Global Spillovers and Domestic Monetary Policy

The Impacts on Exchange Rates and Other Asset Prices

By

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Abstract: I discuss how the unconventional monetary policy measures implemented over the past several years – quantitative and credit easing, and forward guidance – can be analysed in the context of conventional models of asset prices, with particular reference to exchange rates. I then review alternative approaches to interpreting the effects of such policies, and review the empirical evidence. Finally, I examine the ramifications of the evidence for thinking about the impact on exchange rates, and asset prices, particularly for emerging market economies. I conclude that although the implementation of unconventional monetary policy measures may introduce more volatility into global markets, in general it will support global rebalancing by encouraging emerging market currency revaluation.

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1. Introduction

The implementation of unconventional monetary policy measures in the wake of the Great Recession has forced a reconsideration of the efficacy and desirability of unconventional monetary policy measures, ranging from forward guidance to quantitative/credit easing. Before 2007, it would be fair to say that most macroeconomists (who believed in the relevance of monetary policy) held the belief that once the zero lower bound was encountered, monetary policy would be almost completely hamstrung. That conjecture extended to the key asset price in international finance – the exchange rate.

In the wake of repeated bouts of easing by way of unconventional policy measures in the US, the euro area, the UK and Japan, a new consensus has arisen. That revision in the consensus is not restricted to the channels by which the domestic economy is affected. It now extends to a belief that such measures can, and in certain instances do, have substantial cross-border impacts. The author of one of the earlier studies of credit easing concludes (Neely, 2012):

> "[Large Scale Asset Purchases] buy announcements reduced expected long-term U.S. bond real yields, expected long-term foreign bond real yields in U.S. goods, and the spot value of the dollar."

More recent analyses have led others to make similar conclusions, applying to both announcements and interventions (deeds as well as words one might say). From Fratzscher et al. (2012):

> "…US unconventional monetary policy measures since 2007 have affected capital flows to EMEs in a pro-cyclical manner, and have raised asset prices globally and weakened the US dollar. This suggests that there is indeed an important global dimension to and externalities from monetary policy decisions in advanced economies."

However, even as a consensus has developed that unconventional measures can have an impact on asset prices and economic activity, a formal tracing out the channels by which these effects occur has not yet been undertaken.

To highlight this point, consider the relationship between expansions of central balance sheets and exchange rates. A cursory examination of the correlation of exchange rate and money base variables does suggest some relationship. Figure 1 illustrates the relationship of the US dollar against the pound, euro and yen. An increase in the exchange rate represents a dollar depreciation, so the conventional view asserts a positive relationship with the *relative* money base. While there is no apparent correlation for the

US dollar/UK pound rate, for the euro and the yen bilateral rates, there does seem to be some relationship of the posited form. For instance, the dollar depreciates against the euro and the yen in the wake of the rapid expansion of the Fed's balance sheet in 2008. (In contrast to the ECB and the Bank of Japan, the Bank of England followed the Fed fairly rapidly in expanding the balance sheet, which may explain the relative lack of apparent comovement.) In general, the US dollar seems to depreciate as the Fed's balance sheet increases, as shown in Figure 2.

That being said, the correlation is more pronounced at some times as opposed to others. The comovement is most pronounced in the wake of the Fed's expansion of the balance sheet. Of course, one would not expect a tight relationship, as many other factors will affect the exchange rate value, such as flight to safety, fiscal and terms of trade shocks, as well as perceptions of future monetary policy not accounted for by current movements in balance sheets.

In this paper, I contrast the traditional approach to exchange rate modeling with the implications from recent empirical findings, thereby demonstrating the need for a different empirical framework. Which framework is most appropriate is an important question. The nature of the spillovers might very well differ according to the transmission mechanism.

Once one has an understanding of what determines exchange rates, one can then discern the implications for economic activity and other variables of concern to policymakers: Capital flows, asset prices and economic activity.

2. Interpreting Unconventional Measures in Traditional Models of Exchange Rates

The workhorse macroeconomic model of exchange rate determination has been for years the monetary approach.[1] The exchange rate is viewed as the relative price of currencies which depends upon the relative demands and supplies of the stocks of money.

The sticky price variant associated with Dornbusch (1976) and Frankel (1979) imposes purchasing power parity only in the long run, so that the nominal interest rate can move independently of expected inflation. Hence, the exchange rate is a function of money stocks and incomes, the interest rate and the inflation rate.

[1] This discussion of conventional macroeconomic models is drawn from Chinn (2012).

$$s_t \equiv (m_t - m_t^*) - \varphi(y_t - y_t^*) - \frac{1}{\theta}(i_t - i_t^*) + (\lambda + \frac{1}{\theta})(\pi_t - \pi_t^*) \quad (1)$$

Here (in logs), *s* is the exchange rate, *m* is the money stock, *y* is real GDP, *i* is the interest rate, φ and λ are the income elasticity and interest semi-elasticity of money demand, respectively.

Because prices are assumed to be sticky in the short run, the interest rate differential differs from the inflation differential. In other words, the real interest rate matters. The interest rate here pertains to a short term instrument, say a one period bond.

Notice that a higher interest rate differential results in a stronger currency, while a negative one induces a depreciation. Formally, this relationship arises because in response to monetary shocks due to the Dornbusch overshooting effect. A monetary expansion that lowers the interest rate requires both a long run depreciation to satisfy PPP and a short run appreciation over time to satisfy uncovered interest parity. In the context of the model (as opposed to reality), no flows are necessary – merely a re-equilibration of asset prices and returns so that no excess returns are anticipated.

It bears repeating that this approach, where money stocks and money demand are the key determinants of exchange rates, uncovered interest rate parity holds. This is tantamount to assuming that other assets besides money do not matter. In the narrowest two-asset models (money and bonds), government bonds issued by different governments and denominated in different currencies are treated as perfect substitutes by a representative agent.

That's why in these models, *sterilized foreign exchange intervention has no effect on the exchange rate.* Consider this assessment from Humpage (2003):

> [B]ecause sterilized intervention does not affect market fundaments, it does not afford monetary authorities a means of routinely guiding their exchange rates along a path that they determine independent of their monetary policies. While monetary authorities in large developed countries certainly can affect nominal exchange rates through non-sterilized foreign exchange intervention, doing so either will conflict with their domestic policy objectives or it will be entirely redundant to open market operation in domestic securities. The outcome depends on the nature of the underlying economic shock to their exchange market.

It is a measure of how far the consensus has moved that it is now widely accepted that sterilized intervention can, and does, have large effects, and not only for currencies for countries with the heavy apparatus of capital controls (e.g., China). Rather, it also applies (or is perceived to apply) to countries

with relatively open financial accounts – consider Switzerland's cap on the franc's value.[2] More recently, the G-20's insistence that Japan forego any foreign exchange intervention as part of its newly invigorated monetary policy suggests that the idea of ineffectiveness has been discarded.[3]

For the remainder of this paper, I focus on the unconventional monetary policies that operate on domestic assets (as opposed to foreign exchange reserves). In the context of these monetary models, neither issuance of greater amounts of government debt, nor central bank purchases of that debt, can have an impact on the exchange rate, unless the purchases of debt results in an increase in the money supply. Clearly, given the increase in the money base due to quantitative easing has not been manifested in corresponding increase in money supply, this interpretation does not make sense.

Of course, it is not possible to rule out a monetary interpretation completely. If the implementation of unconventional monetary policies – either forward guidance or quantitative and/or credit easing – is taken as a signal of future monetary expansion, then a monetary model might be applicable. To see this, consider the following flexible price monetary model, where the exchange rate is the present discounted value of the future stream of monetary fundamentals. Then:

$$s_t = \left(\frac{1}{1+\lambda}\right)\sum_{\tau=0}^{\infty}\left(\frac{\lambda}{(1+\lambda)}\right)^{\tau} E_t\widetilde{M}_{t+\tau} \qquad (2)$$

Where $\widetilde{M}_t \equiv (m_t - m_t^*) - \varphi(y_t - y_t^*)$

Suppose that the monetary authorities are able to affect expectations such that the level of the money supply in the future is going to be higher than previously thought, but the *trend* rate of money growth is not increased. In this case, the inflation rate is not increased, merely the price *level* in the future. This results in an immediate depreciation in the currency.[4] Notice that one implication of the model is that interest rates need not necessarily move at the instant the anticipated increase in money supply becomes credible. This sort of logic underpins the fears that some have that quantitative easing will result in the debasement of the currency.

This interpretation of the impact of quantitative easing would be difficult verify using conventional econometric methods. For instance, the older rational expectations methodology, imposing

[2] This point has been forcefully made by Gagnon (2013).
[3] See e.g., Zuckerman and Chung (2013).
[4] Note that a perceived increase in the future *trend growth rate* of the money supply would result in an immediate increase in the interest rate; that counterfactual prediction seems to make that interpretation less plausible.

cross equation restrictions on the exchange rate equation and auxiliary equations for the fundamentals relies upon the assumption that the time series processes driving the fundamentals are stable. That is a highly untenable proposition, given the regime change implicit in the adoption of unconventional monetary policies.

The monetary interpretation of the exchange rate effects can be resurrected if these measures – expanding the money base – are taken to signal future policy outcomes. This brings back in the relevance of central bank forward guidance.

3. The Potential Impact of Forward Guidance

One component of unconventional monetary policy is the use of forward guidance – in the context of recent years, a commitment to keep low future short term interest rates. The expression of forward guidance should induce a reduction of long term interest rates through the expectations hypothesis of the term structure.

As Del Negro and Patterson (2012) have remarked, forward guidance typically exhibits extremely powerful results in New Keynesian dynamic stochastic general equilibrium (DSGE) models, a phenomenon they coin the "Forward guidance puzzle". Long term interest rates respond strongly to a commitment to keeping short interest rates low, as do other macroeconomic variables.

If long term interest rates respond, how do exchange rates? Here there seems to be a dearth of results. Most studies based upon simulations of forward guidance using DSGEs do not allow for exchange rate effects. However, because of the forward guidance puzzle, one would probably look askance at the simulation results even if they existed.

Consequently, one needs to appeal to less formal results. In a study incorporating announcements, Kiley (2013) notes that long term uncovered interest parity holds even in the recent period encompassing the zero lower bound, confirming results by Chinn and Quayyum (2012). To the extent that the Dornbusch overshooting effect holds, the resulting lower long term interest rates imply depreciated currency values today.

A more ad hoc approach would drop the parity condition, and accept that the carry trade exists. In this worldview, lower interest rates in the US and other advanced economies would induce capital flows to the other economies, thereby depreciating advanced economy currencies. Figure 4 depicts the evolution of inflows to emerging markets; there is some slight evidence of surges of capital inflows into the emerging markets during QE2 and QE3. However, a more formal analysis would control for other factors.

4. QE/CE in a portfolio balance model

In order to explain exchange rate movements arising from credit easing, one has to apply to models that treat different bonds (of identical default risk) differently. It's easiest to relate this to the literature when talking about government bonds.

The portfolio balance model differs from the monetary model in that it assumes that assets denominated in different currencies are not perfectly substitutable; this means that returns on bonds, when expressed in a common currency, might differ due to a risk premium.[5] For expositional ease, I draw on a model due to Frankel (1984). Here, perfect capital mobility (CIP) holds, while perfect capital substitutability does not. That is, investors view domestic and foreign bonds as imperfect substitutes. Then investor *j* will allocate her holdings in response to expected returns (expressed in a common currency). Aggregating over homogeneous investors yields:

$$B_t \Big/ S_t B_t^* = \gamma(i_t - i_t^* - E_t \Delta s_{t+1}) \qquad (3)$$

where *B* and *B** are net supplies of domestic and foreign bonds, and it is assumed for simplicity that governments issue debt denominated only in their own currencies. The term in the parentheses on the right hand side of (3) is the deviation from uncovered interest parity, or equivalently, the exchange risk premium on domestic currency. It's clear how credit easing might work in this model – if the central bank were to purchase domestic bonds, this would reduce the stock of bonds held by the private sector.

This expression indicates that holdings of domestic bonds, relative to foreign currency denominated bonds, are a positive function γ of the exchange risk premium. Assuming the functional form for relative bond demand is linear-exponential in γ, then after rearrangement, equation (3) becomes:

$$s_t = \gamma_0 + \gamma_1(i_t - i_t^* - E_t \Delta s_{t+1}) + b_t - b_t^* \qquad (4)$$

The difficulty in implementing equation (4) is that the term in the parentheses is unobservable.[6] To obtain an empirically implementable specification, one could assume expected depreciation is zero -- an assumption that is consistent with the near random walk exchange rates. Then (4) becomes:

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[5] Risk premia can arise in models without this particular structure. In more microfounded approaches, the risk premia arises from the correlation of relative returns with consumption growth. The implications of this type of approach are discussed in Section 4.

[6] As in the case of equation (4), one could recursively substitute out for the expected future exchange rate. This would lead to an expression stating that the current exchange rate is determined as a negative function of current and

$$s_t = \gamma_0 + \gamma_1 (i_t - i_t^*) + b_t - b_t^* \qquad (5)$$

Notice the equation indicates that as b^* increases, s falls (appreciates): As the stock of foreign assets held by home rises, the exchange rate appreciates.

The impact of central bank purchases of bonds has ambiguous effects, as it removes bonds from the private sector, reducing b. In equation (4), that implies an appreciation of the exchange rate, counter to intuition regarding credit easing. However, it's not appropriate to hold all else constant; purchases of bonds will likely reduce the home country interest rate. Moreover, in a more general hybrid monetary-portfolio balance model, money supplies would also matter (as in Frankel, 1984).

In the specification represented by equation (4), it is assumed that all investors have the same portfolio preferences, presumably because they consume the same basket of goods. For the sake of expositional simplicity, I'll retain this assumption. However, there are two complications one would want to address.

The first is in order to deal with effects at the zero interest rate lower bound, it's not plausible to assume an offsetting interest rate effect. The second complication actually helps with addressing the first – and that is that the distinction of different maturities of government bonds is essential. Then one can view b as a sum of short term and long term government bonds, and the interest rates as a weighted average of the corresponding yields, which is likely to be above zero.

How does foreign intervention fit into the model? Dooley and Isard (1982) note explicitly that b is government debt net of purchases via open market operations and foreign exchange intervention. However, foreign exchange intervention does not have the same impact as purchases of domestic bonds, as the currency composition of the holdings of the private sector differ in the two cases.

While equation (4) is a useful heuristic for considering the impact of credit easing on the exchange rate, it is a very partial equilibrium approach. In particular, one does not know how expected depreciation will evolve.[7] [8]

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discounted future expected interest rates, and a positive function of current and discounted future expected stocks of domestic currency bonds, relative to foreign denominated bonds. This expression, likes its monetary counterpart, is not tractable from an empirical standpoint.

[7] Closing the model formally is possible (e.g., Blanchard, Giavazzi and Sa, 2005), but would not provide particular illumination for the issues we are concerned with.

[8] It is probably best to think of the portfolio balance approach as a heuristic in general, given the less than complete success encountered by researchers, in particular those using the mean-variance approach, as in Frankel and Engel

Neely (2012) deploys a multi-asset portfolio balance model with mean-variance optimization. The long run exchange rate value is pinned down by purchasing power parity, combined with the assumption that bond purchases do not affect the long run price level (the long run horizon assumed to equal the maturity of the benchmark bonds, ten years). In this model, designed to motivate the analysis of announcement effects, the exchange rate "jumps" at the time of the announcement, with the magnitude depending upon the covariation of returns, and the coefficient of risk aversion. He finds that the observed exchange rate jumps are consistent with the portfolio balance model he uses.

Neely's framework is quite useful, but in order to obtain some quantitative estimates, he relies upon a fairly simplified framework. A more sophisticated – but difficult to empirically implement – framework recognizes that the central bank is operating on *several* different assets, with differing maturities, as noted by Portes (2012). Consider the Fed. In addition to the short term government bonds and foreign exchange reserves held pre-2008, the Fed now holds long term government bonds and Agency debt and mortgage backed securities. The impact of purchases of any given category of securities will depend in part upon the substitutability of these assets. In the standard portfolio balance model, purchases of short and long term government bonds would change yields relative to foreign short and long term bonds. But if home and long term government bonds are highly substitutable – more than short term – then thinking of relative home and foreign bond supplies net of central bank holdings might not be the most useful approach.

This is why it is so difficult to disentangle the theoretical implications of the changes in balance sheets on exchange rates. Perhaps more important than the magnitude of the change in central bank balance sheets is the changes in the composition. Figure 5 highlights this point for the Federal Reserve. The increase assets on the balance sheet in September 2008 was accounted for by special loans to financial institutions. With the implementation of the Fed's quantitative easing ("QE1") in November of 2008 and March 2009 the balance sheet increased modestly in size, as emergency loans were wound down, and were supplanted by holdings of Agency debt and MBS's and longer term debt. Then second round of quantitative easing ("QE2") which began in November of 2010 increased the balance sheet and the weighting toward long term Treasurys.

If the portfolio balance adjustment process is the key factor in exchange rate movements, then it is not surprising that it has proven difficult to trace out how the channels of effects. The strength of such individual adjustments will depend not only upon substitutability of assets issue mentioned earlier, but as

(1984). See Engel (1996) for a discussion.

well as exogenous shifts in private demand for assets, even as central banks undertake purchase programs. All these factors are difficult to account for in a structural model.

5. Empirical Evidence on International Effects

The international repercussions of the impact of advanced economy unconventional measures can be undertaken in a variety of ways, mostly of a non-structural flavor – which makes sense given the preceding discussion. One way is to use event studies to analyze the impact on asset prices, or use other high frequency information on actual policy interventions. The second is to use lower frequency data to assess both real and financial effects, but spanning periods of both crisis and tranquility (or, non-crisis).

5.1 Announcement and Intervention Effects

Since the advent of unconventional monetary policy measures is relatively new (with one or two exceptions), the empirical literature is also fairly small, albeit growing rapidly. One can break the literature down into two main groups. The first is based on an examination of announcement effects. The second augments announcements with actual interventions and news. Most of these early studies fall into the first category, and focused in on the impact on domestic assets (and necessarily on the first large scale asset purchases, or "LSAP") (e.g., Gagnon, et al. 2010; Bauer and Rudebusch, 2011). Hamilton and Wu (2011) examined both LSAP1 and LSAP2.

Neely's (2012) examined the impact of the LSAP1 events. He found that the dollar depreciated against foreign currencies upon announcement, with the depreciations ranging from 7.76 ppts to 3.54 ppts (for the Euro and British pound) within the one day window around the announcement.[9] These magnitudes are consistent with the portfolio balance model he forwards combined with the 22% reduction in net bonds implied by the LSAP. The responses of exchange rates are shown in Figure 3.

This finding is of interest because of the inclusion of controls for the element of anticipation, and the fact that the analysis spans a larger number of episodes than the earlier studies. This latter point is of some relevance because some research had shown decreasing effectiveness of more recent rounds of unconventional measures. This study confirms the effect remains (although it does not counter the possibility that the effect has declined over time).

[9] Neely finds that the changes are slightly larger using a two day window, suggesting protracted market adjustment.

Extending and elaborating on the approach of Gagnon et al. (2010), Chen et al. (2012) examine the cross-border (Asian) effects of announcements. They find that the two rounds of quantitative easing lowered Asian bond yields, boosted equity prices and exerted upward pressure on exchange rates (against the US dollar). In updated work[10] encompassing the maturity extension program (MEP) and QE3, and including forward guidance statements, the authors find that not all monetary easing policies had the same impact. The MEP had opposite effects from the various rounds of QE on Asian 2 year and 10 year bond yields and, interestingly, the exchange rate (the dollar tended to appreciate with the MEP).

Interestingly, they find forward rate guidance seemed to have a noticeable impact on exchange rates. This is one of the rare instances where forward guidance is both examined, and found to have had the expected impact on the dollar's value. (For instance, Campbell et al.'s (2012) survey of forward guidance does not make any mention of the impact on the dollar.)

The problem with this announcement approach (and some of the early event studies) is that the LSAP announcements (as well as other unconventional measures) could have been partly anticipated. This would mean that market adjustments to the policy measures would be mismeasured, and downwardly biasing the estimated impact. Glick and Leduc address this issue by using high-frequency intra-daily data, and use changes in long term Treasury futures to identify the surprise component of the announcements. In a sample encompassing all three rounds of large scale asset purchases, as well as statements regarding forward guidance and conditional inflation targeting, the authors find that a one standard deviation surprise easing results in a 40 bps decline within an hour. By way of comparison, a one standard deviation surprise easing in the federal funds rate leads to a 6 bps decline. Using a rescaling parameter related to long term rates, the authors map the unconventional surprises standard deviations into those for conventional surprises, and find that an (adjusted) one standard deviation surprise in unconventional policy has an impact of about 5 to 6 bps, surprisingly similar to conventional surprises.

Are the findings of an impact arising from LSAP's signaling? Bauer and Rudebusch (2012) use a term structure model to decompose changes in long rates into a risk premium component and an expected future interest rate component (associated with portfolio balance and signaling motivations, respectively). They conclude that the expected future short rates effect dominates, hence the signaling effect is of primary importance.

There is another possibility of how signaling is working. It could be that announcement of an unconventional monetary policy could be taken as an indicator that the economic conditions are even

[10] Personal communication from A. Filardo.

worse than previously thought. In this case, reductions in interest rates and currency values would be driven not by anticipation of the impact of future monetary policy, but rather news regarding the state of the economy. Neely observes that the concurrent increases in oil and equity prices is inconsistent with this interpretation. Hence, one can take from this that the "bad news" interpretation of LSAP announcements does not hold up to the data, at least for the sample Neely investigates.

While the Glick and Leduc approach addresses the possibility of anticipated policy measures when assessing announcement effects. The examination of announcement effects presupposes that the policies are credible. It is possible that there is an additional effect of these unconventional measures that comes from actual implementation.

In this vein, Fratzscher et al. (2012) examine the exchange rate and cross-border implications of quantitative easing measures (QE1 and QE2), but use daily data on both announcements as well as actual implementation as the explanatory variables. While the included policies include liquidity provision to financial institutions, and to credit markets, in addition to large scale asset purchases, they do not include forward guidance. The announcements analyzed include the QE1 and QE2 measures, while the actual market interventions include liquidity support measures, purchases of long term Treasury bonds, and purchases of mortgage backed securities.

The dependent variables include data on both asset prices as well as private flows under management by equity and bond funds.11 Hence the authors are able to measure both quantity (flow) and price responses.

In order to control for anticipation effects, they include country fixed effects, lagged variables to account for financial shocks (VIX, ten year T-bond yield, and 3 month OIS rate-T bill spread), and lagged returns in domestic market returns. It's not clear that these controls will deal with the possibility of anticipated policies, but they are potentially better than no controls at all.[12]

Their analysis covers the January 2007 to December 2010 period, and covers asset prices as well as flows. The key finding they uncover is that there is a distinguishing feature between what happens in QE1 and QE2. QE1 was adjudged to be successful in lowering sovereign yields and raising equity markets in the US and in 65 countries.

[11] The data set is provided by EPFR, and includes data for 16000 equity and 8000 bond funds, encompassing about 5-20% of market capitalization for most countries.
[12] The usefulness of these control variables as proxy for anticipated policies would depend on the consistency and strength of these lagged variables with anticipated policies.

Fratzscher et al. conclude that QE1 spurred a portfolio rebalancing, with capital flows moving out of the emerging market economies, and into the advanced economies. By way of contrast, QE2 induced the reverse effect. Capital flows to the emerging markets, and away from the advanced economies, did then increase. In other words, the conventional interpretation of quantitative easing as necessarily triggering capital equity and bond flows to the emerging markets might need some rethinking.13

This combined announcement/policy approach yields a particularly interesting point – announcement effects do not tell the whole story. In fact the authors conclude "the impact of Fed operations, such as Treasury and MBS purchases, on portfolio allocations and asset prices dwarfed those of Fed announcements." This result implies that the announcement studies understate the impact of unconventional monetary policy measures.

The cumulative (2007-2010) impact of QE1 announcements was to depreciate the dollar by 3.2%. The cumulative impact of Treasury purchases was to depreciate the dollar by 4.8% (interestingly, MBS purchases appreciate the dollar by 5.1%). By way of contrast, QE2 announcements depreciated the dollar by a mere 0.2%.

The results highlight differential impacts on country groups. For instance, QE1 announcements depreciated the dollar much more against advanced economy currencies than against emerging market currencies. The same is true for QE2 announcements, although as noted before, the overall magnitude is much smaller. The cumulated overall impact of US monetary policy (announcements *and* purchases) is shown in Figure 6. The calculations indicate that the cumulated impact on the dollar (vis a vis emerging market currencies) was appreciation, while it was depreciation against other advanced economy currencies.

Treasury purchases also had a bigger impact on advanced economy currencies (the study does not distinguish between Treasury purchases under QE1 and QE2). These results run counter to the perception that emerging market currencies came under more pressure than advanced economy currencies as a consequence of US asset purchases.

5.2 Quasi-structural Approaches

A different approach is to assume that the relationships that held prior to the global financial crisis and the advent of unconventional monetary policies persisted into the post-crisis period. Chen et al. (2012)

13 While Fratzscher et al. find U.S. monetary policy did drive some of the inflows into emerging markets, other factors are more important. A similar finding, using balance of payments data, is obtained by Ahmed and Zlate (2013).

implement a global vector error correction model which links the US 10 year-3 month term spread to variables at home and abroad. This is an appropriate approach, insofar as one thinks of the relative price of short and long term US government securities is the key one.

They estimate the model on monthly data over the 1995-2012 period, and find that there are significant effects on foreign – primarily emerging market – economic variables.[14] As they note, "the impact on the emerging economies is significant and appeared to have been widespread. The US term spread shock affects all variables: real GDP, inflation, stock prices, bank credit, foreign exchange pressure and money growth. This indicates that several different transmission channels may have been at play." (p. 252). Some of these effects are shown in Figures 7 and 8.

The figures indicate a variety of responses. GDP in particular increases for Hong Kong, Singapore and Malaysia. Interestingly, China's response is fairly small. Stock prices increase substantially for most countries, despite minimal money supply responses; the authors take these varied patterns as indicating different channels are of greater and lesser importance for different countries.

In contrast, the GDP responses for Argentina and Brazil are substantial, despite essentially negative response of money growth and inflation for most countries. And in all four Latin American countries, stock prices rise.

There are two limitations of this approach. The first is that the estimation spans both pre-crisis and post-crisis periods; there is no guarantee that the propagation mechanisms that hold during the earlier period holds now. The second potential difficulty is that the approach presupposes that a given amount of quantitative easing can be translated into a corresponding reduction in the term premium. This might be a reasonably good approximation, but still might miss some subtleties.

Interestingly, the results of the various tests reported in Section 4 depends upon how governments and in particular central banks respond to the monetary policy measures undertaken in the advanced economies. One way to organize one's thoughts on this matter is to recall the implications of the trilemma. A country can simultaneously opt for two of three policy goals – exchange rate stability, monetary policy autonomy, and capital account openness – but not all three. Each of these dimensions of policy are difficult to measure, but Aizenman, Chinn and Ito (2010) have shown that indeed the trilemma binds, at least according to the indices they construct.

[14] They also find significant effects for US GDP over the entire sample, but not over the pre-crisis sample. This finding is consistent with those of Chinn and Kucko (2012) who find the predictive power of the term premium rise in the last decade.

In their global vector error correction analysis of emerging market economy responses, Chen et al. (2012) find that Korea, Indonesia and Hong Kong experienced substantial exchange market pressure as a consequence of a term spread reduction. That is, upward pressure on (a weighted average of) the currency's value and reserves occurred. Interestingly, China is one country that did not experience substantial increase in exchange market pressure.

5.3 Central Bank Responses to Changes in the Federal Reserve Balance Sheet

An alternative means of examining this issue is to estimate a series of simple VARs, involving money base to GDP and exchange rates, over the period of the unconventional monetary policies, 2008M09-2013M03. Here I am implicitly assuming either that the size of the balance sheet relative to GDP is the key monetary factor, or that changes in the size correlate with changes in the portfolio of holdings by the central bank. As the previous discussion indicates, these are arguable propositions. On the other hand, the balance sheet is a clearly observable and controllable instrument of the central bank – as opposed to the term premium which represents the interaction of public and private actions. This approach, involving a (perhaps too) parsimonious specification also has the advantage of being able to focus on the post-crisis period. Hence, one need not assume that the pre- and post- crisis periods exhibit the same behavior.

First, I examine whether US money base affects the dollar exchange rate (after controlling for financial stress), and second, whether US money base affects emerging market economy exchange rates and money base. The money base is an admittedly imperfect proxy measure for central bank policies, but it has the virtue of being closely related to what the central bank itself is doing (in contrast to for instance the money supply, which is driven by both central bank and private sector decisions).

In terms of the United States dollar's response to the increase in the Fed's balance sheet, I examine the impulse response functions for a trivariate VAR including (the first differences of) the advanced economy financial stress index, log US money base-GDP and log trade weighted nominal exchange rate.[15] The stress index is included to account for the safe-haven effects on the US dollar. In Figure 9, the impulse response functions suggest that an increase in advanced country financial stress appreciates the dollar. Controlling for that effect, an increase in the money-base/GDP ratio weakens the dollar at horizons of two to three months. The results are *not* robust to changes in the specification; in particular, the level of statistical significance varies, even if the broad patterns remain in place.

[15] The VAR is estimated using 6 lags, and ordered with the financial stress index, first and money base and exchange rate second and third, respectively.

In contrast, euro area and UK exchange rate and money base measures do not respond to US money base changes (results not reported), in accord with the results in Chen et al. (2012). Interestingly, Japan's exchange rate appreciates. However, this result does not survive truncating the sample to begin in 2009M01. In other words, some of the apparent impact of money base is driven by the 2008M09 increase in the Fed's balance sheet. In any case, the results are not very robust, suggesting that changes in Bank of England and ECB balance sheet sizes were not driven by changes in the Fed's balance sheet.[16]

Turning to the emerging market economies, I focus in on Brazil, Russia, India and China. The hypothesis is that US monetary policy in the form of money base (at least during the sample period) exerts upward pressure on currency values or reserves. The monetary authorities either allow appreciation of the currency, or accumulation of reserves, or a combination thereof. Once one allows for differential responses to these pressures, it should not be surprising to see varied responses in macro variables as documented by Chen et al. (2012).[17]

Turning to some emerging market economies, I rely upon a simple three variable, three lag VAR involving US money base, the emerging market nominal effective exchange rate and the emerging market money base. The inclusion of the exchange rate and the money base is reminiscent of Chen et al.'s use of an exchange market pressure variable, but in this case I allow that the emerging market central bank can either allow appreciation, allow reserve accumulation, possibly sterilizing the inflow, or both.

In the case of Brazil (Figure 10) the currency value and money base do not respond in the expected fashion. The Russian currency depreciates 3 to 5 quarters in, while money base does not react (Figure 11). Interestingly, for the case of India (Figure 12), no statistically significant responses to the US money base are detected. If these emerging market central banks are forced to respond, it's very hard to discern that in these data.

The case of China (Figure 13) merits some discussion. At the one-month horizon, the currency appreciates in response to a money base increase. That effect dissipates quickly (at least statistically significant responses only show up at the one horizon). Chinese money base increases significantly at the 3 month horizon; since the variables are growth rates, this means the level of money base ratio is higher in the wake of a US money base increase.[18]

[16] It's possible that inclusion of additional variables such as GDP growth could uncover a relationship, but the brevity of the post-crisis sample prevents further investigation.
[17] In principle, one would want to control for other factors, including the imposition of capital controls. However, to my knowledge there does not exist a measure sufficiently accurate to capture subtle changes in de facto restrictions.
[18] The pattern of results do not change substantially with changes in lag structure or ordering. However, starting the

6. Spillover Effects, Uncoordinated Monetary Policy and Rebalancing

Several implications flow from this survey. In general, quantitative and credit easing and forward guidance seem to weaken the home currency, at least in some instances. This means that countries not matching expansionary monetary policy in the advanced economies will occasionally see their currencies face upward pressure. Policymakers in these countries will then have to decide whether to offset the upward pressure with increased foreign intervention, lower interest rates, or capital controls.

The consequent policy challenge will vary depending on the situation facing individual countries. Countries already at or near full employment might welcome the resulting appreciation of their currency, as long as they were near external balance. However, for those countries that are far below full employment, such an occurrence will be very unwelcome. (And of course, even countries near full employment might not welcome currency appreciation for reasons of political economy).

In other words, global rebalancing remains important. If the economies facing considerable economic slack (mostly the advanced economies, Figure 14) were to undertake monetary easing as a group, while the emerging market economies (near full employment, Figures 14 and 15) were to allow currency appreciation, this might actually yield a positive outcome.[19]

In the medium to long run, the impact is ambiguous. That is partly because the transmission mechanism involved differs from that related to foreign exchange intervention (at least as far as credit easing goes). To the extent that credit easing lowers interest rates facing firms and households, or loosens credit constraints, domestic absorption is raised. This in turn will lead to greater economic activity and hence self-reinforcing growth, as opposed to expenditure switching. Obviously, had foreign exchange intervention been pursued, the boost to economic activity would have more likely come from the respective export sectors.

However, the implications for impacted countries will take on a different complexion depending upon the channel by which exchange rate depreciation is effected. For instance, if the primary effect is through a signaling effect regarding the conduct of future monetary policy – for instance a commitment to low interest rates into the future – then a depreciated exchange rate has straightforward impact, switching expenditures toward the country implementing the policy.

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sample after 2008M09 does reduce the estimated impact on Chinese money base.

[19] A similar point is made regarding rebalancing in Chinn (2012).

If however the currency depreciation is accompanied by other effects related to portfolio balance motivations, then the implications will vary by country. For instance, if credit easing works through increasing demand (or equivalently reducing net supply) for U.S. long term Treasurys, then other assets that have returns that are correlated with U.S. long term Treasurys will also likely react similarly. For instance, as shown in Gagnon et al. (2010), yields on long term securities for the advanced economies all declined when LSAPs were announced.

This suggests a differential impact for advanced economies versus emerging market economies. Long term yields for sovereign bonds are all likely to decline in response to purchases of US long term Treasurys, as they are relatively substitutable. On the other hand, sovereign debt of emerging markets will likely exhibit a more muted effect, and the dollar's decline against those currencies will likely be measurably greater (Although Fratzscher et al.'s results suggests there are no assurances.)

One perspective on the ongoing program of monetary expansion by way of unconventional means holds that these measures threaten the stability of the global economy. Another perspective – the right one in my view – takes the reflationary measures in the advanced economies as a welcome development.

The international dimension of the anxieties is centered, I believe, on the fact that advanced economy measures force a choice upon emerging markets: to accept capital inflows (perhaps offsetting domestic effects by sterilization), to stem those inflows by way of capital controls, by allowing currency appreciation, or a combination of these measures. The (understandable) fear is that such capital inflows will spark a credit boom-bust cycle. The choices are most stark for small open economies.

However, the benefits of expansionary monetary policy outweighs the costs. If the advanced economies undertake expansionary policies that tend to weaken their respective currencies, then one is tempted to say that this is a wash, with no advantage conferred to a given country. Yet, if the unconventional measures raise the inflation rate, thereby reducing real interest rates, and spur domestic economic activity, both the advanced economies and the emerging market economies benefit.

It is true that some countries might face upward pressure on currency values; if they resist by way for foreign exchange intervention (as in China's case in the past), they will be forced to engage in ever more extensive sterilization procedures, or imposition of capital controls. The evidence of the efficacy of the latter, in the face of recent capital inflows from the advanced economies arising from large scale asset purchase, is quite limited (Fratzscher, et al., 2012).

But if they relent on currency values, then this is a partial solution to the problem of global imbalances, wherein the advanced economies experience slack demand and current account deficits, while many emerging market countries excess demand and current account surpluses.[20]

There is a knock-on effect, if uncovered interest parity does not hold. As emerging market economy currencies appreciate, presumably expected appreciation will also rise, raising the expected return to assets denominated in those currencies.[21] That will re-double the upward pressure on those currencies.

It would be preferable if a coordinated solution were arrived at: advanced economies with slack synchronizing their policies, while emerging market economies in external surplus simultaneously accepting currency appreciation. However, that is not a viable option, and so the choice is between uncoordinated stimulus in the advanced economies versus inaction. It seems the former is a better path, and one the global economy is embarked upon (Eichengreen, 2013).

7. Conclusion

How do unconventional monetary policies affect exchange rates and other asset prices cross-border? With respect to exchange rates, it seems that our conventional models are ill-equipped to deal with the impact of the asset purchases that are associated with credit easing.

There are ways to distinguish between the various channels by which the differing unconventional monetary policy measures affect asset prices. However, sharp inferences are difficult to make, exactly because the experience with these unconventional measures is so limited. That being said, it is remarkable how much the profession's view of how effective asset purchases and balance sheet increases have changed in recent years. Ten years ago, sterilized foreign exchange intervention was viewed as having limited effectiveness. Now it is taken as a given that it can be effective. Moreover, purchases of domestic assets are perceived as having an effect, although of a more uncertain direction.

[20] In other words, this is a mechanism whereby which the persistent hoarding problem of creditor countries Keynes pointed out in the 1940s can be mitigated.
[21] Portes (2012) makes this point. Obviously, such an interpretation presupposes uncovered interest parity does not hold exactly. For evidence on this point, see the discussion in Chinn (2006).

Apparently, not all episodes of quantitative/credit easing are created equal. This suggests that the effectiveness of such measures may vary with the state of the economies and the financial markets. The differential impacts of QE1 and QE2 highlighted by various studies.

To the extent that the unconventional policies put upward pressure on the currencies of those countries that are near full employment, and/or have current account surpluses, the implementation of these measures are probably beneficial to the world economy. This is true, despite the fact that there is little coordination in the monetary policies being implemented in the US, the euro area, the UK and Japan.

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Data Appendix

Money base. Source: IMF, *International Financial Statistics*. IMF definitions for all countries except for China and India, which use national definitions.

Real and nominal GDP. Source: IMF, *International Financial Statistics* and OECD, *Main Economic Indicators*, via FRED.

UK money base proxied by notes and coins and reserves. Source: Bank of England.

Bilateral exchange rates, against US dollar. Source: IMF, *International Financial Statistics*. Quarterly data average of monthly data.

Broad nominal trade weighted exchange rates except for US. Source: Bank for International Settlements.

US major currencies and broad trade weighted exchange rate: Source: Federal Reserve Board via FRED.

Financial Stress Index, advanced economies. Source: IMF, personal communication.

Output gaps for US, euro area, UK, Japan: IMF, *World Economic Outlook* database, April 2013.

Output gaps for emerging markets. Source: World Bank, *Global Economic Prospects*, June 2013.

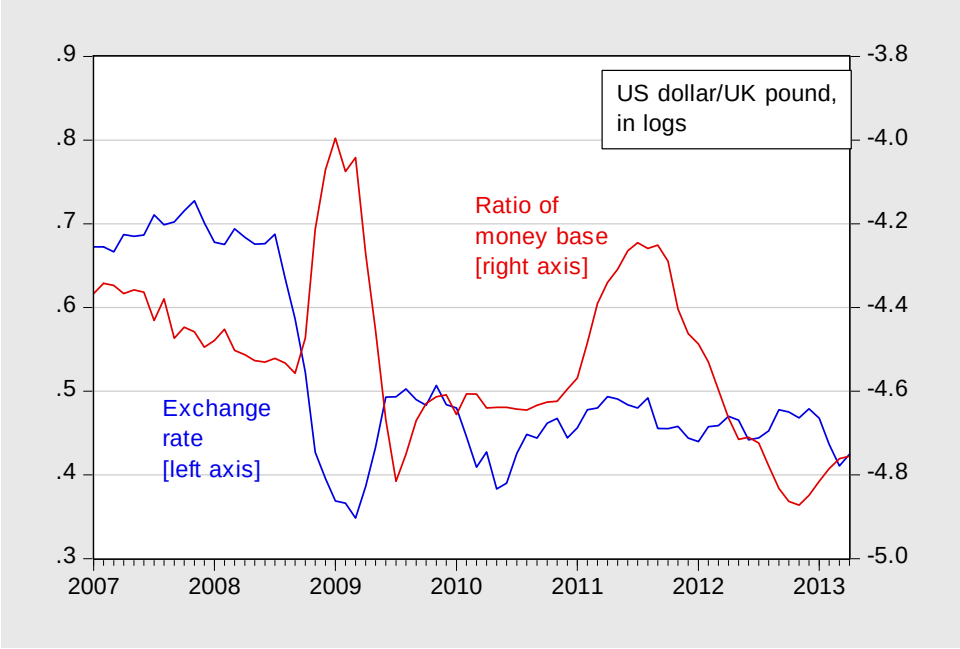

Figure 1.a.

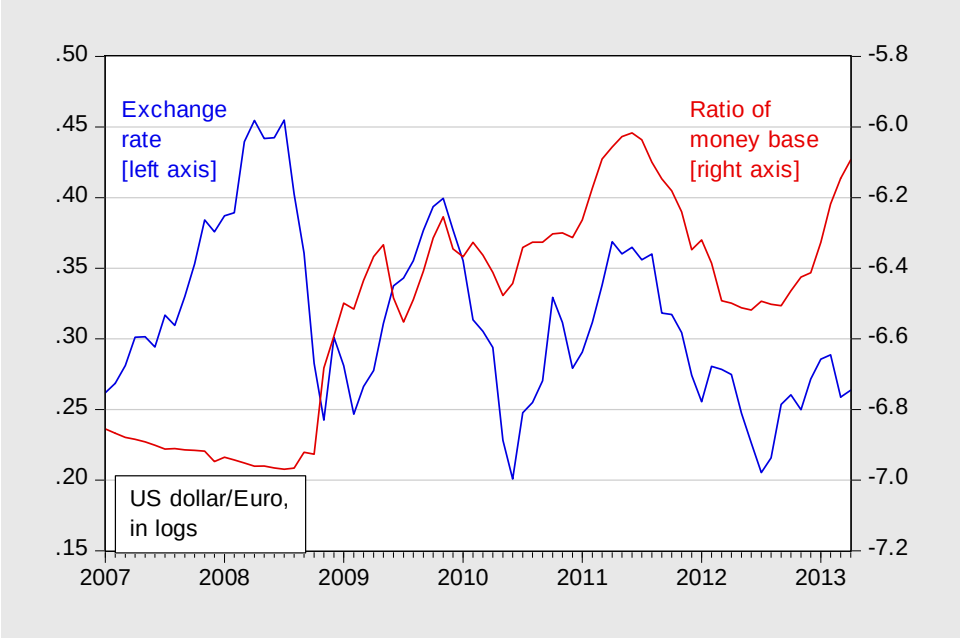

Figure 1.b.

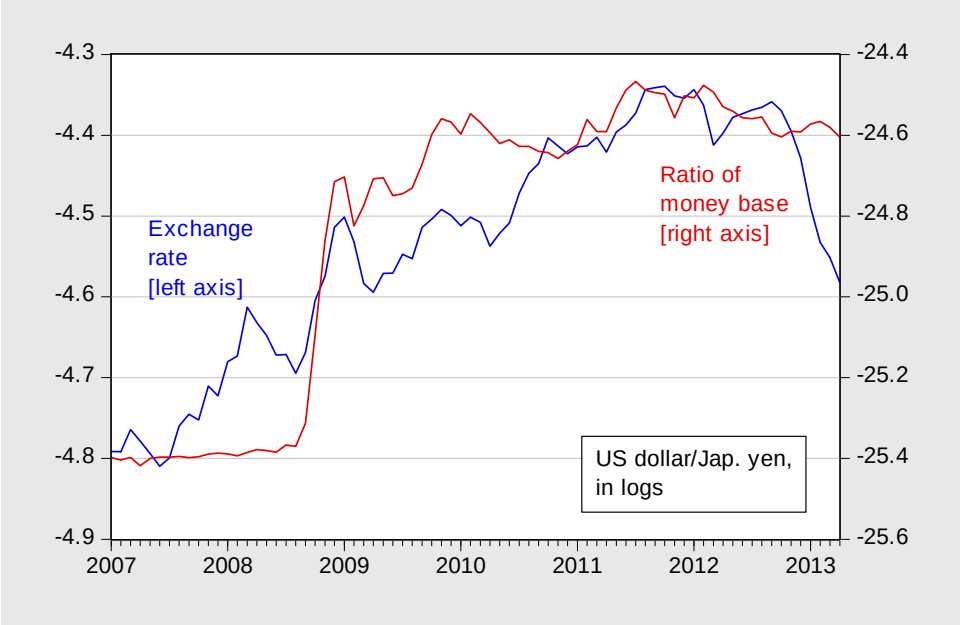

Figure 1.c.

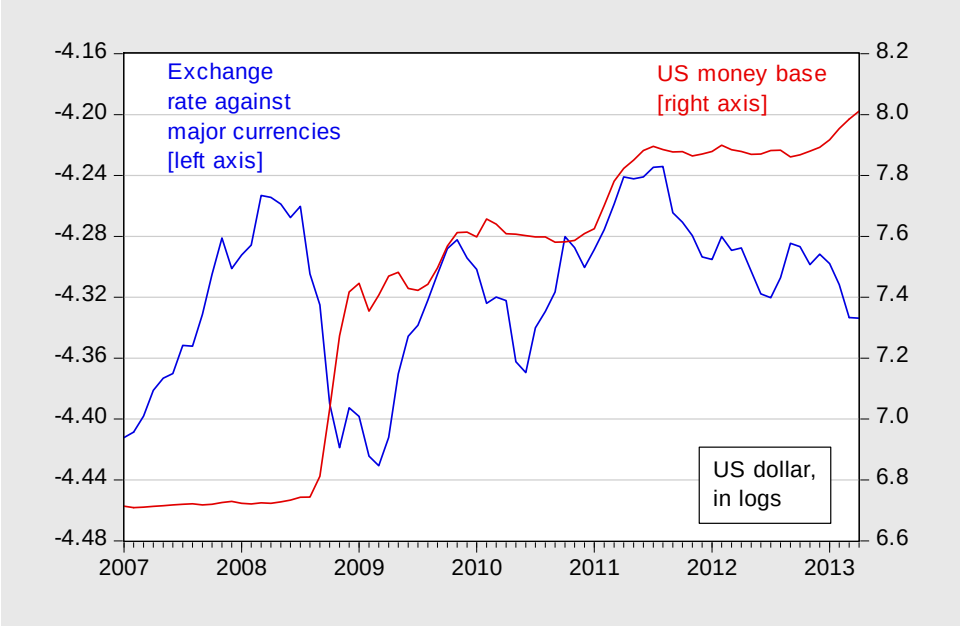

Figure 2. Log US dollar exchange rate (major currencies index), and log US money base.

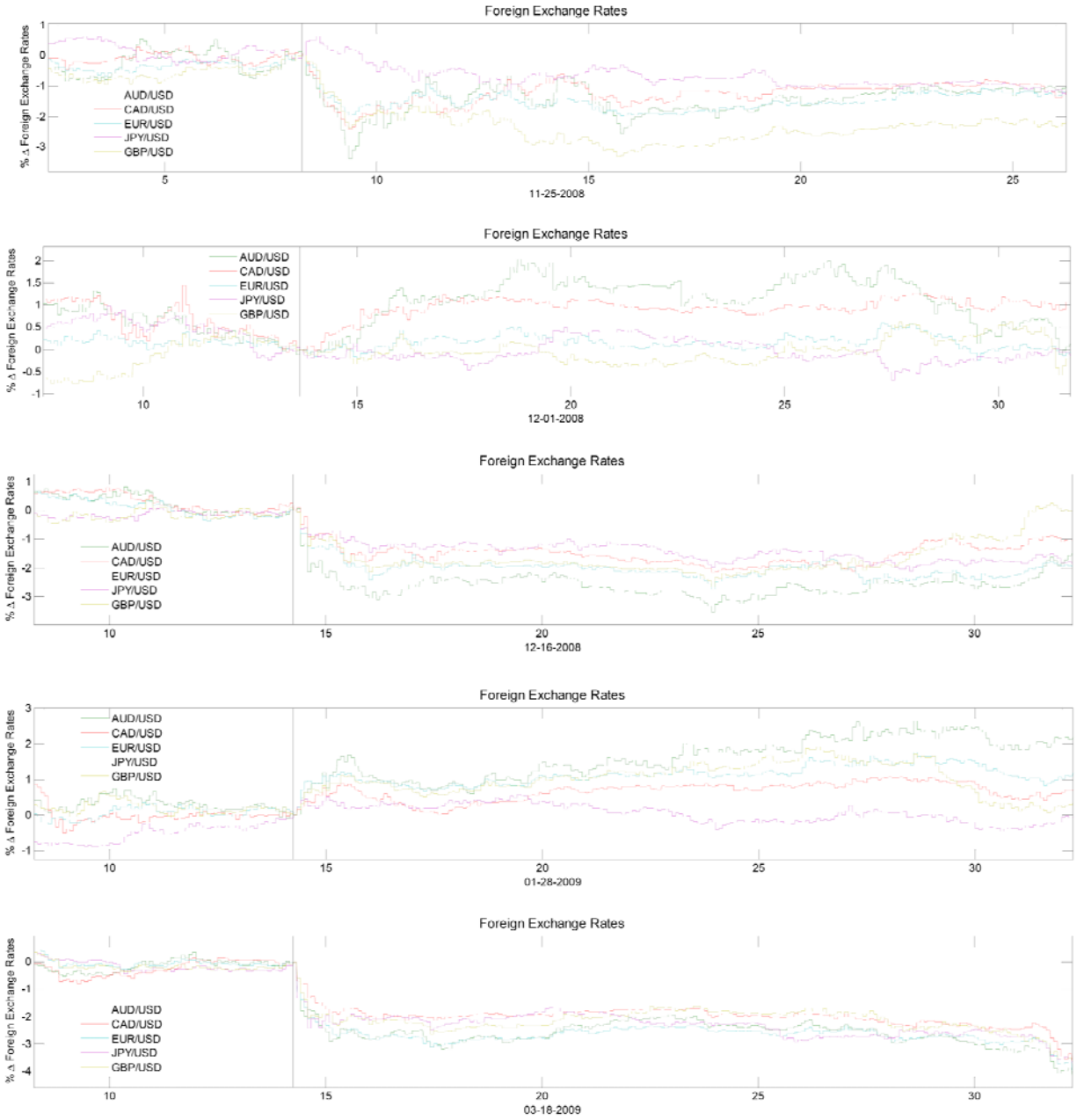

Figure 3. Exchange rate changes on dates of LSAP-related announcements. Source: Neely (2012).

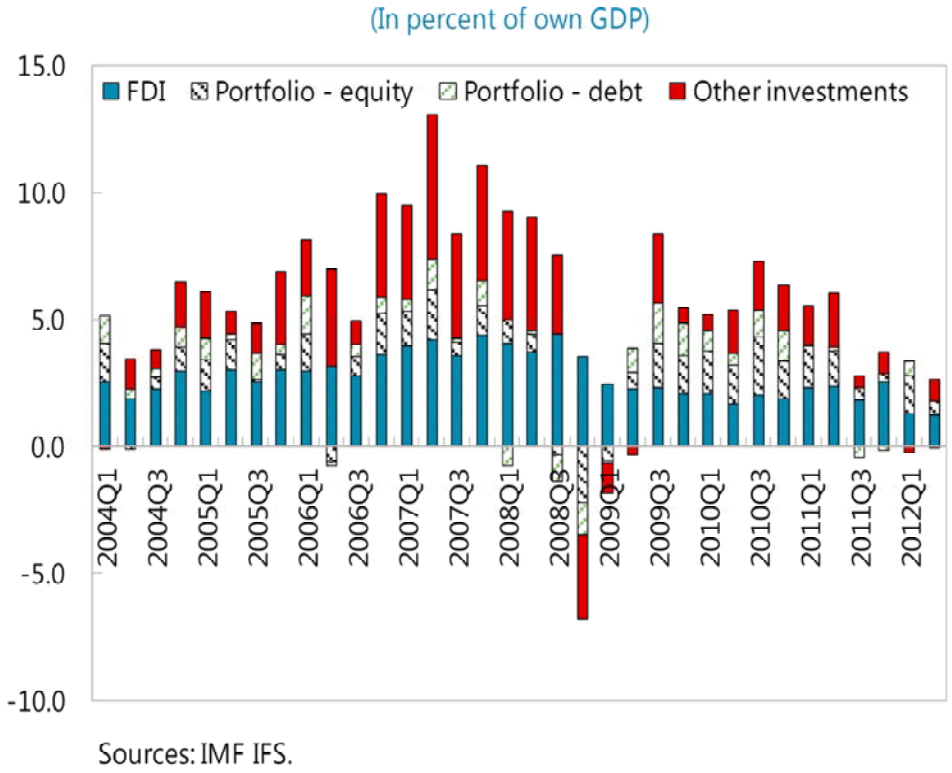

Figure 4: Capital inflows to emerging markets. Source: IMF (2013).

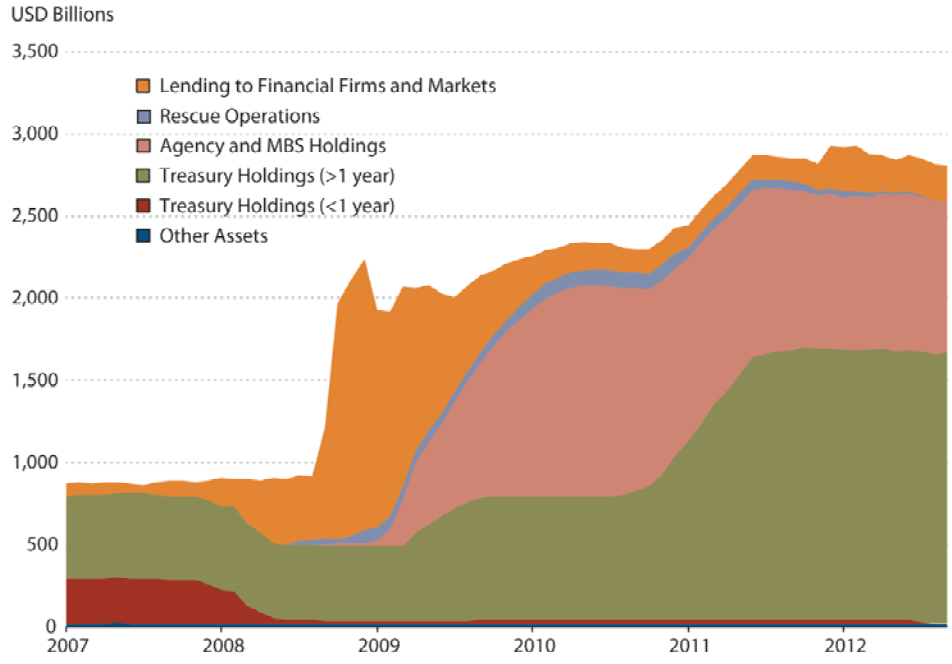

Figure 5: Federal Reserve holdings. Source: Fawley and Neely (2013).

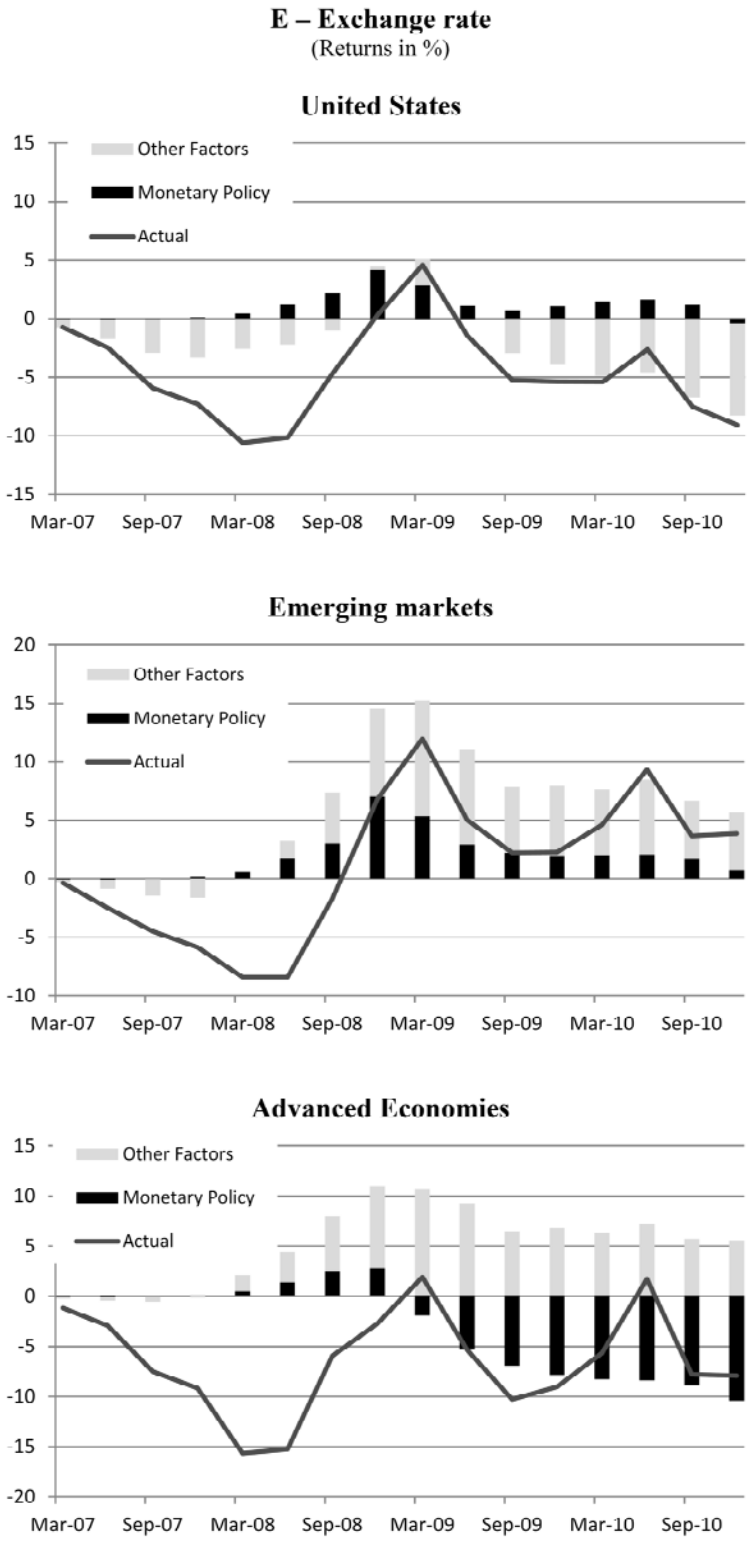

Figure 6: Cumulative impact on exchange rate from all measures. Source: Fratzscher et al. (2012), Table 2.E.

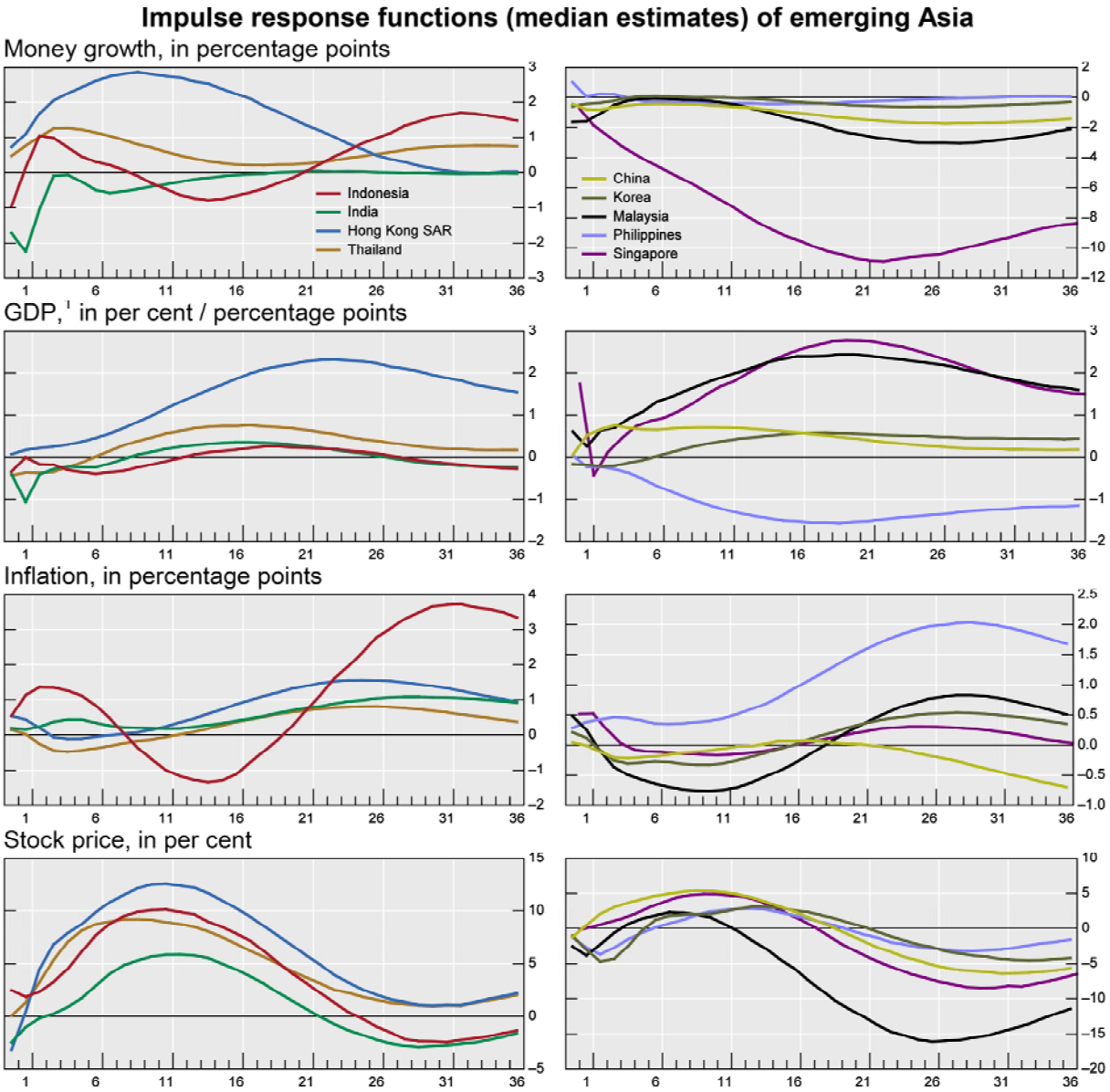

Figure 7: Excerpt from Graph IV.10 from Chen et al. (2012).

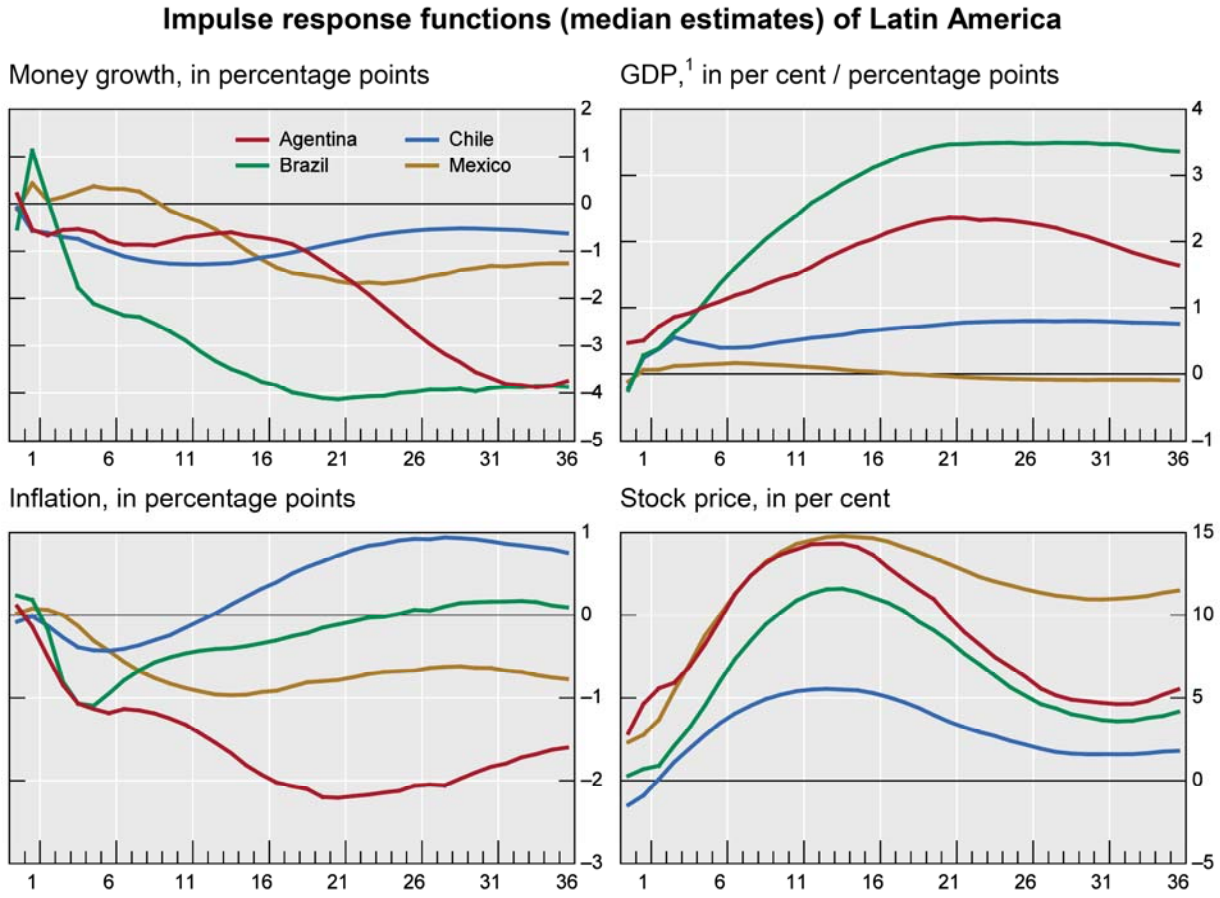

Figure 8: Excerpt from Graph IV.11 from Chen et al. (2012)

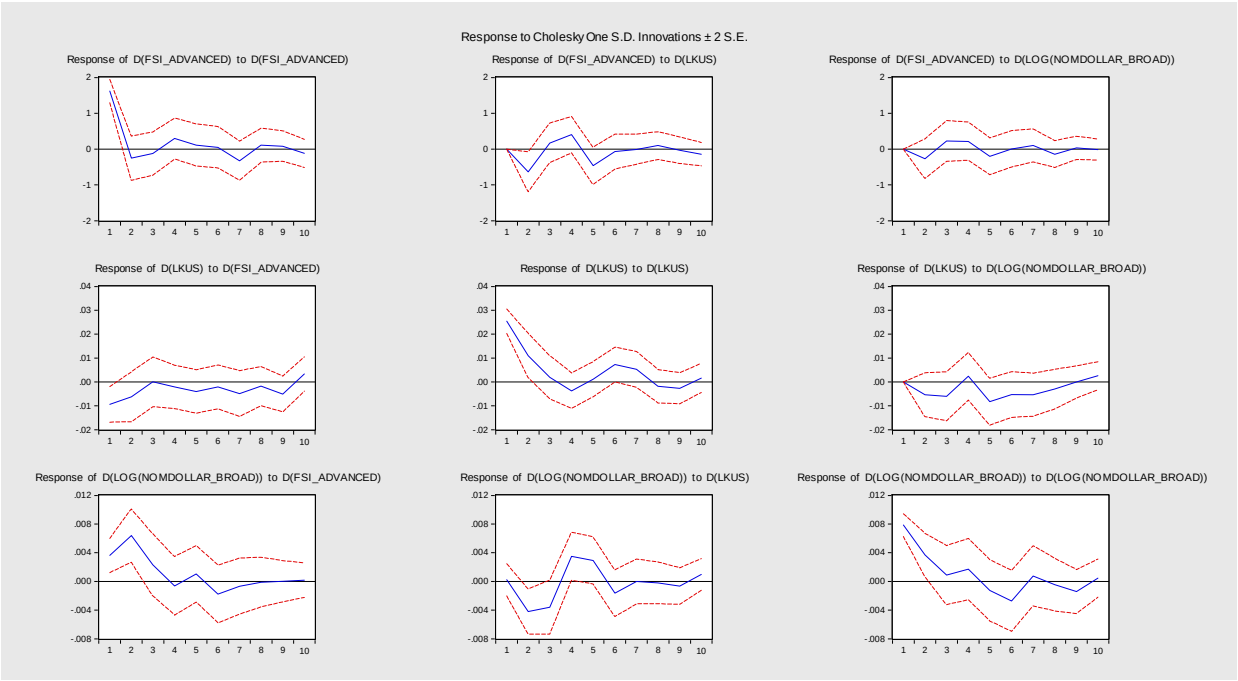

Figure 9: Impulse response functions for FSI, US money base, US dollar, 2008M09-2013M03

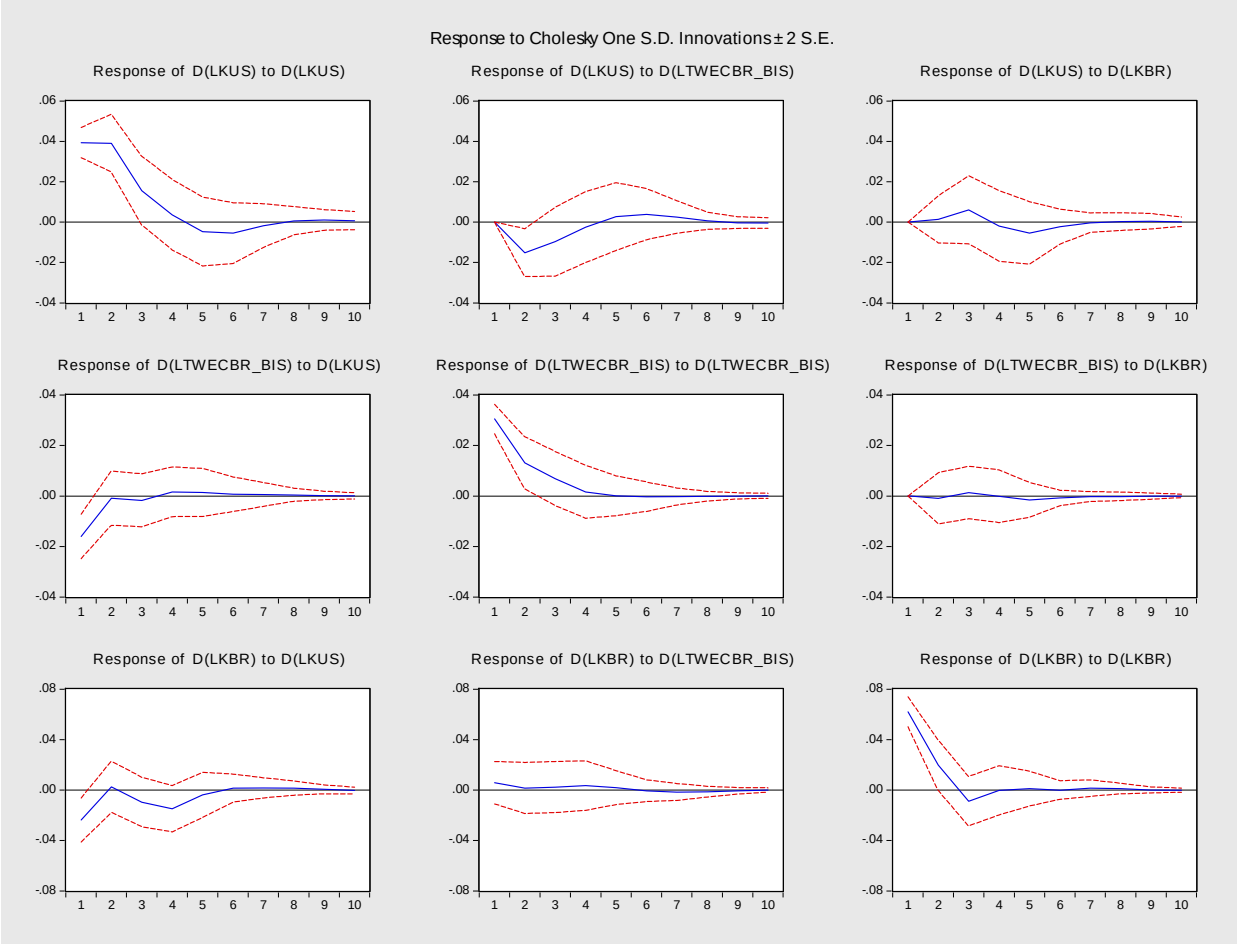

Figure 10: Impulse response function for Brazil's response to US money base, 2008M09-2013M03

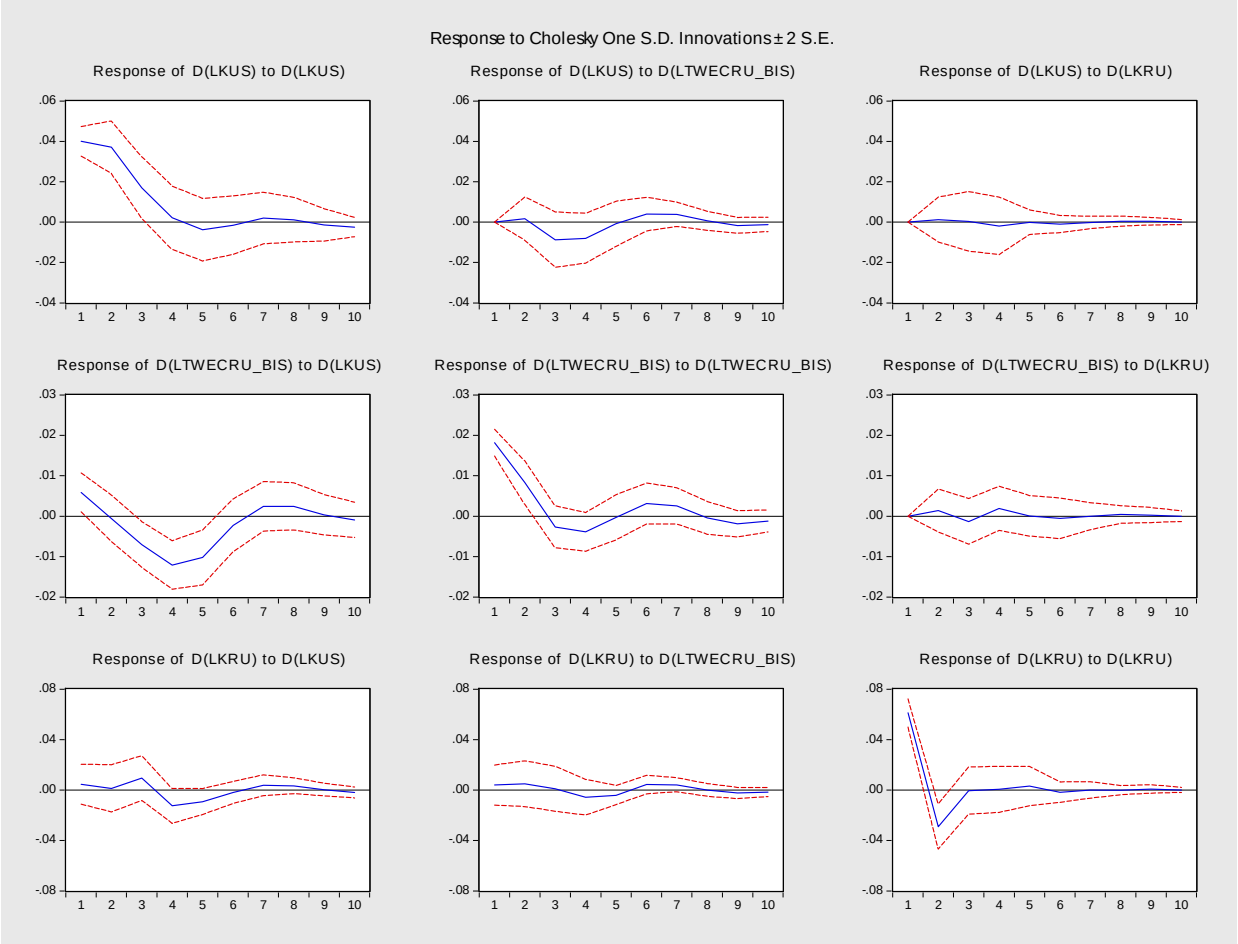

Figure 11: Impulse response function for Russia's response to US money base, 2008M09-2013M03

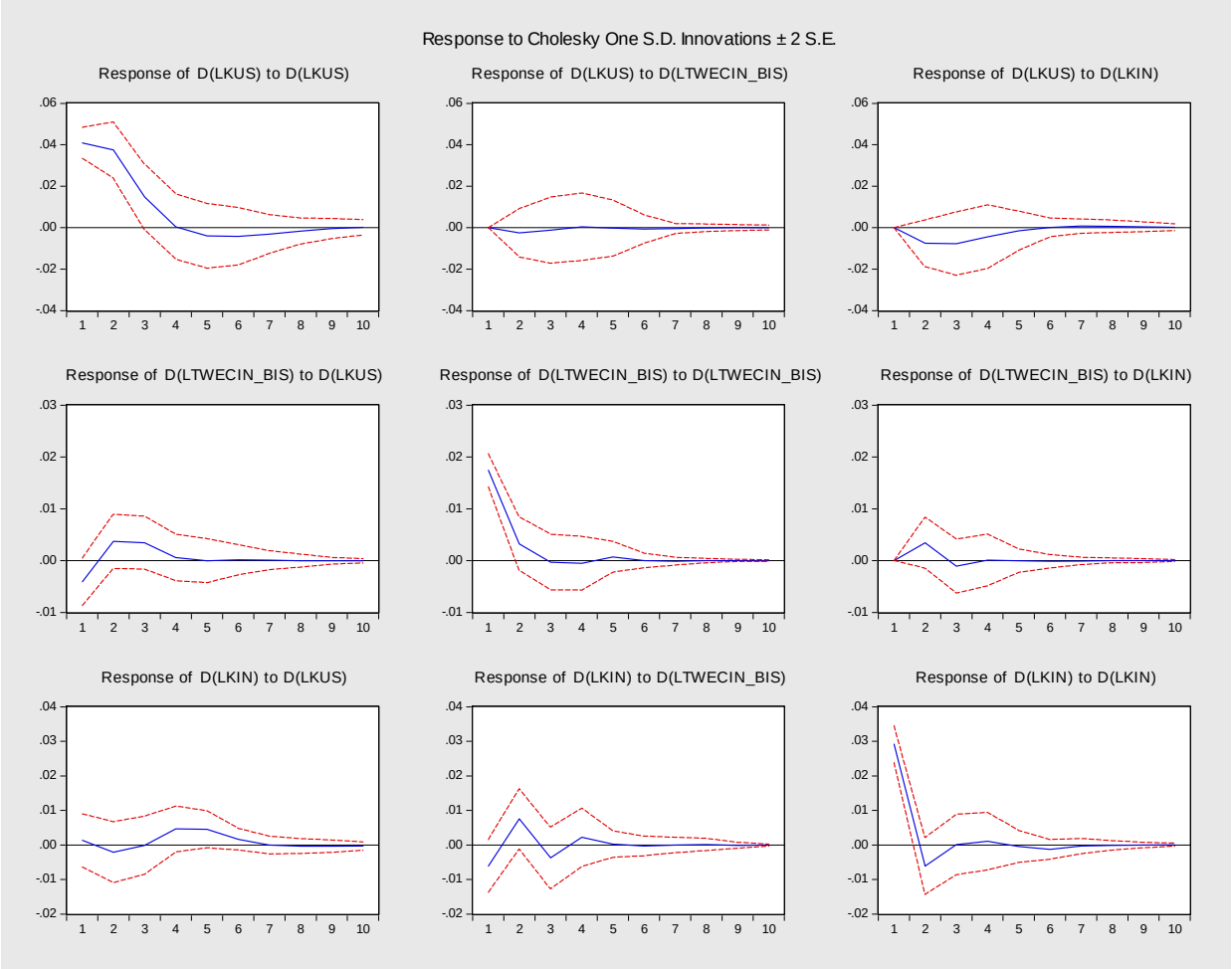

Figure 12: Impulse response function for India's response to US money base, 2008M09-2013M03

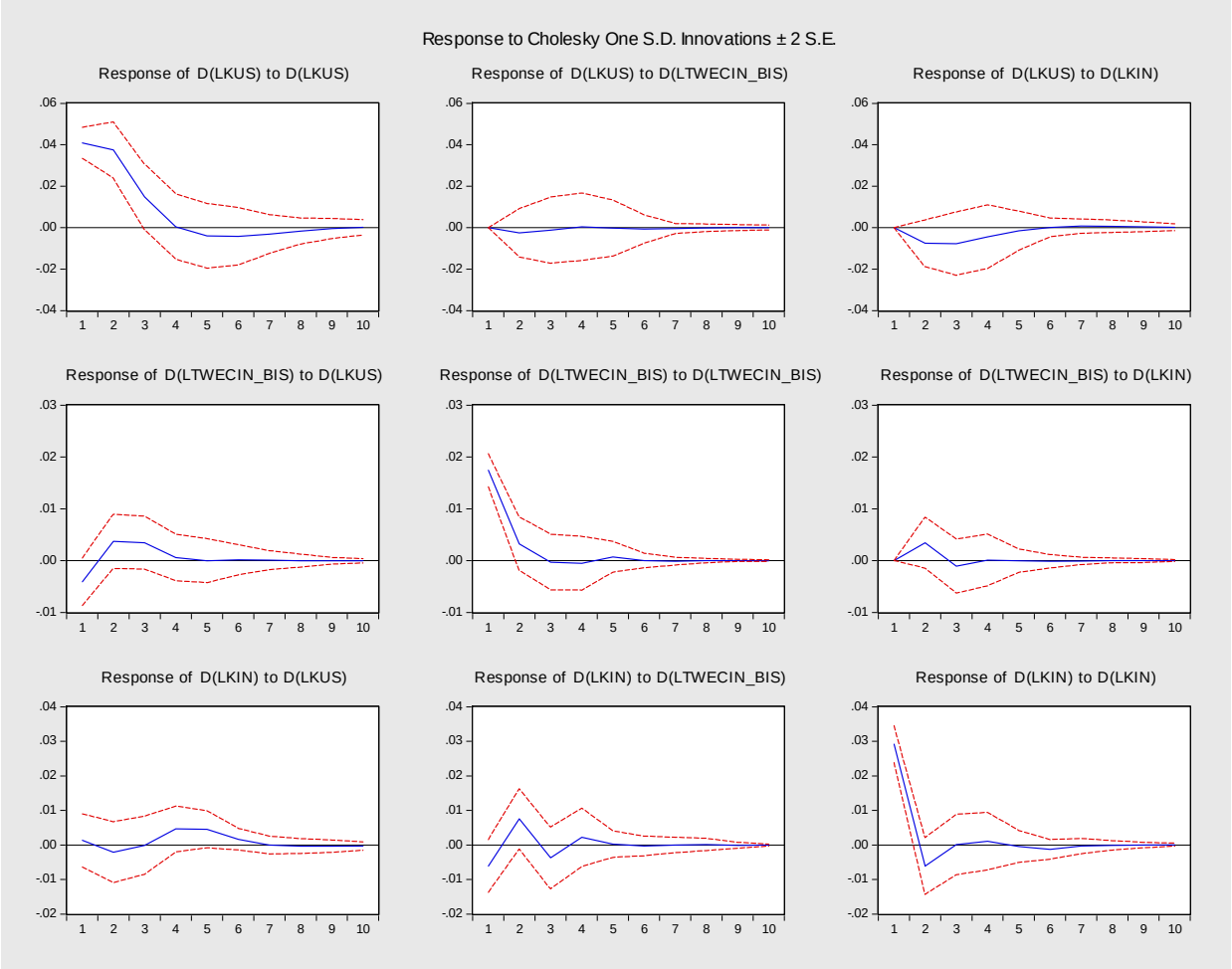

Figure 13: Impulse response function for China's response to US money base, 2008M09-2013M03

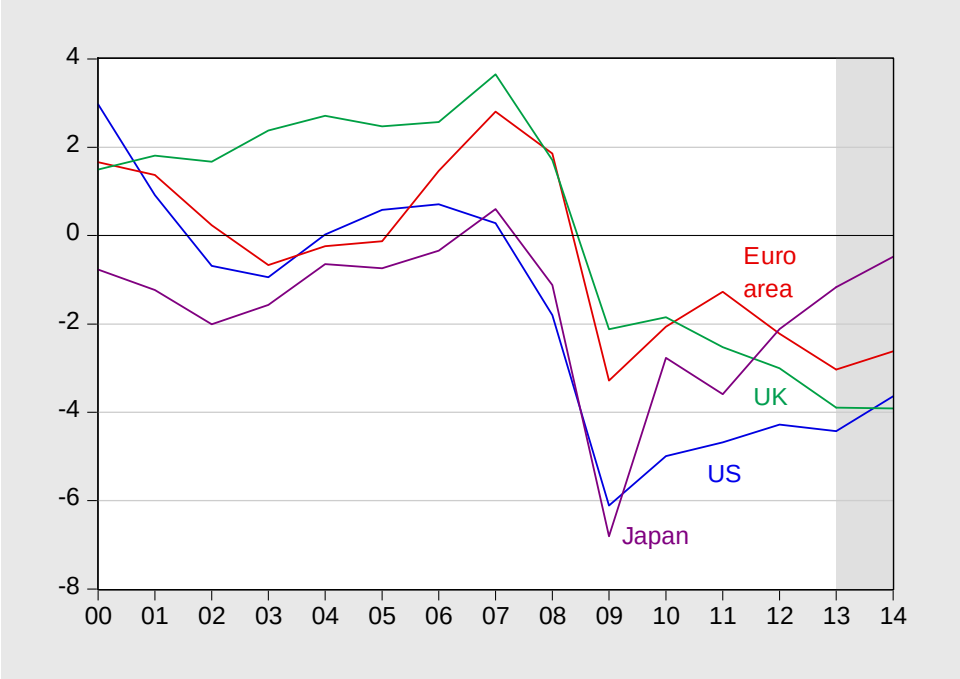

Figure 13: Output gaps, as share of GDP. Source: IMF

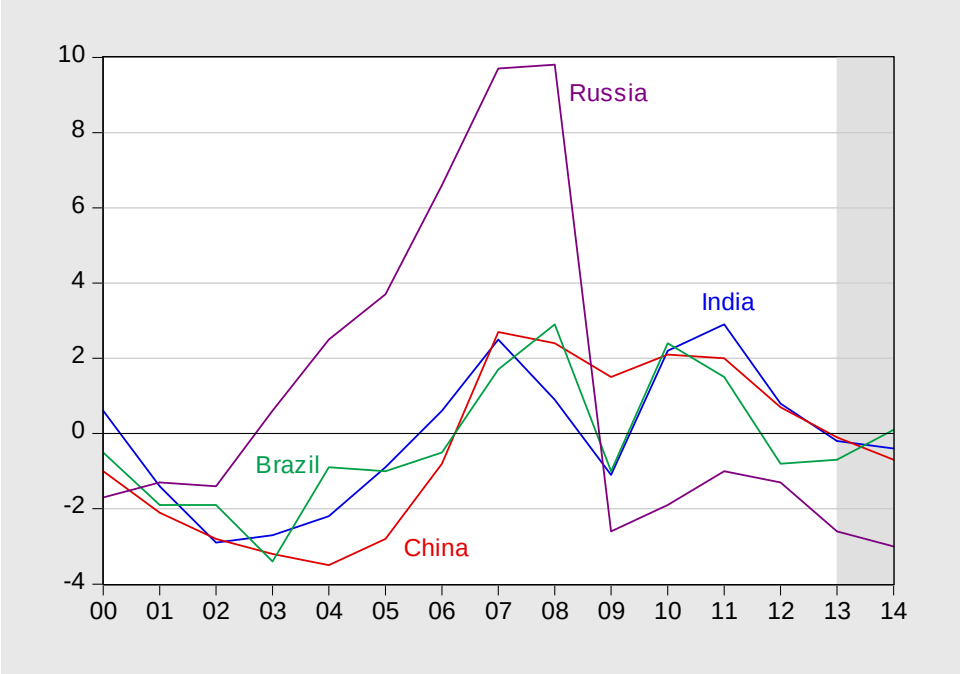

Figure 15: Output gaps, as share of GDP. Source: World Bank

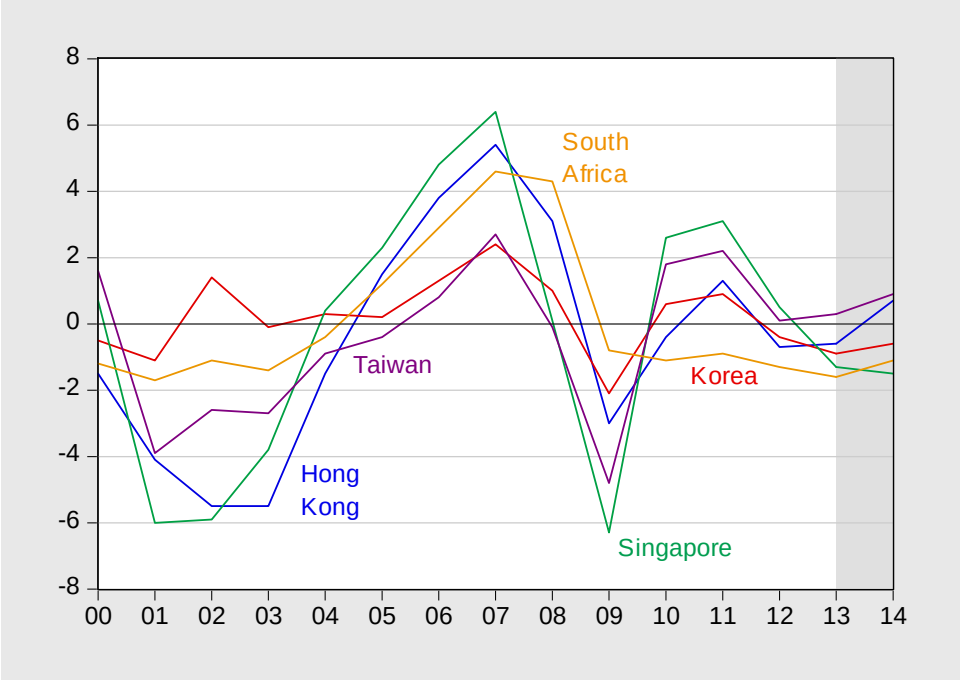

Figure 16: Output gaps, as a share of GDP. Source: World Bank