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Boom-and-Bust Cycles in Emerging Markets: How Important is the Exchange Rate?

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Abstract

This paper examines the macroeconomic implications of exchange rate shocks in a sample of 13 emerging market and 6 advanced economies since the early 1990s. Factor-augmented vector autoregressions are estimated with three separate factors identified. They are: real, monetary and financial factors. The main conclusion is that there is no 'one size fits all' when interpreting the domestic responses to an exchange rate shock. International policies that aim to define a particular exchange rate or exchange rate regime are unlikely to be able to deal with so many idiosyncratic responses. Nor is it the case that a particular monetary policy strategy, such as inflation targeting, can immunize a domestic economy against external shocks. International cooperation should instead encourage individual economies to seek out the menu of policies that ensure that each one's house is in order.

Keywords: USD exchange rate channel, emerging markets, boom-and-busts, monetary policy strategy, globalization

JEL classification: F62,F42, E32, E65, E58

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1. Introduction

Since the end Bretton Woods there has been considerably more flexibility in exchange rates. However, in emerging market economies (EME), policy makers have tended to demonstrate greater resistance to exchange rate flexibility (e.g., see Reinhart and Rogoff (2004), Ilzetski, Reinhart, and Rogoff (2017), Frankel (2017)), possibly to their detriment, at least according to some recent empirical studies (e.g., see Bowman et. al. (2015), Hausman and Wongswan (2011)). But, as Frankel (1999) points out, in an extensive review of the literature, 'one size does not fit all' in the choice of exchange rate regimes. In any case, one cannot ignore the fact that there have been large movements in nominal and real exchange rates over the past few decades.[1]

The foregoing reflects the waxing and waning of the role of the exchange rate in policy discussions. Monetary authorities have occasionally pointed out the importance of exchange rates for monetary policy and financial stability. Since 2008 the G20 have held 12 summits. In only 3 of these summits are exchange rates explicitly mentioned in the Leaders' Declarations and EME are singled out only three times (in 2010, 2013, and 2013) when crisis conditions were affecting the advanced economies (AE).[2] However, the implications of exchange rate fluctuations are still not adequately understood (e.g., see Forbes 2016).

Between 1999 and 2015, that is, since the European Central Bank (ECB) was established, the ratio of the minimum to maximum nominal EUR/USD exchange rate is 0.56. The same ratio, over the same period, is 0.74 for China's renminbi, and 0.44 for Brazil's real, two large EME. Hence, there is considerable scope for large movements in the level of exchange rates.[3] The last three decades have also seen sizeable fluctuations in many asset, credit and commodity prices. Indeed, when judged against the number and frequency of financial crises of various kinds (e.g., see Reinhart and Rogoff

[1] A fairly close connection between nominal and real exchange effective rate movements exists. The discussion that follows will focus on nominal exchange rates, due to the policy implications of the proposed study, but empirical estimates are comparable for both exchange rate indicators.

[2] A typical statement is "…excess volatility of financial flows and disorderly movements …can have adverse implications for economic and financial stability…" (St. Petersburg G20 Leaders' Declaration, 6 September).

[3] And in the volatility of exchange rates. Nor are large exchange rate movements necessarily a feature of EME alone. For example, the same ratio for the Canadian dollar is 0.61.

(2009), Laeven and Valencia (2012), and Bordo and Meissner (2016)), there is something to be said for linking USD movements, and exchange rate movements more generally, to boom-and-bust cycles, especially in EME (e.g., Plantin and Shin (2016), Hofmann and Schnabl (2016)).

The combination of 'original sin'[4], USD pricing of key commodities, together with the coupling and decoupling of business cycles over time, also draw attention to a relationship between USD fluctuations and economic performance in EME (inter alia, Gopinath (2016), Ilzetzski, Reinhart, and Rogoff (2017), Obstfeld et. al. (2017), and references therein). Finally, ultra-low or negative interest rates have contributed to enhancing the exchange rate channel (e.g., Brainard (2016)). According to some policy makers EME could play an important role in the third act of a trilogy that began with the US financial crisis of 2007 (i.e., the Global Financial Crisis or GFC), followed by the Eurozone's sovereign debt crisis in 2010 (Haldane (2015)), although the precise trigger for such an event has never been clearly spelled out.

There has been comparatively little recognition given to the offsetting effect of the financial cycle whose impact is opposite to the trade cycle emphasized by most authors. Under the latter a currency appreciation is contractionary since exports fall while imports rise. In contrast, the financial cycle can lead to an economic expansion since domestic balance sheets are strengthened leading to a potential rise in credit expansion.[5]

More generally, while there is a literature establishing a long-term historical link between credit or financial cycle booms-and-busts and economic activity (e.g., see Schularick and Taylor (2012)), assigning a role for exchange rates has sometimes been deemed secondary to other factors. This view is undergoing some changes, however, principally because it has become clear that financial globalization has blunted the ability of a floating regime to insulate against external shocks (e.g., Plantin and Shin (2016)). Therefore, in spite of greater flexibility in exchange rate regimes EME remain vulnerable to global shocks. The argument that fundamentals and institutions also matter has

[4] This refers to borrowing by EME, and others, in USD because of restrictions and frictions that prevent or limit borrowing in the domestic currency. See Eichengreen, Hausmann, and Panizza (2007).

[5] The financial channel is now often referred to as the risk-taking channel (e.g., Bruno and Shin 2015). It is not entirely divorced from the concept of the financial cycle, an old idea revived in the aftermath of the GFC (see, Borio 2012).

also been revived (e.g., Ahmed et. al (2015), Chow et. al. (2015)), a point that has previously been made by others (e.g., Calvo and Mishkin (2003)).

There was considerable reaction when, in 2010, Brazil's former Finance Minister Mantega mused about the possibility of a "currency war" in response to the introduction of unconventional monetary policies (UMP) in the US. These fears proved transitory.[6] Moreover, any 'beggar-thy-neighbour' fallout was dwarfed by the 'safe haven' status of US financial assets (e.g., Caballero et.al. (2015)).[7] Nevertheless, the focus of attention on a role for the USD, in reaction to the global impact of its domestic policies, has not abated, especially since the USD has, as this is written, once again been appreciating.

Even the shift in emphasis to focusing on the spillovers effects of UMP has not diminished interest in the role played by fluctuations in the USD. As Rajan, former Governor of the Reserve Bank of India, put it: "disregard for spillovers could put the global economy on a dangerous path of unconventional monetary tit for tat." (Rajan (2014)) Beyond the real economic effects were large movements in capital flows which also react to sizeable fluctuations in the USD exchange rate. This is hardly a new phenomenon. For example, Rodrik (1998, p.2) points out: "Boom-and-bust cycles are hardly a side show or a minor blemish in international capital flows; they are the main story." Finally, in recognition of China's critical role, commodity prices, also prone to boom-and-bust cycles, have separately contributed as a source of both real and financial shocks for EME. This is unsurprising since markets for commodities are largely driven by the USD while the so-called 'financialization' of commodity markets (e.g., Cheng and Xiong (2013)) and loose monetary policies (e.g., see Frankel 2007) also play roles.

Given the prospect for the continued 'exorbitant' privilege enjoyed by the USD (e.g., see Prasad (2014), McKinnon (2013)), it is worthwhile empirically examining how exchange rate movements

[6] In Asia, the spectre of beggar-thy-neighbour policies was revived when the Bank of Japan launched qualitative and quantitative economic easing (QQE).

[7] To be sure, some advanced economies (AE), such as the U.K. and the Eurozone, eventually also benefited from large currency depreciations against the USD. Both economies also introduced large doses of UMP to assist in the recovery of their respective economies. It should be noted that the "currency war" idea did not get much traction since exchange rate movements, at least in advanced economies, reflected not a deliberate attempt to manipulate currency values but, rather, the consequence of attempting to keep monetary policy looser for longer.

impact asset, commodity markets, and economic conditions in EME more generally. Indeed, Obstfeld and Rogoff (2000, p. 380) argued that the "…extremely weak short-term feedback between the exchange rate and the economy" is one of the continuing puzzles of international finance. They argue that a richer model[8] is necessary to make progress in solving this puzzle.

Accordingly, this paper investigates the role of exchange rate fluctuations in creating conditions that lead to drift in fundamentals potentially leading to booms-and-busts in EME. We estimate a series of vector autoregressions using quarterly data for almost 20 economies around the globe to determine how they respond to various exchange rate shocks. Given that exchange rate shocks have different real and financial implications I am also interested in determining the importance of these shocks for monetary conditions and the macroeconomy more generally.

The data reveal that all EME and AE experience periods with sharp and prolonged deviations in exchange rates away from some estimated trend or equilibrium value and that the real economy and financial assets are not immune to these fluctuations. Estimates from econometric models suggest considerable cross-country diversity in the response to an exchange rate shock. Equally important, almost none of the economies are immune to an exchange rate shock and neither the chosen exchange rate regime nor the adoption of a particular monetary policy strategy (e.g., inflation targeting) is associated with a particular set of responses to such a shock. An important caveat to the role of inflation targeting is that I am unable to isolate its effects with precision both because adoption dates differ considerably across the countries in the data and the data do not readily permit separate estimation for a sample when the targets were in place.

The rest of the paper is organized as follows. Following a review of the most relevant literature in the next section, section 3 describes the data and the methodology to investigate the main questions of interest. I provide evidence based on select individual country estimates based on a factor vector autoregressions (FAVAR). Unlike other work in this area the FAVARs explicitly allow for external real, financial, and monetary shocks to impact each economy considered. Finally, in view of concerns over the reliability of VAR models with modest sample spans some local projections are also estimated for

[8] That is, one that moves beyond simple purchasing power or interest rate parity relationships.

selected case studies. Section 4 describes the main econometric results while section 5 concludes and offers some policy implications.

2. Literature Review

The events of the past decade have led policy makers to devise strategies to prevent future financial crises, even if history suggests a less sanguine outcome. Many of course point to the ironic title of Reinhart and Rogoff's (2009) celebrated book. Nevertheless, this is a story that is well-known. Rodrick (1998), for example, noted almost two decades ago the inevitability of large swings in financial markets, that is, of boom-and-bust cycles, adding that appropriate economic policies can reduce their likelihood but not eliminate them (also, see Bordo and Jeanne (2002)).

The downplaying of the role of exchange rates began around the late 1990s and continued, until the international financial crisis of 2007-9, aided in no small part by growing evidence of a drop in pass-through effects (e.g., see Mihaljek and Klau (2008), Bussière, Delle Chiaie, and Peltonen (2013), Jašová et. al. (2016) for emerging markets; Bailliu and Fujii (2004), Vigfusson, Sheets, and Gagnon (2009) and Choudhri and Hakura (2015) for advanced economies). Since the GFC crisis, however, there has been a revival in interest in the impact of changes in exchange rates. As Shin (2016) notes: "Exchange rates are back in the news". This sentiment is also echoed in a recent speech by the vice-chair of the FOMC who notes: "[F]or small open economies, the exchange rate may well matter as much for output and inflation as do interest rates." (Fischer (2015))[9]

Contributing to this development in no small part is the recent admission by the Fed that "…the exchange rate channel may have played a particularly important role recently in transmitting economic and financial developments across national borders." (Brainard (2016)) The recognition that exchange

[9] The link between interest rates and exchange rates, of course, has a long history and the GFC does not appear to have dimmed the connection between these variables (e.g., see Hui et. al. 2016, Fong et. al. 2016). Nevertheless, it has proved hazardous for policy makers to combine the two as a way of illustrating, for example, how exchange rate and interest rate movements provide information about the tightening or loosening of the stance of monetary policy. This is reflected in the largely discarded attempt to define a monetary conditions index (e.g., see Siklos (2000), and references therein).

rate movements feed into investor behavior means that a risk-taking channel also exists and operates on a global scale (e.g., Avdjev and Takats (2016) and De Bock and Filho (2015)). Shin (2016) outlines this channel to explain how a depreciating US dollar leads to more lending in USD and, consequently, to looser credit conditions. This is particularly relevant for EME but the bottom line is that US monetary policy has a significant influence on global financial conditions. Not everyone shares this view. Bernanke (2015), for example, points out that changes in the Fed's monetary policy stance translated into exchange rate changes that somewhat blunted any spillovers. Needless to say, the subject of spillovers (and spillbacks) is the subject of a separate mushrooming literature that cannot be considered here (e.g., see Ammer et. al. (2016), Aizenman, Chinn, and Ito (2015)).

A crucial element in the latest debate is accounting for the impact of quantitative easing (QE) in the advanced economies where the crises of 2008-9 and 2010-11 originated. There are at least two strands in this literature. Several studies focus on high frequency reactions in interest rates or exchange rates to the various QE announcements that have been made. Of greater relevance to the present study are the macroeconomic effects of policies that resulted in considerable easing leading to ultra-loose monetary policies in many advanced economies. Their effects spilled over into EME but the size and persistence of the impact of QE on EME is a matter that is hotly debated in an emerging literature (see Lombardi, Siklos, and St. Amand (2017), and references therein).

Bhattari et. al. (2015) examine data for over a dozen EME and their monthly structural VARs with a Bayesian flavor suggest that QE has significant real and financial effects, as well as contributing to a depreciation of the USD. Indeed, the impact of QE is up to 4 times larger in the group of EME known as the fragile five (i.e., Brazil, India, Indonesia, Turkey, and South Africa).

Tillmann (2016), who also estimates a VAR and examines a slightly different set of EME, also finds that QE has significant effects on financial conditions. Nevertheless, since the precise form of the exchange rate regime adopted by various EME, and their institutional capacity, is rather heterogeneous, so is the impact of QE type shocks. This is precisely the conclusion reached by Bowman et. al. (2015) who rely on an identification scheme that exploits changing heteroscedasticity of financial time series at the time unconventional policies are introduced. Interestingly, they also

conclude that spillovers from US monetary policy are not unusually different since the GFC relative to an era when policy was more conventional.[10]

The so-called 'taper tantrum' of May 2013 is an especially important event and, according to the results of Ahmed et. al. (2015), it appears that the vulnerability of EME to external shocks does appear to have changed since the GFC, thus contradicting the Bowman et. al. (2015) findings. Nevertheless, the most important indicator of vulnerability in EME is exchange rate depreciation. Indeed, Glick and Leduc (2015) report that while a surprise easing of policy in the US has always led to a depreciation of the USD the size of the depreciation for a given US monetary policy shocks is three times larger since the GFC. It has long been known that large depreciations can have important economic effects in EME (e.g., Frankel and Rose (1996)) but it is not clear that the GFC has changed the magnitude or duration of large exchange rate movements (De Gregorio (2016)).[11]

The USD is not the only contributor to this phenomenon. Any 'global' currency has the potential of influencing global financial conditions though, of course, the USD, followed by the euro and the Japanese yen, are likely the currencies that contribute most to enhancing the influence of the exchange rate (e.g., see Avdjiev and Takats (2016)). Beyond any link between exchange rate movements and financial conditions, fluctuations in the former are also seen as having large real economic effect, that is, they significantly impact output and prices (e.g., see Forbes et.al. (2015)). Kearns and Patel (2016) is a unique example of a study that explores the balance between the trade and financial effects of USD exchange rate fluctuations. They conclude that the risk-taking channel, whose impact is estimated based on debt-weighted as opposed to the usual trade-weighted exchange rates, can indeed offset the trade channel, particularly in EME. Nevertheless, an issue that is often subsumed in studies of the kind discussed so far is the possibility that the duration of swings in exchange rates, including the USD, is the proximate reason for the balance of changes in macroeconomic conditions (e.g., see International Monetary Fund (2015)).

Obstfeld et. al. (2017) also revisit the role of the exchange rate, and financial conditions by using a

[10] Except for Brazil and Singapore.

[11] What may also matter is the duration of the depreciation since there are likely different macroeconomic consequences from temporary versus permanent changes in exchange rates.

VIX-like proxy (the VXO index which predates the VIX), and estimate a variety of panel regressions. They conclude that exchange rate regimes matter with fixed variety exchange rate regimes relatively more sensitive to financial type shocks.

If exchange rate movements matter in both real and financial terms then so does the choice of the exchange rate regime. Mody (2004), for example, noted over a decade ago that several emerging market economies chose to adopt more flexible exchange rate regimes, coupled with institutions that would ensure greater credibility of their macroeconomic policy strategies. This approach fits nicely with views held in advanced economies, and reiterated by several central bankers, such as Carney (2008), who argued that "[O]ur floating exchange rate helps to achieve the appropriate adjustments without forcing very difficult changes in the overall level of wages, output, and prices." Ilzetzski, Reinhart, and Rogoff (2017) reprise and update their widely used exchange rate indicator and conclude that the USD remains the dominant anchor currency and that exchange rates are less flexible than many believe. Of course, one may quibble with the somewhat *ad hoc* index of exchange rate flexibility. Nevertheless, if *de facto* exchange rate regimes are less flexible than we thought then it is also possible that the exchange rate channel has greater scope for real, monetary, and financial effects.[12]

Bernanke (2015) has also pointed to the exchange rate as shock absorber to downplay the impact of global spillovers from the Fed's policies since 2008. The impression that floating regimes buy domestic macroeconomic flexibility continues to be expressed even after the GFC (e.g., see ECB 2015, Shambaugh (2015)) no doubt partly reinforced, at least as far as Asian economies are concerned, by the conclusion that exchange rate regime management was significantly to blame for the Asia Financial Crisis (AFC) of 1998 (e.g., Goldstein (1999)).

There have long been doubts about the commitment to exchange rate flexibility in emerging markets as reflected in the 'fear of floating' phenomenon (Calvo and Reinhart (2002)). More recently, it is the growing importance of China, in Asia especially but also globally, that has received attention

[12] Frankel (2017) reminds us that various attempts are labelling exchange rate regimes produces indicators that are substantially in disagreement with each other. As a result, he suggests that it is preferable to think of policy makers as trading off exchange rate flexibility against their desire to hold foreign exchange rate reserves.

concerning the behavior of exchange rates in that region and its consequences for macroeconomic outcomes (e.g., see Dizoli et. al. (2016)). The results, for example, reported by Kluyev and Dao (2016), and Caporale et. al. (2016), suggest that the pure float often associated with the desire to rely on the exchange rate as a shock absorber does not describe movements in this variable at least in the ASEAN region.[13]

China's emergence as a global economic power also raises the question whether its currency, the renminbi (RMB), has reached the status of a global currency and, as such, plays a dominant role, most notably, in Asia. Opinion is divided at this early juncture with some suggestive evidence in favor of this view (e.g., Girardin (2011), Kessler and Subramanian (2012), Fratzscher and Mehl (2014), Caporale et. al. (2016), Klujev and Dao (2016)).

Two other features of the global economic environment since 2007 also deserve mentioning. A distinct relationship between commodity price and exchange rate movements has been rediscovered (e.g., Kolscheen et.al. (2016)) even though, at least in the case of oil prices, such a link has been known to exist for some time, especially in resource rich economies (e.g., see Amano and van Norden (1995) for Canada, and references therein). Moreover, commodity prices are also subject to boom-bust behavior (e.g., see Cheng and Xiong (2013)) further establishing a connection between these kinds of prices and exchange rates. Next, financial conditions, particularly of the global variety, create boom and bust cycles in asset prices. Hence, since exchange rate movements can display these characteristics, they also have a role to play in financial cycles (e.g., see Alessi and Detken (2009), Claessens et. al. (2012), and Borio (2014)).

Overall, the literature, insofar as it considers the role of exchange rate movements for EME, has not extensively considered the extent to which global factors, especially of the financial variety, have become more important over time. Clearly, even if domestic fundamentals and institutions are resilient and capable of absorbing external shocks the growing sensitivity to such shocks does potentially call into question whether sovereign nations have the necessary tools to deal with them.

[13] The ASEAN is the Association of Southeast Asian Nations.

3. Data and Methodology

Data used in the estimated models described below are sampled at the quarterly frequency. The sample begins in 1989Q1 and ends in 2016Q1 before any transformation or differencing is applied. Two main sources of data are employed. They are: *International Financial Statistics* (IFS) CD-ROM from the International Monetary Fund, and the Bank for International Settlements (August and October 2016 editions). The latter is the source for exchange rate and financial asset price data while the IMF data source provides the bulk of real and monetary variables. A few other data sources were used to fill some gaps (see the appendix). For several EME, the samples are shorter for a number of reasons. First, there is often a considerable delay in reporting key economic series in the IFS (e.g., real GDP and price data). Second, the availability of several financial and monetary series, for example, does not always stretch back to 1989. Finally, in at least two cases (viz., Argentina, and Brazil), it was deemed preferable to exclude certain extraordinary economic periods when either macroeconomic or financial data exhibit massive variations that would render econometric estimation difficult.[14]

Table 1 lists the economies under consideration. A total of 13 EME and 6 AE are considered. The AE are included in the analysis to provide some contrast with the results for the EME. Since any debate over the future of exchange rate policies must involve not only EME but also AE it was thought useful to provide broader evidence on the impact of exchange rates on economic conditions. The time series used in the empirical analysis are sub-divided into five groups of variables. They are: real economic variables (e.g., output), financial variables (e.g., credit), monetary policy (e.g., a policy interest rate), commodity prices (e.g., oil), and the exchange rate.

To analyze the exchange rate channel I proceed in two steps. In a first stage I apply some univariate techniques to the exchange rate and key EME time series to identify boom-and-bust periods. They are: a threshold-based selection method and a turning point based procedure. The threshold

[14] For Argentina and Brazil the hyperinflation episodes of the 1980s and early 1990s are excluded.

technique is one that has been widely employed in the related literature to identify periods when certain series experience prolonged departures from normal or equilibrium conditions (e.g., see Filardo and Siklos (2016), and references therein). Hence, deviations in some variable of interest (e.g., here the exchange rate) from some trend (see below) that exceed, say, 2% or 3% are seen as excessive and, if they persist, they are deemed to be prolonged. Next, if these episodes are found to overlap with declines in economic activity (e.g., a recession or when there are two consecutive quarters of negative economic growth or negative growth that again exceeds a 2% or 3% threshold), the result is a 'painful' economic period. Alternatively, one can identify turning points in economic activity and ask whether or not these take place simultaneously with large exchange rate movements. Turning point identification is typically based on the Pagan and Harding (2002) technique.[15] Once dates are identified these serve to develop some stylized facts prior to the estimation of an econometric model.

An important consideration is how the deviations from fundamentals or trend are determined. For output or the (real) exchange rate I use the filter recently recommended by Hamilton (2017) as an improvement over the better known and more widely used H-P filter. Alternatively, one can simply use rates of change (e.g., real GDP growth). The same applies to the exchange rate variable. Alternatively, one can use some moving average or deviations thereof. In what follows I adopt a 12 quarters moving average (i.e., 3 years) as this seems suitable for capturing the evolution of trend or equilibrium conditions in many economic time series.

Since the exchange rate variable is central to the analysis some additional discussion is in order. At least three different exchange rate variables are available for analysis.[16] They are: the bilateral USD-domestic currency unit exchange rate, and the nominal and real effective exchange rates. It is well known that the behavior of the last two exchange rate indicators is similar in first log difference form. Indeed, the broad time series properties of the two are similar. I relegate to the Appendix a series of plots that visually supports this contention. Choosing between the bilateral and either the real or

[15] Their methodology is inspired by the so-called Bry-Boschan (1971) cycle dating method. Also, see Mendoza and Terrones (2008) for a variant on turning point detection.

[16] We do not consider the debt-weighted exchange rate series proposed by Kearns and Patel (2016).

nominal effective exchange rates need not be inconsequential.[17] As Hofmann, Shim and Shin (2016) point out the USD exchange rate has a strong (financial) symbolic role as many financial transactions, not to mention prices, are expressed in USD (also see Gopinath (2016)). Nevertheless, examining the weights used in constructing the nominal effective exchange rate (NEER) suggests not only a fairly sizeable decline in the relative importance of the USD over the sample used in this study (see the Appendix for the details) but, with the exception of Mexico, the weight of the US is modest. Therefore, it is unclear whether policy makers interested in the overall impact of exchange rates on their economies would want to focus on the USD exchange rate alone as the introduction of the euro and the rise of China ought also to play a role. Moreover, since intervention and other restrictions on bilateral exchange rate movements is prevalent among EME, not to mention the choice of exchange rate regimes (see below), the time series properties of bilateral USD exchange rates can be subject to large, albeit temporary, movements that make it difficult to use in models of the kind estimated here. Hence, all results below are based on the nominal effective exchange rate.[18]

Once some stylized facts are established I next move on to estimate an econometric model. The usual approach is to estimate a model relying on a few observable variables, such as real GDP growth, inflation, an exchange rate variable and a variable that captures the role of monetary policy (e.g., a policy interest rate). Instead, I estimate factor models where these are estimated via the method of principal components. This serves the dual purpose of recognizing the possibility that multiple economic variables are germane in describing real, monetary and financial factors while acknowledging that the curse of dimensionality plagues many attempts to estimate models of the kind investigated here. For example, in several EME, monetary policy relies on several instruments. Similarly, an evaluation of the real effects of exchange rate fluctuations might benefit from the recognition that policy makers care not only about output performance but how these interact with expectations and performance of the external sector of the economy (e.g., the current account),

[17] A Table in the Appendix shows the correlation between bilateral and various proxies used in this study derived from the nominal effective exchange rate. The simple correlations are very high with only the cases of China, Hong Kong and Singapore standing out from the rest.

[18] All models were also re-estimated using the USD bilateral exchange rate. While some of the conclusions discussed below are unchanged, not surprisingly, many other results do change. The evidence in Ilzetski, Reinhart, and Rogoff (2017) would suggest that existing weights used to construct effective exchange rates may provide a biased interpretation of the exchange rate channel. When re-estimating the FAVARs using bilateral USD exchange rates the overall conclusions drawn from the empirical results remain unchanged. Of course, country by country estimates do change (not shown).

particularly since EME are open economies. Finally, events of the past decade have reminded the profession that the financial sector can and does create frictions with monetary policy and the real economy. Hence, interest rates and credit, to give two examples, influence and are influenced by the exchange rate as well as the real and monetary variables in an economy.

Estimation of the three factors proceeds as follows. Suppose there are *N* series used to identify real, monetary, and financial factors. Table 2 lists the potential time series that are classified as belonging to each group. Note that not all series are available for all the economies considered. The appendix provides additional details while the Table identifies some of the series that may not be included in estimating the various factors for the economies listed in Table 1. Given the earlier discussion the selection of series in estimating each factor should be self-explanatory.[19]

We apply the method of principal components to estimate the number of factors. This, of course, represents nothing more than a linear combination of the series that are labeled as belonging to each one of the identified categories. The Kaiser-Guttman technique is used to identify the prospective number of principal components.[20] However, the final number of retained principal components is also selected based on each component's explanatory power. As is well known, the first component has the largest possible explanatory power and this declines with each additional principal component. When more than one principal component is retained a rotation[21] is applied such that the resulting vector consists of orthogonal components. The resulting factor scores are used as proxies for real, monetary and financial factors.

Finally, all the relevant observed and factor model generated series are combined into a vector autoregressive (VAR) type model.[22] The observed variable is a proxy for exchange rate movements as described above. Estimated factors from US data serve as exogenous variables, lagged one

[19] Because of the unbalanced nature of the data set (i.e, availability and coverage varies across economies) the potential length of factor scores can vary. Some sensitivity analysis was conducted wherein, for example, some series in Table 2 were omitted to obtain a longer sample. Generally, the empirical analysis was unaffected. Hence, all reported results below use the full available complement of data for each factor.

[20] Essentially this technique relies on retaining the principal components with eigenvalues that exceed 1.

[21] The Varimax approach is used to rotate the principal components.

[22] Or a VAR model that would consist of a block of AE could also be used to estimate 'global' shocks. It seems more practical to resort to US only data but, in principle, other variants could be considered.

quarter, in a VAR for each one of the AE and EME in the data set (see Table 1; except for the US). The result is a factor-augmented VAR (or FAVAR). In slightly more detail, model estimation proceeds as follows.

The factors are estimated for each economy separately according to

$$\mathbf{\Phi}^{i}_{j,t} = A(L)\mathbf{\Phi}^{i}_{j,t-1} + \mathbf{v}^{i}_{j,t} \quad (1)$$

where Φ, is the vector of real, monetary, and financial factors (scores) at time t extracted from data for each economy, and *j* are the economies listed in Table 2.

The estimated factor scores then serve as endogenous variables in the VAR where the exchange rate variable is an additional endogenous variable. Recall that this variable is estimated in several ways but the discussion below focuses on two forms. They are: deviations in the logarithm of the NEER either from a 12 quarters moving average or from the application of Hamilton's (2017) filter to the logarithm of the NEER. I can then write

$$\begin{bmatrix} \theta^{i}_{j,t} \\ \mathbf{\Phi}^{i}_{j,t} \end{bmatrix} = B(L)\begin{bmatrix} \theta^{i}_{j,t-1} \\ \mathbf{\Phi}^{i}_{j,t-1} \end{bmatrix} + \mathbf{X}^{US}_{t-1} + \boldsymbol{\kappa}_{t-1} + \mathbf{e}^{i}_{j,t} \quad (2)$$

where the factors have previously been defined, θ is the nominal effective exchange rate variable as defined above (i.e., in deviations from Hamilton's (2017) filter), **X** is the vector of US real, monetary and financial factors, presumed exogenous,and κ is either a commodity price indicator or the rate of change in world oil prices.[23] Equation (2) is a factor-augmented VAR or FAVAR model.[24]

[23] In the results reported below I ended up using the world price for energy from IFS. However, the first principal component of a large number of commodity prices (obtained once again from IFS) was also used with similar results.

[24] In the foregoing expressions we exclude other exogenous influences (e.g., the period of the global financial crisis). These can easily be added without jeopardizing the thrust of the discussion so far.

Notice that the exchange rate variable is listed first in the VAR. Since a Choleski decomposition is employed and impulse responses can be sensitive to the ordering of the variables some additional discussion is warranted. It is often the case that an exchange rate variable is last in many standard VARs. The argument is that the exchange rate then responds immediately to all shocks in the system while an exchange rate shock can affect the other variables with a lag. This is sometimes justified by stating that, in doing so, any potential remaining endogeneity is minimized. However, the typical VAR usually often includes the rate of change in the (bilateral) USD exchange rate and not, as in the present study, deviations from some trend or estimated equilibrium value. It is not clear why the exchange rate should only affect all the other variables with a lag especially since, for example, the real factor includes forward looking variables (i.e., one year ahead inflation and real GDP growth forecasts) and exchange rates are also subject to feedback effects (e.g., Plantin and Shin (2016)). Moreover, since the remaining endogenous variables are themselves composites of various real, monetary and financial variables it is not obvious that an exchange rate variable, also a composite indicator, should be viewed as responding immediately to all other shocks in the system.[25] In any case, results presented in the following section also consider the more traditional ordering where, in equation (2), θ is ordered last in the FAVAR.

Finally, since any estimated model is an approximation Jordà (2005) proposes estimating impulse response by local projections instead of extrapolating at increasingly distant horizons as in standard VAR estimation. I also apply this approach to select cases as a further test of the sensitivity of the basic FAVAR results.[26]

The foregoing estimation strategy is consistent with Obstfeld and Rogoff's (2000) call for specifying broader models to address outstanding puzzles in this area. Equally important, the strategy explicitly recognizes global economic interdependence and permits us to estimate the impact of exchange rate fluctuations in a variety of economies where international spillovers (here proxied by US spillovers)

[25] As is clear the estimated impact of exchange rate shocks considered here are not, strictly speaking, of the structural variety.

[26] The local projections rely on the same VARs as the ones discussed in the following section, using the same lags. It is argued that local projections are more robust to misspecifications.

are also accounted for.[27] Hence, this provides policy makers with a clearer understanding of the economic effects of large and persistent exchange rate fluctuations.

4. Empirical Results

4.1 A Few Stylized Facts

I begin with a series of stylized facts to describe the links between exchange rate movements and their potential economic consequences. Figure 1 shows the contrast between movements in the exchange rates, proxied here by deviations in the logarithm of the NEER from Hamilton's (2017) filter, and Reinhart and Rogoff's (2004) exchange rate regime classification. Only the US is excluded leaving 18 economies.[28] There is little connection between exchange rate regime choice and the behavior of the NEER. Two notable illustrations include Hong Kong (first plot in the second row) and Singapore (third plot in the third row) and they demonstrate that, in spite of an unchanged *de facto* exchange rate regime there can still be considerable movement in the NEER. The same can be said of the experiences of Colombia, Mexico, and Chile. Similarly, greater flexibility in the NEER can be a prelude to more stable NEER movements (e.g., Argentina), as is a less flexible exchange rate regime (e.g., Russia). Assuming that overall exchange rate movements are better interpreted through an analysis of NEER there are few insights offered from some existing exchange rate classifications (also, see Frankel (2017)).

Figure 2 shows for all 19 economies in the sample (see Table 1) the three proxies for θ, namely the series labeled MA1 which are deviations from a 12 quarters moving average of the logarithm of the NEER, MA2 where deviations are relative to Hamilton's (2016) filter, while MA3 is the simple 12

[27] Although our model(s) estimates US spillover effects I do not present the results as this is outside the scope of the present study. In a nutshell, US spillovers are found to be sizeable and present in all EME and AE in the data set.

[28] Results are comparable when deviations from a moving average are used (not shown). Overall conclusions are also similar when the USD bilateral exchange rate is used. The plot is relegated to the Appendix. The Reinhart and Rogoff 'coarse' index is used and the data end in 2010. At the time of writing the updated index (to 2015) reported in Ilzetzski, Reinhart, and Rogoff (2017) was unavailable.

quarters moving average of the rate of change in the NEER. It is obvious that each proxy can visually produce different time series properties. Nevertheless, both the MA1 and MA2 show clear indications that large and persistent deviations in exchange rate movements are a fact of life in many economies. Some events appear to clearly be the culprit for some of the large departures. For example, the impact of the Asian Financial Crisis (AFC) of 1997-98 is evident from the data for Hong Kong, Indonesia, Malaysia, the Philippines, and Thailand. Nevertheless, the AFC's impact dwarfs other economic events only for Indonesia and Thailand but not the other economies in the region directly impacted by this event. Similarly, the GFC of 2008-9 shows up in the behaviour of the NEER for Chile, Korea, South Africa, and the United Kingdom, but this crisis does not appear to dominate exchange rate movements in many other economies. However, it is plausible that the Eurozone sovereign debt crisis of 2010-11 has a noticeable impact on the NEER for several economies including, of course, the Eurozone, Brazil, Chile, Colombia, the U.K., and South Africa. Notice also that the behaviour of the NEER proxy suggests that it is unclear that the exchange rate responds immediately to all shocks as the events mentioned above appear to be prolonged. Hence, it is far from obvious that exchange rate shocks would affect other economic variables with a lag as is assumed in many standard VAR specifications that rely on observable economic time series.

Tables 3 and 4 consider the joint occurrence of disorderly exchange rate movements with painful business cycle episodes. Disorderly exchange rate movements take place when a proxy for exchange rates (i.e., either MA1, MA2, MA3) exceeds the 2% or 3% threshold. Similarly, a 'painful' economic growth episode takes place when there are two or more consecutive quarters of negative real GDP growth rates that exceed 2% or 3%. Table 3 shows the fraction of the sample when both events jointly take place and the count (i.e., number of quarters). Obviously, the higher threshold reduces both the fraction of the time and count of joint occurrences. Nevertheless, what is striking is the diversity of experiences ranging from zero such episodes for China to a high of over 20% for Argentina. Nor is it the case that EME are more prone to such joint occurrences since Japan's experience is worse than most other economies except Argentina. Although the picture changes somewhat when the 3% threshold is used it remains the case that EME are not more prone to disorderly NEER movements together with painful business cycle movements. Table 4 repeats the same exercise except that the

Bry-Boschan turning points criteria are used. Using this metric there are now greater indications that there is a possible link between turning points in exchange rate movements and business cycle activity.

4.2 Impulse Response Functions

Next, I turn to the FAVAR estimation results. As noted previously, estimation of equation (2) is preceded by the estimation of the factor scores from equation (1). Table 5 displays the number of principal components used in the FAVAR for each economy. Also shown is the proportion of the variation explained by the most important principal components. In about half of the economies in the data set two principal components are retained for the real factor. In the case of the monetary and financial factors usually one principal component suffices.[29] Turning to the interpretation of the principal components the factor loadings (not shown) suggest that if the first real factor captures aggregate demand the second factor captures global economic factors (see below). In the few cases where two principal components for the monetary variables are found the first largely captures the use of the policy rate as the main instrument of policy while the second one is seen as reflecting exchange rate influences on the stance of monetary policy. In the few cases where two components are retained the second likely represents a concern for the exchange rate as an additional instrument of policy or, in the case of the US, the resort to unconventional monetary policy. Finally, the first principal component represents overall financial conditions.[30] The second principal component likely reflects a concern for financial stability (e.g., the US). In the case of the financial factor these are inverted in the sense that a fall in the factor scores reflects greater stress on the financial system while looser conditions lead to higher scores.

Figure 3 illustrates the estimation of principal components in a selection of cases. The Figures plot the real, monetary, and financial factors for Hong Kong, China, the US, Brazil and Thailand. The real

[29] In particular, estimation of the monetary factor is not unlike the one used to estimate central bank policy rates (e.g., see Lombardi et. al. 2015)

[30] Indeed, a growing number of central banks publish financial conditions indexes that are often constructed via the application of a principal components analysis of the kind conducted here.

factor scores clearly pick up the impact of the AFC on Hong Kong and Thailand while the GFC is also seen to produce a large downturn for all economies shown with the possible exception of Brazil. For China we can observe why the second principal component captures global financial conditions. While in appearance in synch with aggregate demand conditions[31] the two do not always operate in parallel with, for example, an improvement in domestic aggregate demand in 2009-2010 showing up very clearly as the Chinese government intervenes with a large fiscal stimulus to counter some of the effects from the GFC. The monetary factors also appear to capture tightening and loosening phases in monetary policy including the rapid loosening of monetary policy, most notably in the US, around the time of the GFC. Finally, financial conditions appear more volatile on the whole than monetary conditions as might be expected since central banks tend to be more cautious in permitting changes in the stance of monetary policy.

I now turn to the FAVAR and other companion VAR-type estimates. Given the large number of results it is impractical to present all of them. Accordingly, the results are discussed in two parts. Tables 6 and 7 summarize the response of real, monetary and financial variables to a one standard deviation shock in two of the three proxies for exchange rate movements. As discussed earlier, the placement of the exchange rate variable in a VAR is subject to different interpretations. Accordingly, the two polar cases discussed are considered, namely placing the exchange rate variable first (Table 6) or last (Table 7) as in several empirical studies where the exchange rate channel is not the primary concern, are shown. Figure 4 provides select examples of impulse responses.

The definition of the nominal effective exchange rate is such that a rise signals an appreciation while a decline implies a depreciation. Four general impressions emerge from the results in Table 6. First, it is clear that responses to an exchange rate shock are diverse and there is obvious distinction to be made between responses in AE compared with those in EME. Second, there is some sensitivity of the results to how the exchange rate variable is defined.[32] In view of the earlier discussion about the construction of these proxies (see Figure 2) this is not surprising. Unfortunately, economic theory does not provide guidance about the best way of measuring departures from trend or equilibrium

[31] As noted previously, the components are rotated before scores are extracted.

[32] Except for Thailand and Singapore where the results are the same whether one relies on the MA1 and MA2 proxies.

values. Third, with the exception of Thailand and Singapore, no economy is immune to exchange rate shocks. Finally, we do not find that inflation targeting (IT) economies stand out when it comes to immunity from exchange rate shocks.[33] Since IT economies differ considerably across a variety of dimensions (e.g., see Siklos (2008)) this also should come as no surprise.

Turning to some of the individual responses we might have concluded that a NEER appreciation would worsen the domestic real economy via the trade response. However, this response is contradicted in a couple of instances for the MA1 proxy and more frequently when the MA2 proxy is considered. However, an appreciation, if it signals lower future inflation, can imply stronger economic activity. Similarly, a NEER appreciation ought to translate into a loosening of monetary and financial conditions but this also ignores the role played by a stronger balance sheet and higher financial asset prices that would result in tighter monetary policy and financial conditions. Once again the results in Table 6 demonstrate that 'one size does not fit all'. Finally, when the exchange rate variable is placed last in the VAR the summary of results suggest far greater immunity from exchange rate shocks than in the case shown in Table 6. And if one is looking for a result consistent with the standard view than an appreciation implies a contraction in real economic activity then the results when MA1 is the exchange rate proxy supports this interpretation. In addition to Thailand and Singapore one can now add Colombia, Japan, and Hong Kong to the list of economies completely immune to an exchange rate shock regardless of how the exchange rate variable is measured. Overall, the results in Table 6 appear plausible.

Figure 4 displays select impulse responses based on the FAVAR in equation (2). Five different illustrations are provided. In several cases a NEER appreciation does indeed lead to a reduction in real activity, a tightening of monetary policy and looser financial conditions. The latter result is obtained because the appreciation strengthens balance sheets. In all cases, however, the impact of any exchange rate shock is temporary.

[33] The IT economies in the sample are: BRA, COL, GBR, IDN, KOR, MEX, PHI, THA, TUR, and ZAF. However, it should be added that this strategy was adopted sometime after the sample begins. See Siklos (2008).

4.3 A Few Case Studies: Local Projections

Figures 5 and 6 provide further evidence of the response to an exchange rate shock. Using local projections three separate panels are estimated. The first one differs from the previous cases considered by investigating the impact of a shock in the bilateral exchange rate between Hong Kong and China (the HKG-CNH exchange rate). Perhaps unsurprisingly, a depreciation of the HKG dollar vis-à-vis the Chinese renminbi boosts the Hong Kong economy. However, the interdependence between these two economies goes deeper. Changes in monetary conditions in Hong Kong have real economic effects in China. A tightening of Chinese monetary policy is seen as leading to looser monetary policy conditions in Hong Kong as well as a tightening of financial conditions in China. Finally, improving real conditions in Hong Kong produce looser monetary policy in China whereas tighter financial conditions in Hong Kong have an offsetting effect in China.

Parts (b) and (c) of Figure 5 report that the local projections estimated for two separate panels, namely Brazil and the US, and China and the US, confirm some of the results in Table 6. A NEER appreciation leads to a loosening of monetary conditions in Brazil and a negative real effect in China.

5. Conclusions

This study assesses, from a global perspective, whether the influence of exchange rate shocks implies certain policy recommendations for EME, in particular, such as seeking out greater international cooperation on exchange rate regime selection. From the regional perspective economies in Asia have long grappled with the consequences of living under a dollar standard and, more recently, the rising importance of the renminbi.

Both the stylized and the econometric evidence in this study support Frankel's (1999) conclusion reached almost twenty years ago, in spite of the global financial crisis. Therefore, one size fits all does not apply to how different economies react to exchange rate shocks. Complicating matters further is

that Frankel's survey did not make a distinction between real and financial responses to exchange rate fluctuations. While an appreciation does, under normal circumstances, lead to a real contraction the resulting change in financial conditions can actually boost domestic real economic activity. Hence, exchange rate effects operate in ways that are not as predictable as they were once thought to be. Indeed, after examining the response to an exchange rate shock in 13 emerging market and 6 advanced economies the only result that is found to hold across almost every economy examined is that very few economies are likely to be entirely immune in the face of this kind of shock. The only other general result is that, with two notable exceptions (viz., Indonesia and Korea), an exchange rate shock usually has real or monetary or financial effects on the domestic economy but never are all three factors affected.

Almost five decades ago a former US Treasury Secretary, John Connally, warned other countries by stating that "[T]he dollar is our currency but its your problem". The estimates in this paper confirm that this dictum continues to hold in spite of the events of the past decade. The introduction and rise of other major currencies, namely the euro and the renminbi, only serves to add to the number of currencies that can create 'problems'. More importantly, they also suggest that monetary policy regimes such as inflation targeting and the choice of exchange rate regimes cannot on their own render an economy immune to exchange rate shocks.

To the extent that greater international cooperation can help, the empirical findings of this paper suggest that it should be sought not to prescribe a particular exchange rate regime. The results may point in the direction of supporting the long held views of several policy makers (and former central bankers; e.g., see Bernanke 2015) that keeping one's house in order is the best protection against the effects of exchange rate fluctuations. Countries should, therefore, adopt policies that ensure this outcome instead of seeking common goals that are unlikely to be suitable for all economies.

Nevertheless, as a cautionary note, there are a number of extensions that can be considered in future research before reaching a definitive conclusion. First, levels of monetary and financial maturity vary across countries. As a result, more testing of the factor models used to extract the real, monetary and financial conditions that enter into the estimated models of this study would be welcome. Second, the

impact of the Asian and Global financial crises was only taken into account indirectly. In particular, estimating separate pre and post GFC models might provide a clearer picture of cross-country differences in the response to an exchange rate shock. Third, the exchange rate proxy variables in this study, which seek to identify large and persistent movements in the exchange rate away from the some trend or equilibrium value, appear to behave in an asymmetric fashion. The implications of the asymmetry need to be explored further. Finally, the consequences of using bilateral versus effective exchange rate measures also needs to be examined in greater detail. In particular, it may be enlightening to include bilateral and effective exchange rate indicators simultaneously in some fashion. All of these extensions are left for future research.

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Table 1 Sample of Economies Included in the Data Set

Emerging Market Economies	Advanced Economies
1. Argentina: ARG	1.Eurozone: EUR
2. Brazil: BRA	2.Great Britain: GBR
3. Chile: CHL	3.Hong Kong: HKG
4. China: CHN	4.Japan: JPN
5. Colombia: COL	5.Korea: KOR
6. Indonesia: IDN	6.United States: USA
7. Mexico: MEX	
8. Malaysia: MYS	
9. Philippines: PHI	
10. Russia: RUS	
11. Thailand: THA	
12. Turkey: TUR	
13. South Africa: ZAF	

Table 2 Series Used in the Construction of Real Monetary and Financial Factors

Real	Monetary	Financial
Real GDP growth	Policy Interest Rate§	Credit/GDP
Real GDP Growth Forecast§	Central Bank Assets/GDP§	Short-term market interest rate(s)
Inflation	Foreign Exchange Reserves	Long-term interest rate§
Inflation Forecast§	Reserve requirement§§	Private Sector Non-Financial Assets/GDP§
Current Account Balance/GDP		Stock Index Return
		Property Prices§

Note: § data not available for all economies. See the Appendix for details. §§ for China only.

Table 3 Joint Episodes of Disorderly Exchange Rate and Painful Growth Episodes

Economy	**Painful: 2% Threshold** (% OF SAMPLE; [COUNT])	**Painful: 3% Threshold** (% OF SAMPLE; [COUNT])
ARG	20.72 [23]	9.01 [10]
BRA	8.11 [9]	3.60 [4]
CHL	5.41 [6]	1.80 [2]
CHN	0	0
COL	8.11 [9]	5.41 [6]
EUR	*9.01 [10]*	*1.80 [2]*
GBR	*9.91 [11]*	*2.70 [3]*
HKG	*7.21 [8]*	*5.41 [6]*
IDN	3.60 [4]	3.60 [4]
JPN	*16.22 [8]*	*4.50 [5]*
KOR	*4.50 [5]*	*2.70 [3]*
MEX	9.01 [10]	3.60 [4]
MYS	5.41 [6]	2.70 [4]
PHI	1.80 [2]	0
RUS	*11.71 [3]*	6.31 [7]
SGP	*6.31 [7]*	*3.60 [4]*
THA	9.01 [10]	6.31 [7]
TUR	10.81 [12]	6.31 [7]
USA	*5.41 [6]*	*2.70 [3]*
ZAF	13.51 [15]	1.80 [2]

Note: See Table 1 for codes that identify each economy. Advanced Economies in *italics.* The main body of the text provides the explanation for the calculations which involve 2 consecutive quarters of negative real GDP growth for the thresholds indicated and large movements in the nominal effective exchange rates.

Table 4 Joint Occurrences of Exchange Rate and Growth Cycles

Economy	P to T (log NEER)	T to P (real GDP growth)	Joint occurrence
ARG	43.75 [49]	30.36 [34]	6.25 [7]
BRA	28.57 [32]	20.54 [23]	2.68 [3]
CHL	47.32 [53]	22.32 [25]	16.96 [19]
CHN	27.68 [31]	19.64 [22]	4.46 [5]
COL	55.36 [62]	7.14 [8]	7.14 [8]
EUR	*34.82 [39]*	*11.61 [13]*	*7.14 [8]*
GBR	*55.36 [62]*	*10.71 [12]*	*8.93 [10]*
HKG	*42.86 [48]*	*16.96 [19]*	*4.46 [5]*
IDN	53.57 [60]	3.57 [4]	3.57 [4]
JPN	*37.50 [42]*	*29.46 [33]*	*13.39 [15]*
KOR	*24.11 [27]*	*5.36 [6]*	*5.36 [6]*
MEX	36.61 [41]	13.39 [15]	8.04 [9]
MYS	41.96 [47]	13.39 [15]	4.46 [5]
PHI	45.54 [51]	0	0
RUS	46.43 [52]	16.96 [19]	5.36 [5]
SGP	*33.93 [38]*	*13.39 [15]*	*8.93 [10]*
THA	36.61 [41]	25.89 [29]	10..71 [12]
TUR	25.00 [28]	17.86 [20]	2.68 [3]
USA	*20.54 [23]*	*9.82 [11]*	*4.46 [5]*
ZAF	50.89 [57]	3.57 [11]	1.79 [2]

Note: See Table 1 for codes that identify each economy and notes to Table 3. P= peak; T=Trough. Figures shown are in percent. In brackets the count (number of quarters). The Bry-Boschan technique is used to identify peaks and troughs in the nominal effective exchange rate and real GDP growth.

Table 5 Number of Estimated Factors: Real, Monetary, and Financial

Economy	Real	Monetary	Financial
ARG	2 (69,30)	1	1 (85)
BRA	1 (65)	1 (76)	1 (80)
CHL	2 (61,32)	2 (59,41)	1
CHN	2 (59,41)	1 (79)	1 (94)
COL	2 (66,34)	1	1 (89)
EUR	2 (66,34)	1	1
GBR	2 (63,37)	1	1 (84)
HKG	1 (77)	1 (83)	1
IDN	1 (75)	1 (71)	1 (76)
JPN	1	1	1 (67)
KOR	2 (77,23)	1	1 (74)
MEX	2 (55,45)	1	2 (57,43)
MYS	1 (73)	2 (61,39)	1 (64)
PHI	1 (90)	1	1
RUS	1 (72)	1	1 (93)
SGP	2 (66,34)	1	1 (79)
THA	1 (76)	1 (77)	2 (62, 38)
TUR	1	1 (70)	1 (86)
USA	1 (78)	2 (67,33)	2 (59, 29)
ZAF	1	2 (61,39)	2 (58,35)

Note: The number of factors used in the estimation is shown first with the proportion of the explained variation in parenthesis. The number of series used to estimate the factors is shown in Table 2. Note that not all series are available for all economies. See the main body of the text and the Appendix.

Table 6 Summary of FAVAR Estimates

	EXCHANGE RATE: DEVIATIONS FROM 3 YR MA			EXCHANGE RATE: DEVIATIONS FROM HAMILTON FILTER		
ECONOMY	REAL	MONETARY	FINANCIAL	REAL	MONETARY	FINANCIAL
ARG	-	0	-	+	0	+
BRA	0	+	+	0	-	-
CHL	+	-	0	0	0	0
CHN	-	+	0	-	0	0
COL	0	0	0	0	-	0
EUR	0	0	0	0	-	0
GBR	0	+	+	0	+	+
HKG	-	0	-	+	+	+
IDN	-	-	-	0	+	0
JPN	-	0	0	+	0	0
KOR	+	+	+	-	-	-
MEX	-	0	-	0	+	0
MYS	-	0	0	+	+	0
PHI	0	0	0	0	-	0
RUS	-	0	0	+	-	-
SGP	0	0	0	0	0	0
THA	0	0	0	0	0	0
TUR	0	-	+	0	+	-
ZAF	0	0	-	0	0	+

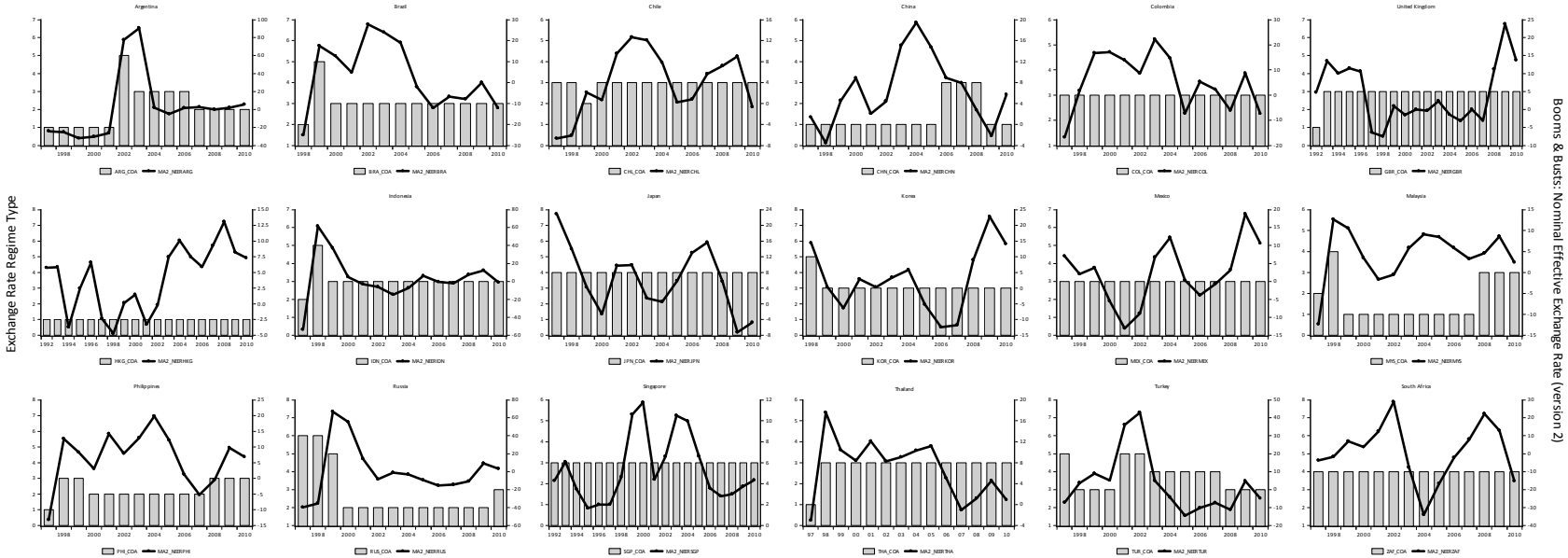
Note: +/- indicates the sign of the response of the three factors to a 1 standard deviation shock in the exchange rate proxy shown at the top of the table. A value different from zero is assigned whenever the estimated response is found to be significant for at least one period after the shock (up to 10 quarters were estimated) based on confidence intervals estimated via Monte Carlo (1000 replications). The proxies are defined in the main body of the text. The exchange rate proxy is the first endogenous series in the FAVAR.

Table 7 Summary of FAVAR Estimates (cont'd)

	EXCHANGE RATE: DEVIATIONS FROM 3 YR MA			EXCHANGE RATE: DEVIATIONS FROM HAMILTON FILTER		
ECONOMY	REAL	MONETARY	FINANCIAL	REAL	MONETARY	FINANCIAL
ARG	-	0	+	+	0	+
BRA	0	0	+	0	0	-
CHL	0	0	0	-	-	0
CHN	-	+	+	-	0	0
COL	0	0	0	0	0	0
EUR	0	0	0	0	0	+
GBR	-	-	-	0	0	0
HKG	0	0	0	0	0	0
IDN	-	0	0	+	+	0
JPN	0	0	0	0	0	0
KOR	0	0	0	-	0	0
MEX	-	+	0	0	0	-
MYS	0	0	0	0	0	0
PHI	0	0	0	0	-	0
RUS	-	0	+	+	0	-
SGP	0	0	0	0	0	0
THA	0	0	0	0	0	0
TUR	0	+	+	0	0	-
ZAF	0	0	0	0	0	+

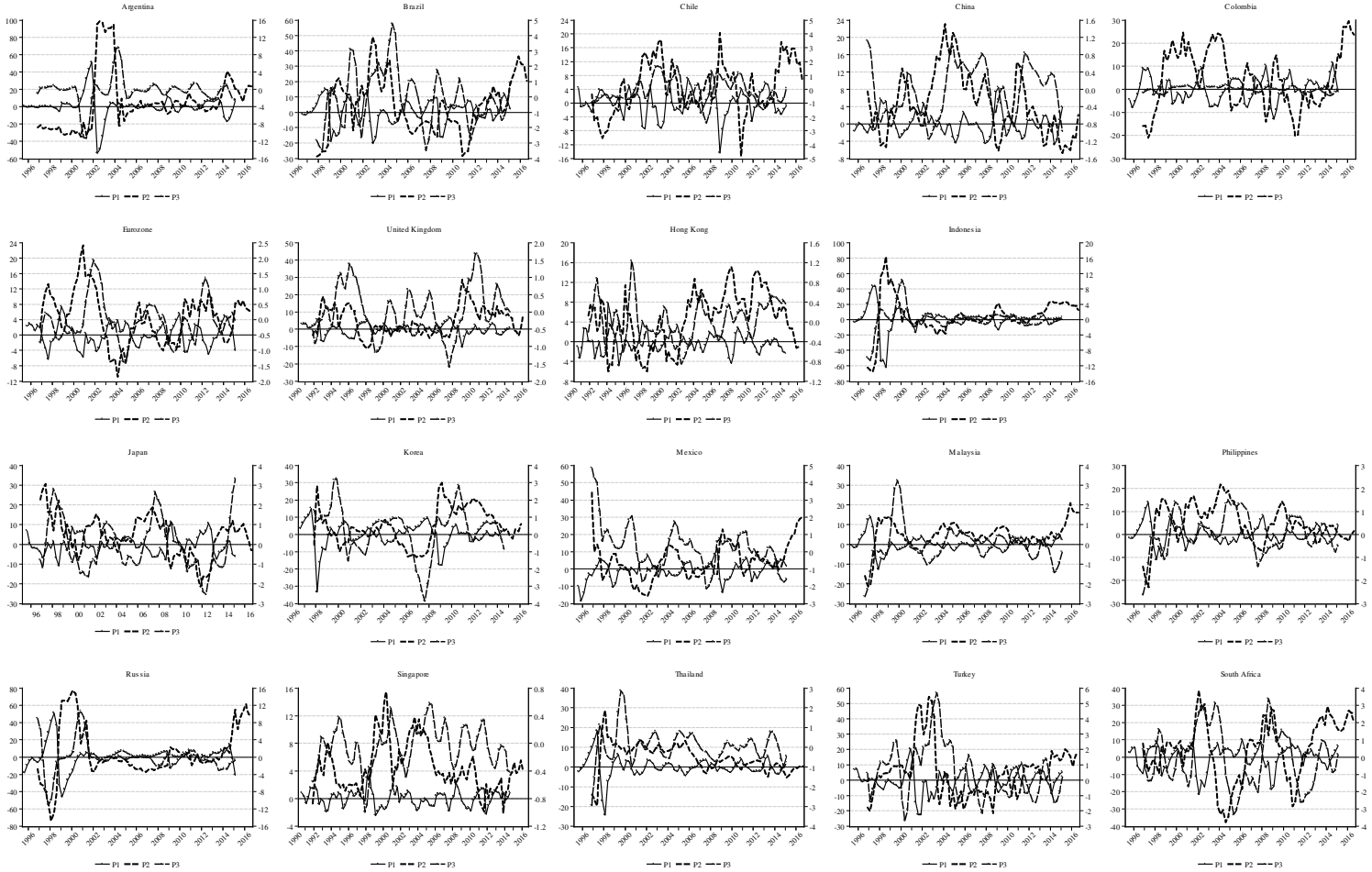
Note: See note to Table 6. The exchange rate variable is ordered last in the FAVAR.

Figure 1 Exchange Rate Movements and Exchange Rate Regimes



Note: MA2_NEER* is the exchange rate proxy used in estimation derived from deviations from a Hamilton (2016) filter applied to the log of the nominal effective exchange rate (NEER) in economy *. It is plotted on the right hand side axis. The left hand side axis plot as bars the so-called 'coarse' Reinhart and Rogoff (2004) exchange rate regime indicator which ranges from 1 to 15. 4 is a de facto peg while 13 is a freely floating exchange rate.

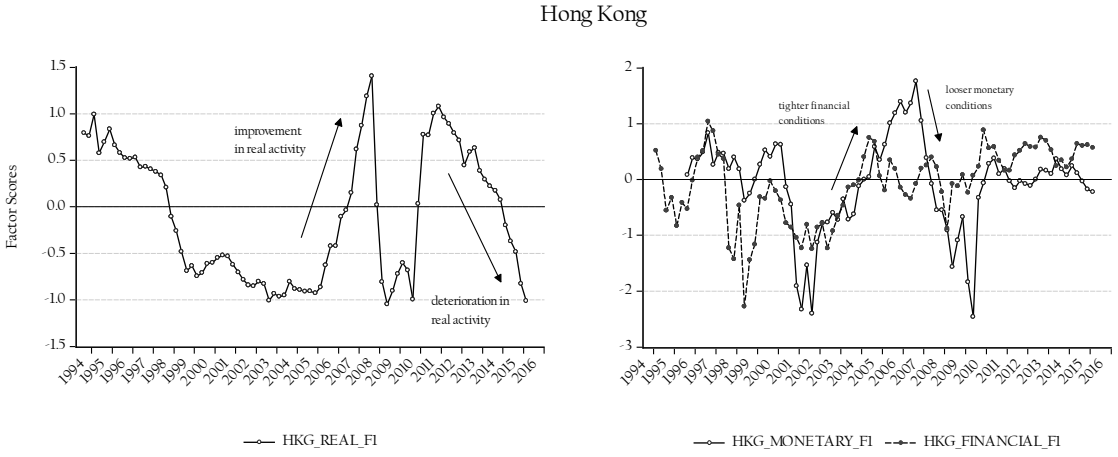
Figure 2 Exchange Rate Indicators



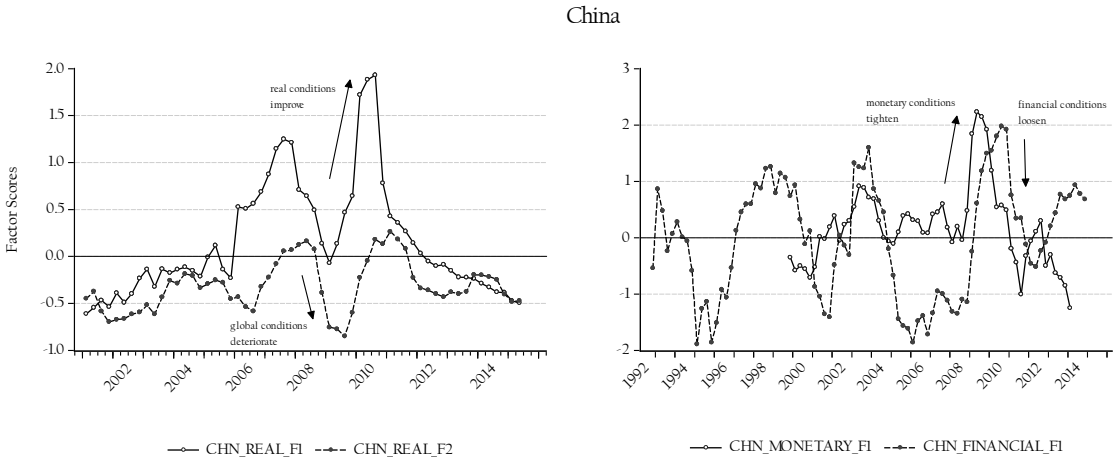
Note: The three exchange rate indicators are P1 (deviation in the log of the nominal effective exchange rate from 12 quarter moving average; MA1), P2 (deviation from a Hamilton trend in the logarithm; MA2), and P3 (12 quarter moving average in the first log difference in the nominal effective exchange rate.

Figure 3 Select Factor Estimates

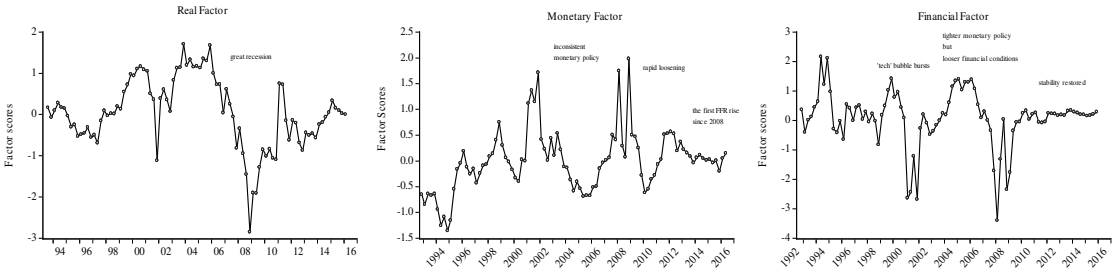
(a) Hong Kong



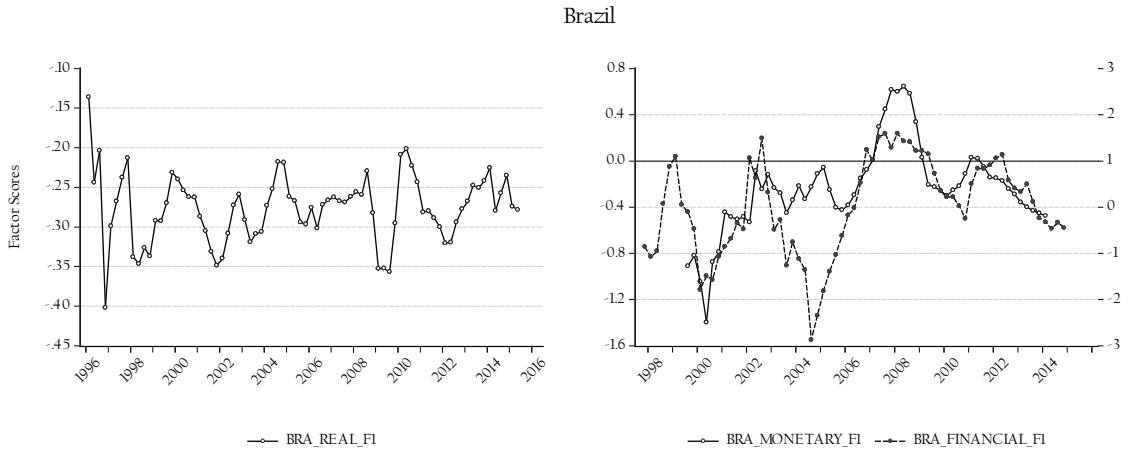
(b) China



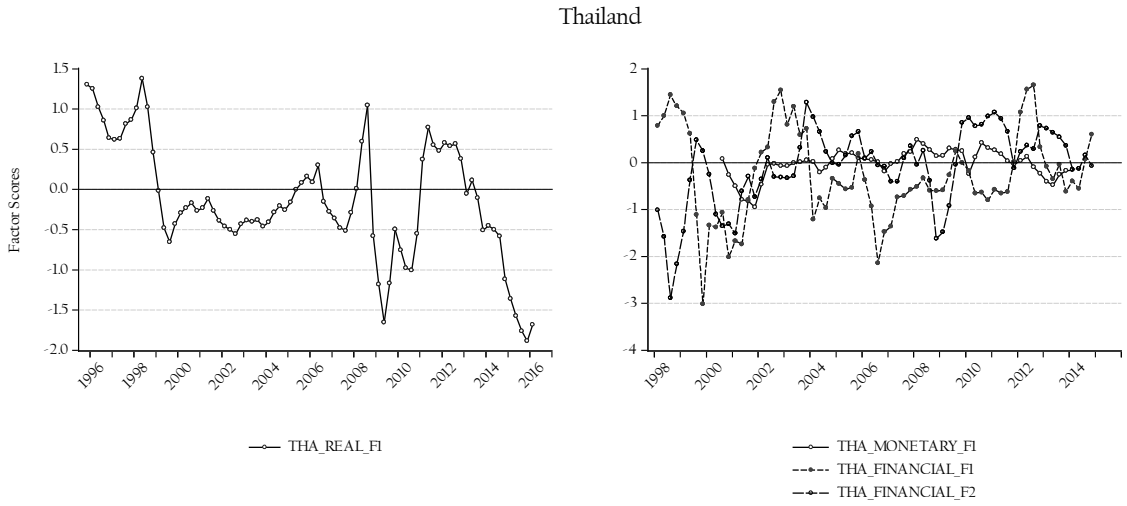
(c) United States



(d) Brazil



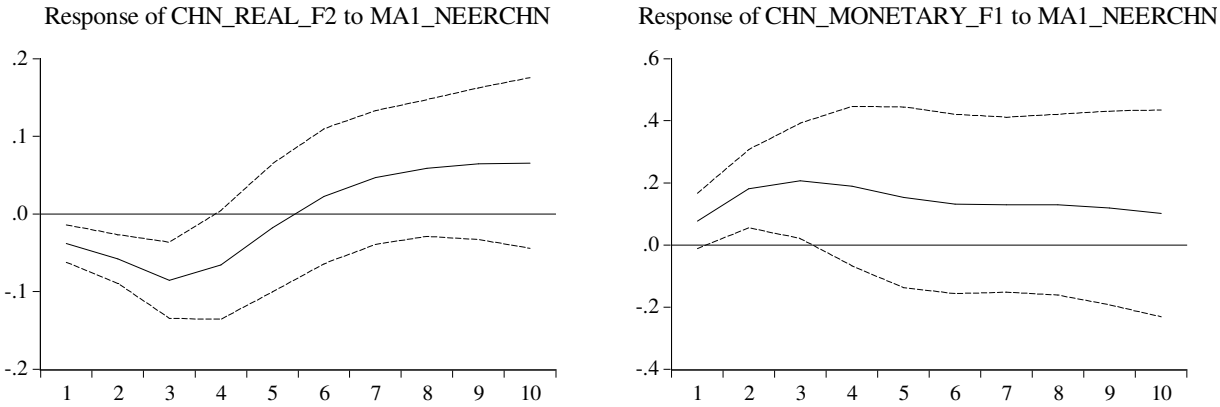
(e) Thailand



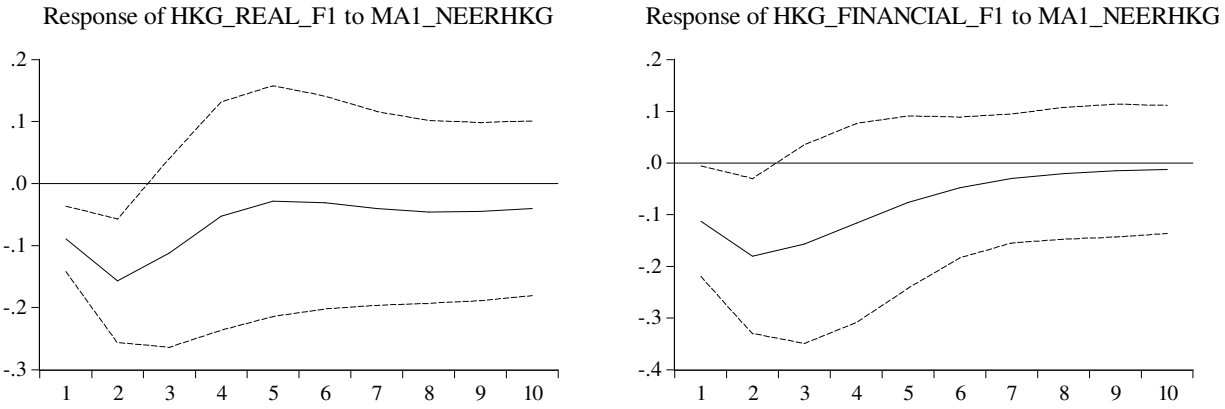
Note: Principal components estimated as detailed in the main body of the text. Number of factors estimated via Kaiser-Gutman method. When more than one factor estimated they are rotated via the Varimax method prior to obtaining the scores. The factors are labelled REAL, MONETARY, and FINANCIAL as explained in the text. F1, and F2 refer to the first and second principal components, where relevant. The first three letters refer to the country codes.

Figure 4 Selected Impulse Response Functions

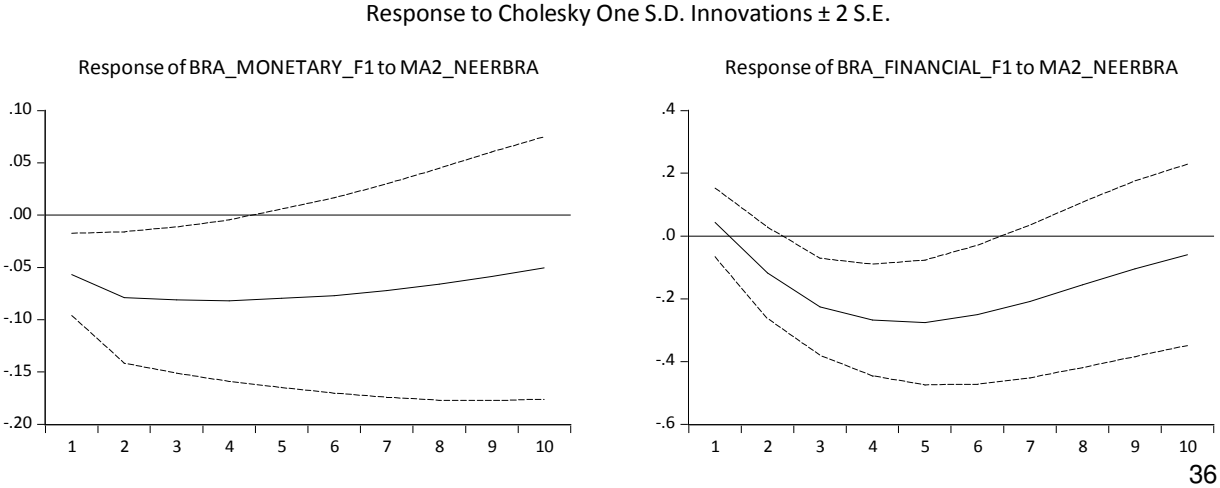
(a) China



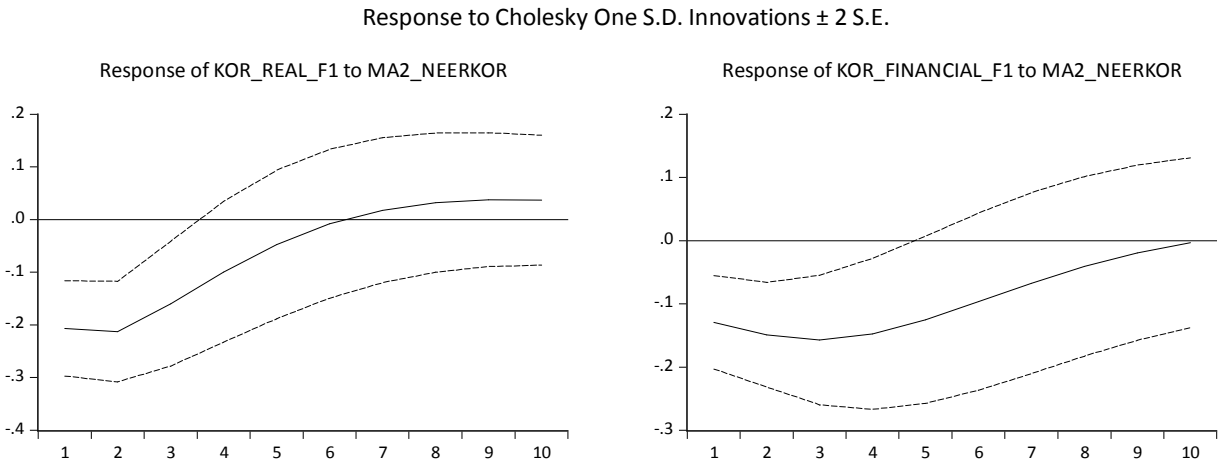
(b) Hong Kong



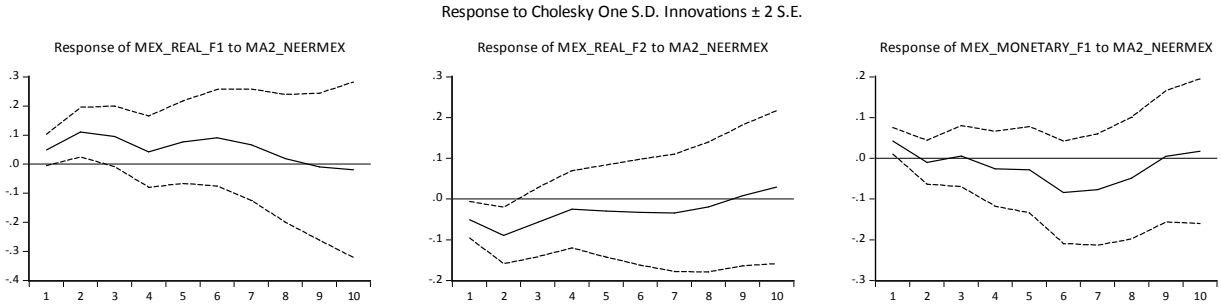
(c) Brazil



(d) Korea



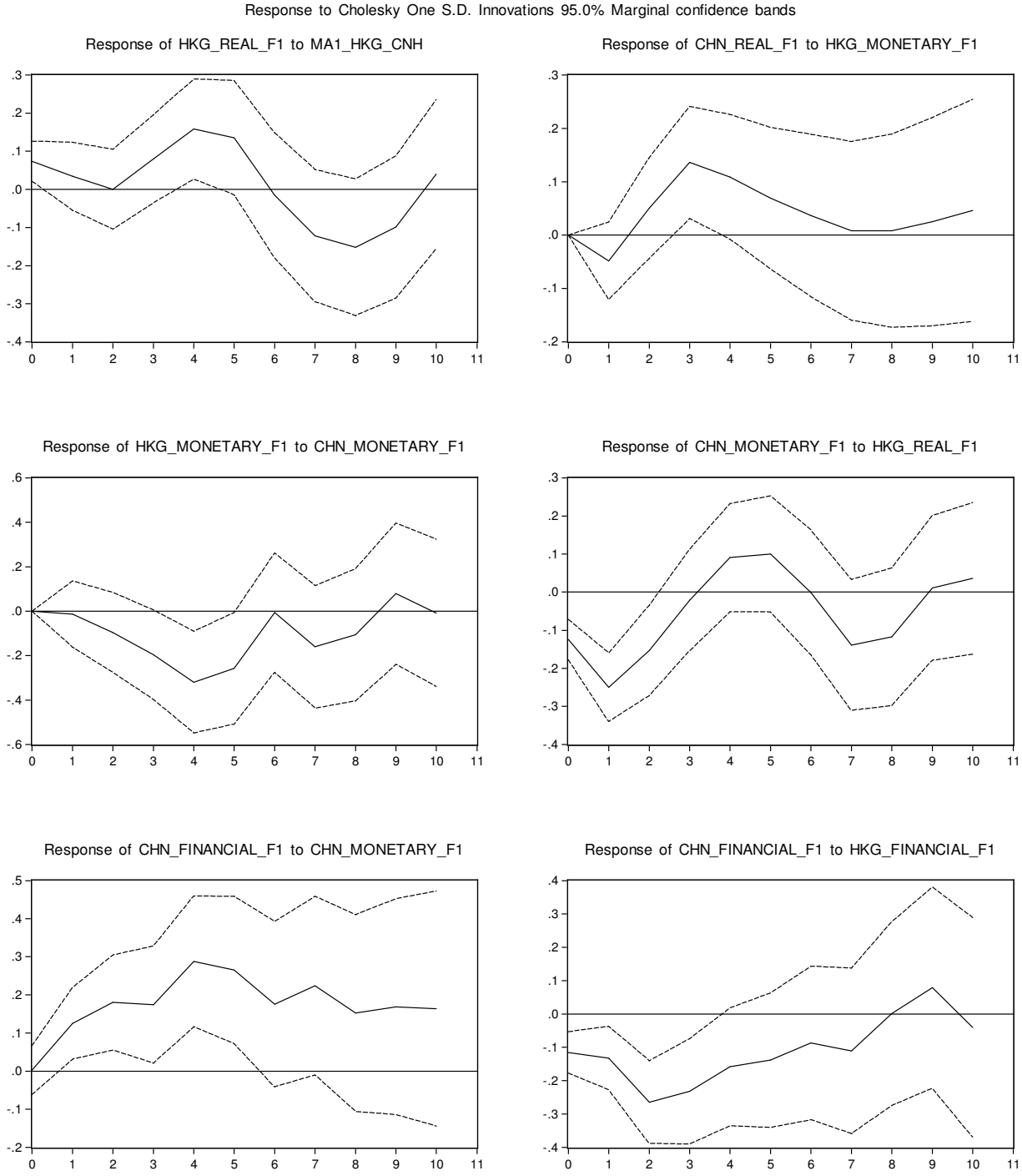
(e) Mexico



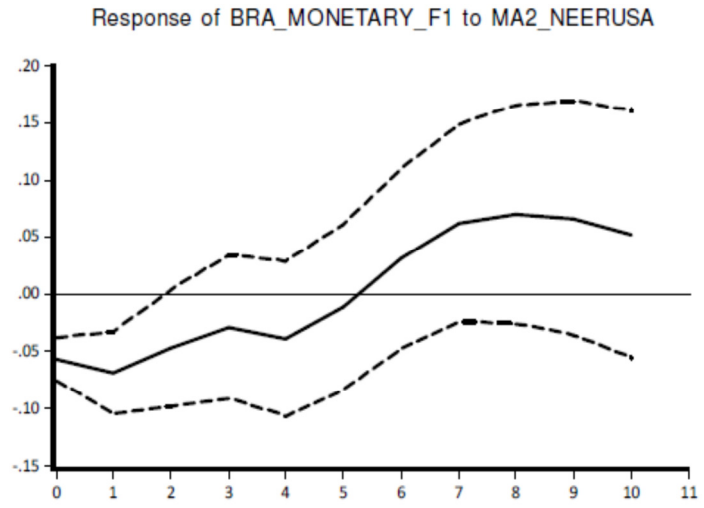
Note: Impulse responses are based on the FAVAR described in the text with the nominal effective exchange rate (NEER) proxy (MA1, MA2; see text and Figure 2) the first series in the VAR. the confidence intervals (dashed lines) are estimated via Monte Carlo (1000 replications). REAL, MONETARY, and FINANCIAL refer to the factors estimated separately. Also, see notes to Figure 3.

Figure 5 Select Local Projections

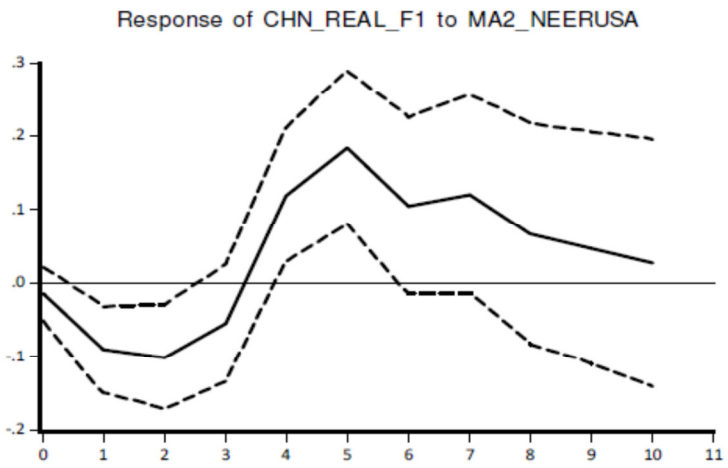
(a) Hong Kong and China



(b) Brazil and the USA



(c) China and USA



Note: Codes for each economy, and variable descriptions are found in Tables 1 and 2, and Figure 2. The local projections are based on the same VARs used in earlier figures.