GLOBAL CO-MOVEMENTS OF INTERNATIONAL RESERVES AND THEIR EFFECTS

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Abstract

This paper examines global co-movements of international reserves (IR) and their effects on the variations of IR holdings in each country. To begin with, we evaluate how pervasive global co-movements of international reserves are. For this, we estimate the global, regional and country-specific factors of international reserves by using a dynamic factor model with time-varying factor loadings and stochastic volatility. We find that a global factor is a dominant component and it causes co-movements among international reserves in the world. Then the degree of association of each country's reserve holding with the common global factor is analyzed. Results show that after the great financial crisis (GFC) the correlation of each country with the global factor drops remarkably compared to the pre-crisis period. Following the fact, we examine the driving forces of the IR through the estimated global factors of key macro-economic variables and notice that the dynamics of the driving forces become opposite after the financial crisis. Lastly, we examine the inter-temporal effects of the global factor of IR with the global factors of the key control variables by using a VAR model.

JEL codes: C5, C8, E6, F6

Keywords: Co-movement, Dynamic Factor Model, Global Factor, International Reserves

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1. Introduction

This paper examines global co-movements of international reserves (IR, henceforth) and their effects on the variations of IR holding in different countries. We first wish to evaluate how pervasive global co-movements of international reserves are. Is there any evidence of certain co-movements in international reserves in the world? This is the first key question to examine in this paper. At first, it seems that there may be no compelling reasons why IR in the world tend to move together. Individual countries adopt different macro-economic policies based on their economic conditions. Especially, the emerging countries have restrictive access to international private capital markets from which they might supplement their reserves. Besides, some nations follow a floating exchange rate regime that becomes extremely volatile during the financial crises. However, other countries persist with a pegged exchange rate arrangement which might be susceptible to speculative attacks, affecting the domestic economy. As a result, different countries have different reserve requirements. Accordingly, such co-movements in reserves are unlikely.

Yet in recent decades, the demand for international reserves has increased in both emerging and developed countries, and it seems that the trend is not an isolated phenomenon. A series of papers document that international reserves prove to be an important safeguard to establish the stability of an economy, especially during the periods of economic turmoil. The main purpose of holding IR is to make international payments to repay the debt and hedge against exchange rate risks. A general consensus postulates that international reserves are aimed to smooth out short-run payment imbalances and defuse the possible speculative run on currencies. For example, after the Asian financial crises in the late 1990s, most of developing economies raised their international reserves in the share of gross domestic product (GDP, henceforth) to minimize the induced volatility from financial globalization. Again, after the great financial crisis (GFC, henceforth) during 2007, IR holding exceeds 10 trillion dollars in 2011, much higher than 7.5 trillion dollars at the beginning of the crisis. Following this trend, emerging economies' IR climbed almost 6 trillion dollars after the crisis from 5 trillion dollars. Hence, we observe that international reserves tend to increase in response to global shocks, such as GFC, which explicates their degree of synchronization with the world.

Concerned with the purpose of preserving the IR, Jeanne and Renciere (2011) show that international reserves by emerging countries might be explained by the precautionary motives, leaving China aside. Steiner (2013) depicts that financial crises during the period 1970 – 2010 permanently increased the precautionary demand for reserves by both the developed and emerging countries. Aizenman and Marion (2003) note a large precautionary demand for international reserves and explain that countries with higher perceived sovereign risk and higher fiscal liabilities will opt to increase their demand for international reserves. Again, international reserves serve as a stabilizer of international capital flows. As such, the demand for IR has increased significantly during the periods of the Asian financial crisis in 1997, the 2007 global financial crisis, and afterward. Also, Alberrola et al. (2016) find that large holds of foreign reserves are associated with higher capital inflows and lower capital outflows.

In the context of the increasing demand for IR, especially during the periods of financial shocks, many studies including Aizenman and Lee (2007) and Cheung and Ito (2009) examine various specific determinants of IR. These papers identify that the ensuing crisis during the 1990s is one of the key factors of the increased demand for international reserves, among which the weights of financial factors and the past crises rise remarkably. Following the trend, Aizenman et al. (2015) evaluate the structural changes in the pattern of demand for IR after the GFC during the years 2007-2009.[2] So far, macro-economic policymakers are increasingly interested in the nature and causes of IR to neutralize the effects of big economic turmoils in the world economy, including the 2007's great financial crisis.

However, it appears that the existing literature is mainly focused on the domestic factors of IR[3] and tend to ignore the effects of co-movements in the international reserves by different countries across the world. Due to the increasing trend of global financial integration, it is also important to determine the degree of the effects of external factors which can be exogenous to domestic economic conditions and could explain such co-movements of IR. Moreover, it is also likely that the changing trend of the capital flows in the global world economy can affect the demand for IR. More importantly, it is possible that international or regional business cycles can affect the demand for international reserves. That is, these external factors, which can be comprised with the common global factor of reserves, can have important policy implications for both the advanced and emerging countries. This perception motivates us to investigate the reasons for such co-movements which is so far not discussed in the literature as per our knowledge.[4]

[2] They find that some of the significant explanatory variables such as commodity price volatility become insignificant for IR after the financial crisis. Even some of these variables show opposite effects, reflecting frantic market conditions. Though their results show that propensity to import and gross domestic saving continue to show strong positive effects on IR in both the emerging and in the advanced countries. They also establish a change in the link between the outward direct investment and IR in pre – and post – crisis period which concludes a complimentary relation between IR and macro-prudential policy. In addition, Pina (2017) shows a positive relationship between IR and foreign interest rate by assuming that Central Bank of any country manages foreign reserves to smooth inflation over time. Bussiere et al. (2015) notes the importance of the degree of capital controls in measuring the IR, as measured by the Chinn and Ito (2006) index.

[3] For example, Sula (2011) adopts a quantile regression approach in determining the optimal demand for IR and finds that the level of reserves is as important as other determinants, influencing the demand for IR. Jung and Pyun (2016) suggest that countries are willing to hold more U.S. reserves despite its low return due to the declining financial frictions in over-the –counter markets. This rises the liquidity premium on U.S. T-bonds, which induces more foreign investment for emerging countries to hold for more liquidity i.e. U.S. T-bonds. Qian and Steiner (2017) show that higher IR lengthens the maturity period of external debt via flattening the yield curve.

[4] Marcellino, Stock and Watson (2000) observe that the main reason of the homogeneity in the EMU economies are the common components of main macroeconomic variables of those countries which they derive from the dynamic factor model. Neely and Rapach (2011) show that the common shocks in international trade produce similar reaction functions by the central banks. As a result, they generate common components in international inflation rates which strongly influence the economic policies of the countries. Kose, Otrok and Prasad (2012) analyze the evolution of the degree of global cyclical interdependence by decomposing the macroeconomic fluctuations in output, consumption, and investment in common factor, factor specific to the country groups, and country-specific factors.

To analyze the extent of the global co-movements of IR, we first attempt to estimate the global and regional factors of international reserves. Then, we evaluate their effects on the variations of IR holdings in each of the countries to explain the underlying reasons of possible homogeneity in the demand for the reserves by different countries across the regions. Additionally, we explore how the countries decide their reserve levels by analyzing the driving forces that cause a breakdown in the reserve co-movements in different countries, especially after the GFC in 2007.

This paper attempts to contribute to the existing literature as follows:

First, this paper focuses on the ratio of international reserves to GDP and estimates the global, regional, and country-specific factors, and evaluates the source of such co-movements. Specifically, this paper tries to find the degree of the variations of IR that could be explained by the common global factor, regional factors, and country-specific economic factors. To our know-how, no previous paper has examined this issue.

Second, this paper examines the effect of the global factor on the variations of international reserves to address how the reserves of each country and different groups in the sample are synchronized with the world economy. That is, we establish the relation with the global factor to examine how each country or group is integrated with the world financial market.

Third, we attempt to find the driving forces of the global factor of IR which play important role in defining the economic policy regarding the amount of foreign reserve to be held by any country. Following Marcellino, Stock, and Watson (2000), we presume that international reserves depend on global commonalities in addition to some key macroeconomic variables. Because the time changing economic structures and business cycles can affect all countries at a given period, this can yield common factors affecting both international reserves and their determinants. In particular, we adopt a similar procedure from Crucini, Kose, and Otrok (2011) who examine the driving sources of international business cycles in terms of the estimated factors of the determinant variables. To gain more insights on the changing dynamics of driving sources, rolling window regressions are performed. We also control the effects of the global factors of the control variables and their cross-correlation effects with the error term. Hence, our analysis permits to capture the time-varying relationships between the common factor of IR and the common factors of its determinant variables.

Lastly, we examine the inter-temporal effects of the global factor of IR with the global factors of the key control variables by using a VAR model and determine the causal relation of the global factor of IR with its driving sources. Results are reaffirmed from the impulse response functions.

Overall, our estimation strategies recognize the importance of the global and regional factors in explaining the co-movements in IR, on top of the domestic determinant variables that are employed in the previous literature. There are several findings of interest. First, altogether our sample shows a clear common trend between the average international reserves and its global factor. This implies that most of the co-movements among reserves come from its common global factor. Second, we find that the relative contributions of different factors change over time, reflecting the dynamic nature of financial markets. Third, most countries in our sample show that the global factor of IR plays the dominant role in explaining the variance of the IR, especially before the GFC during 2007. Fourth, the correlation between the IR of each country and its global factor declines significantly after the GFC for all the five regions in our sample. This means that after the crisis, various countries opted different macro-prudential policies to mitigate the effects of the recession. Fifth, we observe that the dynamics of the global components of some key macro-economic variables become opposite in explaining the IR after the GFC. Sixth, the rolling regression helps us to identify the maximum integration of the macro-economic variables with international reserves during the period of the financial crisis. Lastly, our Granger causality analysis recognizes the influence of the global business cycle on the IR holdings.

The remaining paper is organized as follows. Section 3.2 explains the time-varying stochastic dynamic factor model (DFM, henceforth). Section 3.3 describes the data and presents our empirical results from DFM. Section 3.4 reports the degree of synchronization of the estimated factors with the reserve itself. We also explain the mechanism of driving forces of IR in Section 3.4. Finally, Section 3.5 concludes.

2. Dynamic Factor Models

In this section, we present the conceptual framework of our empirical analysis. Following Del Negro and Otrok (2008), we extend the standard dynamic factor model to allow for time-varying loading parameters and stochastic volatility (DFM – TV – SV). We use a dynamic factor model as it quantifies both the extent and nature of co-movements in time-series data across different countries. A dynamic factor model (DFM), originally proposed by Geweke (1977), decomposes a variety of macroeconomic variables into dynamic factors. Sargent and Sims (1977) show that a few factors from DFM can explain a large fraction of the variance of many macroeconomic series, such as output, employment, and prices.[5] The foundation of DFM is that a few latent dynamic factors drive the co-movements of a high-dimensional vector of time-series variable, which is also affected by a vector of idiosyncratic disturbances. The idiosyncratic disturbances arise from measurement errors and special specific features of individual time-series.

As noted above, no previous studies investigate the effects of common global factor of IR and their determinants. However, a recent paper by Byrne and Fiess (2016) recognizes the importance of the common global factor and examine the extent of commonalities in global capital flows. To be specific, they note that capital flows might depend on a global factor. They use the principal components to identify the global factor of capital flows and note substantial differences across countries, regions and periods, especially during the post-crisis periods.[6] One limitation of using the principal components analysis is that it does not provide details on the sources of the estimated factors. Fabrigar et al. (1999) show that the estimates from principal components are inflated and contaminated with the variance of the error term. Suhr (2009) shows that principal components account for the maximal amount of variance for observable series, whereas DFM accounts for a common variance in the data. As a result, DFM captures the common underlying factors for the co-movements in the time-series data more accurately.

[5] Giannone, Reichlin, and Sala (2004) and Watson (2004) confirm this fact.

[6] See Rozada and Yeyati (2008), Reinhart and Rogoff (2009), Broner et al. (2013), and McQuade and Schmitz (2017) for details.

Accordingly, we estimate the IR of each country in our sample through DFM – TV – SV method and decompose the variation in IR into three components, namely – i) a global factor, ii) a regional factor, and iii) a country-specific idiosyncratic factor. That is, we estimate the following equation,

$$y_{i,t} = \gamma_{i,t} G_t + \lambda_{i.t}^{*}{}' R_t + e_{i,t} \qquad (1)$$

where $y_{i,t}$ is the international reserves for country i at time t. G_t is the global factor that affects the changes in the IR at time t, and $\gamma_{i,t}$ is the factor loading at time t. R_t is a vector that contains m regional factors R_{jt} that captures the possible co-movements in IR specific to region j, where $j = 1, 2, \ldots\ldots, m$. $\lambda_{i.t}^{*}$ is a row vector that has non-zero elements $\lambda_{i,t}$ in the position corresponding to the region from which country i belongs to and zero otherwise. In the above equation $\lambda_{i,t}$ is the time-varying regional loading parameters. Finally, $e_{i,t}$ represents the idiosyncratic country-specific factor.

We specify the time-varying loadings for the global and regional factors as a random walk process. Formally,

$$\beta_{i,t} = \beta_{i,t-1} + \eta_{i,t}; \qquad \eta_{i,t} \sim i.i.d. N\,(0, \Sigma^{B}) \qquad (2)$$

where $\beta_{i,t} = [\gamma_{i,t}, \lambda_{i,t}']'$ and $\eta_{i,t} = [\eta_{i,t}^{g}, \eta_{i,t}^{r}{}']'$; and where $\eta_{i,t}^{g}$ and $\eta_{i,t}^{r}$ are the shocks to the loading parameters $\gamma_{i,t}$ and $\lambda_{i,t}$ respectively, and Σ^{B} is the variance-covariance matrix of $\eta_{i,t}$ for which $\eta_{i,t}^{g}$ and $\eta_{i,t}^{r}$ are assumed to be uncorrelated. That is, we follow Del Negro and Otrok (2008) and assume that the shocks to the loading parameters are independent across different regions. The assumption eliminates the possibility of any common movement among these time-varying loading parameters.[7]

Following the conventional identification strategy in dynamic factor models, we assume that the global factor, regional factors, and the individual country factors are orthogonal to each other. Then, the time variations

[7] According to Del Negro and Otrok (2008), this assumption would not alter the empirical results. They choose to keep $\eta_{i,t}^{g}$ and $\eta_{i,t}^{r}$ uncorrelated to avoid the introduction of additional free parameters. We adopt the same approach in this paper.

in the loading parameters allow us to capture the change in the relative contributions of each factor to y_i over time. The variance decomposition implied by our model is given by:

$$var(y_{i,t}) = \gamma_{i,t}{}^2\, var(G_t) + \lambda_{i.t}^{*}{}'\, var(R_t)\, \lambda_{i.t}^{*} + var(e_{i,t}) \tag{3}$$

To identify the model, we need to assume time series properties for each of the three factors and their respective stochastic volatilities. We assume that the global factor follows a stationary AR(p) process with stochastic volatility:

$$G_t = \varphi_{0,1}{}^g\, G_{t-1} + \cdots + \varphi_{0,p}{}^g\, G_{t-p} + e^{h_{0,t}{}^g}\, u_{0,t}{}^g \tag{4}$$

where $u_{0,t}{}^g \sim N\left(0, \sigma_g^2\right)$. The stochastic volatility of this factor is assumed to follow a random walk process:

$$h_{0,t}^g = h_{0,t-1}^g + \sigma_g^h\, \omega_{0,t}^g \tag{5}$$

where $\omega_{0,t}^g \sim i.i.d. N(0,1)$. Similarly, each regional factor is assumed to follow a stationary AR(l) process:

$$R_{j,t} = \varphi_{j,1}{}^r\, R_{j,t-1} + \cdots + \varphi_{j,l}{}^r\, R_{\,j,t-l} + e^{h_{j,t}{}^r}\, u_{j,t}{}^r \tag{6}$$

where $u_{j,t}{}^r \sim N\left(0, \sigma_{j,r}^2\right)$. The stochastic volatility of regional factor follows a random walk process:

$$h_{j,t}^r = h_{j,t-1}^r + \sigma_{j,r}^h\, \omega_{j,t}^r \tag{7}$$

where $\omega_{j,t}^r \sim i.i.d. N(0,1)$. Finally, each idiosyncratic country factor follows a stationary AR(q_i) process:

$$e_{i,t} = \varphi_{1,i}\, e_{1,t-1} + \cdots + \varphi_{i,q_i}\, e_{i,t-q_i} + e^{h_{i,t}}\, u_{i,t} \tag{8}$$

where $u_{i,t} \sim i.i.d. N(0, \sigma_i^2)$. The stochastic volatility of country-specific idiosyncratic factor also follows a random walk process:

$$h_{i,t} = h_{i,t-1} + \sigma_i^h\, \omega_{i,t} \tag{9}$$

where $\omega_{i,t} \sim i.i.d. N(0,1)$. The volatility shocks in each of the above equations are assumed to be orthogonal to each other.[8] Note that the loading parameters and their corresponding factors shock variances are not separately identifiable. To normalize we first restrict the shocks to the global and regional factors so that $\sigma_g^2 = \sigma_{1,r}^2 = \cdots = \sigma_{m,r}^2 = 1$.Then, following Del Negro and Otrok (2008) we impose the restriction that the time-varying volatility *h*'s in equations (5) , (7) and (9) all start from zero as their initial values, i.e., $h_0^g = h_{j,0}^r = h_{i,0}$ for *j* = 1 , 2 , 3 . . . .*m* and *i* = 1 , 2 , 3 , . . . *n* . Finally, since the means of the factors are not separately identifiable, we demean each international reserve before estimating the model.

The above DFM-TV-SV is estimated using the Monte Carlo Markov Chain (MCMC) Bayesian estimation method.[9] We use the standard Gibbs-Sampling algorithm suggested by Kim and Nelson (1999) and the procedure is widely used to compute the draws of stochastic volatility as recommended by Kim et al. (1998).

3. Data and Estimation Results

We construct an annual database for 83 countries from the year 1968 to 2019. Our sample construction is driven by the objective to include as many countries from different continents as allowed by the availability of data for international reserves. The data of IR comes from the *International Financial Statistics* of the *International Monetary Funds* (IFS). The international reserves comprise holdings of monetary gold, special drawing rights, reserves of International Monetary Funds (IMF) members held by the IMF, and holdings of foreign exchange under the control of monetary authorities. The gold component of the reserves is valued at year-end (December 31) London prices. The main variable of our interest is the international reserves as percent of GDP. Since the high persistence in the IR makes it difficult to identify various components described above, we use IR as a share of GDP.

[8] To avoid introducing additional parameters, we assume $\omega_{0,t}^g$, $\omega_{0,t}^r$, and $\omega_{i,t}$ are uncorrelated to each other.
[9] See Del Negro and Otrok (2008) for more details.

The historical data of gross domestic product is taken from the World Bank. Then the data for total reserves as a share of GDP is created for each country over the period 1968 – 2019. The countries in the data set have been divided into five regions according to the continental division of the World Development index. In our sample, we are using the major countries of Asia, Europe, North America, Latin America, the Middle East, and North Africa (MENA, henceforth), and Africa respectively. Both the total reserves and GDP are measured in current U.S. dollar.

Figure 1 plots international reserves as a share of GDP for 83 major countries in five different regions, namely, Asia, Europe, Latin America, Middle East & North Africa, and Africa. The plots of the share of international reserves out of GDP do not necessarily show clear patterns of co-movements. A rough pattern of co-movements can be noticed in Panel (b) of Figure 1 where the reserves are plotted differently for five regions. From Panel (b) of Figure 1, it seems that in the post-2007 period, there is disintegration in the co-movements of foreign-reserves almost for all the regions.

The data of key macro-economic variables such as gross-savings, import, export, real GDP, current account, and capital inflow are drawn from the International Monetary Fund as well. Goss-savings, import, and export are expressed as the percent of GDP. Due to the availability of data, the control variables are drawn for 48 countries over the sample period of 1972 – 2019. Throughout the analysis, we use annual data, and all the data are in current USD.

We now discuss the estimation results from DFM-TV-SV model. In Figure 2, we plot the estimated global and regional factors. The figures plot the median across the Markov Chain Monte Carlo (MCMC) draws with a 95% confidence band. In general, it is evident from the first block of Figure 2 that the global factor follows an upward trend over time. The rest of the blocks in Figure 2 show the estimated regional factors across different regions.

The regional factors follow different patterns in different regions. For example, Asian countries experience a sharp fall in the regional factor during the 1980s which can be explained from the policy reforms in some countries, including Japan and four other countries (South Korea, Taiwan, Singapore, and Hong Kong) which ended up with economic success. Nonetheless, the regional factor of Asia significantly goes up during the Asian financial crisis in the late 1990s. Similarly, the regional factor is following a downward trend in Middle Eastern and North African (MENA) countries in 1980, resulting from the policies to reduce oil price volatility to stabilize the economic growth. Again, it switched into an upward movement during 2000 when these countries adopt more open trade policies to alleviate the effects of global shocks. In contrast, Latin American and African countries show persistent patterns of the regional factors.

For European countries, the regional component follows a downward trend, especially after the global financial crisis in 2007. One potential reason of this fall in the regional factor is sovereign debt crisis that European countries experienced during 2009. This fact asserts that the adoption of a common currency in European countries failed to reduce the risk from international trade and financial crises, which intern results a general fall in the regional factor in European region. It seems surprising to observe that the regional factor increases drastically around 2010 not only in Europe but in other continents also. The results are discussed in more details in the next section.

In Figure 3, we relate the global factor, the average of regional factors and the average of country-specific idiosyncratic factors with the average IR for all the countries in our sample. We plot these factors at levels. The figure shows a clear common trend between IR and its global factor over time. In comparison, the average regional factor does not change much over the sample period, implying that regional factors tend to cancel each other across different regions. Finally, the average country-specific idiosyncratic factor shows a negative trend, diverging from the pattern of the IR.

We next examine how much the estimated global factor can explain the variation in IR. For this, we inspect the results of the variance decomposition as explained in equation (3). The relative importance of the global factor in explaining the reserves of different countries are different. While for some countries, a large portion of IR is explained by the global factor, the other countries show relatively small contribution of a common factor in explaining the reserves. To have a definite result, we need to focus on how much variation in IR can be explained by each of the global, regional, and country-specific factors.

In Figures 4, 5 and 6 the results for the variance decomposition analysis are plotted to explore the relative importance of global, regional, and country-specific factors in the variation of the international reserves. With the results, we try to explain the IR dynamics and how they are evolved in each country across the regions to interpret the reserve variation.[10] Looking at the results in Figure 4 with the exception of Australia in Asia, it is clear that global factor plays a dominant role in the variation of IR (as a share of GDP) for most of the countries in this continent. This observation is especially valid before the financial crisis during 2007. From the figure it is important to note that even after two financial crises in Asia (in 1997 and 2007, respectively), overall the global factor accounts almost 75% in explaining the IR in most of the countries except Australia. This implies that Asian countries are strongly integrated with the global market, as commonly reported in the literature.

On the contrary, the results are very different for European countries, shown in Figure 5. The member countries of European Economic and Monetary Union (EMU) such as Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Malta, the Netherlands, Portugal, and Spain behave differently from each other in the context of holding IR. For example, even after the global financial crisis in 2007, the fluctuations in IR for the countries like, Austria and Belgium, Ireland, the Netherlands, and Portugal are mostly explained by the global factor, reflecting their financial integration with the rest of the world. On the other hand, some countries like France, Germany, and Italy show the strong influence of the regional factor in their IR dynamics, especially after the financial crisis. Following Aizenman et al. (2015), one potential reason is that these countries are more advanced and more persistent to global shocks as being the members of EMU.

In contrast, ignoring both the global and regional factors and the presence of EMU, the country-specific factor plays a dominant role in Finland, Greece, Malta, and Norway in explaining the reserves fluctuations. It is

[10] To save space, we only report the variance contribution of global, regional, and country-specific factors of Asian, European, and Middle East & North African countries. Other results are available in the Appendix, refer to the Appendix Figures 9 & 10.

interesting to note that Greece is the only European country with such a large contribution of the country-specific factor among the European countries which adopt Euro currencies. In other European countries such as France, Germany, Italy, Portugal, and the Netherlands which opted for Euro currencies, the contribution of the country-specific factor is low, but the share of the regional factor is relatively large compare to the global factor. In short, the regional effects are significant for those countries except for Greece. Although different countries behave differently in holding the IR, some European countries share a much stronger tie with the world economy, especially before the great financial crisis.

Finally, in Figure 6 for most of the Middle Eastern countries including Uruguay, Egypt, Kuwait, Qatar, and Saudi Arabia, we find that country-specific factor contributes a significant portion in the variation in IR, especially after the 1980s. Nonetheless, the global factor is again the dominant factor in explaining the IR for all the other countries. The possible reasons for this finding might lie on the fact that most of the Middle Eastern countries are oil exporting countries and hence the country-specific factor plays an important role in determining their IR.

Table 1-a presents the summary of the results on the relative contributions of each of the global, regional, and country-specific factors to the variation of the international reserves. Then, the average contributions of the global and regional factors in each region are outlined in Table 1-b. Also, we pick some large countries in terms of their gross domestic products[11] and report the relative contributions of the global and regional factors in section c of Table 1. All the results are reported for the whole sample period, before, and during and after the great financial crisis. From Table 1-a, we observe that for the whole sample period, on average the global factor accounts for almost 70 percent in explaining the IR. Again, this is an important finding of the paper which reinforces the above findings that the co-movements of international reserves are mainly due to the global factor. Before the financial crisis, the global factor explains almost 81 percent variation of the reserves while the number

[11] We select some largest countries according their gross domestic products according to 2018 record.

decreases drastically to 47.5 percent after the GFC. These results support the previous result that in the post-2007 period, there is a break down in the co-movements of international reserves, observed initially in Figure 1.

On the contrary, the relative contribution of the regional factor increases drastically after the financial crisis. From Table 1-a, we notice that the average contribution of regional factors increases from 4 percent in the pre-crisis period to 47.7 percent once the crisis is over. Panel-b of the Table emphasizes this fact and summarizes the contributions of the global and regional factors across different regions. Among all the five regions in our sample, the Asian continent shows the highest contribution of the global factor to the variation in IR. That is, for the entire sample period in the region the global factor accounts for 76.3 percent in the variation of IR where the regional factor contributes only 1.8 percent. The association with the global factor is even stronger before the GFC in Asian countries. However, after the GFC this integration becomes much lower while the regional factor contributes more than 50 percent to the variation of IR. A similar pattern is observed in all other regions where the global factors plays a much smaller role to the variation in the IR, especially after the GFC. Finally, in Table 1-c, the relative contributions of the global and regional factors to the variations in international reserves are summarized for some large countries in the world according to their GDP. Results show that the global factor explains almost 90 percent of variation in IRs in emerging economies, like Japan, India, Korea, and Brazil. Nonetheless, the European countries, such as Germany, France, and Italy, show a much stronger effect of the regional factor. One special case is Greece which shows a very small effect of the regional factor despite adopting the common currency in the Euro zone. However, during and after the crisis the relative importance of the regional factor goes up significantly for these countries. Lastly reaffirming the previous results from the table, all the countries show much smaller contribution of global factor after the GFC than the pre-crisis period where the relative importance of the regional factor is noticeable. Again, one exception is Greece, where the relative importance of both the global and regional factors increases after the GFC.

4. The Synchronization Effect

It is established from the previous section that the global factor is the main source of the variation in international reserves. Leading from this fact, in this section, we will examine how each country in their respective regions is synchronized with the global factor. The purpose of this analysis is to evaluate how closely the IR of each country across various regions tends to move together with the global factor, following the approach of Marcellino, Stock, and Watson (2000). To analyze the synchronization effect of each country with the world, we use time-series regression of international reserves on the estimated global factors for all 83 countries in our sample. To describe the correlation between IR and its global factor, the average R^2 values are reported for each region in Panel-a and the R^2 values for the ten largest countries are described in Panel-b of Table 2.[12] Like the previous section, we divide the whole sample period in two subsamples: before the great financial crisis and during & after the financial crisis to analyze the dynamics of the relationship between the IR and its global factor. To be specific, we want to check how each country in different regions is integrated with the world economy.

The results from Panel-a of Table 2 are very interesting. First, for the whole sample, Asian countries show the highest correlation, followed by the Middle East and Latin American countries. This means that Asian countries are more synchronized with the world economy, compared to the other regions. Second, European and African countries have lower correlations with the global factor for the entire sample period, implying their less synchronization with the global economy. The results support the literature since most of the European countries are driven by the EMU and common currencies which make them isolated from the world. Third, the correlations fall significantly for all the regions, except for Europe after the financial crisis compared to the pre-crisis period. The results support the findings in the previous part, which show that after the GFC, the relative importance of the global factor in the variation in IR falls significantly. This fact indicates that the financial shock drives countries to adopt different macro-economic policies, based on their economic conditions. As a result, there is a break-down in the reserve co-movements in the post-crisis period, which we observe initially in Figure 1. This is one of the major contributions of this paper. To reaffirm the results in Table 2-a, we report the correlations of IR with its global factor for the ten largest countries according to their GDPs. Supporting the literature, for the whole sample period, the total reserves of emerging economies, e.g., India and Brazil are sharing high correlations with

[12] To save space, we select only ten largest countries and report their correlations of IR with the global factor. Results are available on request.

the world factor. That is, the developing countries are more susceptible to the financial crisis, and they maintain a strong bond with the rest of the world.

In contrast, while some countries like United Kingdom, France, Italy, Canada, and Korea share stronger integration with the world after the financial crisis, for other countries like United States, Japan, Germany, India, and Brazil such integration is lower in the post-crisis period. The results across the countries are mixed. This entails us to examine the role of country-specific individual macro-economic policies which work as the driving forces of IR through their global factors.

We next examine the effects of the driving forces of the international reserves. We consider some of the key macro-economic variables that are responsible for the fluctuations in IR. It will be a difficult task to identify the exact main driving sources, but we inspect six variables, namely, gross-savings, import, export, real GDP, current account, and capital inflow as potential driving forces of IR. In the last section, we observe that the association of IR with its global factor falls significantly after the GFC. Hence, we are interested in examining the effects of driving forces on the estimated global factor of IR, which cause fluctuations in the correlations between the reserves and its factors. We adopt a similar estimation procedure by Crucini, Kose, and Otrok (2011) who attempt to evaluate the effects of the global factors of the control variables, instead of directly using the variables. In present discussion, since our objective is to differentiate the shocks between the global financial market and the domestic economy, we use the same methodology. According to Crucini, Kose, and Otrok (2011), global factors of such variables are the obvious sources of the fluctuations in terms of trade, business cycle, and investment decision in explaining the so-called international business cycles.

We first estimate the global, regional and country factors for each of the mentioned control variables, the potential driving forces of IR, by using the dynamic factor models discussed in Section 2. In Table 3, we report the contributions of each of the global, regional, and country-specific factors for each of our driving variables and conclude the same as Crucini, Kose, and Otrok (2011). Results in Table 3 show that except for gross-savings, the variations in all the control variables like import, export, real GDP, current account and capital inflow mainly come from their global factors. Hence, we regress the global factor of IR on each of the global factors of the driving variables, and the results allow us to recognize only the effects of common world factor in explaining the fluctuations in IR, apart from the domestic factors. Particularly, we estimate the following univariate regression for each of the driving variables:

$$\widehat{GF}_t^{IR} = \pi + \delta\widehat{GF}_t^{x} + \varepsilon_t \quad (10)$$

where x denotes gross-savings, import, export, real GDP, current-account, and capital inflow, respectively; and GF stands for global factor.

Table 4 reports the relations between the estimated global factor of each control variables and the estimated global factor of IR through the estimated coefficients, namely $\hat{\delta}$ in equation (10). The mentioned regression is performed for each of the explanatory variable for the whole sample period, before GFC, and during and after GFC.[13] Results show that for the whole sample period, the effects of each of the global factors of savings, import, export, and capital inflow are significant and positively related to IR. Besides, it is evident that before the crisis real GDP shares a negative relation with the IR and is a significant component in explaining the variation of international reserves. For the whole sample period, this association is positive but insignificant. The converse is true for capital inflow. Overall, before the financial crisis, the coefficient of the global factor of capital inflow is insignificant while for the entire sample, it is significant even at 1 percent significance level. Moving forward, during and after the financial crisis, the mechanisms of the driving variables are completely the opposite of the pre-crisis period. For example, before the GFC the world factors of gross-savings, import, export and current account are positively associated with the global factor of IR. But, during the post-crisis period, their association with IR becomes negative. Again, the current account which proves to be insignificant both in the whole sample and the pre-crisis period, is significant after the crisis. On the contrary, the coefficient of the global factor of real GDP which is negatively associated with the total reserve during the pre-crisis era, becomes positively related to

[13] Due to the availabilities of the data of all the driving variables, we consider 45 years from 1972 – 2017 and 48 countries for this analysis.

the global factor of international reserves once the crisis is over. Overall, we notice that during and after the financial crisis all the control variables contribute significantly in explaining the fluctuations in IR. This finding confirms that globally the relative importance of country-specific macro-economic policies have increased in explaining IR, which causes a disintegration among countries regarding the reserves holding.

Next, we examine the time-varying effects of the driving forces on IR. For this, we employ the rolling window regression analysis of the standardized global factor of IR on the standardized global factors of control variables, namely the driving forces. The estimated coefficients of each standardized global factors of control variables are plotted in Figure 7 with the 95 percent confidence intervals. From the figure, we observe that the association with each driving forces significantly increases in the post-2007 period and after 2009 and then there is a sudden drop in such association. This implies that during the era of crisis, individual countries adopt different macro-economic policies, which dramatically reduce the global integration effect among them, reflected by a general fall in the co-movements of IR during the post-crisis period as shown in Figure 1 at the beginning of the paper.

The rolling regression results are described in Table 5, for each of the whole sample period, before the GFC, during the GFC, and after the GFC periods. Since, we standardize both the explained and control variables, the coefficient of each control variable explains the correlation coefficient between them. Supporting what we observe in Figure 7, Table 5 shows that during the years of the financial crisis all the driving forces, which are the global factors of the control variables, share the highest correlation with IR. Moreover, although during the GFC all the control variables have positive effects on IR, such integration effects are reduced drastically once the crisis is over. Even, the associations become negative in the post-crisis period with the exceptions of real GDP and capital inflow.

To further analyze the global dynamics of each driving forces of IR, we use a vector autoregression (VAR, henceforth) model. The objective is to identify the structural shocks and infer their causal relationships with IR by using the estimated global factors of the driving variables. That is, instead of taking the variables themselves, we use their estimated global factors to construct the VAR. Before proceeding, the unit root tests are performed first for each of the variables. We perform both the Dickey-Fuller (DF, henceforth) which does not allow for breaks, and the Lee and Strazicich (2003) (LS, henceforth) LM test which controls for the structural breaks to check the presence of a unit root in a time-series. Table 6 summarizes the test results.[14] From Table 6, it is observed that the results are more supportive to be stationary when we consider structural breaks in the LS test. So, we use the level data of all the global factors of the variables instead of using them at their first differences.[15] Second, we perform the Bai-Perron test to check if there are any structural breaks in the global factor of IR which is our variable of interest.[16] It seems clear that breaks are present in the data. So, we include a Fourier function in VAR to capture the structural changes. Enders and Jones (2016) note that the Granger-causality tests based on usual VAR models without breaks can be biased towards rejecting the null hypothesis of non-causality even when the null is correct. The similar error can be obtained if the breaks are mis specified. One may include dummy variables as an alternative procedure, but this task can be challenging, and the test results can be sensitive to the estimates of break dates. As such, we rely on the Fourier function to approximate structural breaks without having to estimate exact break dates. To be specific, we estimate the following model,

$$z_t = c + \sum_{k=1}^{n} a_{ik} \sin\left(\frac{2\pi kt}{t}\right) + \sum_{k=1}^{n} b_{ik} \cos\left(\frac{2\pi kt}{t}\right) + \sum_{i=1}^{p} A_i Z_{t-i} + e_t \quad (11)$$

where, $z_t = [\widehat{GF}_t^{IR}, \widehat{GF}_t^{Savining}, \widehat{GF}_t^{Import}, \widehat{GF}_t^{Export}, \widehat{GF}_t^{RGDP}, \widehat{GF}_t^{CurrentAccount}, \widehat{GF}_t^{CapInflow}]'$, c is a (7×1) vector of intercepts, k is the number of frequencies, and a_{ik} & b_{ik} are the amplitude and displacement of sinusoidal components or the break parameters, A_i is a (7×7) coefficient vector, and e_t is the vector of innovations. A VAR- lag select test is performed for every single equation to estimate the optimal lags of the

[14] We use Lee and Strazicich (2003) LM test which controls for two structural breaks in unit root test since the Bai-Perron and the recursive least squares results confirm the presence of two breaks in the global factor of IR.

[15] The results from Dickey-Fuller test at the first differences are reported in Appendix Table 8 in the Appendix.

[16] We perform Bai-Perron test with both level-shift and trend shift models and find two breaks from the level-shift model and four breaks from the trend-shift model by using the minimum residual sum of squares (SSR) and BIC criteria. To confirm the exact number of breaks, we estimate a recursive least squares (RLS) that uses Kalman filter and find two breaks in the series of global factor of IR. However, to avoid such confusion, we employ a Fourier function to approximate the structural breaks in the global factors that doesn't require to estimate the number and exact dates of breaks to capture them. Results of the Bai-Perron test and RLS are available upon request.

model. According to AIC criteria, we select 2 lags *i.e.* we proceed with $p = 2$ in equation (11) throughout our estimation process. Equation (11) is estimated with $n = 2$ by testing the cross-equation restriction that all values of $a_{i2} = b_{i2} = 0$ where $i = 1, \ldots, n$. Since, both the multivariate AIC and SBC select $n = 2$ over $n = 1$, 2 is chosen as the number of frequencies in this model.[17]

Table 7 summarizes the test results from the VAR model. We only report the results of the causality tests, generated for the causal relationship from the driving forces to the global factor of IR at levels.[18] As shown in Table 7, the global factors of export, current account, and capital inflow are Granger-caused by IR. Gross-savings has a causal relationship with import, export, and capital inflow respectively. On the contrary, import is only Granger caused by the global international reserves. Following the pattern, the common world factors of export, real GDP, and capital inflow show causal effects on the IR. Overall, the VAR results show that terms of trade, business cycle, and capital inflow are the major driving forces in explaining the IR, supporting what we got in the previous analysis.

Figure 8 shows the impulse responses produced by one standard deviation shock on each of the global factor of the driving source variables. From the figure, we observe that the entire system displays substantial interactions given the shocks to each variable in the system. One potential reason for such high interaction is the inclusion of the Fourier function into the system which captures the potential nonlinearity in the data. For example, one standard deviation shock in global import increases the average reserve for all countries. However, a one standard deviation shock in real GDP causes an increase in international reserves for 3 years before decreasing approximately 0.3 standard deviations in two years. The capital inflow also interacts with IR and globally a one standard deviation shock to capital inflow causes reserves to go up.

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[16] The global factors of each of the driving variables (savings, import, export, RGDP, current account, and capital inflow) are estimated from SV-TV-DFM, described in section.2.

[18] We report the results of Granger-causality tests without break and with sharp breaks at levels in Appendix Tables 9 and 10 respectively in the Appendix. Also, the results of Granger-causality test with Fourier approximation at the first differences are shown in Appendix Table 1 in the Appendix. Results suggest that Granger causality test with Fourier function at levels shows the highest possible causalities, generated from IR to the other variables as shown in Table 7, compare to other test results in Tables 9, 10, and 11 respectively Also, the results of Table 7 are consistent with LS unit root test that captures the structural breaks in time series.

5. Conclusion

This paper attempts to estimate the global and regional factors of international reserves and evaluate their effects on the co-movements of IR across the countries, present in the sample. Following Del Negro and Otrok (2008), the paper uses a time-varying dynamic factor model with time-varying stochastic volatility and contributes to the existing literature in the following ways. First, the paper focuses on the share data of international reserves out of GDP and estimates their global and regional factors to explain the main sources of IR co-movements. Specifically, this paper tries to find the degree of the variations of international reserves that could be explained by the world global factor, regional factors, and country-specific economic factors. We find that the global factor plays a dominant role to explain the fluctuations in IR. Second, we find that the contribution of the global factor on IR variation has been decreased significantly after the GFC, reflecting the break down in reserve co-movements after 2009. Results show that after the financial crisis regional factors exhibit much influence on IR. Next, the paper examines the effects of the global factor on IR fluctuations to address the degree of synchronization of each country with the world economy. Following Marcellino, Stock, and Watson (2000), we observe the correlation of IR with its global factor for each country and find that after the financial crisis the global association of IR with the world drops significantly compared to the pre-crisis period. Lastly, we employ the methodology of Crucini, Kose, and Otrok (2011) and identify the driving forces of IR. We find that the dynamics of the driving variables change significantly after the GFC. Then we construct a VAR model to observe the causalities of the driving forces and identify the impact of global business cycle and terms of trade on the co-movements of the IR. Overall, our estimation strategies recognize the importance of the global factor in explaining the international reserves co-movements, on top of the domestic determinant variables that are examined in the previous literature.

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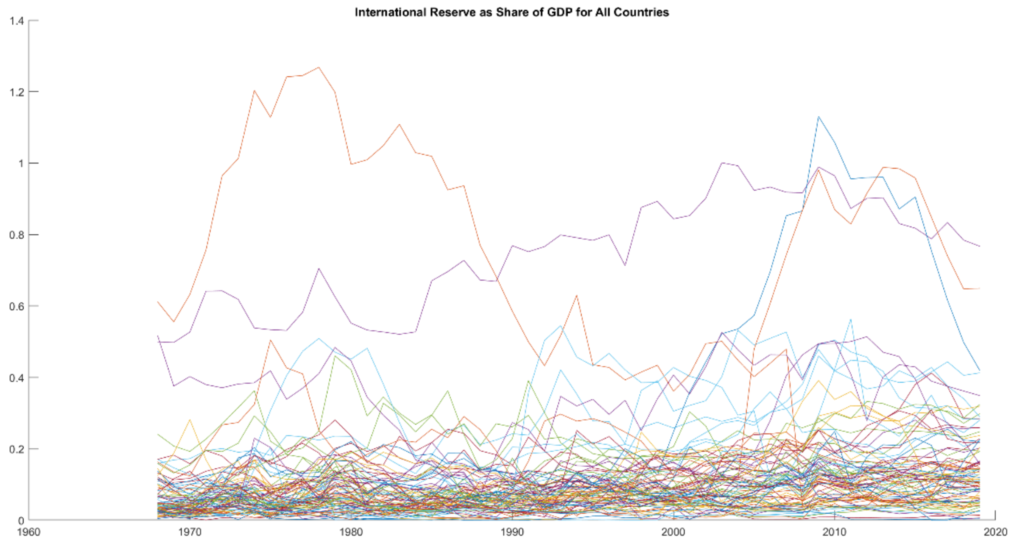
Figure 1. Total Reserves as a Share of GDP Across Countries

Panel (a)



Panel (b)

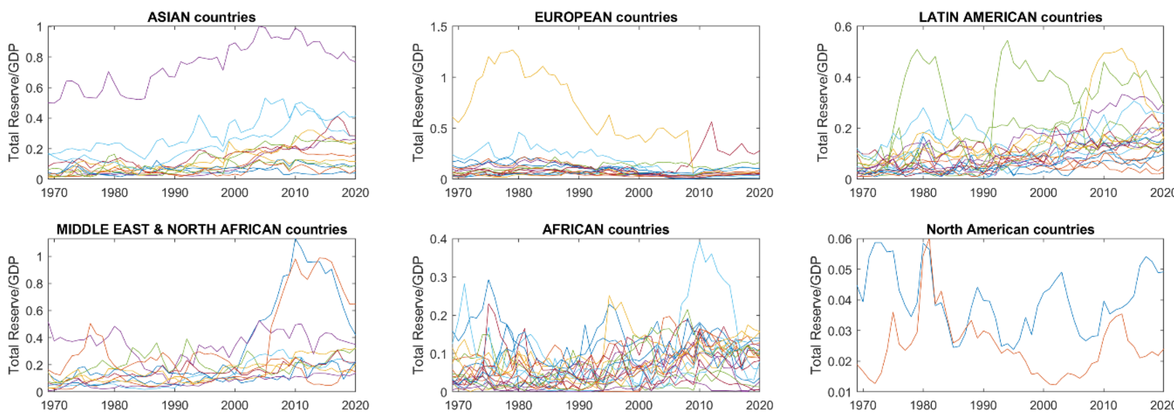


Figure 2. Estimated Global and Regional Factors of International Reserves across Regions

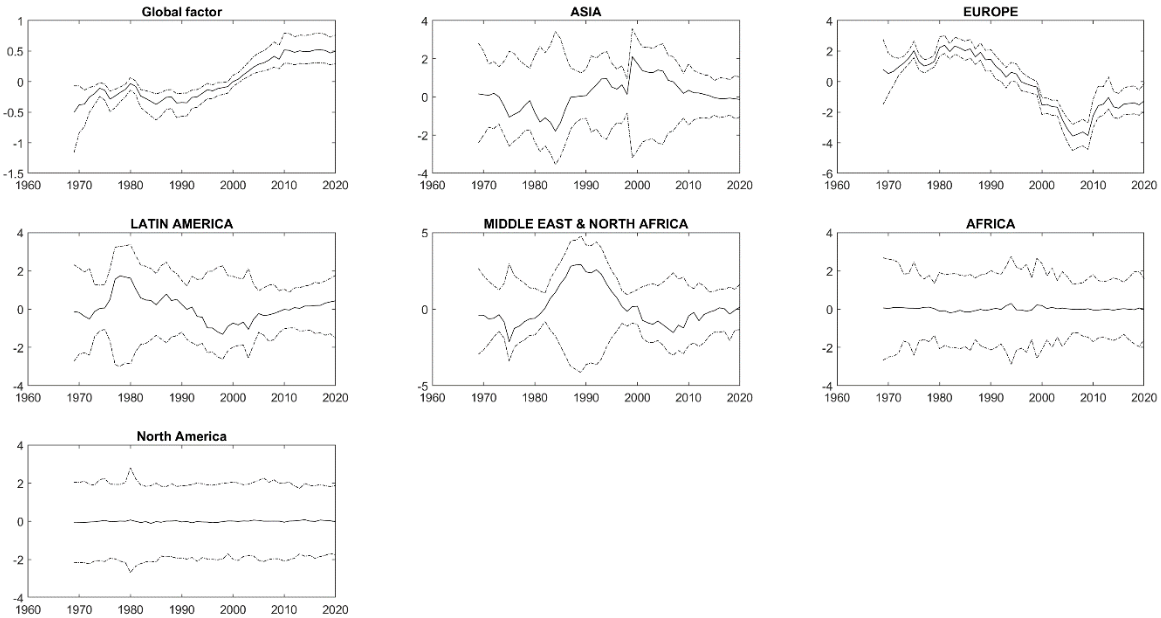


Figure 3. Plots of Average International Reserve over Time and
Decomposition of Global, Regional & Country-Specific Factors

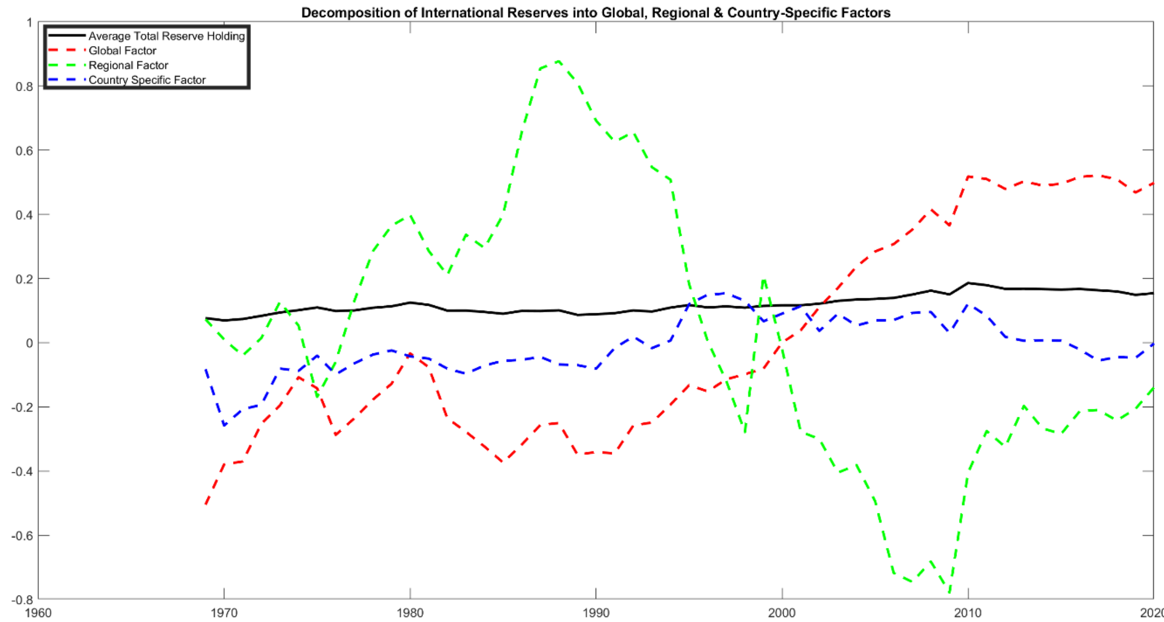


Figure 4. Variance Contribution of Global, Regional, and Country Specific Factors in Asian Countries

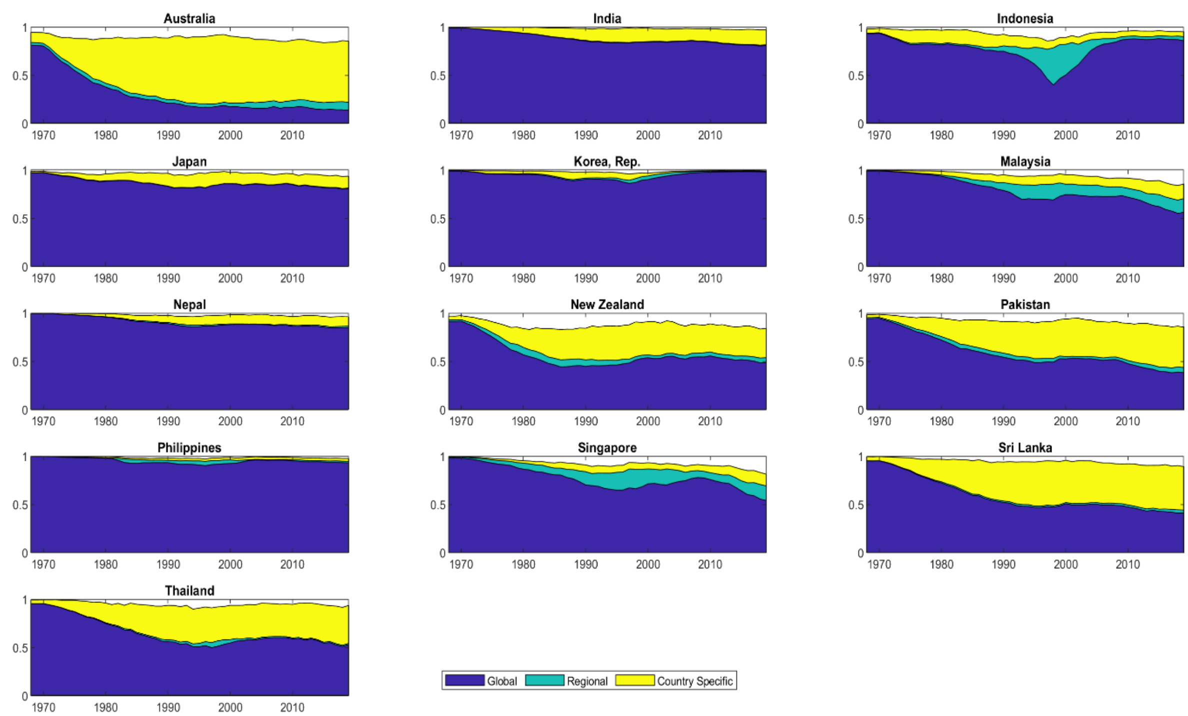


Figure 5. Variance Contribution of Global, Regional, and Country Specific Factors in European Countries

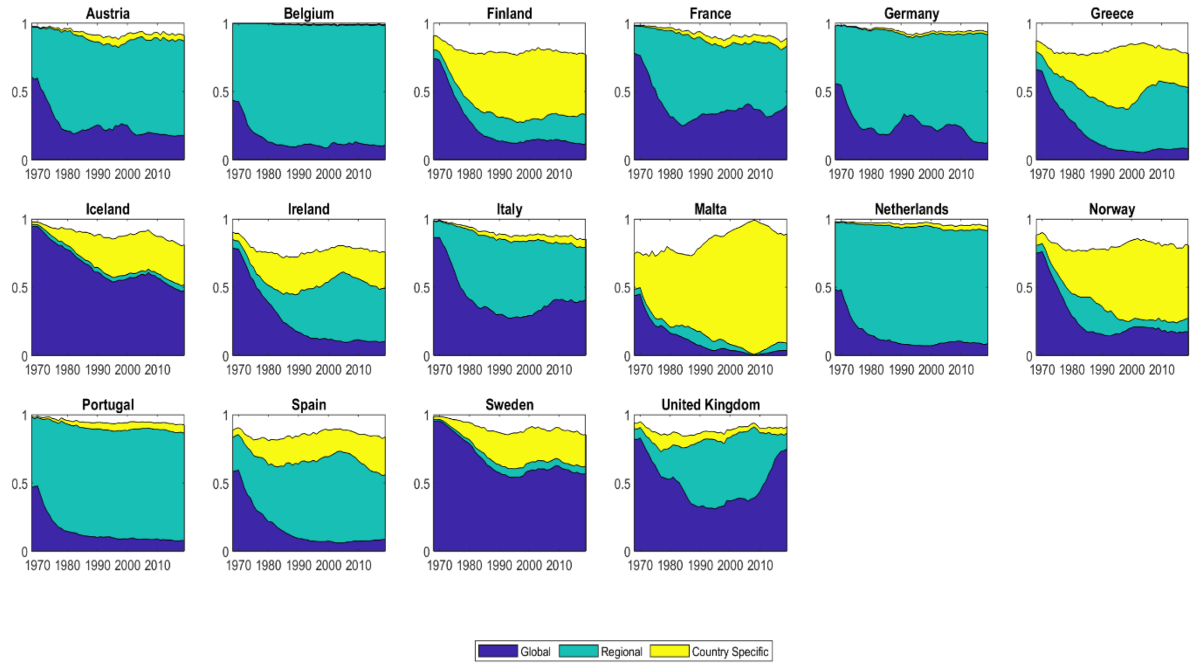


Figure 6. Variance Contribution of Global, Regional, and Country Specific Factors in Middle East & North African Countries

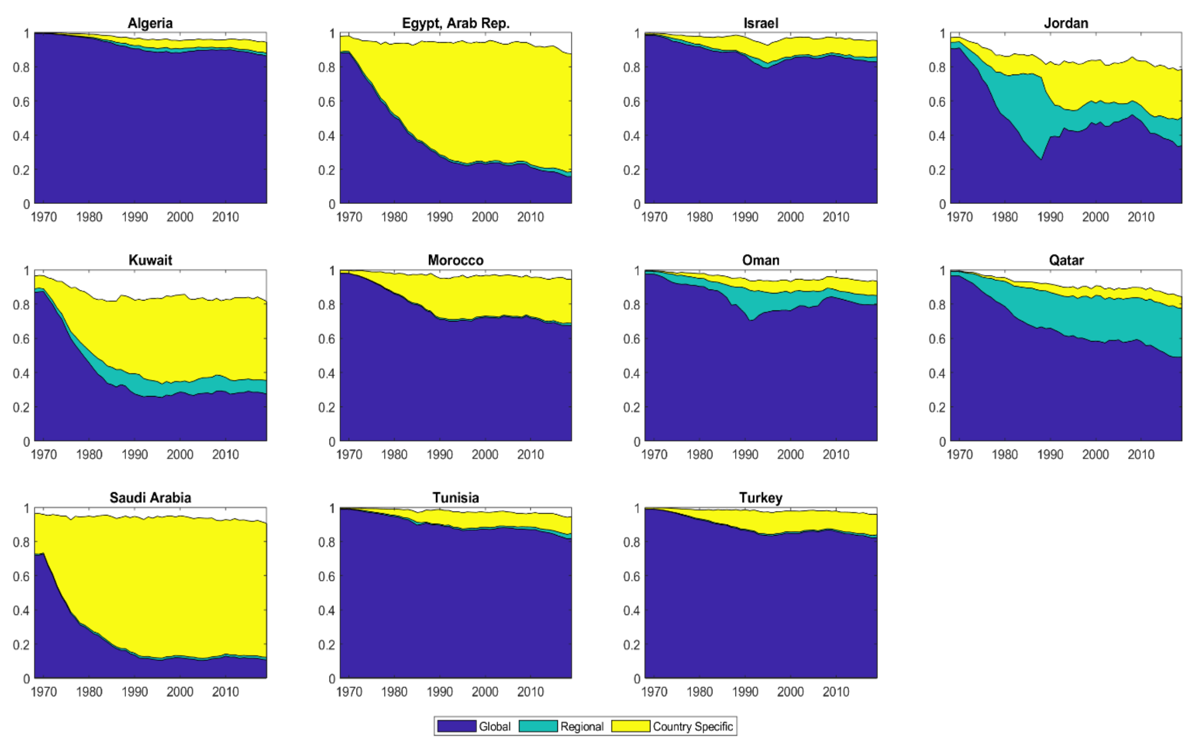


Figure 7. Variance Contribution of Global, Regional, and Country Specific Factors in North American Countries

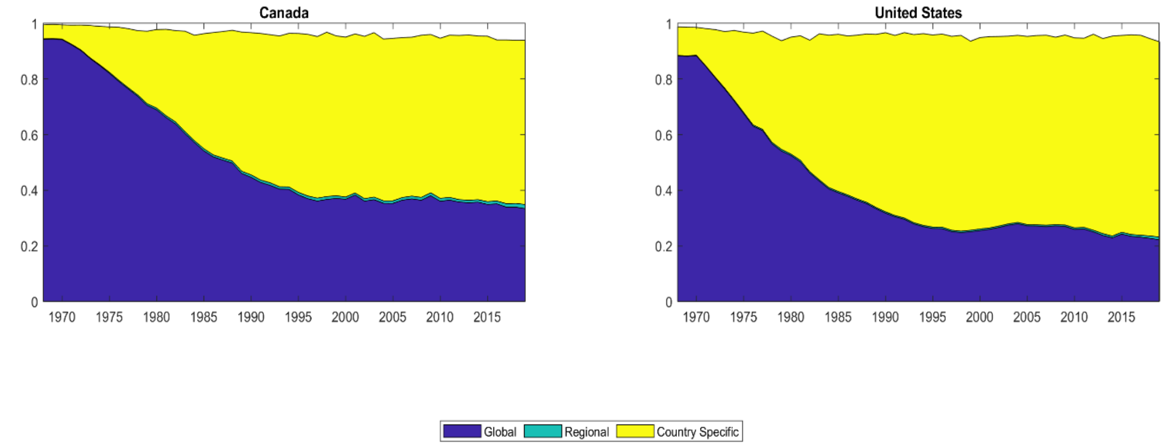


Figure 8. Results of Rolling Window Regression on the Driving Forces of International Reserves

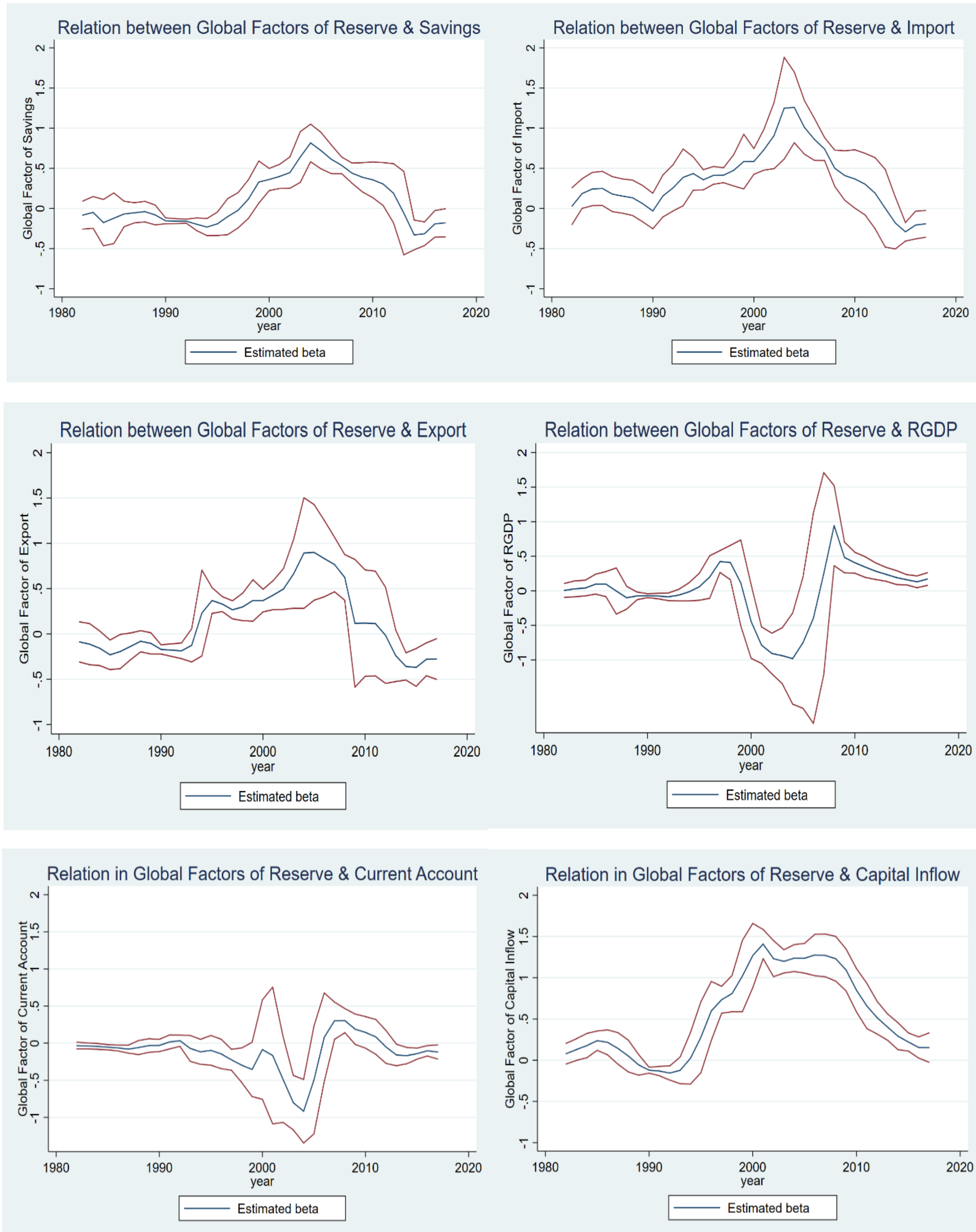


Figure 9. Impulse Responses from VAR Model

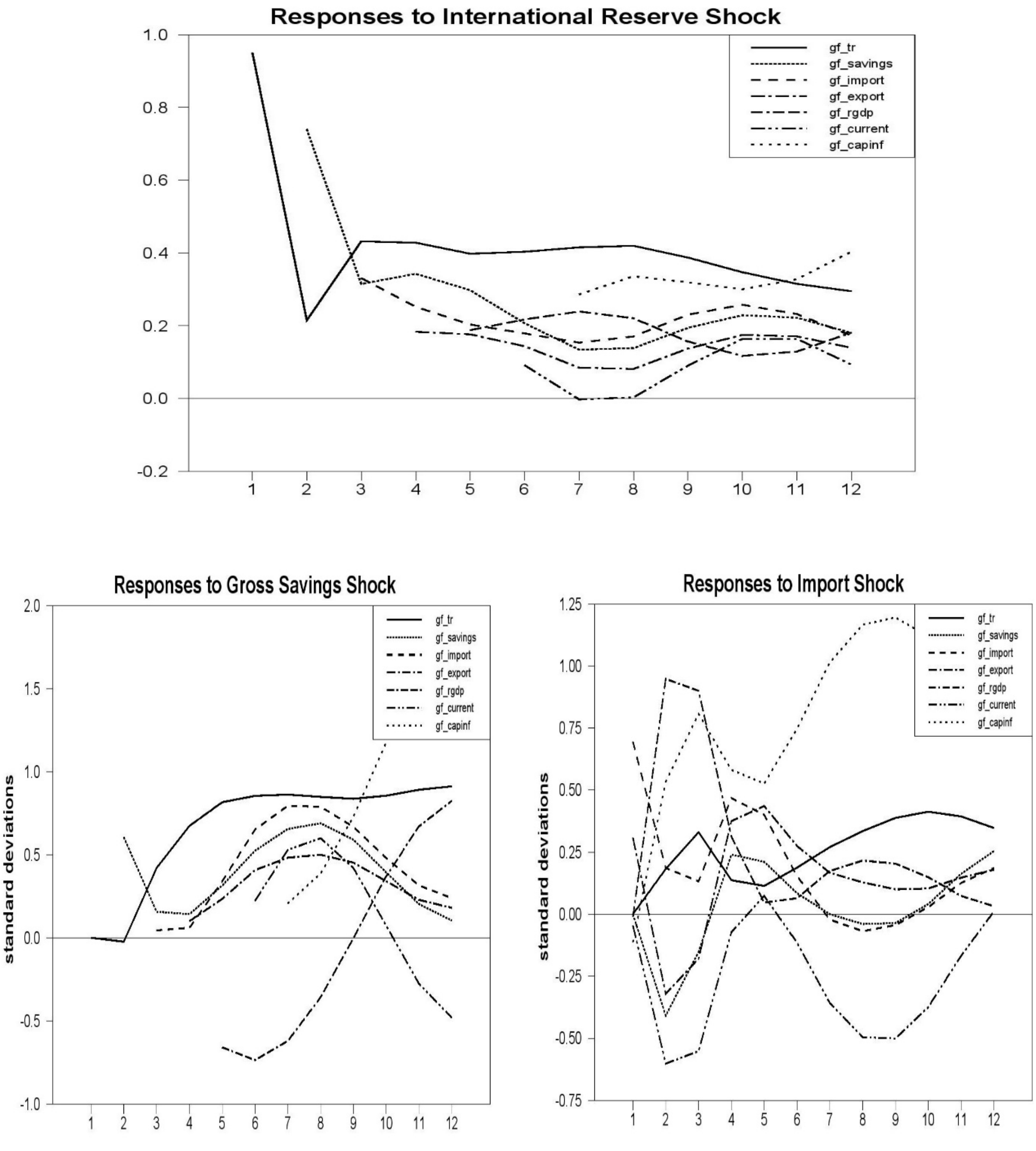


Figure 10. Impulse Responses from VAR Model (continued)

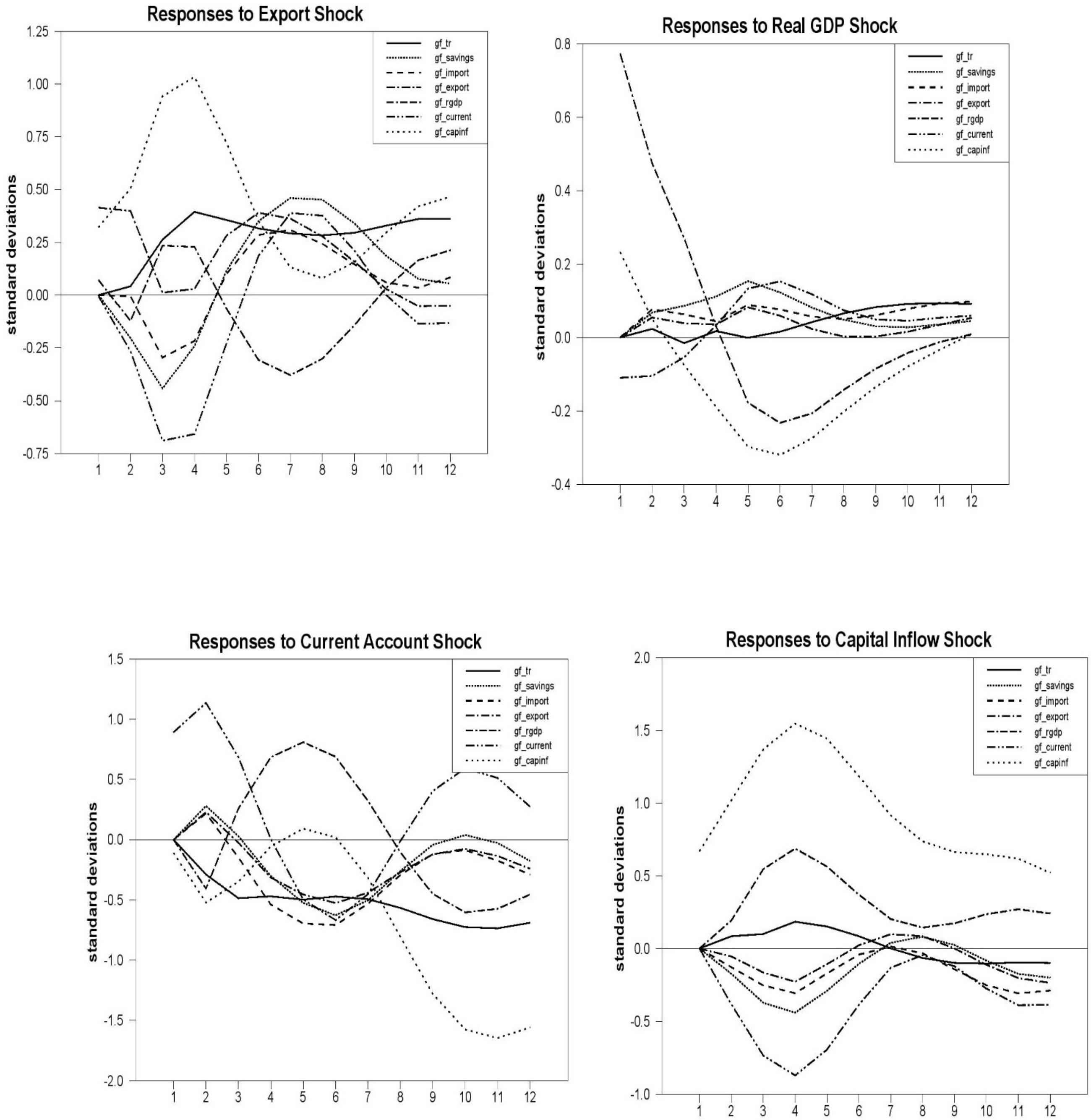


Table 1. The Relative Contributions of Global, Regional, and Country-specific Factors to the Variation of International Reserves

	Whole Sample Period	Before the Financial Crisis	During & After the Financial Crisis
	1968 - 2019	1968 - 2006	2007 - 2019
1-a. Average Relative Contributions of Each Factor			
Global Factor	0.583	0.606	0.507
Regional Factor	0.081	0.077	0.094
Country-specific Factor	0.270	0.256	0.316
1-b. Average Relative Contributions of Each Factor in Different Regions			
Asia			
Global Factor	0.747	0.769	0.674
Regional Factor	0.032	0.030	0.038
Europe			
Global Factor	0.382	0.410	0.289
Regional Factor	0.329	0.318	0.365
Latin America			
Global Factor	0.626	0.639	0.580
Regional Factor	0.027	0.024	0.034
Middle East & North Africa			
Global Factor	0.679	0.710	0.578
Regional Factor	0.010	0.008	0.016
Africa			
Global Factor	0.554	0.577	0.480
Regional Factor	0.015	0.012	0.024
North America			
Global Factor	0.471	0.516	0.320
Regional Factor	0.053	0.050	0.064
1-c. Relative Contributions of Each Factor in Some Large Countries			
United States			
Global Factor	0.391	0.437	0.403
Regional Factor	0.023	0.025	0.015
Japan			
Global Factor	0.945	0.949	0.931
Regional Factor	0.004	0.003	0.006
Germany			
Global Factor	0.292	0.343	0.123
Regional Factor	0.673	0.627	0.827
United Kingdom			
Global Factor	0.325	0.309	0.381

Regional Factor	0.372	0.376	0.359
India			
Global Factor	0.859	0.882	0.779
Regional Factor	0.005	0.003	0.009
France			
Global Factor	0.193	0.209	0.139
Regional Factor	0.610	0.605	0.625
Italy			
Global Factor	0.298	0.309	0.262
Regional Factor	0.540	0.553	0.496
Brazil			
Global Factor	0.927	0.931	0.914
Regional Factor	0.009	0.008	0.012
Canada			
Global Factor	0.550	0.594	0.480
Regional Factor	0.084	0.075	0.112
Korea, Rep			
Global Factor	0.948	0.941	0.972
Regional Factor	0.012	0.013	0.009
Greece			
Global Factor	0.202	0.234	0.094
Regional Factor	0.337	0.256	0.606

Table 2. Average Cross-Country Correlation between International Reserves and its Global Factor across Regions and Countries

Specification: $IR_{i,t} = \alpha + \beta \widehat{GF}_t^{IR} + \epsilon_t$

Region/Country	Whole Sample Period	Before the Financial Crisis	During & After the Financial Crisis
	1968 - 2019	1968 - 2006	2007 - 2019
2-a. Correlations between International Reserve & its Global Factor across Regions			
Asia	0.606	0.570	0.230
Europe	0.327	0.230	0.394
Latin America	0.441	0.326	0.299
Middle East & North Africa	0.523	0.412	0.236
Africa	0.303	0.225	0.257
2-b. Correlations between International Reserve & its Global Factor across Countries			
United States	0.018	0.110	0.059
Japan	0.899	0.793	0.124
Germany	0.325	0.340	0.265
United Kingdom	0.010	0.070	0.542
India	0.903	0.880	0.267
France	0.064	0.127	0.394
Italy	0.063	0.212	0.391
Brazil	0.771	0.503	0.389
Canada	0.000	0.009	0.547
Korea, Rep.	0.892	0.753	0.761

We use time-series regression of international reserves on the estimated global factor for each country over the sample periods. The average of R^2 for each region is reported. IR stands for international reserve and $\widehat{GF}_t^{IR}$ is the estimated global factor of international reserve at time t.

Table 3. The Average Contribution of Global, Regional, and Country-specific Factors of Each of the Control Variables

	Gross Savings	Import	Export	Real GDP	Current Account	Capital Inflow
Global Factor	0.300	0.920	0.715	0.795	0.927	0.648
Regional Factor	0.082	0.008	0.014	0.052	0.002	0.117
Country-specific Factor	0.656	0.102	0.288	0.168	0.075	0.225

Table 4. The Relation between the Global Factors of International Reserves and its Driving Forces

Specification: $\widehat{GF}_t^{IR} = \pi + \delta\widehat{GF}_t^{x} + \varepsilon_t$

Variables	Whole Sample Period	Before the Financial Crisis	During & After the Financial Crisis
	1972 - 2019	1972 - 2006	2007 - 2019
Global Factor of Gross Savings	0.778***	0.507***	-0.191**
	(0.079)	(0.119)	(0.072)
Global Factor of Import	0.912***	0.812***	-0.205**
	(0.064)	(0.049)	(0.075)
Global Factor of Export	0.880***	0.659***	-0.288**
	(0.058)	(0.062)	(0.090)
Global Factor of RGDP	0.134	-0.420***	0.132***
	(0.160)	(0.100)	(0.040)
Global Factor of Current Account	-0.107	0.082	-0.103**
	(0.171)	(0.101)	(0.032)
Global Factor of Capital Inflow	0.687***	0.170	0.152**
	(0.075)	(0.142)	(0.056)

Robust standard errors are in parentheses. ***, **, and * mean significant at 1%, 5%, and 10% levels respectively. $\widehat{GF}_t^{IR}$ is the estimated global factor of international reserves at time t and $\widehat{GF}_t^{x}$ is the estimated global factor of the control variables. We use the univariate time-series regression and report $\hat{\delta}$ for each variable such that the estimated coefficients show the correlation between IR and the respective variable.

Table 5. Summary of Rolling Correlation Coefficients of Each of The Driving Forces of International Reserves

Variable	Whole Period	Before The Financial Crisis	During The Financial Crisis	After The Financial Crisis
	1972 - 2019	1972 - 2006	2007 - 2009	2010 - 2019
Global Factor of Gross Savings	0.103	0.102	0.455	-0.028
Global Factor of Import	0.359	0.451	0.550	-0.001
Global Factor of Export	0.136	0.188	0.503	-0.163
Global Factor of RGDP	-0.017	-0.169	0.558	0.241
Global Factor of Current Account	-0.119	-0.182	0.265	-0.064
Global Factor of Capital Inflow	0.545	0.511	1.198	0.405

Table 6. Unit Root Test Results

Series	DF tests	LS tests
Global Factor of International Reserve	-1.961	-6.150*
Global Factor of Gross Savings	-2.261	-5.4629*
Global Factor of Import	-2.035	-6.138*
Global Factor of Export	-2.395	-6.797**
Global Factor of RGDP	-5.991	-5.284*
Global Factor of Current Account	-3.211	-5.820*
Global Factor of Capital Inflow	-1.186	-6.364**

Note: ***, **, and * mean significant at 1%, 5%, and 10% levels respectively.
Note: DF tests refer to the Dickey-Fuller tests, and LS tests refer to the Lee and Strazicih (2003) tests.

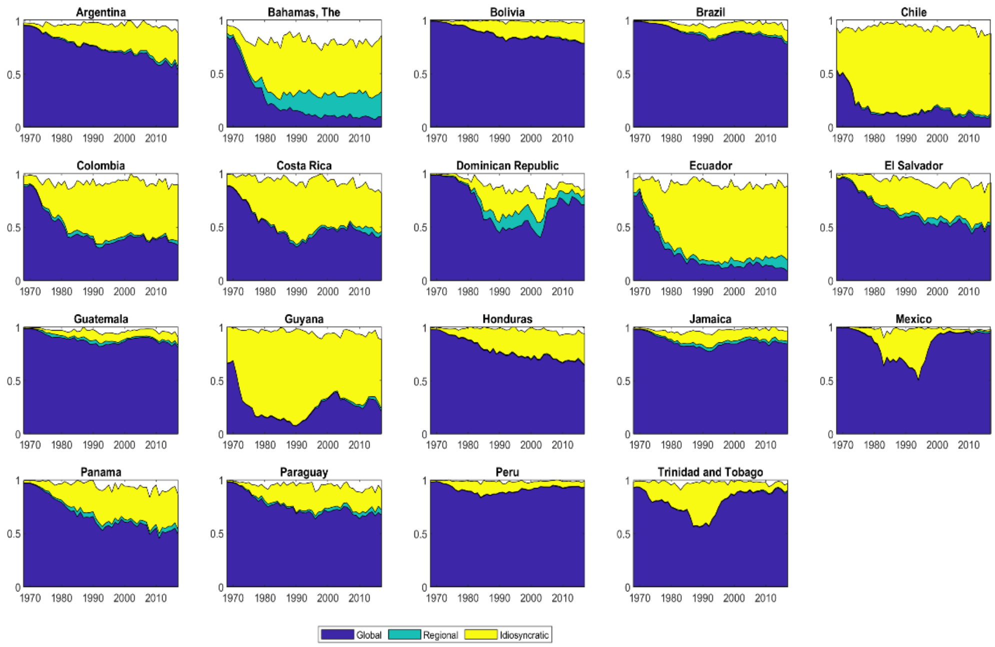
Table 7. Causality Test Results in VAR

	$\widehat{GF}_t^{IR}$	$\widehat{GF}_t^{Savings}$	$\widehat{GF}_t^{Import}$	$\widehat{GF}_t^{Export}$	$\widehat{GF}_t^{RGDP}$	$\widehat{GF}_t^{Current}$	$\widehat{GF}_t^{CapInf}$
$\widehat{GF}_t^{IR}$	-	0.4520	1.0204	7.576***	0.012	5.242**	2.739*
$\widehat{GF}_t^{Savings}$	0.066	-	5.079**	5.122**	2.146	1.655	3.223*
$\widehat{GF}_t^{Import}$	2.935*	1.988	-	0.415	1.361	0.043	0.958
$\widehat{GF}_t^{Export}$	5.224**	0.029	2.335	-	4.882**	3.907**	0.908
$\widehat{GF}_t^{RGDP}$	8.106***	10.446***	1.154	6.525***	-	13.378***	0.260
$\widehat{GF}_t^{Current}$	2.668	0.156	4.517**	2.903*	0.136	-	0.104
$\widehat{GF}_t^{CapInf}$	6.560***	2.186	2.364	8.326***	0.153	1.379	-

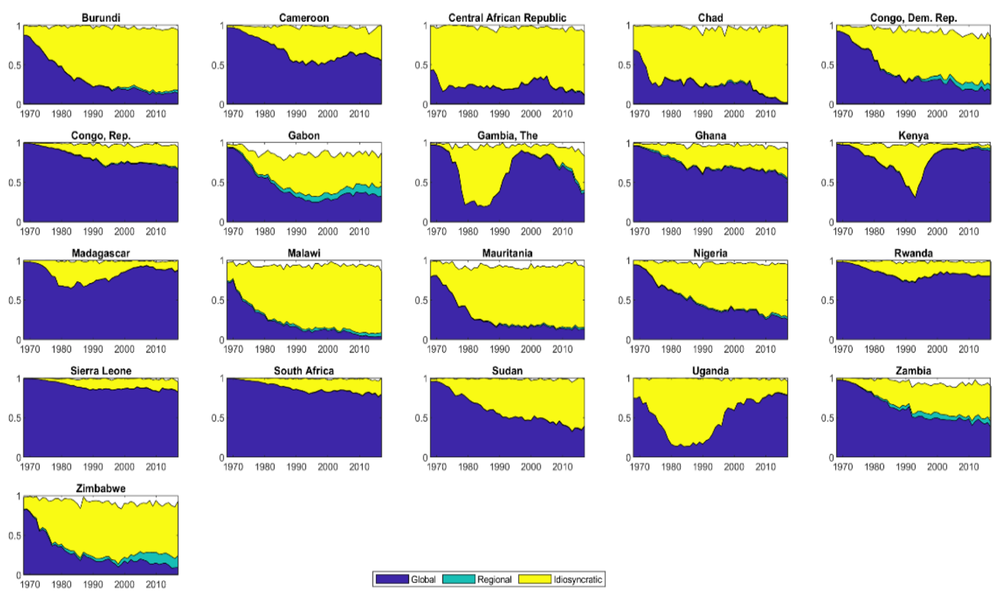
$\widehat{GF}$ stands for the estimated global factors of the variables. We report the F-statistics for the null hypothesis of no causality. ***, **, and * mean significant at 1%, 5%, and 10% levels respectively.

Appendix

Appendix Figure 9. Variance Contribution of Global, Regional, and Country Specific Factors in Latin American Countries



Appendix Figure 10. Variance Contribution of Global, Regional, and Country Specific Factors in African Countries



Appendix Table 8. Dickey-Fuller (DF) Test Results at the First Differences of the Variables in VAR

Series	DF at level	DF at First Differences	τ_{DF}
Global Factor of International Reserve	-1.961	-4.417	-3.516
Global Factor of Gross Savings	-2.261	-4.433	-3.516
Global Factor of Import	-2.035	-5.233	-3.516
Global Factor of Export	-2.395	-5.731	-3.516
Global Factor of RGDP	-5.991	-5.991	-3.516
Global Factor of Current Account	-3.211	-5.012	-3.516
Global Factor of Capital Inflow	-1.186	-4.599	-3.516

τ_{DF} is the critical value of Dickey-Fuller test at 5% level of significance.

Appendix Table 9. Causality Test Results in VAR at Levels without Structural Breaks

	$\widehat{GF}_t^{IR}$	$\widehat{GF}_t^{Savings}$	$\widehat{GF}_t^{Import}$	$\widehat{GF}_t^{Export}$	$\widehat{GF}_t^{RGDP}$	$\widehat{GF}_t^{Current}$	$\widehat{GF}_t^{CapInf}$
$\widehat{GF}_t^{IR}$	-	0.062	0.519	2.571	0.339	1.368	0.505
$\widehat{GF}_t^{Savings}$	0.111	-	1.114	0.679	0.101	3.037*	0.743
$\widehat{GF}_t^{Import}$	16.738***	0.375	-	0.934	3.029*	6.813**	1.975
$\widehat{GF}_t^{Export}$	0.024	1.032	3.312*	-	0.291	1.717	1.092
$\widehat{GF}_t^{RGDP}$	0.158	1.014	0.092	1.938	-	15.768***	15.633***
$\widehat{GF}_t^{Current}$	0.408	0.313	0.015	0.137	0.083	-	2.756*
$\widehat{GF}_t^{CapInf}$	0.534	2.338	3.146*	0.050	1.341	3.082*	-

$\widehat{GF}$ stands for the estimated global factors of the variables. We report the F-statistics for the null hypothesis of no causality. ***, **, and * mean significant at 1%, 5%, and 10% levels respectively.

Appendix Table 10. Causality Test Results in VAR at Levels with Sharp Breaks

	$\widehat{GF}_t^{IR}$	$\widehat{GF}_t^{Savings}$	$\widehat{GF}_t^{Import}$	$\widehat{GF}_t^{Export}$	$\widehat{GF}_t^{RGDP}$	$\widehat{GF}_t^{Current}$	$\widehat{GF}_t^{CapInf}$
$\widehat{GF}_t^{IR}$	-	0.054	0.501	2.498	0.322	1.244	0.336
$\widehat{GF}_t^{Savings}$	0.103	-	1.192	0.683	0.167	3.512*	1.305
$\widehat{GF}_t^{Import}$	24.504***	0.001	-	1.040	2.368	11.682***	7.610***
$\widehat{GF}_t^{Export}$	0.368	1.331	3.399*	-	0.382	2.071	1.555
$\widehat{GF}_t^{RGDP}$	0.149	1.000	0.084	1.880	-	13.906***	9.476***
$\widehat{GF}_t^{Current}$	2.927*	0.011	0.053	0.133	0.262	-	5.774**
$\widehat{GF}_t^{CapInf}$	0.082	1.906	2.994*	0.050	1.371	3.0578*	-

$\widehat{GF}$ stands for the estimated global factors of the variables. We report the F-statistics for the null hypothesis of no causality. ***, **, and * mean significant at 1%, 5%, and 10% levels respectively.

Appendix Table 11. Causality Test Results in VAR at First Differences with Smooth Breaks using Fourier Approximation

	$\widehat{GF}_t^{IR}$	$\widehat{GF}_t^{Savings}$	$\widehat{GF}_t^{Import}$	$\widehat{GF}_t^{Export}$	$\widehat{GF}_t^{RGDP}$	$\widehat{GF}_t^{Current}$	$\widehat{GF}_t^{CapInf}$
$\widehat{GF}_t^{IR}$	-	0.410	3.047*	1.250	0.019	0.131	1.153
$\widehat{GF}_t^{Savings}$	2.242	-	9.157***	0.394	0.352	1.762	0.771
$\widehat{GF}_t^{Import}$	2.934*	1.988	-	0.415	1.361	0.043	0.958
$\widehat{GF}_t^{Export}$	0.478	0.630	7.839***	-	0.611	0.247	0.782
$\widehat{GF}_t^{RGDP}$	2.715*	1.623	9.792***	3.242*	-	10.450***	1.665
$\widehat{GF}_t^{Current}$	0.232	2.976*	8.749***	0.893	0.030	-	0.010
$\widehat{GF}_t^{CapInf}$	21.550***	0.005	12.341***	7.721***	0.540	4.567**	-

$\widehat{GF}$ stands for the estimated global factors of the variables. We report the F-statistics for the null hypothesis of no causality. ***, **, and * mean significant at 1%, 5%, and 10% levels respectively.