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Global Liquidity and Monetary Policy Autonomy

An Examination of Open-Economy Policy Constraints

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Abstract

This paper examines the monetary policy constraints facing economies on a fixed peg or managed float regime, contrasting the Mundell-Fleming Trilemma view against the Compensation view commonly found at central banks. While the former holds that foreign exchange inflows and outflows affect the domestic money base, constraining monetary policy under non-floating regimes unless capital controls are adopted, the latter purports that endogenous sterilisation of foreign exchange flows invalidates this trade-off. The predictions of both theories are empirically evaluated for five East Asian economies using central bank balance sheets, vector error correction models and impulse response functions. The findings indicate that the dynamics for the economies studied correspond more closely to the Compensation view than the Trilemma view, suggesting that it is a sustained loss of foreign exchange reserves that imposes a relevant constraint on autonomy rather than the adoption of a non-floating exchange rate regime.

Keywords: central banking; balance sheets; monetary policy; exchange rates; policy autonomy

JEL Classifications: E51; E58; F41.

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1 Introduction

Thought about the international monetary system and its working mechanisms has traditionally been guided by various notions of an "impossible trinity", according to which it is impossible for an economy to simultaneously achieve stable exchange rates, free capital movement and monetary policy independence. The theory goes that policy-makers are forced to choose a combination of any two of these goals, but cannot realise all three of them at the same time.

The most popular and arguably most influential representation of this *Trilemma view* is the Mundell-Fleming IS-LM-BP model, which holds that foreign exchange inflows and outflows directly affect the domestic money base under a fixed peg or managed float regime, making it impossible for an economy to pursue an independent monetary policy unless capital controls are adopted. While this view has been questioned from a variety of perspectives, with several studies arguing that the empirical effectiveness of sterilised foreign exchange market intervention (cf. Löffler et al., 2012; Ito, 2003) or the dominance of global financial cycles render the choice of the exchange rate regime irrelevant (cf. Rey, 2015), the idea that an economy loses its autonomy when adopting a peg is still widely held on to in the literature, irrespective of theoretical orientation.

This paper argues that the procedural principles underlying modern central bank systems largely invalidate the Trilemma trade-off, suggesting that an economy's degree of autonomy ultimately depends on its ability to accumulate foreign exchange rather than its choice of exchange rate regime. The paper builds to this argument through three sections: First, the Mundell-Fleming Trilemma is theoretically contrasted against the so-called *Compensation view*, a perspective commonly found in the writings of central bank practitioners (cf. Le Bourva, 1959, 1962; Berger, 1972; Goodhart, 1984, pp. 291–292) which holds that *endogenous* sterilisation of foreign exchange flows offsets possible effects on domestic monetary policy. Second, the predictions of both theories are examined on the basis of central bank balance sheet data and evidence is provided showing that empirical dynamics correspond more closely to the Compensation view than the Trilemma view. Finally, several important consequences of these findings pertaining on an economy's political autonomy and sovereignty are identified and analysed. The main implication is that currency pegs may be less costly in autonomy terms than has been traditionally assumed, whereas the gains from floating or monetary union may not be as high as generally expected.

2 Theoretical background

Consider an economy with a fixed exchange rate regime and an open capital account, where the central bank stands ready to convert foreign currency to local currency at some pre-announced parity. In the Trilemma view, the central bank in such an economy is understood to increase the domestic money supply whenever there is an inflow of foreign exchange (vice versa in the case of outflows). The resulting one-to-one link between the items "net foreign exchange reserves" and "money base" ($ALFR \uparrow\ LMB \uparrow$, where $\Delta ALFR = \Delta LMB$) on the central bank's balance sheet (figure 1) is said to deprive the central bank of its ability to set domestic interest rates by manipulating the money base, thus causing a loss of policy autonomy (cf. Ethier, 1995, p. 442; Obstfeld and Rogoff, 1995, p. 75).[1] Given free financial flows, the Trilemma view hence regards the choice of exchange rate regime as the determinant of policy autonomy.

Figure 1: Stylised Central Bank Balance Sheet

Assets		**Liabilities**	
$ALFR$	Net foreign exchange reserves	Money base	LMB
AGS	Government securities	Central bank securities	LCS
APR	Claims on private sector	Government deposits	LGD
		Other liabilities to private sector	LPR

The Compensation view, on the other hand, holds that a deviation of the money base in response to foreign exchange inflows would be prevented by movement in other balance sheet items, as such inflows would be offset by a decrease of other central bank assets (e.g. $ALFR \uparrow\ AGS \downarrow$) or an increase of other central bank liabilities (e.g. $ALFR \uparrow\ LCS \uparrow$). Such a *compensating* response could, contingent upon institutional factors and banks' liquidity preference, instantaneously absorb up to the full amount of the foreign exchange inflow (e.g. $\Delta ALFR = \Delta LCS$, where $\Delta LMB = 0$), preventing interest rate-distorting effects on the money base. Transitory or minor residual effects on the money base would then merely reflect changes in the demand for precautionary reserve holdings or national variations in reserve requirements and their associated maintenance periods, with no bearing on the domestic interest rate.

[1] While these transactions occur less frequently in the case of intermediate regimes (soft pegs, managed floats etc.), the mechanics are the same.

Known as *sterilisation*, the Trilemma view sees neutralizing transactions of this kind as a secondary and discretionary measure that is largely ineffective (e.g. McCallum, 1996, p. 138) or even detrimental to the integrity of a fixed exchange rate system (cf. Mundell, 1963, p. 485). In the Compensation view, by contrast, sterilisation is the logical consequence of the operation of an interest rate-targeting central bank system and is non-discretionary, as described by the former governor of the Bank of Japan, Shirakawa (2008, pp. 291–292):

> "*It does not make [theoretical] sense to distinguish between 'sterilised intervention' and 'unsterilised intervention'.* Moreover, based upon our understanding of the modern practices for monetary policy operations and foreign exchange market intervention, it is difficult to imagine an operation which would end up being an 'unsterilised intervention'. Consider the case of intervening by buying foreign currency, for example. In such a case, domestic currency [...] is paid to the market, so that the balance of central bank reserves increases. 'Unsterilised intervention' means that the central bank then leaves things as they are, but in this case the short-term interest rate would fall. Since the central bank has a target level for the short-term interest rate, however, [...] it will be necessary to conduct a funds absorption operation equal in size to the foreign exchange market intervention in order to realise the decided interest rate level. *In other words, as long as a target level for the short-term interest rate has been set, foreign exchange market intervention will always be 'sterilised'.* [...]" (Translation, annotation and emphases by the author of this paper)[2]

Shirakawa goes on to outline how the purchase of foreign currency by Japanese authorities involves the simultaneous issuance of "Short-Term Financing Bills", which automatically sterilise the transaction. Even when this is not the case, offsetting transactions may nevertheless occur automatically at the initiative of the private sector, as argued by Goodhart (1984, pp. 191–192), former member of the Bank of England's Monetary Policy Committee:

> "In order to achieve the desired level of [high-powered money], [...] the authorities have to try to offset movements, which may on occasions be very large, in all these other flows by inducing people to purchase, or if needs be to sell, marketable government debt. [Continued in footnote] *There is, however, some tendency towards negative covariation in these flows, i.e. they*

[2]The author thanks Tomohiro Kinoshita for helpful comments on the translation of this paragraph.

> *seem to interact in a way that produces some partial compensation, which alleviates certain of the difficulties facing the authorities.* A large foreign exchange inflow usually encourages sales of gilts [i.e. government bonds] and also reduces company demand for bank credit." (Annotations and emphasis by the author of this paper)

In a situation where commercial banks find themselves holding excess reserves that pay little or no interest, and without recourse to inter-bank lending in a situation where the system-wide demand for reserves is satisfied at the prevailing interest rate level, they will attempt to substitute the corresponding reserves for interest-earning assets while minimizing credit risk and liquidity risk, purchasing government securities or central bank securities from the central bank. Such transactions would be most common in economies where monetary policy primarily assumes the form of open-market operations, as in Anglo-American systems (cf. Mehrling, 2011). In economies where monetary policy typically relies on standing facilities and loans, as has historically been the case in the bank-dominated financial systems of Europe and East Asia (cf. Yoshino, 2012), banks may instead wish to repay part of their debt to the central bank and thereby reduce their debt servicing costs. Both responses would lead the money base to fall back to its original level without any explicit action on the part of the authorities, whereas in the Trilemma view it would remain at its new higher level, since an increase of commercial bank reserves is assumed to set into motion a multiplier process leading to a manifold expansion of the total money supply. Again, while sterilisation is recognised within the Trilemma view, it is seen as a fundamentally ineffective operation which should remain the exception, since frequent application would lead to a breakdown of the peg.

Under the Compensation view, sterilisation is thus an *endogenous* operation: In order to prevent interest rate movement away from its target level, a central bank must either accommodate private demand for reserves through credit facilities or open market operations, or find other ways to induce commercial banks to hold on to excess reserve balances. Whereas the sale of securities involves a "dual decision" by the central bank and the private sector, sterilising transactions may also be initiated autonomously by the private sector alone through drawings on central bank credit lines,[3] extending equivalent arrangements between commercial banks and firms (cf. Kaldor and Trevithick, 1981; Robinson, 1956, pp. 225–244). It is the latter demand-driven sterilisation in particular that Le Bourva (1959; 1962) and Berger (1972) of the Banque de France term the "compensation principle" (cf. Lavoie, 1992).[4]

[3]The author thanks Marc Lavoie for pointing out this distinction.

[4]Ehnts and Barbaroux (2015) give an account of the historical development of the Compensation thesis.

Within this framework, an economy remains autonomous so long as it maintains an inflow of foreign exchange, as its central bank faces no balance sheet constraint with respect to assets and liabilities denominated in its own currency and consequently no technical limitations to its ability to sterilise foreign exchange inflows (cf. Buiter, 2008).[5] By contrast, an economy experiencing a sustained outflow is limited by its remaining stock of foreign exchange reserves. Only the latter would find its autonomy constrained, understood here as the ability to achieve its interest rate target (cf. Lavoie, 2001).

3 Empirical analysis

3.1 Methodology

To determine which theory provides a better description of the workings of modern central bank systems, their predictions are compared on the basis of central bank balance sheets for five East Asian economies. If foreign reserve accumulation in these economies is primarily associated with a dominating, positive, significant and lasting increase of the money base, the Trilemma view would apply. If dominating, significant and lasting offsetting movement in other balance sheet items (negative in the case of assets and positive in the case of liabilities) is the observed response, the Compensation view would apply. To explore this question, vector error correction models (VECM), a multi-variate time-series framework which accounts for the presence of long-run stationary relationships among a group of variables (cointegration), are estimated and impulse response functions are calculated. This approach is somewhat similar to that followed by Lavoie and Wang (2011), who analyse the balance sheet of the People's Bank of China for the period from 1999 to 2007 and test restrictions on the long-run relations in the VECM.

In order to retrieve that part of the movement in balance sheet items that is due to an inflow of foreign exchange reserves, a standard Cholesky ordering is used to identify the orthogonalised impulse responses. Effects are assumed to run successively from net foreign exchange reserves to the money base before affecting other balance sheet items, arranged in order of decreasing importance as suggested by their outstanding positions. While this approach primarily corresponds to the causality predicted by the Trilemma view, it also allows for the possibility of transitory or minor liquidity effects on the money base, e.g. rising private reserve positions in anticipation of increased payment commitments during an economic expansion or precautionary reserve holdings during periods of stress in the financial system.

[5] Large-scale sterilisation is nevertheless said to incur 'quasi-fiscal cost' due to a possible negative interest rate differential between low-yielding foreign assets and high-yielding domestic liabilities.

The economies of South Korea, Taiwan, Malaysia, China and Hong Kong (in order of decreasing exchange rate flexibility) were selected for study here on the grounds that they are geographically close, institutionally well developed, and rather heterogeneous in their central bank set-ups and use of capital controls. Less developed economies typically do not make good candidates for analysis of this kind since necessary structures such as inter-bank markets or domestic bond markets are often absent or insufficient (cf. Yoshino et al., 2006). In more advanced economies, on the other hand, unconventional monetary policies involving interest payments on excess commercial bank reserves turn said reserves into near-perfect substitutes for treasury paper, causing their opportunity cost to disappear (or even become negative), which invalidates the negative relationship with interest rates that is central to both the Trilemma and the Compensation view (cf. Bindseil, 2014, pp. 93–95).

Monthly balance sheet data for the five economies analysed was obtained from the International Monetary Fund's (IMF) International Financial Statistics and from those economies' monetary authorities.[6] Raw data was aggregated to obtain the series shown in figure 1, where equity capital excluded as it is not relevant to the question at hand. The specific time frames were chosen so that the sample periods would coincide with significant foreign exchange reserve accumulation in the target economies while avoiding structural breaks within their balance sheets, i.e. instances where the outstanding position of any item becomes zero.

In order to eliminate cases where economies increase foreign reserve holdings by incurring foreign liabilities and reduce variation stemming from changes in the exchange rate, foreign liabilities (LFR) are subtracted from reserves (AFR) to obtain net figures ($ALFR$ in figure 1) and subsequently converted to US dollars ($ALFRU$) using the prevailing market exchange rate vis-à-vis local currency units (LCU).

$$ALFRU_t = (AFR_t - LFR_t) \cdot x_t \frac{USD}{LCU} \tag{1}$$

Finally, to ensure coherent treatment of balance sheet items across all five economies, the money base is adjusted in the cases of China and Hong Kong to maintain correspondence with its conventional definition, i.e. currency in circulation plus commercial bank reserves, which requires subtraction of components with a maturity larger than zero, including less liquid items and those kept in a non-discretionary fashion.[7]

[6] All statistics for Taiwan were obtained from the Central Bank of the Republic of China (Taiwan). Data on required reserves in China was obtained from the People's Bank of China. Data on Exchange Fund Bills and Notes in Hong Kong were obtained from the Hong Kong Monetary Authority.

[7] This corresponds to the definition used by the US Fed (2014) and the ECB (2015), among others.

3.2 Data

The balance sheets of the five monetary authorities under study are shown in figures 2 to 6, with assets stacked in positive territory and liabilities stacked in negative territory.[8] All balance sheets indicate significant foreign exchange reserve accumulation in the period after the Asian Financial Crisis that, on the basis of a first-look visual observation, does not show any obvious association with the money base, which merely seems to increase linearly over time. Indeed, in several instances changes in the money base appear to correlate negatively with changes in net foreign exchange reserves in US dollars.

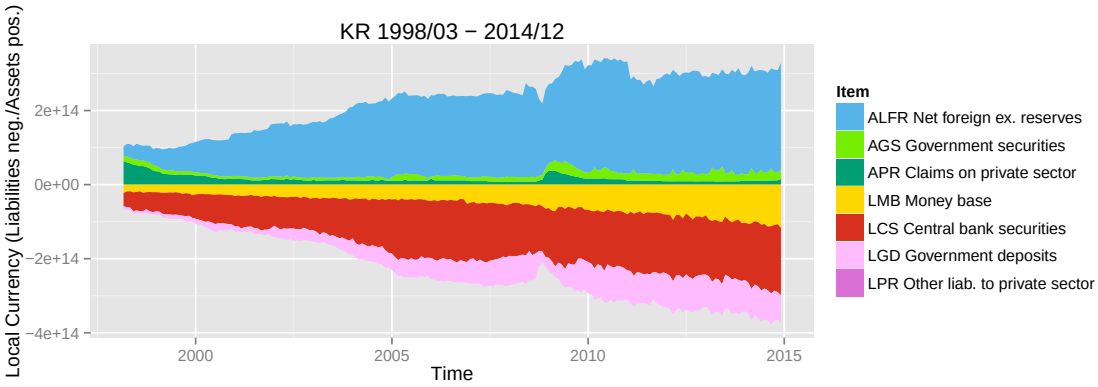
Several institutional observations are in order. While monetary policy in East Asia used to rely primarily on standing credit facilities, the accumulation of foreign exchange reserves within the last several years has shifted the focus towards the liability side of central bank balance sheets. All of the economies under consideration issued central bank securities in large amounts (LCS), which, in Taiwan's case, were complemented by so-called "re-deposits", reserves financial institutions are obliged to hold with the central bank (Yang and Shea, 2006). In China, central bank bills played an important role up to 2009 (Lavoie and Wang, 2011; Körner and Ehnts, 2013), when emphasis shifted towards required reserves (LRR), the ratios of which are substantially higher and more frequently adjusted than in other economies (Ma et al., 2013). Also, government deposits (LGD) have been a prominent item on the balance sheet of the Bank of Korea for several years and, most importantly, as a counterbalancing item to foreign exchange inflows in Hong Kong, which is a feature of many currency boards (cf. Dobrev, 1999).

Taiwan and Malaysia both stabilise exchange rates to a greater degree than Korea, albeit at lower frequencies than China or Hong Kong. In addition, Malaysia and China rely on various types of capital controls, although those seem to be weakening somewhat in recent years due to some cautious stepwise official liberalisation of the capital account and, especially in the latter's case, unofficial circumvention via over-invoicing and under-invoicing of current account transactions.

As mentioned earlier, in order to ensure coherent treatment of balance sheet items across different economies, the "money base" as defined in China and Hong Kong is modified to correspond to the same concept as in other economies. In China, this requires accounting for the large positions of required reserves, which are either absent or negligible in other economies. Reserves absorbed in this way cannot be used for other purposes, so they essentially function like any other central bank security (cf. Bindseil, 2014, pp. 93–95).

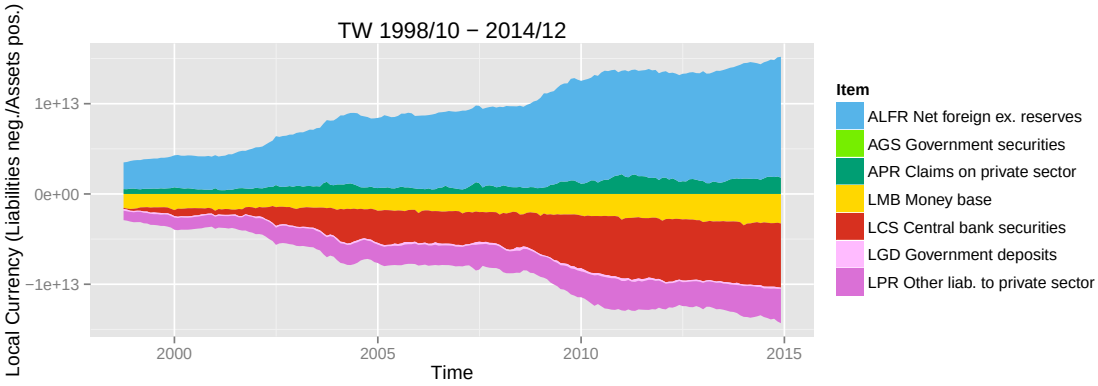
[8] Liabilities are plotted on a negative scale only for exhibition. The actual data series are positive.

Figure 2: Balance sheet of Bank of Korea



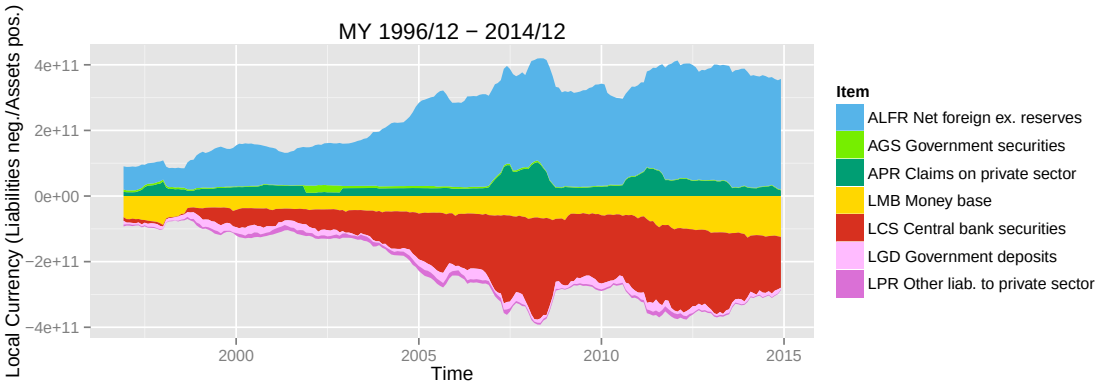
Source: IMF International Financial Statistics

Figure 3: Balance sheet of Central Bank of the Republic of China (Taiwan)



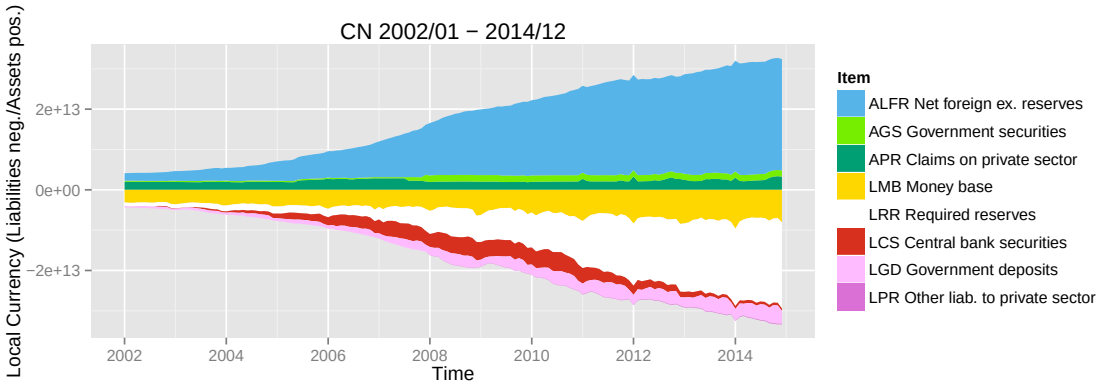
Source: Central Bank of the Republic of China (Taiwan)

Figure 4: Balance sheet of the Bank Negara Malaysia



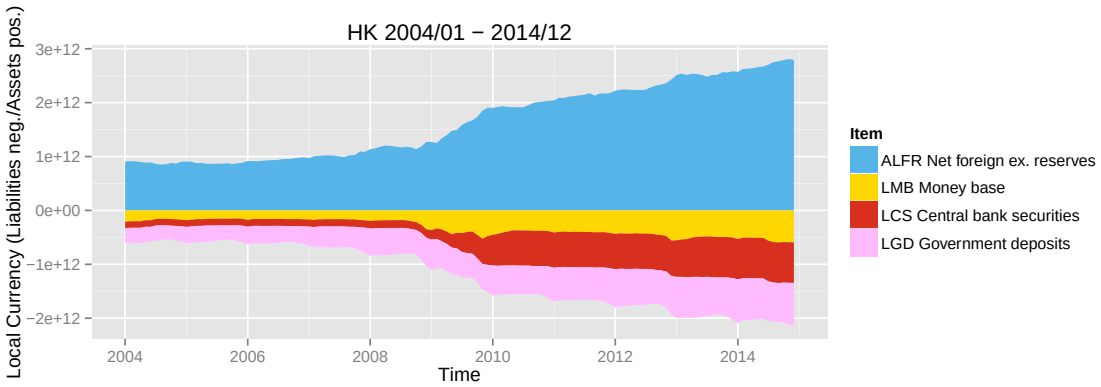
Source: IMF International Financial Statistics

Figure 5: Balance sheet of the People's Bank of China



Source: IMF International Financial Statistics, People's Bank of China
Note: The area LRR represents the share of the money base which is held as required reserves. The remaining area LMB thus represents excess reserves.

Figure 6: Balance sheet of the Hong Kong Monetary Authority



Source: IMF International Financial Statistics, Hong Kong Monetary Authority
Note: Exchange Fund Bills and Notes (LCS) are by definition part of the money base in Hong Kong but analysed separately here for reasons of consistency.

The outstanding amount of required reserves is consequently approximated (as LRR) and taken out of the money base.[9] This item is then summed up with central bank securities into a pseudo-instrument "required reserves plus central bank bills" ($LRRCS$) to compensate for the structural shift between these two items.

[9]Since the actual calculation of required reserves is complex, differing according to both type of deposits and size of the institution in question, the outstanding amount of required reserves is approximated on the basis of the average reserve requirement rate for small and large banks and total demand and savings deposits in the banking system.

Similarly, the money base in Hong Kong includes securities issued by the Hong Kong Monetary Authority (HKMA) which require separate treatment (as LCS). While the HKMA goes to great lengths to demonstrate that its securities are fully backed by US dollar reserves, are issued in a non-discretionary manner and have the same standing as other components of the money base with respect to its convertibility undertakings (HKMA, 2011), other currency boards do make an explicit distinction here, an example being Macao, which itself pegs to the Hong Kong dollar. The situation is complicated somewhat by the fact that a money base as such did not exist in Hong Kong until the late 1990s, as inter-bank settlement and clearing was conducted through balances with the HSBC, formerly the "Hong Kong and Shanghai Banking Corporation" (cf. Latter, 2009). Even after this function was taken over by the HKMA, variation on the liability side remained extremely small until the first decade of the new millennium.

3.3 Estimations

In preparation for the estimations, all series were converted to natural logarithms and subjected to unit root tests to ensure that non-stationary series were present in all data sets, which was the case in each of the economies analysed. Furthermore, in each economy's data set, the presence of deterministic trends could not be ruled out for one or more balance sheet items. This is accounted for by including unrestricted constants and restricted trend terms in the specification of the VEC models, in line with Doornik (1998):

$$\Delta y_t = \mu_0 + \mu_1 t + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \epsilon_t \qquad \text{with } \alpha' \perp \mu_1 = 0 \tag{2}$$

where Π can be represented by a loading matrix α and a cointegration matrix β, which determine the speed of adjustment and the cointegration space respectively

$$\Pi = \alpha\beta'$$

Using a lag order suggested by the Hanna-Quinn information criterion, the number of long-run stationary relations was determined using Johansen cointegration tests and specified in the final models that were used to obtain the orthogonalised impulse responses, on the basis of which the reactions of balance sheet items to a one-standard error increase in the natural log of net foreign exchange reserves in US dollars ($lnALFRU$) were analysed. Finally, since interest primarily lies in the absolute size and direction of responses, the logged impulse responses are converted to mean responses in local currency terms, averaged over short and long horizons and presented in figure 7.

Figure 7: Mean impulse responses in levels

Mean responses to a 1% increase in net foreign exchange reserves, averaged over short-run (horizon 0 to 5) and long-run (6 to 47), in millions of local currency units

	Horizon	AGS	APR	LMB	LRR	LCS	LGD	LPR
KR	Short	−57 040	−44 811	31 700	–	85 169	385 774	−194
	Long	−44 042	−64 327	23 003	–	−103 000	72 146	−149
TW	Short	−33	7 651	42	–	70 865	507	2 334
	Long	−52	15 501	280	–	61 874	396	2 402
MY	Short	−12	−110	−254	–	3 225	11	106
	Long	−9	−83	−252	–	4 087	111	110
CN	Short	4 042	−22 635	−23 709	108 702		38 242	−2 482
	Long	59 596	−55 669	5 589	474 457		80 557	33 413
HK	Short	–	–	1 637	–	685	5 152	–
	Long	–	–	2 667	–	6 707	1 283	–

Shaded cells: response different from zero given 68% confidence bands for majority of horizons within range

Mean response in levels obtained by scaling shock to 1% and multiplying the response of each item in log terms by its mean in levels

3.4 Results

No strong endogenous relation was found between the money base (LMB) and net foreign exchange reserves ($ALFRU$) in the economies analysed. The response of the money base to foreign exchange inflows is typically quantitatively small, mostly indeterminate and statistically insignificant given the 68% confidence bands used in the calculation of impulse responses. Instead, it appears that there exists an endogenous link between net foreign exchange reserves and other balance sheet items, since one or several items generally dominate the effect on the money base, with the direction of large responses largely corresponding to the predictions of the Compensation view for most significant and even most insignificant items.

There is evidence of asset-side sterilisation through claims on the private sector (APR) in South Korea and China, indicating potentially automatic demand-side sterilisation at the initiative of the private sector, as predicted by the Compensation view, even within the highly regulated financial system of China. While the corresponding item for Taiwan appears to be positive and significant, this association quickly turns insignificant when lag order is increased. Central bank securities (LCS), in contrast, seem to play a more

important role in Taiwan and Malaysia. They are also used in China in combination with required reserves ($LRRCS$), the latter representing a case of non-market-based sterilisation. Interestingly, central bank securities do not seem to be directly related to foreign exchange inflows in South Korea, where they are issued at regular intervals and not exclusively for the purpose of sterilisation (cf. BOK, 2013, pp. 84–88). Rising government deposits (LGD) can further be observed to offset the inflow of liquidity in South Korea, Hong Kong and China, although this effect was not as present in the case of Korea when experimenting with alternative time frames.

A small reaction of the money base, where present at all, can be attributed to transitory or liquidity effects. The only case where the money base shows a significant increase over several horizons which is also somewhat relevant in local currency terms is Hong Kong. The HKMA appears to follow a more passive strategy of maintaining financial market integrity within the limits of its convertibility undertaking arrangement, allowing for more variation of the money base. It should also be noted that the response observed here is most likely at least partly the result of large liquidity injections undertaken in reaction to stress in the financial system in 2008, so the response of the money base may be somewhat overstated (cf. HKMA, 2010). In any case, sterilisation plays an overriding role in Hong Kong similar to other economies under consideration, suggesting that there is no inherent incompatibility between sterilisation and exchange rate stabilisation, as demonstrated by the remarkable stability of Hong Kong's peg.

In summary, these findings suggest that sterilisation is in fact the norm rather than the exception in all of the economies under consideration. Although the means of achieving sterilisation are distinct, relying on different items, varying in timing and scope, and encompassing non-market-based approaches, transactions initiated on the demand side, and operations involving a dual decision by the central bank and the private sector, they all aim at maintaining policy conditions in line with official objectives. Sterilisation isolates the money base from external impacts and thus occurs systematically, as held by the Compensation view.

3.5 Robustness

The dynamics found are generally fairly robust across a variety of specifications. Variations in the estimation procedure, such as changing of the Cholesky ordering of the variables, increasing the lag order or the size of confidence bands, removing trends in borderline cases, and restricting sample periods to the most recent decade, typically reinforce the results presented above. Some instability remains in the case of Hong Kong, which again highlights the difficulty of tracing balance sheet effects in the presence of large official liquidity injections. Selected alternative specifications are provided in the statistical appendix.

Variance decompositions not reported here further confirm that variance in net foreign exchange reserves is a primary contributor to variance in the items showing the most significant impulse responses, whereas its contribution to variance in the money base is generally minor. One potential source of bias remaining is the possibility of higher degrees of integration in the series entering the models. This can be regarded as unlikely, however, given the finite growth exhibited by the series in levels and their conversion to natural logarithms, which further serves to stabilise growth behaviour.

4 Interpretation and implications

Transactions of the kind empirically observed here occur because interest rates act as a price signal mediating private and public sector balance sheets. Since the formulation of balance sheet quantities is simply the result of these transactions, inflows and outflows of foreign exchange do not affect the domestic money base and, by extension, the domestic interest rate level. In terms of the dichotomy between *balance sheet policy* and *interest rate policy* as given by Borio and Disyatat (2010), foreign exchange transactions represent an instance of the former, whereas autonomy is exercised through the latter.

As a consequence, adoption of a non-floating exchange rate regime does not necessarily lead to a loss of policy autonomy; it may merely reduce the scope within which monetary policy can operate (cf. Moore, 1988, p. 274). As long as an economy is accumulating foreign exchange, its central bank can set a short-term interest rate target in line with domestic policy objectives, thus restricting interest rate arbitrage (along the lines of the interest rate parity condition) to those rates further removed from official control, i.e. rates at the long end of the yield curve, yields on private sector securities, or rates on offshore markets. Policy-makers may choose not to exercise this autonomy; nonetheless they do have it.

The relevant constraint on domestic monetary policy comes in the form of a sustained outflow of foreign exchange reserves, which no central bank can compensate for indefinitely. Thus, rather than having to choose between monetary policy autonomy and pegging, economies with an open capital account face a trade-off between monetary policy autonomy and a loss of foreign exchange reserves, only one of which can be maintained in the long run.

This shift in perspective has important consequences for traditional political economy and international relations theory on national sovereignty in international markets (such as Realism, Intergovernmentalism or Neofunctionalism). Small European economies prior to the introduction of the euro, for example, were generally understood to have given up their monetary policy autonomy in favour of pegging to the German mark, so joining the monetary union may have seemed like an attractive proposition, since policy-makers could at least increase their de-facto autonomy as a result of gaining the ability to influence policy-making on supranational levels. The results presented here, however, point strongly to a reconsideration of that conclusion, as it has been shown that economies adopting non-floating regimes do not automatically lose their autonomy, whereas recent European experience has demonstrated that an imperfect monetary union has the potential to restrict members' autonomy in matters far beyond the monetary. Consequently, the adoption of a peg in itself cannot be interpreted as a change in the "power" relationship between two economies.

East Asian economies found themselves in a similar situation following the 1997–98 Asian Financial Crisis, when dissatisfaction with the IMF's crisis response led to calls for monetary integration as a form of protection from the negative externalities associated with dollar-pegging. The political reality in the region made institutionalisation of the process difficult, however, and it seems that acceptance of this fact has served East Asian economies rather well. The post-crisis strategy of adopting similarly structured currency baskets has kept intra-regional exchange rates relatively stable while providing more flexibility than would monetary union (cf. Williamson, 1996; Yoshino et al., 2004). In short, putting pragmatism ahead of higher, possibly unattainable goals may be a more effective strategy for achieving regional stability and prosperity.

5 Conclusion

This study examined the predictions of the Trilemma view and the Compensation view with regard to the relationship between an economy's foreign exchange reserves and its domestic money base, in an effort to ascertain whether a link exists between the two which constrains monetary policy independence under a fixed peg or a managed float regime. Analysis of five East Asian economies could not confirm the prediction of the Trilemma view that foreign reserve accumulation primarily leads to a large, significant and lasting increase of the money base. Rather, the results indicate that sterilisation offsets foreign exchange inflows systematically and endogenously, with the direction, size and significance of the movement in central bank balance sheet items corresponding more closely to the Compensation view.

These findings suggest that economies accumulating foreign exchange reserves do not face a constraint of their monetary policy autonomy. The absence of such a mechanical relation implies that economies can maintain a degree of policy autonomy even if they choose to stabilise exchange rates, so long as they continue to accumulate foreign exchange reserves. In that light, pegging one's exchange rate may not be as costly in autonomy terms as traditionally assumed, whereas the gains from floating or monetary union may not be as high as assumed.

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7 Statistical appendix

7.1 South Korea

Figure 8: Unit root tests: South Korea

Critical values and corresponding significance level

Item	Det.	ADF	KPSS	Item	Det.	ADF	KPSS
lnALFRU	C, T	-2.114	0.324 ***	lnLCS	C, T	-1.804	0.311 ***
lnALFRU	C	-2.101	1.169 ***	lnLCS	C	-2.009	1.201 ***
lnAGS	C, T	-2.892	0.182 **	lnLGD	C, T	-3.151 *	0.299 ***
lnAGS	C	-0.737	1.095 ***	lnLGD	C	-2.202	1.296 ***
lnAPR	C, T	-3.030	0.175 **	lnLPR	C, T	-2.473	0.276 ***
lnAPR	C	-3.177 **	0.583 **	lnLPR	C	-2.834 *	0.886 ***
lnLMB	C, T	-2.463	0.130 *				
lnLMB	C	0.031	1.438 ***				

Sign.: *** 0.01, ** 0.05, * 0.1; Det. = Deterministic components: C = Constant, T = Trend

Figure 9: Johansen cointegration test: South Korea

Number of equations = 7
Lag order = 1
Estimation period: 1998:04 - 2014:12 (T = 201)
Case 4: Restricted trend, unrestricted constant
Log-likelihood = 1602.16 (including constant term: 1031.75)

Rank	Eigenvalue	Trace	p-value	Lmax	p-value	Lmax*	p-value
0	0.48749	366.96	0.0000	134.36	0.0000	366.96	0.0000
1	0.35291	232.61	0.0000	87.491	0.0000	232.61	0.0000
2	0.2502	145.12	0.0000	57.877	0.0000	145.12	0.0000
3	0.17683	87.24	0.0001	39.112	0.0039	87.24	0.0001
4	0.13349	48.128	0.0123	28.799	0.0164	48.128	0.0135
5	0.053218	19.328	0.2672	10.992	0.5258	19.328	0.2726
6	0.040625	8.3362	0.2321	8.3362	0.2322	8.3362	0.2321

* Degrees of freedom corrected for sample size

Figure 10: Vector error correction model: South Korea

(Only error correction part shown to save space, full estimations available from author upon request)

VECM system, lag order 1

Maximum likelihood estimates, observations 1998:04–2014:12 ($T = 201$)

Cointegration rank = 5

Case 4: Restricted trend, unrestricted constant

Cointegrating vectors (standard errors in parentheses)

$\ln ALFRU_{t-1}$	1.00000	0.00000	0.00000	0.00000	0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
$\ln LMB_{t-1}$	0.00000	1.00000	0.00000	0.00000	0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
$\ln LCS_{t-1}$	0.00000	0.00000	1.00000	0.00000	0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
$\ln LGD_{t-1}$	0.00000	0.00000	0.00000	1.00000	0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
$\ln AGS_{t-1}$	0.00000	0.00000	0.00000	0.00000	1.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
$\ln APR_{t-1}$	−3.91122	0.853455	−4.35373	−1.70822	−1.38861
	(0.900984)	(0.172070)	(0.942829)	(0.431992)	(0.181125)
$\ln LPR_{t-1}$	0.0306490	−0.00332421	0.0231280	0.0330550	0.000831883
	(0.0526807)	(0.0100609)	(0.0551273)	(0.0252586)	(0.0105904)
trend	0.00391389	−0.00992477	0.00525455	−0.00378176	−0.00762481
	(0.00832915)	(0.00159070)	(0.00871598)	(0.00399355)	(0.00167441)

Adjustment vectors

$\ln ALFRU_{t-1}$	1.00000	−0.364920	5.59043	−0.239394	0.0518858
$\ln LMB_{t-1}$	−0.643444	1.00000	−5.19514	0.267387	0.111176
$\ln LCS_{t-1}$	0.181887	−0.0766385	1.00000	−0.0883768	0.0897360
$\ln LGD_{t-1}$	−1.12685	−0.442380	−1.88953	1.00000	−0.171502
$\ln AGS_{t-1}$	0.818716	0.489257	5.05598	−0.0256014	1.00000
$\ln APR_{t-1}$	−0.0203868	0.303700	1.30205	0.602168	−0.0273180
$\ln LPR_{t-1}$	11.0527	−2.84196	49.2174	−6.23210	1.18036

Log-likelihood = 1022.08

Determinant of covariance matrix = 0.00000

AIC = −9.7521

BIC = −9.0618

HQC = −9.4728

Figure 11: Impulse responses: South Korea

Impulse responses to one SE shock in $lnALFRU$
48 period forecast, 68% bootstrapped confidence bands

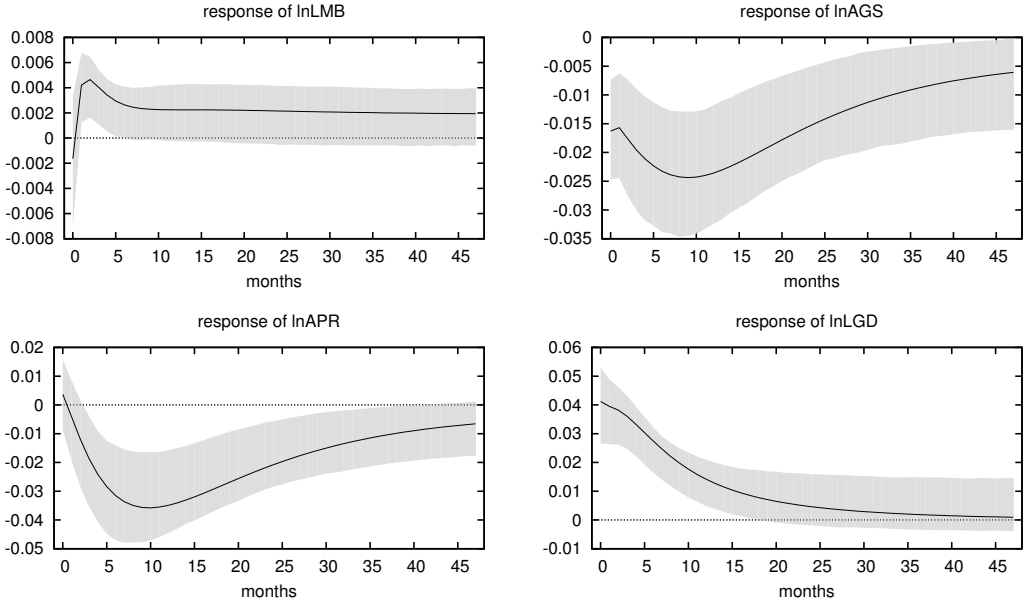
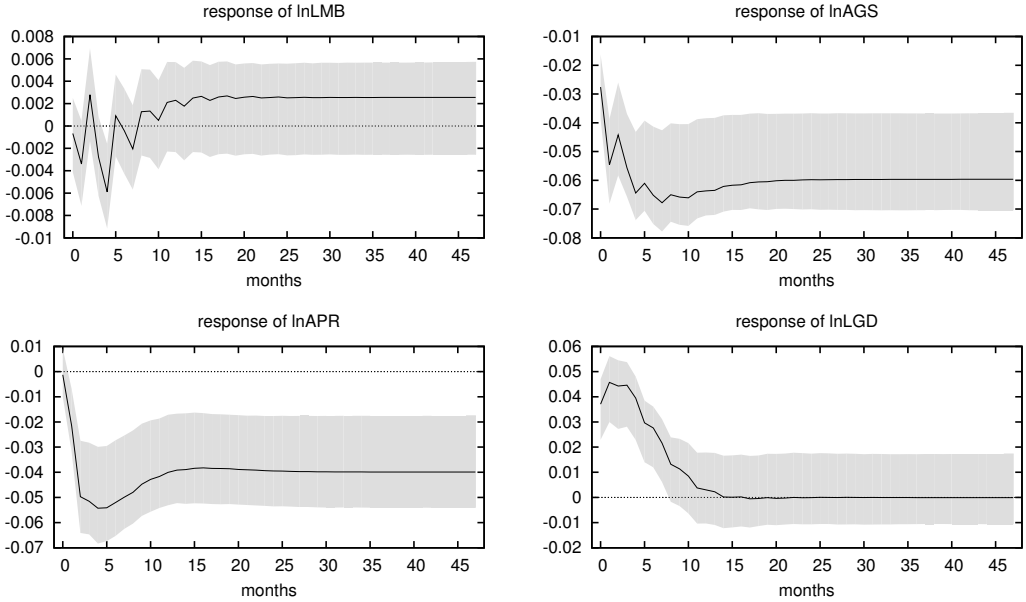


Figure 12: Robustness check: South Korea

Removal of restricted trend term causes HQ information criterion to rise to 3 and cointegration rank to decrease to 2
Impulse responses to one SE shock in $lnALFRU$ for a corresponding VEC model below



7.2 Taiwan

Figure 13: Unit root tests: Taiwan

Critical values and corresponding significance level

Item	Det.	ADF	KPSS	Item	Det.	ADF	KPSS
lnALFRU	C, T	-1.090	0.266 ***	lnLCS	C, T	-1.999	0.280 ***
lnALFRU	C	-2.724 *	1.338 ***	lnLCS	C	-3.059 **	1.236 ***
lnAGS	C, T	-1.683	0.245 ***	lnLGD	C, T	-4.409 ***	0.222 ***
lnAGS	C	-1.870	1.035 ***	lnLGD	C	-4.340 ***	0.625 **
lnAPR	C, T	-3.202 *	0.110	lnLPR	C, T	-2.873	0.204 **
lnAPR	C	-2.016	1.088 ***	lnLPR	C	-1.569	1.286 ***
lnLMB	C, T	-4.413 ***	0.267 ***				
lnLMB	C	0.172	1.334 ***				

Sign.: *** 0.01, ** 0.05, * 0.1; Det. = Deterministic components: C = Constant, T = Trend

Figure 14: Johansen cointegration test: Taiwan

Number of equations = 7
Lag order = 1
Estimation period: 1998:11 - 2014:12 (T = 194)
Case 4: Restricted trend, unrestricted constant
Log-likelihood = 2041.76 (including constant term: 1491.21)

Rank	Eigenvalue	Trace	p-value	Lmax	p-value	Lmax*	p-value
0	0.33509	265.97	0.0000	79.172	0.0000	265.97	0.0000
1	0.26685	186.8	0.0000	60.219	0.0002	186.8	0.0000
2	0.22839	126.58	0.0000	50.3	0.0006	126.58	0.0000
3	0.16738	76.276	0.0025	35.536	0.0149	76.276	0.0031
4	0.1108	40.74	0.0801	22.783	0.1211	40.74	0.0856
5	0.04836	17.958	0.3541	9.6163	0.6655	17.958	0.3604
6	0.042086	8.3415	0.2316	8.3415	0.2318	8.3415	0.2317

* Degrees of freedom corrected for sample size

Figure 15: Vector error correction model: Taiwan

(Only error correction part shown to save space, full estimations available from author upon request)

VECM system, lag order 1

Maximum likelihood estimates, observations 1998:11–2014:12 ($T = 194$)

Cointegration rank = 4

Case 4: Restricted trend, unrestricted constant

Cointegrating vectors (standard errors in parentheses)

$\ln\text{ALFRU}_{t-1}$	1.00000	0.00000	0.00000	0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
$\ln\text{LMB}_{t-1}$	0.00000	1.00000	0.00000	0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
$\ln\text{LCS}_{t-1}$	0.00000	0.00000	1.00000	0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
$\ln\text{LPR}_{t-1}$	0.00000	0.00000	0.00000	1.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
$\ln\text{APR}_{t-1}$	−0.333291	−0.0633080	−0.728973	0.0423070
	(0.0831136)	(0.0759276)	(0.310062)	(0.128900)
$\ln\text{LGD}_{t-1}$	−0.424872	0.634565	−1.62857	−1.35297
	(0.102555)	(0.0936882)	(0.382590)	(0.159052)
$\ln\text{AGS}_{t-1}$	0.00977772	0.00793683	0.00953128	−0.0162883
	(0.00387523)	(0.00354018)	(0.0144568)	(0.00601005)
trend	−0.00314988	−0.00409977	−0.00275080	−0.00563392
	(0.000928038)	(0.000847800)	(0.00346212)	(0.00143929)

Adjustment vectors

$\ln\text{ALFRU}_{t-1}$	1.00000	0.141707	−0.0186139	0.0818403
$\ln\text{LMB}_{t-1}$	−0.754349	1.00000	0.291614	8.45047
$\ln\text{LCS}_{t-1}$	−3.03429	−0.0487415	1.00000	−6.16341
$\ln\text{LPR}_{t-1}$	−0.173820	0.139563	0.0564749	1.00000
$\ln\text{APR}_{t-1}$	−6.12842	0.0962238	0.590954	0.447984
$\ln\text{LGD}_{t-1}$	−0.521101	0.473772	0.413446	−17.2171
$\ln\text{AGS}_{t-1}$	23.5230	−4.79002	−2.63478	−58.7449

Log-likelihood = 1470.84

Determinant of covariance matrix = 0.00000

AIC = −14.8025

BIC = −14.2129

HQC = −14.5637

Figure 16: Impulse responses: Taiwan

Impulse responses to one SE shock in $lnALFRU$

48 period forecast, 68% bootstrapped confidence bands

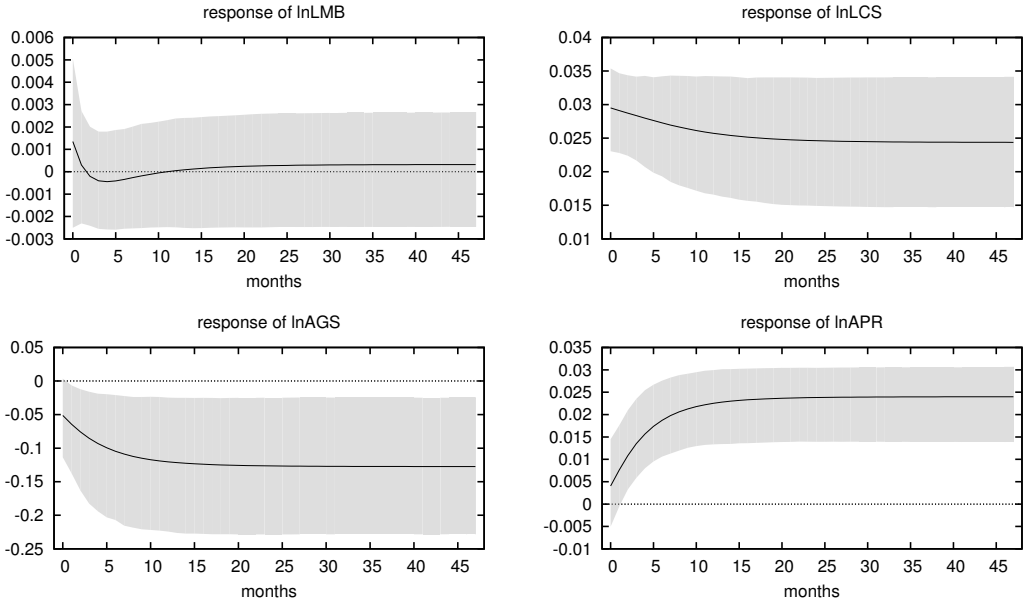
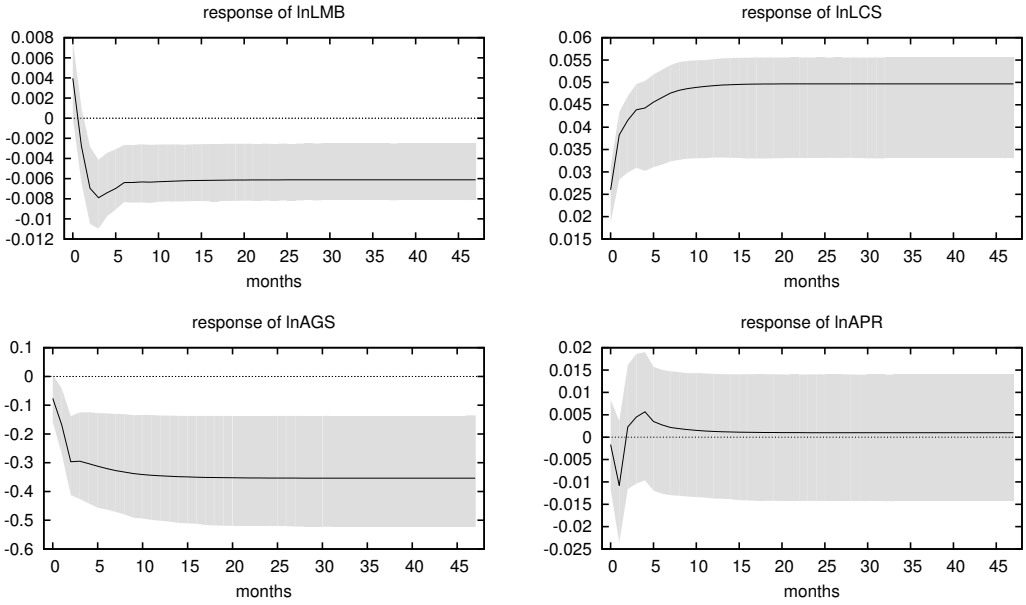


Figure 17: Robustness check: Taiwan

Increase of lag order to 3 causes cointegration rank to decrease to 3

Impulse responses to one SE shock in $lnALFRU$ for a corresponding VEC model below



7.3 Malaysia

Figure 18: Unit root tests: Malaysia

Critical values and corresponding significance level

Item	Det.	ADF	KPSS	Item	Det.	ADF	KPSS
lnALFRU	C, T	-0.979	0.206 **	lnLCS	C, T	-1.823	0.278 ***
lnALFRU	C	-1.440	1.418 ***	lnLCS	C	-2.943 **	1.179 ***
lnAGS	C, T	-2.614	0.171 **	lnLGD	C, T	-4.114 ***	0.069
lnAGS	C	-2.238	0.607 **	lnLGD	C	-4.053 ***	0.071
lnAPR	C, T	-2.232	0.078	lnLPR	C, T	-2.909	0.230 ***
lnAPR	C	-2.312	0.615 **	lnLPR	C	-2.123	0.254
lnLMB	C, T	-2.206	0.234 ***				
lnLMB	C	0.264	0.986 ***				

Sign.: *** 0.01, ** 0.05, * 0.1; Det. = Deterministic components: C = Constant, T = Trend

Figure 19: Johansen cointegration test: Malaysia

Number of equations = 7
Lag order = 1
Estimation period: 1997:01 - 2014:12 (T = 216)
Case 4: Restricted trend, unrestricted constant
Log-likelihood = 1601.31 (including constant term: 988.327)

Rank	Eigenvalue	Trace	p-value	Lmax	p-value	Lmax*	p-value
0	0.25528	170.2	0.0020	63.666	0.0006	170.2	0.0034
1	0.14852	106.53	0.2053	34.729	0.3953	106.53	0.2402
2	0.10383	71.804	0.4403	23.68	0.7631	71.804	0.4723
3	0.087453	48.124	0.5033	19.767	0.6775	48.124	0.5242
4	0.060972	28.356	0.6052	13.589	0.7594	28.356	0.6170
5	0.039686	14.768	0.6002	8.7468	0.7503	14.768	0.6059
6	0.027489	6.0208	0.4681	6.0208	0.4692	6.0208	0.4689

* Degrees of freedom corrected for sample size

Figure 20: Vector error correction model: Malaysia

(Only error correction part shown to save space, full estimations available from author upon request)

VECM system, lag order 1

Maximum likelihood estimates, observations 1997:01–2014:12 ($T = 216$)

Cointegration rank = 1

Case 4: Restricted trend, unrestricted constant

Cointegrating vectors (standard errors in parentheses)

$\ln\text{ALFRU}_{t-1}$	1.00000
	(0.00000)
$\ln\text{LMB}_{t-1}$	−1.05323
	(0.122034)
$\ln\text{LCS}_{t-1}$	−0.589654
	(0.0501277)
$\ln\text{APR}_{t-1}$	0.0527458
	(0.0512642)
$\ln\text{LGD}_{t-1}$	−0.135536
	(0.0380666)
$\ln\text{LPR}_{t-1}$	0.165438
	(0.0428550)
$\ln\text{AGS}_{t-1}$	0.0327651
	(0.0415662)
trend	0.00443042
	(0.00116740)

Adjustment vectors

$\ln\text{ALFRU}_{t-1}$	1.00000
$\ln\text{LMB}_{t-1}$	0.0250381
$\ln\text{LCS}_{t-1}$	4.53212
$\ln\text{APR}_{t-1}$	0.593058
$\ln\text{LGD}_{t-1}$	4.57993
$\ln\text{LPR}_{t-1}$	0.331058
$\ln\text{AGS}_{t-1}$	0.382450

Log-likelihood = 935.061

Determinant of covariance matrix = 4.09799e–13

AIC = −8.5283

BIC = −8.3096

HQC = −8.4400

Figure 21: Impulse responses: Malaysia

Impulse responses to one SE shock in $lnALFRU$

48 period forecast, 68% bootstrapped confidence bands

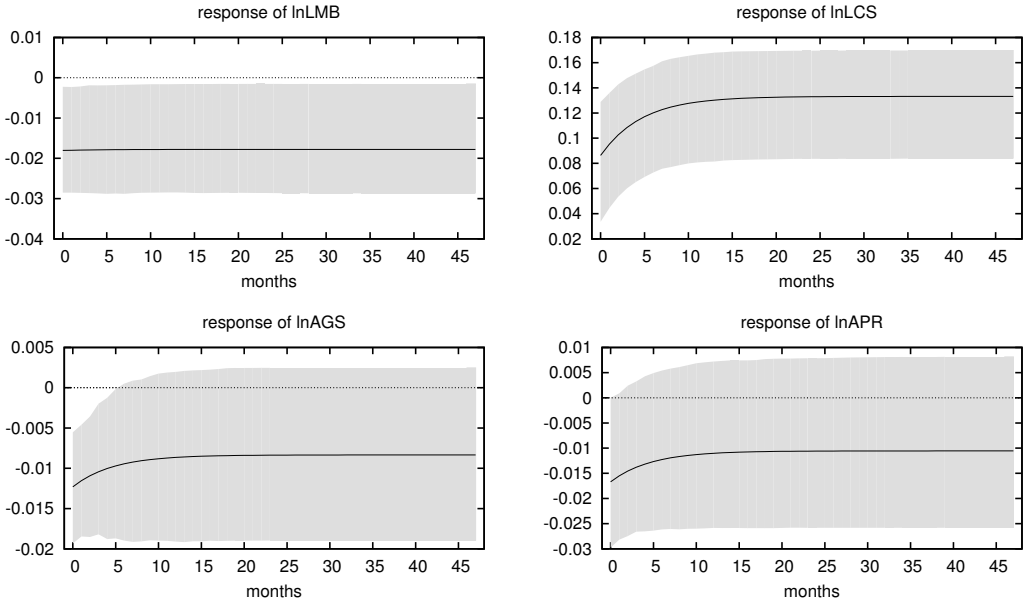
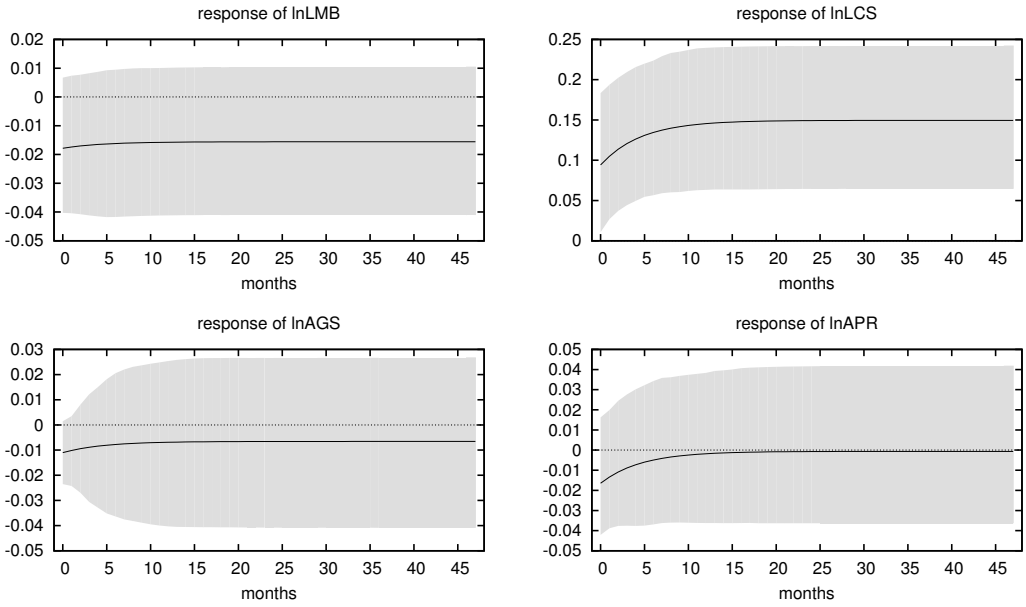


Figure 22: Robustness check: Malaysia

Removal of restricted trend term, $lnLMB$ put last in the Cholesky ordering, increase of confidence bands to 95%

Impulse responses to one SE shock in $lnALFRU$ for a corresponding VEC model below



7.4 China

Figure 23: Unit root tests: China

Critical values and corresponding significance level

Item	Det.	ADF	KPSS	Item	Det.	ADF	KPSS
lnALFRU	C, T	-0.618	0.300 ***	lnLRRCS	C, T	-2.228	0.309 ***
lnALFRU	C	-3.978 ***	1.173 ***	lnLRRCS	C	-5.118 ***	1.146 ***
lnAGS	C, T	-1.957	0.145 *	lnLGD	C, T	-1.890	0.285 ***
lnAGS	C	-1.537	1.004 ***	lnLGD	C	-1.830	1.138 ***
lnAPR	C, T	-2.302	0.105	lnLPR	C, T	-1.701	0.129 *
lnAPR	C	-2.112	0.325	lnLPR	C	-1.274	1.028 ***
lnLMB	C, T	-1.926	0.127 *				
lnLMB	C	-0.797	1.193 ***				

Sign.: *** 0.01, ** 0.05, * 0.1; Det. = Deterministic components: C = Constant, T = Trend

Figure 24: Johansen cointegration test: China

Number of equations = 7
Lag order = 6
Estimation period: 2002:07 - 2014:12 (T = 150)
Case 4: Restricted trend, unrestricted constant
Log-likelihood = 2081.3 (including constant term: 1655.62)

Rank	Eigenvalue	Trace	p-value	Lmax	p-value	Lmax*	p-value
0	0.3025	170.62	0.0018	54.038	0.0169	170.62	0.0054
1	0.19863	116.59	0.0569	33.215	0.4911	116.59	0.0917
2	0.18451	83.371	0.1143	30.595	0.3045	83.371	0.1514
3	0.13808	52.776	0.3016	22.289	0.4855	52.776	0.3408
4	0.092626	30.487	0.4796	14.58	0.6799	30.487	0.5044
5	0.06063	15.907	0.5079	9.3818	0.6889	15.907	0.5197
6	0.04257	6.5254	0.4072	6.5254	0.4081	6.5254	0.4084

* Degrees of freedom corrected for sample size

Figure 25: Vector error correction model: China

(Only error correction part shown to save space, full estimations available from author upon request)

VECM system, lag order 6

Maximum likelihood estimates, observations 2002:07–2014:12 ($T = 150$)

Cointegration rank = 1

Case 4: Restricted trend, unrestricted constant

Cointegrating vectors (standard errors in parentheses)

$\ln\text{ALFRU}_{t-1}$	1.00000
	(0.00000)
$\ln\text{LMB}_{t-1}$	0.836170
	(0.286496)
$\ln\text{LRRCS}_{t-1}$	−1.59848
	(0.150662)
$\ln\text{LGD}_{t-1}$	0.748300
	(0.180364)
$\ln\text{APR}_{t-1}$	0.976738
	(0.213392)
$\ln\text{AGS}_{t-1}$	2.41410
	(0.459422)
$\ln\text{LPR}_{t-1}$	−0.166708
	(0.0302810)
trend	−0.00448302
	(0.00252180)

Adjustment vectors

$\ln\text{ALFRU}_{t-1}$	1.00000
$\ln\text{LMB}_{t-1}$	16.7515
$\ln\text{LRRCS}_{t-1}$	−24.8754
$\ln\text{LGD}_{t-1}$	57.3108
$\ln\text{APR}_{t-1}$	80.7192
$\ln\text{AGS}_{t-1}$	−14.5189
$\ln\text{LPR}_{t-1}$	−0.876715

Log-likelihood = 1597.32

Determinant of covariance matrix = 0.00000

AIC = −17.8443

BIC = −12.6459

HQC = −15.7324

Figure 26: Impulse responses: China

Impulse responses to one SE shock in $lnALFRU$

48 period forecast, 68% bootstrapped confidence bands

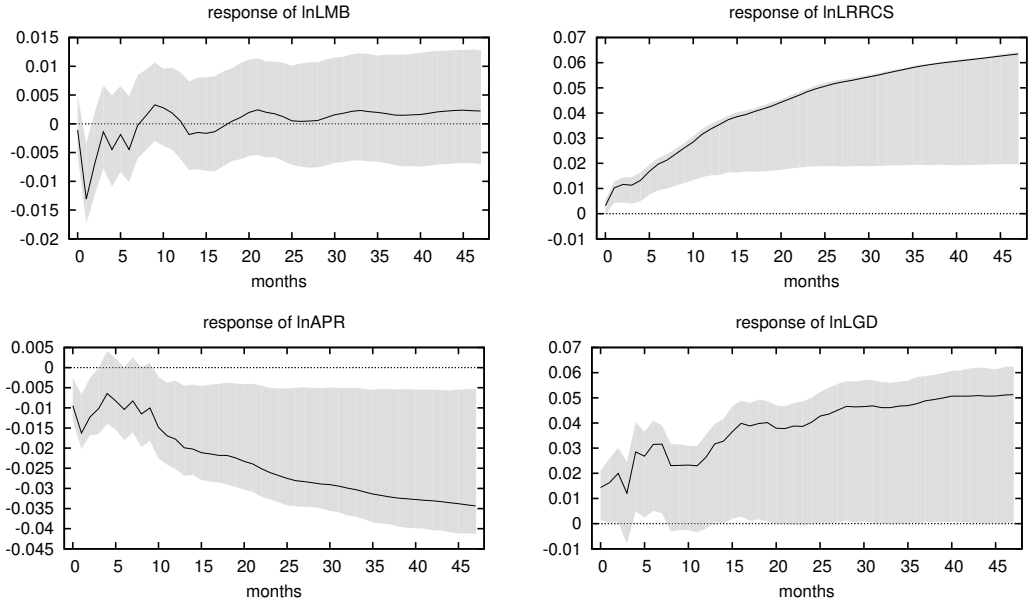
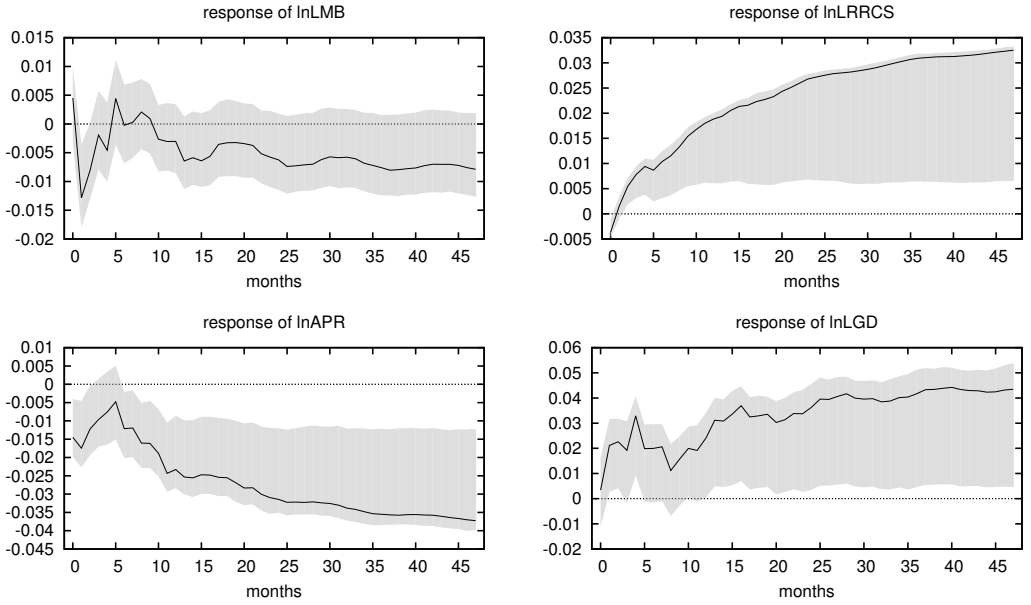


Figure 27: Robustness check: China

Sample restricted to most recent decade, model specification identical

Impulse responses to one SE shock in $lnALFRU$ for a corresponding VEC model below



7.5 Hong Kong

Figure 28: Unit root tests: Hong Kong

Critical values and corresponding significance level

Item	Det.	ADF	KPSS	Item	Det.	ADF	KPSS
lnALFRU	C, T	-0.899	0.133 *	lnLCS	C, T	-2.067	0.123 *
lnALFRU	C	-0.944	1.086 ***	lnLCS	C	-1.347	1.009 ***
lnLMB	C, T	-2.061	0.105	lnLGD	C, T	-3.753 **	0.151 **
lnLMB	C	-0.815	0.998 ***	lnLGD	C	-1.804	1.082 ***

Sign.: *** 0.01, ** 0.05, * 0.1; Det. = Deterministic components: C = Constant, T = Trend

Figure 29: Johansen cointegration test: Hong Kong

Number of equations = 4
Lag order = 5
Estimation period: 2004:06 - 2014:12 (T = 127)
Case 4: Restricted trend, unrestricted constant
Log-likelihood = 1659.5 (including constant term: 1299.09)

Rank	Eigenvalue	Trace	p-value	Lmax	p-value	Lmax*	p-value
0	0.42	122.78	0.0000	69.18	0.0000	122.78	0.0000
1	0.18639	53.604	0.0024	26.197	0.0413	53.604	0.0030
2	0.15383	27.407	0.0297	21.213	0.0239	27.407	0.0321
3	0.047599	6.1937	0.4467	6.1937	0.4478	6.1937	0.4481

* Degrees of freedom corrected for sample size

Figure 30: Vector error correction model: Hong Kong

(Only error correction part shown to save space, full estimations available from author upon request)

VECM system, lag order 5

Maximum likelihood estimates, observations 2004:06–2014:12 ($T = 127$)

Cointegration rank = 3

Case 4: Restricted trend, unrestricted constant

Cointegrating vectors (standard errors in parentheses)

$\ln\text{ALFRU}_{t-1}$	1.00000	0.00000	0.00000
	(0.00000)	(0.00000)	(0.00000)
$\ln\text{LMB}_{t-1}$	0.00000	1.00000	0.00000
	(0.00000)	(0.00000)	(0.00000)
$\ln\text{LGD}_{t-1}$	0.00000	0.00000	1.00000
	(0.00000)	(0.00000)	(0.00000)
$\ln\text{LCS}_{t-1}$	−0.295265	−0.356182	−0.159154
	(0.0233045)	(0.0594010)	(0.0612509)
trend	−0.00541000	−0.00571726	−0.00596537
	(0.000516984)	(0.00131775)	(0.00135878)

Adjustment vectors

$\ln\text{ALFRU}_{t-1}$	1.00000	−1.13821	−0.337195
$\ln\text{LMB}_{t-1}$	0.762491	1.00000	−1.02024
$\ln\text{LGD}_{t-1}$	−1.23164	3.05580	1.00000
$\ln\text{LCS}_{t-1}$	0.815976	−2.57344	−0.537193

Log-likelihood = 1295.99

Determinant of covariance matrix = 0.00000

AIC = −19.1495

BIC = −17.3579

HQC = −18.4216

Figure 31: Impulse responses: Hong Kong
Impulse responses to one SE shock in $lnALFRU$
48 period forecast, 68% bootstrapped confidence bands

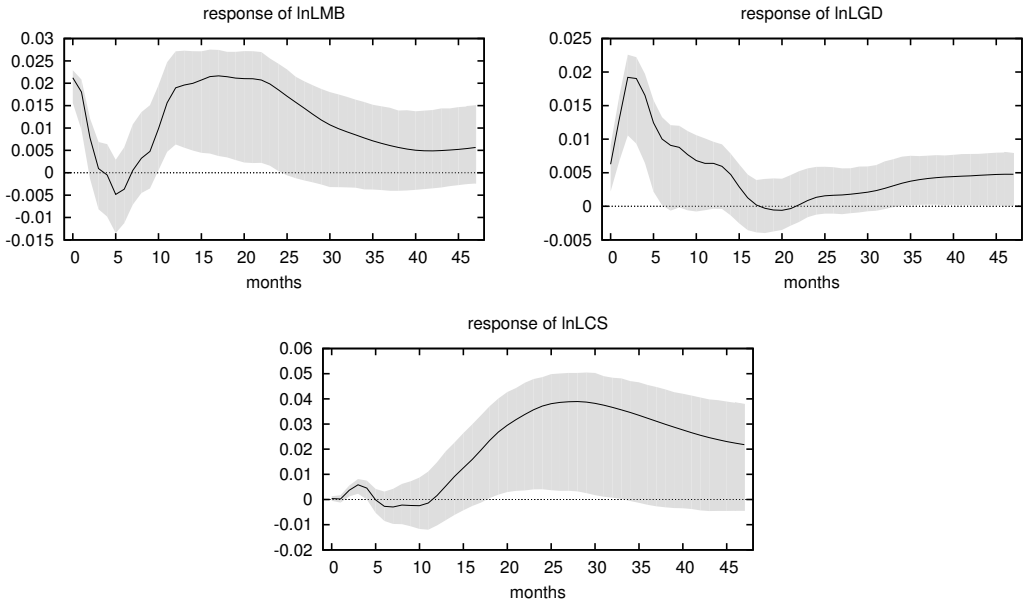
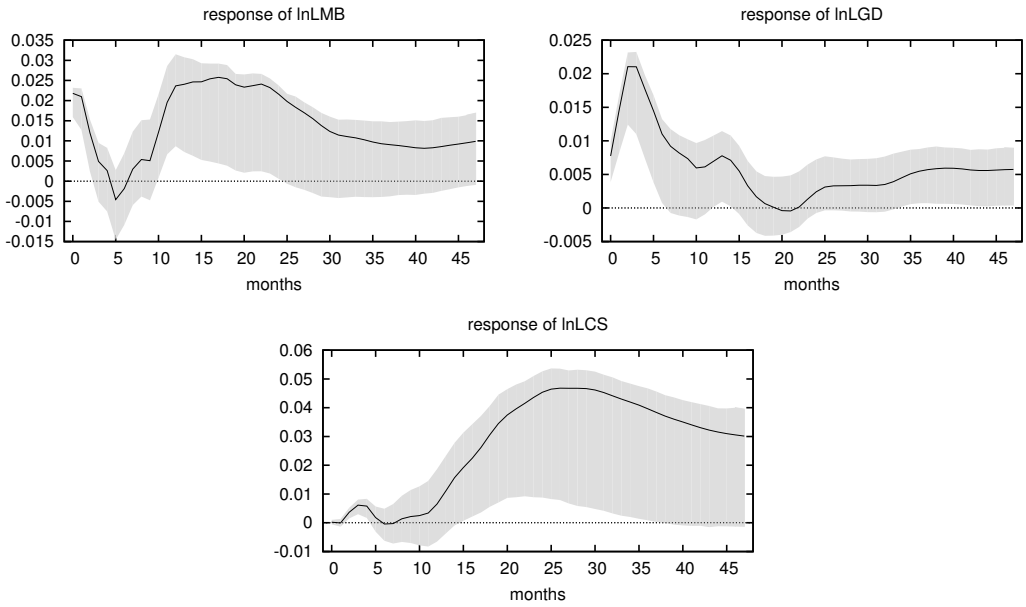


Figure 32: Robustness check: Hong Kong
Increase of lag order to 6, $lnLMB$ put last in the Cholesky ordering
Impulse responses to one SE shock in $lnALFRU$ for a corresponding VEC model below



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