*	0.204	-0.242	0.617***	0.423*
	(0.134)	(0.156)	(0.131)	(0.211)	(0.134)	(0.151)	(0.131)	(0.211)
pl_deviation	-0.256**	-0.762*	-0.280*	0.0820	-0.245**	-0.688	-0.280*	0.0761
	(0.122)	(0.399)	(0.137)	(0.425)	(0.120)	(0.401)	(0.137)	(0.434)
xr_regime	0.0485	-0.0808	0.139***	0.0554***	0.0480	-0.0769	0.139***	0.0552***
	(0.0389)	(0.0849)	(0.0242)	(0.0120)	(0.0393)	(0.0870)	(0.0255)	(0.0127)
age_dependency_diff	0.0130***	0.0111*	0.0143*	0.0291***	0.0125***	0.0125*	0.0143*	0.0296***
	(0.00339)	(0.00616)	(0.00731)	(0.00272)	(0.00345)	(0.00648)	(0.00677)	(0.00332)
cost_reserves	-0.0678**	-0.00265	-0.988***	0.208	-0.0697**	-0.00461	-0.988***	0.245
	(0.0330)	(0.0218)	(0.200)	(0.990)	(0.0320)	(0.0225)	(0.204)	(0.934)
imf_program	-0.0469	-0.109	-0.000797	0.0128				
	(0.0460)	(0.0806)	(0.0660)	(0.0473)				
Constant	-4.080***	-4.308***	-0.0968	5.219***	-4.378***	-4.695***	-0.104	5.323***
	(0.818)	(1.192)	(1.089)	(1.418)	(0.799)	(1.113)	(0.956)	(1.397)
Observations	1,177	345	432	400	1,177	345	432	400
R-squared	0.331	0.244	0.193	0.114	0.330	0.239	0.193	0.114
Number of countries	71	40	57	62	71	40	57	62

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Fixed effects regressions, alternative costs of reserves measure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		All countries			EMs	AEs	LICs
VARIABLES	Full sample	1980–1997	1998–2006	2007–2014			
gdp_pc	0.281	0.461**	0.982***	-0.792***	0.365***	0.672	0.315
	(0.171)	(0.209)	(0.137)	(0.112)	(0.126)	(0.425)	(0.234)
imports	0.651***	0.813***	0.000902	0.201	0.631***	0.909**	0.366**
	(0.139)	(0.0731)	(0.0827)	(0.154)	(0.176)	(0.355)	(0.171)
capital_inflows	0.000152	0.0344***	0.00501*	0.00285	0.00304	-0.00311	0.0181**
	(0.00233)	(0.00635)	(0.00262)	(0.00166)	(0.00335)	(0.00202)	(0.00769)
volatility_capital_inflows	0.00321*	0.00425	0.00522**	0.00222	0.00200	-0.000219	0.00670**
	(0.00181)	(0.00318)	(0.00219)	(0.00176)	(0.00190)	(0.00143)	(0.00285)
volatility_tot	-0.471	0.216	0.437	0.0773	-0.508	-2.415*	0.0864
	(0.362)	(0.496)	(0.434)	(0.394)	(0.503)	(1.254)	(0.628)
m2	0.534***	-0.155	0.634***	0.614***	0.234*	0.771***	1.106***
	(0.125)	(0.129)	(0.0761)	(0.0877)	(0.125)	(0.142)	(0.160)
pl_deviation	-0.206	-0.487	-0.144	0.00623	-0.264**	0.0112	0.0624
	(0.137)	(0.310)	(0.273)	(0.186)	(0.118)	(0.0896)	(0.403)
xr_regime	0.0198	-0.00816	0.0842	-0.0700***	0.0309	-0.191*	0.0228
	(0.0358)	(0.0652)	(0.0517)	(0.00930)	(0.0361)	(0.102)	(0.0779)
age_dependency_diff	0.00846**	0.0149*	-0.00811**	0.0290***	0.0147***	-0.0137	-0.000411
	(0.00327)	(0.00797)	(0.00347)	(0.00247)	(0.00358)	(0.00888)	(0.00650)
cost_reserves1	0.0218	-0.00750	0.0238	0.0101	0.00996	0.0736***	0.00578
	(0.0267)	(0.0250)	(0.0319)	(0.0134)	(0.0213)	(0.0158)	(0.0532)
imf_program	-0.0489	-0.0381	0.0108	0.0694*	-0.0718	0.589***	0.0171
	(0.0553)	(0.109)	(0.103)	(0.0310)	(0.0451)	(0.215)	(0.104)
Constant	-4.323***	-4.037*	-8.352***	6.319***	-3.787***	-10.79**	-5.100***
	(1.123)	(1.975)	(1.194)	(1.028)	(0.977)	(4.108)	(1.624)
Observations	2,268	618	814	836	1,280	332	656
R-squared	0.237	0.143	0.126	0.158	0.316	0.448	0.229
Number of countries	127	73	112	116	73	21	46

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Fixed effects regressions, volatility of exports

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		All countries			EMs	AEs	LICs
VARIABLES	Full sample	1980–1997	1998–2006	2007–2014			
gdp_pc	0.449***	0.679***	0.708***	-0.787***	0.434***	0.737	0.360
	(0.144)	(0.181)	(0.110)	(0.162)	(0.130)	(0.533)	(0.235)
imports	0.592***	0.722***	-0.0622	0.330	0.628***	0.840**	0.459***
	(0.115)	(0.0908)	(0.100)	(0.181)	(0.166)	(0.370)	(0.123)
volatility_exports	-0.194	-0.149	-0.325	-0.302*	-0.166	1.695**	-0.492
	(0.220)	(0.263)	(0.551)	(0.129)	(0.279)	(0.741)	(0.494)
capital_inflows	-0.00135	0.0269***	0.00581**	0.00295	0.00149	-0.00437**	0.0177
	(0.00206)	(0.00572)	(0.00236)	(0.00180)	(0.00330)	(0.00188)	(0.0106)
volatility_capital_inflows	0.00401**	0.00532	0.00496**	0.000655	0.00215	0.00269	0.00697**
	(0.00169)	(0.00378)	(0.00170)	(0.00156)	(0.00242)	(0.00232)	(0.00334)
m2	0.387***	-0.125	0.579***	0.861***	0.213	0.636***	0.701***
	(0.111)	(0.118)	(0.0585)	(0.147)	(0.131)	(0.177)	(0.145)
pl_deviation	-0.107	-0.0145	-0.181	0.0239	-0.254**	0.0318	0.0311
	(0.149)	(0.0948)	(0.203)	(0.203)	(0.115)	(0.135)	(0.337)
xr_regime	0.0226	-0.0118	0.0873*	-0.0311**	0.0368	-0.130	0.0610
	(0.0353)	(0.0706)	(0.0469)	(0.0109)	(0.0421)	(0.119)	(0.0649)
age_dependency_diff	0.0109***	0.00720	-0.00881	0.0282***	0.0133***	-0.00853	0.00198
	(0.00346)	(0.00694)	(0.00729)	(0.00269)	(0.00309)	(0.0116)	(0.00656)
cost_reserves	-0.0814**	-0.0110	-0.843***	-0.363	-0.0639*	0.550	-0.981**
	(0.0397)	(0.0193)	(0.186)	(0.565)	(0.0337)	(1.874)	(0.447)
imf_program	-0.0143	-0.0734	0.0498	0.0751	-0.0345	0.410*	-0.00259
	(0.0408)	(0.0606)	(0.0861)	(0.0402)	(0.0446)	(0.240)	(0.0922)
Constant	-4.964***	-5.681***	-5.626***	4.864**	-4.283***	-10.89*	-4.253***
	(0.963)	(1.544)	(0.946)	(1.503)	(0.903)	(5.474)	(1.362)
Observations	2,075	617	752	706	1,228	333	514
R-squared	0.319	0.200	0.108	0.211	0.325	0.414	0.272
Number of countries	122	74	105	106	73	21	41

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Fixed effects regressions, de jure capital account openness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		All countries			EMs	AEs	LICs
VARIABLES	Full sample	1980–1997	1998–2006	2007–2014			
gdp_pc	0.295	0.644***	0.961***	-1.456***	0.130	0.475	0.978**
	(0.215)	(0.147)	(0.183)	(0.130)	(0.170)	(0.508)	(0.379)
imports	0.657***	0.524***	-0.0264	0.230	0.768***	0.670*	0.270
	(0.140)	(0.138)	(0.107)	(0.218)	(0.154)	(0.331)	(0.239)
volatility_tot	-0.692	-0.155	0.493	0.440	-1.072	-3.007*	0.932
	(0.594)	(0.561)	(0.911)	(0.465)	(0.661)	(1.572)	(0.797)
ka_open	0.00594***	0.00834***	-0.000483	0.00756***	0.00574**	0.00456	-0.00358
	(0.00198)	(0.00175)	(0.000580)	(0.00153)	(0.00218)	(0.00317)	(0.00342)
volatility_capital_inflows	0.00613***	0.00818***	0.00618	-0.00187	0.00505**	-0.000916	0.0122**
	(0.00185)	(0.00280)	(0.00363)	(0.00150)	(0.00211)	(0.00197)	(0.00507)
m2	0.335***	-0.113	0.582***	1.168***	0.193	0.519**	0.911***
	(0.114)	(0.112)	(0.0865)	(0.276)	(0.133)	(0.196)	(0.243)
pl_deviation	-0.172	-0.303*	-0.222	0.390**	-0.412**	0.0323	0.399
	(0.166)	(0.164)	(0.211)	(0.158)	(0.156)	(0.109)	(0.568)
xr_regime	-0.00110	-0.0612	0.0914	-0.0941**	0.0200	-0.289**	0.182*
	(0.0334)	(0.0718)	(0.0520)	(0.0270)	(0.0379)	(0.135)	(0.104)
age_dependency_diff	0.0104**	0.00229	-0.0131	0.0407***	0.0167***	-0.00738	-0.0108
	(0.00408)	(0.00714)	(0.00933)	(0.00429)	(0.00259)	(0.0107)	(0.0165)
cost_reserves	-0.0663*	-0.00723	-0.932***	-1.439**	-0.0493*	1.616	-0.869*
	(0.0344)	(0.0224)	(0.149)	(0.572)	(0.0281)	(1.379)	(0.432)
imf_program	-0.0517	-0.110	0.0710	-0.0423	-0.0687*	-0.0944	0.0434
	(0.0394)	(0.0673)	(0.114)	(0.0436)	(0.0370)	(0.297)	(0.158)
Constant	-4.137**	-5.323***	-7.970***	9.458***	-2.446**	-6.857	-8.692***
	(1.557)	(1.022)	(1.659)	(1.587)	(1.122)	(5.113)	(2.517)
Observations	1,510	498	612	400	954	321	235
R-squared	0.333	0.249	0.112	0.277	0.380	0.360	0.218
Number of countries	95	56	87	80	58	21	25

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: CCEMG and CCEPMG regressions, no IMF program

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	all	all	EMs	EMs	AEs and EMs	AEs and EMs	LICs and EMs	LICs and EMs
VARIABLES	MG	PMG	MG	PMG	MG	PMG	MG	PMG
				Error correction term				
ec	-0.654 ***	-0.605 ***	-0.652 ***	-0.631 ***	-0.672 ***	-0.607 ***	-0.701 ***	-0.669 ***
	(0.0493)	(0.0438)	(0.0846)	(0.0781)	(0.0648)	(0.0593)	(0.0643)	(0.0602)
				Short run				
D.imports	0.201	0.123	0.356 **	0.110	0.138	-0.100	0.495 ***	0.328 **
	(0.210)	(0.186)	(0.175)	(0.163)	(0.192)	(0.189)	(0.173)	(0.141)
D.m2	0.404 *	0.237	0.502 **	0.431 **	0.52 ***	0.341 **	0.545 *	0.147
	(0.231)	(0.181)	(0.198)	(0.202)	(0.163)	(0.160)	(0.285)	(0.244)
D.age_dependency_diff	-0.1 **	0.110	-0.149	0.0342	-0.0763	-0.00922	-0.0470	0.102
	(0.0501)	(0.0746)	(0.185)	(0.146)	(0.0948)	(0.0911)	(0.128)	(0.158)
pl_deviation	-0.229	-0.272 **	0.0862	0.0468	-0.232	-0.328 **	-0.154	-0.206
	(0.134)	(0.127)	(0.224)	(0.198)	(0.165)	(0.139)	(0.145)	(0.148)
				Long run				
L.imports	1.07 *	0.324 **	1.075	0.115	1.377 **	-0.0973	0.755	0.485 ***
	(0.561)	(0.130)	(0.662)	(0.162)	(0.589)	(0.146)	(0.469)	(0.134)
L.m2	0.0706	0.253 *	0.548	0.257 **	0.51 *	0.276 **	1.212 **	0.284 **
	(0.411)	(0.130)	(0.468)	(0.123)	(0.284)	(0.123)	(0.526)	(0.144)
L.age_dependency_diff	-0.0648	0.0108	-0.0360	0.0342 **	-0.0426	-0.00920	-0.0192	0.0218 *
	(0.0534)	(0.0125)	(0.0475)	(0.0142)	(0.0297)	(0.0135)	(0.0497)	(0.0119)
Constant	-3.959	-2.152	-7.576 *	-5.567	-3.241	-2.113	-5.578	-1.173
	(4.808)	(2.487)	(4.013)	(3.437)	(3.689)	(2.732)	(5.469)	(2.733)
Observations	935	935	528	528	828	828	635	635
Number of countries	28	28	16	16	25	25	19	19
aic	-794.8	-561.2	-382.1	-279.7	-719.9	-525.9	-478.9	-353.3
Chi2		1.923		1.786		4.945		2.791
Joint Haussman test p-value		0.589		0.618		0.176		0.425

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9: CCEMG and CCEPMG regressions, capital inflows

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	all	all	EMs	EMs	AEs and EMs	AEs and EMs	LICs and EMs	LICs and EMs
VARIABLES	MG	PMG	MG	PMG	MG	PMG	MG	PMG
				Error correction term				
ec	-0.681 ***	-0.586 ***	-0.711 ***	-0.602 ***	-0.677 ***	-0.609 ***	-0.700 ***	-0.62 ***
	(0.0497)	(0.0454)	(0.0895)	(0.0891)	(0.0570)	(0.0563)	(0.0710)	(0.0661)
				Short run				
D.imports	0.0624	0.156	0.116	0.153	-0.0463	0.0846	0.123	0.29 **
	(0.188)	(0.170)	(0.234)	(0.151)	(0.214)	(0.174)	(0.205)	(0.129)
D.capital_inflows	-0.00334	0.00735	0.0105	0.0326 **	0.00163	0.00436	0.0146	0.0397 **
	(0.0139)	(0.00974)	(0.0225)	(0.0138)	(0.0132)	(0.0103)	(0.0193)	(0.0177)
D.age_dependency_diff	0.0337	0.0966	0.159	0.29 ***	0.0458	-0.00891	0.175	0.352 **
	(0.0900)	(0.115)	(0.146)	(0.102)	(0.111)	(0.114)	(0.120)	(0.138)
pl_deviation	-0.313 *	-0.254 *	-0.0692	-0.00452	-0.188	-0.196	-0.239	-0.253
	(0.160)	(0.151)	(0.178)	(0.226)	(0.154)	(0.160)	(0.162)	(0.164)
imf_program	0.0646	0.0999	0.122	0.149	0.0874	0.114	0.107	0.123
	(0.0665)	(0.0675)	(0.0939)	(0.0980)	(0.0760)	(0.0803)	(0.0859)	(0.0946)
				Long run				
L.imports	0.219	0.491 ***	-0.674	0.154	0.195	0.32 **	0.919	0.486 ***
	(0.348)	(0.138)	(0.670)	(0.177)	(0.437)	(0.144)	(0.631)	(0.151)
L.capital_inflows	-0.0949	-0.00416	0.0114	0.0853 ***	-0.0920	0.00573	-0.164	0.077 ***
	(0.0721)	(0.00464)	(0.126)	(0.0130)	(0.114)	(0.00490)	(0.130)	(0.0121)
L.age_dependency_diff	-0.00241	0.0221 **	0.0153	-0.00669	0.00894	0.00343	-0.0353	0.0235 **
	(0.0269)	(0.00988)	(0.0340)	(0.0139)	(0.0283)	(0.0117)	(0.0284)	(0.0103)
Constant	1.650	0.904	-3.001	0.233	-1.286	0.376	0.696	2.444
	(2.865)	(2.166)	(2.920)	(1.659)	(2.455)	(1.689)	(3.165)	(2.586)
Observations	946	946	533	533	839	839	640	640
Number of countries	28	28	16	16	25	25	19	19
aic	-920.7	-675.9	-495.1	-297.6	-810.1	-606.9	-608.2	-395.9
Chi2		1.984		2.264		0.703		6.222
Joint Haussman test p-value		0.576		0.520		0.872		0.101

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

APPENDIX A: DATA AND SUMMARY STATISTICS

A1: Countries in the dataset

Emerging markets: Algeria, Argentina, Armenia (from 2014), Azerbaijan (from 2011), Bahamas, Bahrain, Barbados, Belarus, Belize, Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Bulgaria, Chile, China, Colombia, Costa Rica, Cote d'Ivoire (until 1991), Croatia, Cyprus (until 2001), Czech Republic (until 2008), Dominican Republic, Ecuador, Egypt (until 1991 and from 2011), El Salvador, Equatorial Guinea, Estonia, Gabon, Guatemala, Hungary, India (from 2011), Indonesia, Israel (until 1996), Jamaica, Jordan, Kazakhstan, Korea (until 1996), Kuwait, Latvia, Lebanon, Lithuania, Macedonia (from 2004), Malaysia, Malta, Mauritius, Mexico, Morocco, Namibia, Oman, Pakistan, Panama, Paraguay, Peru, Philippines (except 1992-1995), Poland, Qatar, Romania, Russia, Saudi Arabia, Serbia, Seychelles, Singapore (until 1996), Slovak Republic, South Africa, Suriname, Swaziland, Thailand, Trinidad and Tobago, Tunisia, Turkey, Ukraine, Uruguay, Venezuela.

Advanced economies: Australia, Austria (until 1998), Belgium (until 1998), Canada, Cyprus (from 2002), Czech Republic (from 2009), Denmark, Finland (until 1998), Greece (until 2000), Hong Kong, Iceland, Israel (from 1997), Italy (until 1998), Korea (from 1997), Netherlands (until 1998), New Zealand, Norway, Portugal (until 1998), Singapore (from 1997), Spain (until 1998), Sweden, Switzerland.

Low-income countries: Albania, Armenia (until 2013), Azerbaijan (until 2010), Bangladesh, Benin, Bolivia, Cabo Verde, Cameroon, Chad, Comoros, Congo (Rep.), Cote d'Ivoire (from 1992), Djibouti, Egypt (1992-2010), Gambia, Georgia, Ghana, Grenada, Guyana, Haiti, Honduras, India (until 2010), Kenya, Kyrgyz Republic, Macedonia (until 2003), Madagascar, Malawi, Maldives, Mali, Moldova, Mongolia, Mozambique, Nicaragua, Niger, Nigeria, Papua New Guinea, Philippines (1992-1995), Rwanda, Senegal, Sierra Leone, Sri Lanka, St. Lucia, St. Vincent and the Grenadines, Tanzania, Togo, Uganda, Vietnam, Zambia.

A2. Variable definitions and sources

Variable	Description	Source
reserves	Natural log of foreign exchange reserves as percent of GDP	International Financial Statistics (IMF)
gdp_pc	Natural log of per capita GDP, in constant 2010 US Dollars	World Development Indicators (World Bank)
imports	Natural log of imports of goods and services as percent of GDP	World Development Indicators (World Bank)
volatility_tot	Five-year relative standard deviation of the terms of trade index, lagged by one year and winsorized at the 1st and 99th percentile	World Economic Outlook (IMF) and authors' calculation
capital_inflows	Portfolio investment, net incurrence of liabilities, as percent of GDP	World Economic Outlook (IMF)

volatility_capital_inflows	Five-year relative standard deviation of capital_inflows, lagged by one year and winsorized at the 1st and 99th percentile	World Economic Outlook (IMF) and authors' calculation
m2	Natural log of broad money as percent of GDP	International Financial Statistics (IMF)
cost_reserves	The variable in the regressions is defined as log(1 + cost of reserves/100), where the cost of reserves is the spread between domestic and US returns on government bonds or T-bills, the lending rate or money market rate, depending on data availability	International Financial Statistics (IMF) and authors' calculation
pl_deviation	Residuals from a regression of the national price level on each country's per capita GDP relative to US per capita GDP	Penn World Table 9.0
xr_regime	Composite index which takes the value of 1 if the country has a hard peg, 2 if it has a soft peg and 3 in case of a floating exchange rate	IMF and Reinhart and Rogoff (2004)
age_dependency_diff	Total age dependency ratio (population aged 14 and younger or 65 and older in percent of population aged 15-64): difference between (projected) value as of t+20 and current value (linear interpolation of gaps in the data)	United Nations World Population Prospects: 2015 Revision, and authors' calculations
imf_program	Dummy that takes the value of 1 when a country is borrowing from the Fund as part of an IMF program	IMF

A3. Summary statistics

Variable	Mean				Standard Deviation			
	Full sample	EMs	AEs	LICs	Full sample	EMs	AEs	LICs
Reserves	2.4467	2.4886	2.3714	2.3945	0.9733	1.0113	1.0328	0.8227
gdp_pc	8.3983	8.4667	10.4356	6.8779	1.3660	0.8262	0.3692	0.8876
Imports	3.6610	3.6427	3.6562	3.7087	0.5413	0.5558	0.5751	0.4768
volatility_tot	0.06608	0.0693	0.0302	0.0820	0 .0642	0.0684	0.0266	0.0624
capital_inflows	1.4444	1.2689	3.9290	0.2241	4.8686	3.7719	8.8944	2.1296
volatility_capital_inflows	2.8321	2.8468	1.8135	3.4728	6.7906	6.6184	5.8583	7.6591
m2	3.8866	3.8800	4.3438	3.5991	0.6076	0.5724	0.4756	0.5876
pl_deviation	-0.03172	-0.0800	0.3169	-0.1453	0.2458	0.1747	0.2369	0.1926
xr_regime	2.1302	2.0174	2.5732	2.1113	0.8232	0.8172	0.6262	0.8556
age_dependency_diff	-5.2107	-6.1206	6.5313	-10.786	12.1883	11.9103	7.8870	9.8947
cost_reserves	0.10910	0.1319	0.01380	0.1166	0.4213	0.5399	0.0280	0.0965
imf_program	0.3240	0.2960	0.0244	0.5911	0.4681	0.4567	0.1545	0.4921

A4. Correlation table for the full sample

	reserves	gdp_pc	imports	volatiity_tot	capital_inflows	volatility_capital_ inlfows	m2	pl_deviation	xr_regime	age_dependency_ diff	cost_reserves	imf_program
reserves	1.0000											
gdp_pc	0.1115*	1.0000										
imports	0.4599*	0.0858*	1.0000									
volatility_tot	-0.1165*	-0.1892*	-0.1256*	1.0000								
capital_inflows	0.0458*	0.2420*	0.0493*	-0.0989*	1.0000							
volatility_capital_inflows	0.0182	-0.0727*	0.0044	0.0394	-0.0535*	1.0000						
m2	0.3790*	0.4576*	0.3499*	-0.2553*	0.1677*	-0.0913*	1.0000					
pl_deviation	-0.0698*	0.6277*	-0.0579*	-0.1369*	0.2277*	-0.0860*	0.2470*	1.0000				
xr_regime	-0.0414	-0.0037	-0.2803*	-0.1145*	0.0787*	-0.0021	-0.0423	0.0305	1.0000			
age_dependency_diff	0.2405*	0.4985*	0.2086*	-0.2812*	0.1872*	-0.0396	0.3273*	0.2429*	0.1475*	1.0000		
cost_reserves	-0.1382*	-0.0901*	-0.2822*	0.0268	-0.0255	0.0306	-0.1606*	0.0020	0.1077*	-0.0873*	1.0000	
imf_program	-0.1614*	-0.4410*	-0.1210*	0.0708*	-0.1332*	0.0058	-0.3926*	-0.2736*	0.0800*	-0.1240*	0.1581 *	1.0000

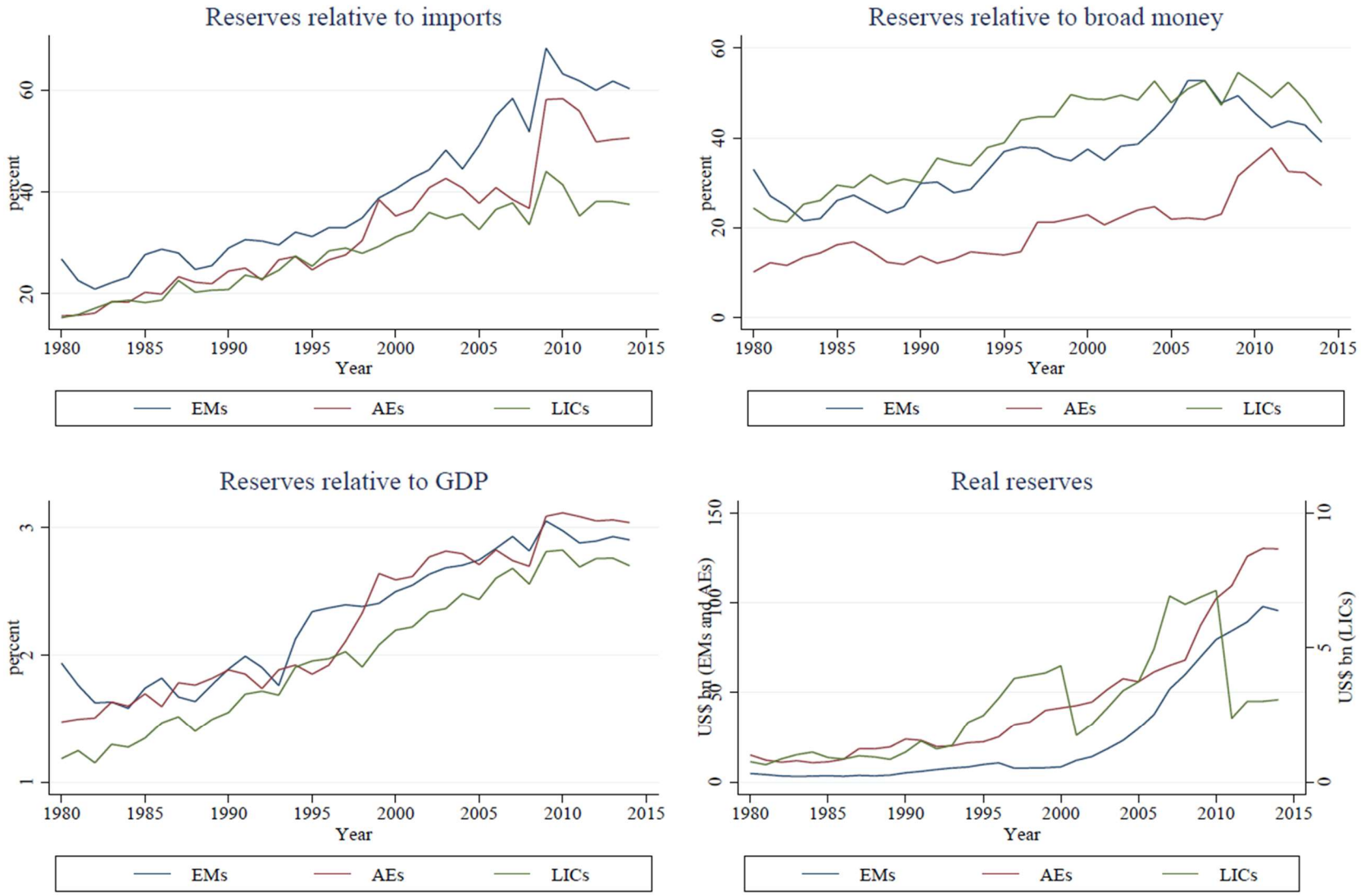
* signifies that the relationship is statistically significant at the 5 percent level.

A5. Results of tests for cross-sectional dependence and serial correlation[24]

		all	EMs	AEs	LICs
Cross-sectional dependence					
Pesaran test	test statistic	4.053	4.260		
	p-value	0.0001	0.0000		
Lagrange multiplier test	test statistic			62.845	40.912
	p-value			0.0000	0.0000
Serial correlation					
Wooldridge test	test statistic	86.733	37.555	23.913	30.083
	p-value	0.0000	0.0000	0.0027	0.0054

[24] Tests require a balanced panel. Therefore, only countries with $T \geq 20$ are taken into account.

Figure 1: Reserve assets, comparison across country groups



APPENDIX B: DETAILS ON CCEPMG ESTIMATION

In the model laid out in Section IV, the unobserved common factors can be approximated by the cross-sectional averages and their lags,

$$f_t = G(L)\bar{z}_t + O_p(N^{-1/2})$$

where $G(L)$ is a distributed lag function and $\bar{z}_t = (\bar{y}_t, \bar{x}_t \quad)$ is a $k+1$ vector of simple cross-sectional averages. More sophisticated formulations, e.g. involving weighted averages or detrending, can be applied. With $\delta_i(L) = \sum_l \ \delta_{il}L^l = G \quad (L)\gamma_i$, the estimation equation can thus be formulated as

$$y_{it} = \alpha_i + \lambda_i y_{i,t-1} + \beta_{1i}'x_{it} + \beta_{2i}'x_{i,t-1} + \sum_{l=0}^{p_T} \delta_{il}{}'\bar{z}_{t-l} + e_{it}$$

where the error term e_{it} contains an idiosyncratic term, an error component due to the truncation of the infinite polynomial distributed lag function, and an error component due to the approximation of unobserved common factors,

$$e_{it} = u_{it} + \sum_{l=p_T+1}^{\infty} \delta_{il}{}'\bar{z}_{t-l} + O_p(N^{-1/2})$$

The number of lags p_T should be large enough so that the bias due to truncation of the infinite lag polynomials is sufficiently small, but at the same time it will be restricted by the degrees of freedom needed for consistent estimation. In our case, due to the many regressors included in the estimation, we restrict $p_T = 1$, resulting in the estimation equation presented in Section IV.