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Limits of Monetary Policy Autonomy and Exchange Rate Flexibility by East Asian Central Banks *

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Abstract

Given low interest rates in the large industrial countries and buoyant capital inflows into the emerging markets East Asian central banks have accumulated large stocks of foreign reserves. As the resulting easing of monetary conditions has become a threat to domestic price and financial stability, the East Asian central banks have embarked on substantial sterilization operations to absorb what we call 'surplus liquidity' from the domestic banking systems. This has brought the East Asian central banks into debtor positions versus the domestic banking systems. We show based on a central bank loss function that given buoyant capital inflows and exchange rate stabilization the absorption of surplus liquidity leads either to financial repression, or rising inflation or both. Assuming that a debtor central bank moved towards a freely floating exchange rate to gain monetary policy independence, we show that monetary policy independence is undermined by sterilization costs and revaluation losses on foreign reserves.

Keywords: Debtor Central Banks, Monetary Policy Autonomy, Sterilization, Exchange Rate Regime, East Asia.

JEL Classification: E52, E58, F31

* Any remaining errors are those of the authors. The findings, interpretations and conclusions do not necessarily represent the views of the Deutsche Bundesbank.

1 Introduction

In the current environment of (close to zero) interest rates in the large advanced economies capital inflows have become a major threat to price and financial stability in the emerging world (Broto et al. 2011, McKinnon 2012). The sustained appreciation pressure on the currencies of emerging market economies as reflected in massive foreign reserve accumulation have triggered a controversial discussion concerning the adequate policy response. Ostry et al. (2010) have proposed (temporary) capital controls to shield off emerging market economies from possible overheating linked to speculative capital inflows. Fischer (2001) argued that emerging market economies could shield off speculative capital inflows by allowing for (more) exchange rate flexibility. Cline and Williamson (2010) proposed for China to allow for more monetary policy autonomy by more exchange rate flexibility to deal with sustained appreciation pressure on the Chinese yuan.

We will show that in emerging market economies facing buoyant capital inflows rapid reserve accumulation and pronounced monetary expansion remain strongly dependent on the monetary policy stance of the large industrial countries independent from the exchange rate regime. In the case of fixed exchange rates – given Mundell's impossible trinity – central banks can only gain monetary policy autonomy by introducing capital controls and absorbing surplus liquidity with non-market based instruments. The cost is financial repression. A move to flexible exchange rates allows for more monetary policy autonomy in the first place, but sterilization costs and revaluation losses on foreign reserves provide a strong incentive to follow the monetary policy stance of the (former) anchor country. Thus, given the prevailing low interest rate environment in the large countries issuing international currencies, central bank independence and exchange rate flexibility in emerging market economies are undermined by high costs of free floating for central banks themselves beyond the costs for the private sector.

As East Asia and in particular China have continued to be one of the most important target regions of international capital flows – and therefore the focal point of the discussion concerning the pros and cons of more exchange rate flexibility – we focus our

research on this region. East Asia is also an important case study, as a broad variety of exchange rate regimes prevails from a tight dollar peg in Hong Kong, to an upward crawling peg in China, to a (mainly) flexible exchange rate in South Korea. After having identified foreign reserve accumulation as a main source of 'surplus liquidity' in section 2 – we use a Barro-Gordon-type central bank loss function to analyse the degree of monetary policy autonomy in an environment of surplus liquidity for fixed exchange rates in section 3 and flexible exchange rate regimes in section 4. Empirical evidence for East Asia is provided in section 4. In section 5 the results are summarized.

2 Monetary Policy and Surplus Liquidity in East Asia

Exceptionally low interest rates in the large industrial countries and the buoyant influx of capital into the emerging world has triggered large-scale foreign exchange intervention around the globe. The resulting pronounced easing of monetary conditions causes – what we call – surplus liquidity in the banking systems of emerging market economies. Surplus liquidity strongly influences the monetary policy pattern of – what we call – debtor central banks. These central banks strive to absorb liquidity from the domestic banking systems instead of providing liquidity to them.

2.1 Sources of Easing Monetary Conditions in Emerging Market Economies

A stability oriented monetary policy will fit the monetary policy stance to a predefined target concerning price stability. Since the 1990s inflation targeting regimes have been introduced in a substantial number of emerging market economies. Nevertheless, in many cases monetary expansion and inflation beyond the predefined targets has been observed. Furthermore, given underdeveloped and shallow capital markets rapid monetary easing and fast credit growth are widely regarded as the possible source of unsustainable credit booms, which finally turn into dramatic bust.

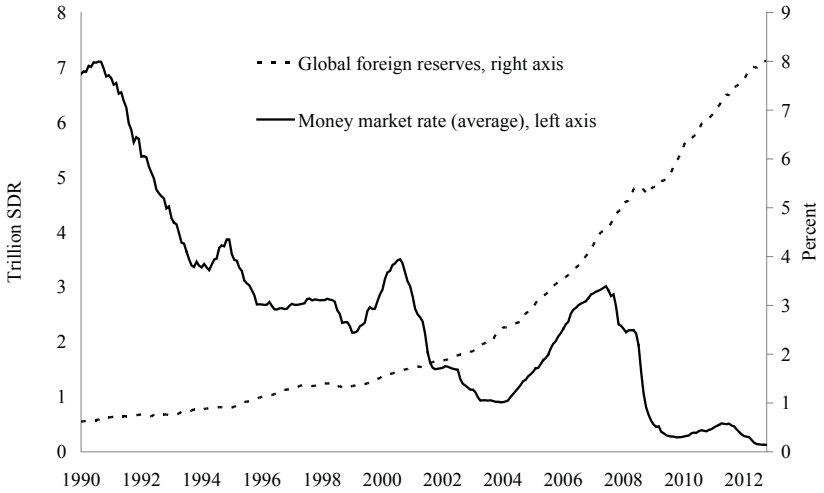
There are mainly three reasons for undue monetary easing in emerging market economies. First, for instance in many Latin American countries during the 1970s and 1980s, government financing via the central bank caused undue easing of monetary conditions

through the excess accumulation of claims to the government. Inflationary pressure and real appreciations of the domestic currencies paved the way into balance of payments crises (Krugman 1979, Flood and Garber 1984). Second, financial crisis and financing needs linked to the restructuring of over-indebted financial sectors has triggered easing of monetary conditions (excess accumulation of claims to the banking system) (Kraft and Jankovic 2005). Inflationary pressure in many emerging market economies, for instance in many Central and Eastern European economies during the 1990s was the consequence.

Third, Calvo and Reinhart (2002) have identified a *fear of floating* in developing countries and emerging market economies. Many countries at the periphery of the international monetary system have chosen tight exchange rate pegs as an external anchor for domestic macroeconomic development. Others have moved towards inflation targeting frameworks and flexible exchange rate regimes. Yet, despite the official shift towards flexible exchange rates since the late 1990s many emerging markets and developing countries have continued to stabilize exchange rates on a discretionary basis to promote exports and/or to ensure domestic financial stability (McKinnon and Schnabl 2004). Within an environment of very loose monetary conditions in the large industrial countries (US, Japan and the euro area) since the turn of the millennium, accelerating foreign reserve accumulation has emerged in both in countries with a high degree of exchange rate flexibility (for instance South Korea) as well as in countries with tight exchange rate pegs (for instance the Baltic countries or China). The outcome has been a substantial expansion of the asset sides of the balance sheets of most emerging market central banks.

Figure 1 visualizes the inverse relationship between the average money market interest rate of the US, Japan and the euro area (before 1999 represented by Germany) and global foreign reserve holdings since 1990. While the average money market interest rate in the large industrial countries gradually declined towards zero, foreign reserves – which are primarily held by emerging markets, developing countries and small industrial countries – have increased to unprecedented levels.

Figure 1: G3 Interest Rates and Global Reserve Accumulation



Source: IMF.

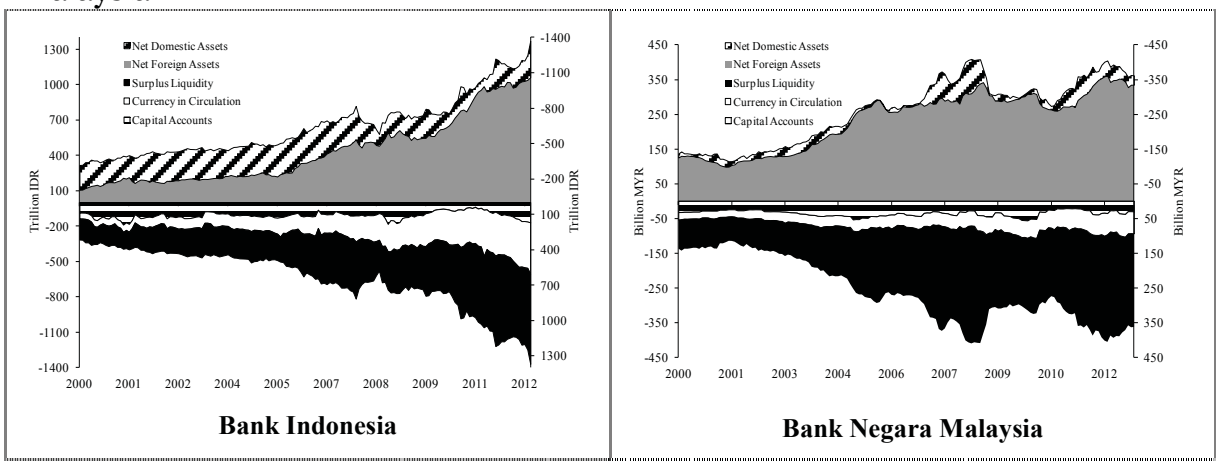
Figure 2 shows with help of the respective central bank balance sheets a significant reserve accumulation in Malaysia and even more Indonesia. The Bank Indonesia exhibits two main sources of easing monetary conditions on the asset side of its balance sheet (with positive sign) as shown in the left panel of Figure 2: financial restructuring after the Asian crisis as represented by high net domestic assets[1] and exchange rate stabilization as represented by a rapid rise of net foreign assets. Foreign reserve accumulation is at the roots of the fast expansion of the central bank balance sheet since the turn of the millennium, whereas domestic assets have remained widely constant or even declined since then. Foreign reserve accumulation in Indonesia continued after the official move towards free floating (and the adoption of an inflation-targeting framework) in the year 2005.

Bank Negara Malaysia has similarly accumulated rising foreign reserves starting from the year 2001, albeit to a lower extend due to tight capital controls. Foreign reserve accumulation continued after the year 2005, when Malaysia officially moved towards a more flexible exchange rate regime. With the global crisis starting in 2008 – with international capital flows being reversed towards the safe havens of the large industrial countries – the process of foreign reserve accumulation temporarily stopped, but re-

[1] The Bank Indonesia purchased government bonds that were issued to finance bank restructuring during the Asian crisis.

sumed starting from 2010. During the crisis years 2007/08 temporarily the holdings of domestic assets increased due to crisis related tensions in the banking system and respective rescue measures.

Figure 2: Central Bank Balance Sheets of Bank Indonesia and Bank Negara Malaysia



Source: IMF: IFS.

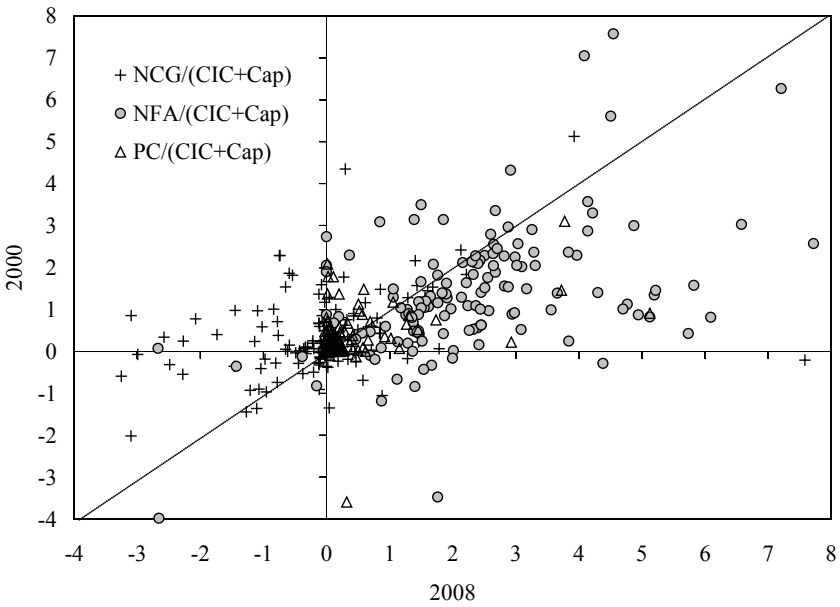
Figure 3 provides a global overview over the three main origins of easing monetary conditions on the asset side of central bank balance sheets – i.e. the acquisition of (1) public assets, (2) domestic assets and (3) foreign assets – for a set of 157 countries. The borderlines between the acquisition of assets linked to stability oriented monetary policy making and easing of monetary conditions beyond the predefined targets of prices stability are blurry. (1) Net central bank claims on government (NCG) theoretically originate either in monetary policy operations based on government bond purchases or government financing via the central bank.[2] (2) Increasing credit to the private sector (PC) can reflect either monetary policy making based on domestic assets or the acquisition of bad assets in the context of financial crisis and the recapitalization of domestic financial sectors.

(3) Changes in net foreign assets (NFA) usually reflect exchange rate stabilization, targeting a specific exchange rate or discretionary foreign exchange intervention under an inflation targeting framework to soften appreciation pressure. In Figure 3 all three variables are divided by currency in circulation (CIC) plus the central bank's capital (Cap)

[2] For instance the US Fed traditionally performed monetary policy based on outright government bond purchases on the secondary market. The European Central Bank usually performed monetary policy operations based on repurchase agreements for a predefined set of securities with commercial banks.

to normalize them. To identify a possible structural break for the possible sources of inflationary pressure we introduce a time dimension by plotting the three variables for the year 2000 on the y-axis and for the year 2008 on the x-axis. Both in the year 2000 and the year 2008 net foreign reserve accumulation has been the dominating source of easing monetary conditions in the majority of countries (most circles are above the zero line). In contrast, net government deposits at the central bank tend to have a negative sign, indicating that the government deposits at the central bank have contributed to tightening monetary conditions.

Figure 3: Origins of Easing Monetary Conditions



Source: IMF: IFS, national central banks.

Claims to the private sector have mostly positive signs reflecting a contribution of this factor to easing monetary conditions, but to a smaller extend than foreign reserve accumulation. The 45-degree line helps to identify the evolution of the role of reserve accumulation for easing monetary conditions since the turn of the millennium. As the cluster of circles is below the line and in the positive range of the x-axis this indicates easing of monetary conditions through reserve accumulation has substantially increased between 2000 and 2008 on a global level.

2.2 Surplus Liquidity and Debtor Central Banks

Ceteris paribus – i.e. without sterilization measures – the accumulation of assets on the asset side of the balance sheet is linked to rising central bank reserves of commercial banks at the central bank (i.e. liquidity), which is equivalent to an easing of monetary conditions. The faster the accumulation of foreign assets (and/or of domestic assets) the higher is the probability that the resulting easing of monetary conditions goes beyond what is in line the pre-defined targets of price stability. Furthermore, it can lead to asset market bubbles that constitute a risk to financial stability (see for instance Kraft and Jankovic 2005). This risk is even higher in emerging markets where the absorption capacity of underdeveloped financial markets is low.

What we call surplus liquidity is assumed to originate in operations that go beyond the main central bank target of controlling inflation, for instance exchange rate stabilization, financial restructuring, or government financing. In this respect, in the stylized central bank balance sheet in Table 1, we regard net foreign assets[3] (item 1), other credit to private sector (item 2.2) and credit to government (item 2.3) as so called liquidity providing autonomous factors.[4] Net foreign assets are assumed to reflect exchange rate stabilization purposes. Other credit to the private sector is assumed to be held for investment purposes and/or for financial system restructuring. Net credit to the government is assumed to be due to financing the government and/or public entities or simply for fulfilling the fiscal agent function.[5] On the liability side of the central bank balance sheet currency in circulation (item 3) is seen as an autonomous liquidity-absorbing factor, because servicing the exogenous cash needs of the public is a central bank task.[6] The own funds of the central bank (capital account, item 8) can be regarded as liquidity absorbing factor as they are held in the central bank. Excess reserves (item 5) as working balance for commercial banks are assumed to be zero at the first

[3] We assume for parsimony that net foreign assets are exclusively held in foreign reserves. Holdings of gold are assumed to be zero.

[4] In practice, it can be difficult to distinguish between domestic assets that are autonomous factors and that are monetary policy operations. Credit to the government, for instance, can reflect monetary policy operations and it can reflect monetary government financing. Similarly, a claim to a commercial bank can arise from regular monetary policy operations, or from financial sector bailout operations.

[5] If item 2.3 is negative, it reflects government deposits at the central bank as sterilization instrument.

[6] If cash supply is tightened this could trigger a shortage of cash and thereby serious risks for payments and financial stability.

place, as commercial banks aim to minimize unremunerated or low remunerated reserves.[7] If the central bank pursues goal beyond the aim to maintain price stability, excess reserves will tend to increase.

Based on these liquidity providing and absorbing autonomous factors surplus liquidity is defined as the difference between the sum of autonomous factors on the asset side (items 1, 2.2 and 2.3 in Table 1) and the sum of autonomous factors on the liability side (items 3 and 8 in Table 1).[8] A positive sign is equivalent to structural surplus liquidity in the banking system as liquidity providing autonomous factors are larger than liquidity absorbing autonomous factors. Surplus liquidity emerges (increases) in form of (rising) excess reserves if the autonomous factors on the asset side of the balance sheet increase more than the autonomous factors on the liability side of the balance sheet. This can lead to declining interest rates, an easing of monetary conditions and thereby risks for price (and financial) stability. In Figure 2 this definition of surplus liquidity is proxied for the balance sheets of the central banks of Malaysia and Indonesia. It is shown that for the period from 2000 to 2012 surplus liquidity has structurally grown.

Table 1: Stylized Central Bank Balance Sheet

Assets	Liabilities
1. (Net) Foreign Assets (NFA)	3. Currency in Circulation (CIC)
	4. Required Reserves
2. Domestic Assets	5. Excess Reserves
2.1 Open Market Operations (OMO)	6. Bonds / Reverse Repos
	7. Net Government Deposits
2.2 Other Credit to Private Sector	8. Capital accounts
2.3 Net Credit to Government	

[7] A central bank targeting only price stability by steering short-term interest rates would perform monetary policy on the assets side of the balances. If a central bank pursues additional goals as listed above surplus liquidity may emerge. The resulting easing of monetary conditions may constitute a risk for price and financial stability. For an overview on liquidity provision in a interest rate targeting framework see Schobert (2012).

[8] We assume that the level of excess reserves that is needed as a working balance of the commercial banks is close to zero. Our definition of surplus liquidity is equivalent to the definition used by Gray (2011) who defines surplus liquidity as a situation where the central bank has net domestic currency liabilities vis-à-vis the banking system. The central bank's balance sheet is asset driven. An exogenous (or policy driven) increase in certain assets results in a balance sheet expansion greater than needed to accommodate banks' aggregate demand for central bank liabilities (Gray 2006).

If the central bank wants to contain risks for price and financial stability it can absorb the surplus liquidity mainly via three sets of instruments. First, surplus liquidity can be absorbed by using market-oriented open market operations, for instance central bank bond sales or reverse repos (item 6). Second, non-market based measures, for example reserve requirements (item 4) with no or low remuneration or the coercive sale of central bank bonds below market rates can be used. Third, the central bank can coordinate its liquidity management with the government. Such fiscal coordination can take two forms. The central bank stores foreign exchange on behalf of the government (and agrees to hold the revenues on its account with the central bank). This is most common in case of oil-exporting countries where the government either owns the exported natural resources or heavily taxes the export revenues.[9]

Alternatively, if the central bank has purchased foreign exchange from the private sector, the operation will be liquidity providing to the domestic banking system. The fiscal authorities can agree to issue and sell more government securities than necessary to cover the budget deficit. The revenues from the excess issuance of government bonds can be held as government deposits at the central bank (item 7). Usually the absorption of liquidity via government deposits at the central bank requires a formal agreement between the central bank and the government to ensure that the government does not use these funds freely, thereby creating liquidity that threatens price stability.

We label central banks, which structurally face liquidity surpluses in the domestic financial system and therefore structurally perform monetary policy on the liability side of the balance sheet debtor central banks (in contrast to creditor central banks, which provide liquidity to the domestic banking systems).

2.3 Management of Surplus Liquidity in East Asia and Risks for the Central Banks

Figure 4 shows the sterilization instruments for three East Asian central banks in the lower parts of the left hand charts. All East Asian central banks have accumulated fast

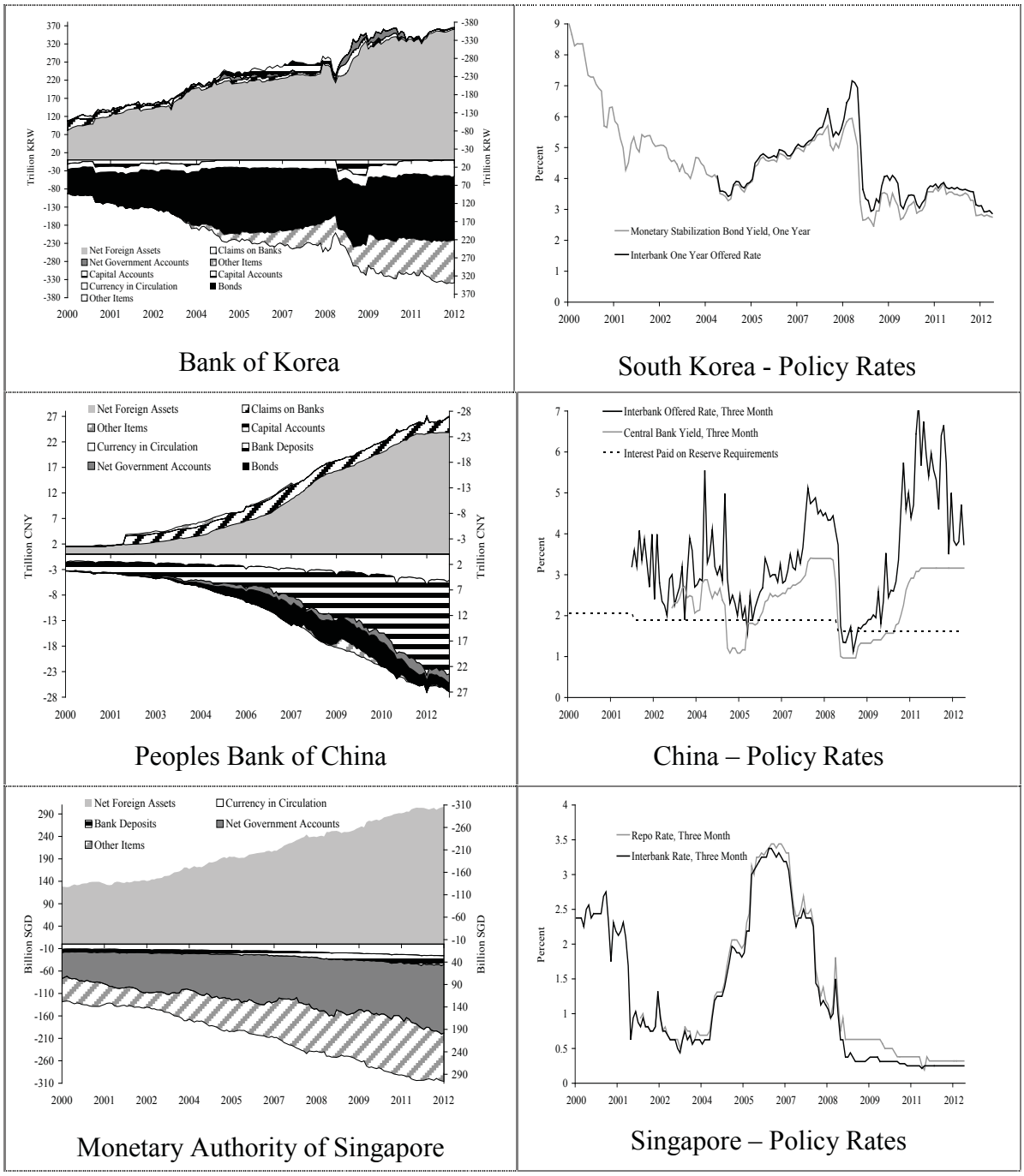
[9] The government deposits at the central bank will have no liquidity providing effect as long as they are held at the central bank account and are not spend in the domestic market. Alternatively the oil revenues are stored directly in a dollar based sovereign wealth fund. As foreign reserves are prevented from being converted into domestic currency, a sovereign wealth fund corresponds to „anticipatory sterilization“ as surplus liquidity creation is prevented from the very beginning (McKinnon and Schnabl 2009).

rising stocks of foreign reserves since the turn of the millennium, what has triggered in most cases extensive sterilization operations. The Bank of Korea (upper left panel) mainly uses sales of central bank bonds (monetary stabilization bonds) to drain liquidity from the markets, which has been created by foreign currency purchases. The yields of these bonds are tightly linked to interbank interest rates (upper right panel), which is an indication for market-based sterilization based on open market operations. Since 2007, there is a small spread between the interbank rate and the yield on monetary stabilization bonds. This can be due to higher risk awareness during the crisis, which causes nearly riskless investment at the central bank to carry a lower interest rate than lending in the interbank market.

The Peoples Bank of China uses a combination of market and non-market based instruments to absorb liquidity (middle left panel of Figure 4). Central bank bills represent in our interpretation market-based sterilization, as their yields are closely following interbank rates. Nevertheless, the fact that these yields remain well below the interbank rate during most of the observation period are an indication for coercive sales of these liquidity-absorbing instruments to the domestic banking sector below market rates (see middle right panel of Figure 4). Reserve requirements (bank deposits) represent non-market based sterilization, as the remuneration rate remains widely unchanged and mostly below interbank interest rates. The middle left panel of Figure 4 also shows that in China the importance of reserve requirements as sterilization instrument has increased over time relative to central bank bonds.

The Monetary Authority of Singapore sterilizes a large share of its net foreign asset accumulation via positive net government deposits at the central bank (lower left panel). As the fiscal agent of the government the Monetary Authority of Singapore manages the issuance of government securities. Given Singapore's persistent budget surpluses the issuance of government securities does not serve government financing but to deepen the financial market and for sterilization purposes. The repo rate on short-term government securities tightly follows the interbank interest rate (lower right panel), which is evidence for a market-based sterilization process.

Figure 4: Liquidity Management in Selected East Asian Central Banks



Source: IMF: IFS, national central banks.

Depending on the sterilization instruments and individual agreements with the government the sterilization costs are shared between the public and the private sector. Under market based liquidity management – as for instance in Korea – the costs are usually born by the central bank and ultimately by the public via lower central bank profit transfers to the government. Non-market based liquidity absorption – as for instance in China – shifts the costs to commercial banks, which may shift it onwards to

their customers. Under fiscal coordination – as for instance in Singapore – the costs can be borne by the government or the central bank, depending on the agreements concerning the remuneration of government deposits at the central bank.

Another cost factor of foreign reserve accumulation cum liquidity absorption are write-downs on the foreign currency positions that emerge when the domestic currency appreciates (McKinnon and Schnabl 2012). The costs can cause sizable central bank losses. Whether these central bank losses matter for monetary policy decisions depends on the degree of central bank independence. In practice, central bank losses often cause conflicts with the government and therefore can have a negative impact on the reputation of the central bank and ultimately on its independence and monetary policy decisions.

In the following section we will show that within a low interest rate environment in the large industrial countries the monetary policy independence of debtor central banks in developing countries and emerging markets will be limited, whatever exchange rate regime they choose. Given fixed exchange rates the scope for monetary policy autonomy is generally low. Non-market based sterilization as a form of capital control creates only limited leeway for monetary policy autonomy from the anchor country as suggested by Mundell's incompatible trinity. Given flexible exchange rates, an illusion of monetary policy autonomy is created in the first place, which is unlikely to materialize in the long run, as costs linked to liquidity absorption limit the autonomy from the monetary policy stance of the reserve currency country.

3 Gaining and Losing Monetary Policy Autonomy Given Fixed Exchange Rates

In a world of free capital flows fixed exchange rates and monetary policy autonomy are incompatible (impossible trinity) (Fleming 1962, Mundell 1963). Given fixed exchange rates, central banks can only gain monetary policy autonomy if they introduce capital controls or use non-market based sterilization (for instance unremunerated required reserves) for the absorption of surplus liquidity as means of indirect capital control. Due to the quasi tax effect of unremunerated reserve requirements on commercial

banks lending rates will increase and/or deposit rates will decrease depending on the availability of substitutes in the credit and deposit market.

If the domestic corporate bond market is underdeveloped and if the access to foreign capital markets is restricted, enterprises and households have to rely on domestic bank credit. This enables commercial banks to shift the costs of unremunerated reserve requirements to the private non-bank sector via higher lending rates. Thus, if the credit market lacks international integration higher reserve requirements can be associated with a monetary tightening without triggering additional capital inflows.[10] However, this will go along with a widening of the spread between lending and deposit rates implying distortions in the financial sector, i.e. financial disintermediation.

Assuming that financial disintermediation causes a disutility / loss for the central bank we analyze the impact of liquidity absorbing operations on monetary policy autonomy based on an augmented a Kydland and Prescott (1977) and Barro and Gordon (1983) type central bank loss function. In contrast to the baseline model it is assumed that the central bank has no output stabilization objective,[11] but trades off inflation against financial disintermediation by deciding on the degree of liquidity absorption in the face of a foreign interest rate shock. Non-market based sterilization is assumed to be linked to financial sector distortions / disintermediation.

This implies minimizing the following central bank loss function LF[12]:

(1) $LF = 0.5(\pi)^2 + \delta rr$.

The term $(\pi)^2$ represents the inflation target which is (for simplicity) assumed to be zero.[13] An inflation rate below or above zero implies a loss for the central bank. The term δrr models the degree of distortion in the financial system, which is assumed to

[10] An alternative, but less discussed effect can be lower deposit rates, if alternative domestic investment opportunities are limited and investment in foreign capital markets is not possible.

[11] We omit the output stabilization target for the sake of brevity as it is of secondary concern for the interpretation of results.

[12] Time subscripts are omitted for parsimony.

[13] While assuming the inflation target to be zero simplifies the model the level of the inflation target has an impact on liquidity absorption. As a higher inflation target increases the demand for currency it reduces the degree of surplus liquidity and therefore the costs to manage the surplus liquidity.

be linked to the degree of non-market based sterilization measured in unremunerated reserve requirements per unit of commercial bank deposits *rr* (with 1 > *rr* > 0). As outlined above an increase of non-market-based sterilization leads to a rising spread between lending and deposit rates and therefore to financial market distortions. The factor δ is the weight determining the size of disutility of financial distortions in the central bank loss function (with $\delta > 0$).

The inflation rate is assumed to be based on the inflation rate of the previous period π_{pre}. Further, we assume a negative impact of the domestic interest rate on loans i_L on inflation dependent on the semi-interest rate elasticity of inflation ϕ *(with* $0 < \varphi < 1$*)*. The term ν is a normally distributed demand shock on inflation with zero mean:

(2) $\pi = \pi_{pre} - \phi i_L + \nu$

Assuming that the costs of required reserves are (partially) shifted to the domestic interest rate on loans i_L there is a positive correlation λ between reserve requirements *rr* and the loan rate, which is usually smaller than unity ($0 < \lambda \leq 1$). The term λ is assumed to contain all financial market characteristics affecting the transmission of *rr* to i_L:[14]

(3) $i_L = \lambda rr$

To link the sterilization operations with the interest rate policy in the anchor country, we assume that a declining interest rate in the anchor country (US) leads ceteris paribus to rising capital inflows into the emerging market economies (East Asia). Given the assumption of fixed exchange rates the central bank has to buy foreign reserves and sell domestic currency. If the central bank aims to maintain price and financial stability, sterilization operations have to absorb the liquidity issued due to foreign exchange intervention, i.e. ***rr*** needs to increase. This implies a positive correlation between the scale factor λ - which affects the transmission of ***rr*** to i_L - and the interest rate in the anchor country i_f indicated by the constant β.

[14]Deposit rates are assumed constant.

(4) $\lambda = \beta i_f$ (with $\beta > 0$).

Substituting (4), (3) and (2) into (1) yields the following expected loss function $E(LF)$:

(5) $E(LF) = 0.5(\pi_{pre} - \phi\beta i_f rr + v)^2 + \delta rr$.

Optimizing (5) with respect to the reserve requirement ratio the optimal inflation rate π_{opt} is:

(6) $\pi_{opt} = \dfrac{\delta}{\phi i_f \beta}$.

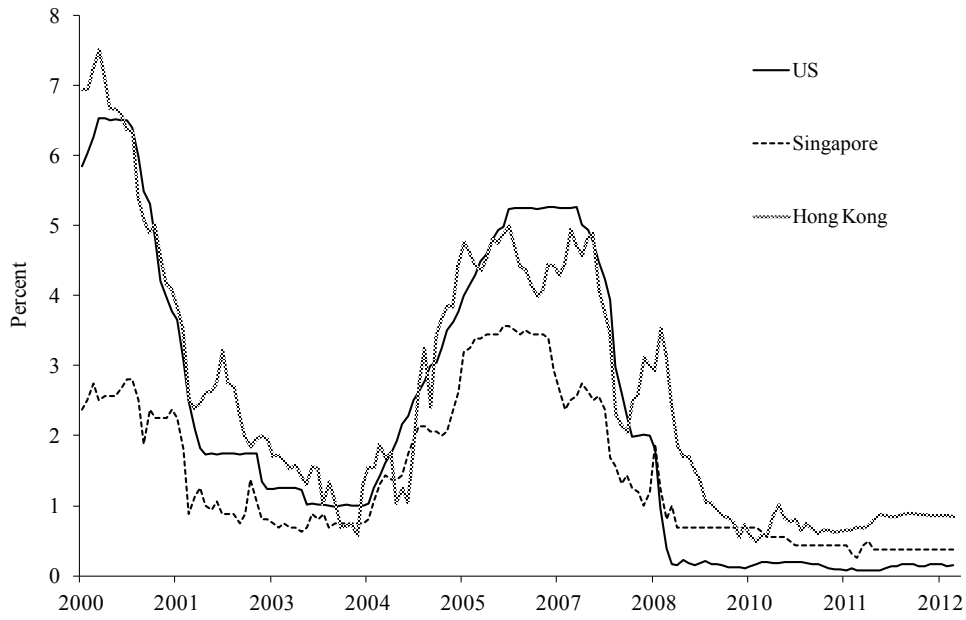
Optimal inflation is high, if the central bank has a high preference to avoid financial distortions (indicated by δ) and if the interest rate transmission to inflation is low[15] (indicated by a low ϕ). The lower the foreign interest rate the higher will be the inflation, which is tolerated by a debtor central bank. This implies that a mandate for the central bank to avoid financial distortions $(\delta > 0)$ makes the central bank dependent on the monetary policy stance of the anchor country. If the central bank does not care about financial distortions (δ converges towards zero) it would be fully autonomous from foreign monetary policy decisions. Optimal inflation would be in line with the inflation target.

In East Asia, Singapore and Hong Kong have a very high degree of capital mobility (highest possible score of the Chinn-Ito-Index[16] on capital mobility) and a high degree of exchange rate stability.[17] They don't follow an autonomous monetary policy as interest rates are set close to the interest rate of the anchor currency country as shown in Figure 5. This suggests a high preference for avoiding financial market distortions (high δ in eq. 1). In Singapore the moderate divergence of the monetary policy rate

[15] The central bank has to create large distortions as a high lending rate is required to curb inflation. When the central bank dislikes these distortions it will allow for higher inflation.
[16] For a definition see Chinn and Ito (2008).
[17] Hong Kong has a currency board arrangement with a fixed exchange rate to the USD and Singapore pegs to a basket of currencies.

from the US policy rate can be explained by the fact that other currencies (euro, yen) are represented in the currency basket.

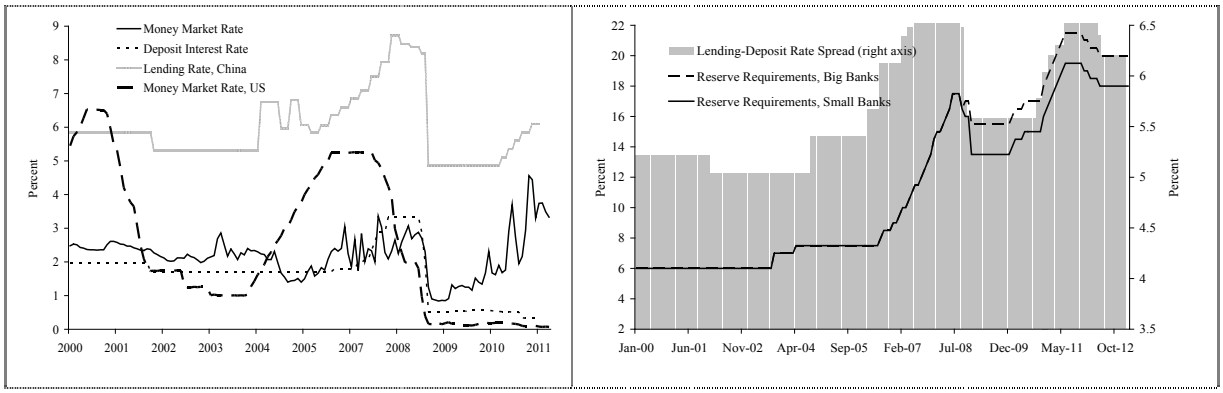
Figure 5: Money Market Rates in Hong Kong, Singapore and the US



Source: IMF: IFS.

The Peoples Bank of China is a central bank operating under a fixed exchange rate regime, which aims to gain monetary policy autonomy through non-market based sterilization. The left panel of Figure 6 shows that despite the tight exchange rate peg – in form of a tight dollar peg or a tightly controlled upward crawling peg depending on the time period – the Chinese money market rate does not follow the US money market rate, which indicates a certain degree of autonomy in monetary policy making as shown in the left panel of Figure 6.

Figure 6: Key Interest Rates and Reserve Requirements in China



Source: Peoples Bank of China.

The permanent increase of required reserves as shown in the right panel of Figure 6 (which are remunerated below market rates) indicates that the policy goal of low inflation outweighs the downsides of financial repression.[18] The high required reserve ratio as well as the spread between banks' lending and deposit rates and their spread versus the money market rate indicates a relatively low preference for avoiding financial distortions.

4 Scope of Autonomy of Freely Floating Countries

Several East Asian countries (Thailand, Malaysia, Philippines, South Korea, and Indonesia) and even China have moved to more exchange rate flexibility since the Asian crisis. The impossible trinity would suggest that full autonomy in monetary policy making can be gained given free capital flows, with the monetary policy strategy being based on an inflation targeting framework. In contrast to the fixed exchange rate setting a debtor central bank without obligation to exchange rate stabilization can absorb surplus liquidity with market-based instruments and therefore theoretically can avoid financial distortions.

However, a debtor central bank, which aims to conduct an autonomous monetary policy under flexible exchange rates by setting interest rates based on liquidity absorbing monetary policy operations faces limitations in monetary policy autonomy, which finally force it to follow the monetary policy stance of the anchor country. The reason is that given low interest rates in the large industrialized countries, i.e. low yields on net foreign assets, debtor central banks will run into net interest expenses on liquidity absorbing monetary policy operations and/or revaluation losses on the stock of foreign reserves.[19] At the latest when the central bank needs recapitalization by the government, this will strengthen the government's position in urging the central bank towards growth enhancing and cost minimizing interest rate cuts. However, even before the

[18] This is congruent to China's growth strategy of supporting exports via an undervalued real exchange rate (McKinnon and Schnabl 2012).

[19] For instance during the period from 2004 to 2007 the Bank of Korea accumulated interest rate losses of roughly 0.5 percent of GDP. In the same period the revaluation adjustment account increased to a book loss of 1.7 percent of GDP. The revaluation account records valuation gains and losses accruing during a predefined period until the gains/losses are realized.

central bank will tend to minimize losses by following the monetary policy stance of the (potential) anchor country.

To show the limited degree of monetary policy autonomy of a debtor central bank, which allows for a freely floating exchange rate the central bank loss function of equation (1) is modified by incorporating sterilization costs and revaluation losses on foreign reserves:

(7) $LF = 0.5\pi^2 + DUM\gamma(iSL - (if + \hat{e})NFA)$.

Whereas the first term of equation (7) remains unchanged (inflation target at zero), the second part represents the costs of liquidity management, subdivided in sterilization costs and revaluation losses. We assume that in contrast to the fixed exchange rate case sterilization operations will be market based. We further assume that in the past foreign reserve accumulation has led to surplus liquidity. The cost of liquidity absorption is given by the interest rate paid on the liquidity absorbing instruments i times the outstanding stock of sterilization debt SL which is assumed to be equal to surplus liquidity defined in section 2. Revenues on foreign reserves ($i_f * NFA$) comprise interest revenues resulting from foreign exchange holdings.

In the face of net capital inflows (outflows) revaluation losses (gains) of an appreciating (depreciating) domestic currency occur as the exchange rate fluctuates freely. These revaluation losses are proxied by the percentage exchange rate change $\hat{e}$ times the stock of net foreign assets NFA with a negative value of $\hat{e}$ indicating appreciation. As central banks normally have no objective to maximize profits the second term of equation (7) will be only relevant if the central bank is running too large losses. Thus the dummy variable DUM takes the value of 0 as long as the central banks' capital (*Cap*) minus central bank losses is above a particular threshold T. In this case the second part of equation (7) cancels out meaning that monetary policy decisions are independent from sterilization costs. If the capital falls below the threshold T the costs will become a relevant factor for monetary policy decisions. Principally the threshold T can be as-

sumed to be above, at, or below zero depending on the preference of the central bank or its statutory requirements regarding a specific size of capital holdings.

$$(8)\quad DUM(0,1) = \begin{cases} 0 \text{ if } & Cap - (iSL - (if + \hat{e})NFA) \geq T, \\ 1 \text{ if } & Cap - (iSL - (if + \hat{e})NFA) < T. \end{cases}$$

The term γ (with $\gamma > 0$) models the weight of financial losses in the central bank objective function for the case that DUM=1. A large gamma stands for a larger concern of the central bank with regard to a 'conditioned recapitalization' by the government or the reputational losses of ongoing central bank losses.

Because without non-market based reserve requirements the interest rate transmission from the money market rate to loan interest rates set by commercial banks is not disturbed (in contrast to the fixed exchange rate case (3)) the money market rate is seen as determinant of inflation. Interest rate cuts lead to higher inflation, dependent on the elasticity of inflation to interest rate changes φ.

$$(9)\quad \pi = \pi_{pre} - \phi i + \nu$$

Exchange rate changes are assumed to be determined by the relative monetary policy stance of the domestic central bank and the central bank of the reference country, i.e. the spread between the domestic and foreign interest rate:

$$(10)\quad \hat{e} = \kappa(if - i) + \varepsilon\,.$$

The term κ indicates the sensitivity of the exchange rate on interest rate differentials. The term ε is a normally distributed error term with zero mean. With ε =0 and κ = -1 uncovered interest parity holds. If kappa is larger than -1, carry trades will be profitable as interest gains will not be eroded by losses linked to the depreciation of the domestic currency.

Substituting (9) and (10) into (7) yields the following expected loss function for the central bank in a freely floating environment:

(11) $E(LF) = 0.5(\pi_{pre} - \phi i + \nu)^2 + DUM\gamma(i(SL - \kappa NFA) - ifNFA(1+\kappa) - \varepsilon NFA)$.

Based on equation (11) we can derive the optimum interest rate of the debtor central bank contingent on sterilization costs and revaluation losses. In doing so, we distinguish two cases. First, the capital of the central bank remains – despite sterilization and appreciation – above the threshold (*DUM*=0) so that the second term of the loss function cancels out. Optimizing eq. (11) with respect to the policy instrument *i*, the optimal interest rate is:

(12) $LF_{DUM=0}: \; i_{opt} = \frac{\pi_{pre}}{\phi}$.

The interest rate is set with respect to inflation of the previous period and the semi-interest rate elasticity of inflation ϕ. It is independent from interest rate decisions in the potential anchor country.

Second, if the sterilization operations reduce the capital of the central bank below the threshold (*DUM*=1) the central bank will care about sterilization losses and react to it by setting interest rates lower than otherwise. With surplus liquidity (*SL*) being equivalent to *NFA* – *CIC* – *Cap* the optimum interest rate is equal to:

(13) $LF_{DUM=1}: i_{opt} = \frac{\pi_{pre}}{\phi} - \gamma \frac{\kappa NFA + SL}{\phi^2}$.

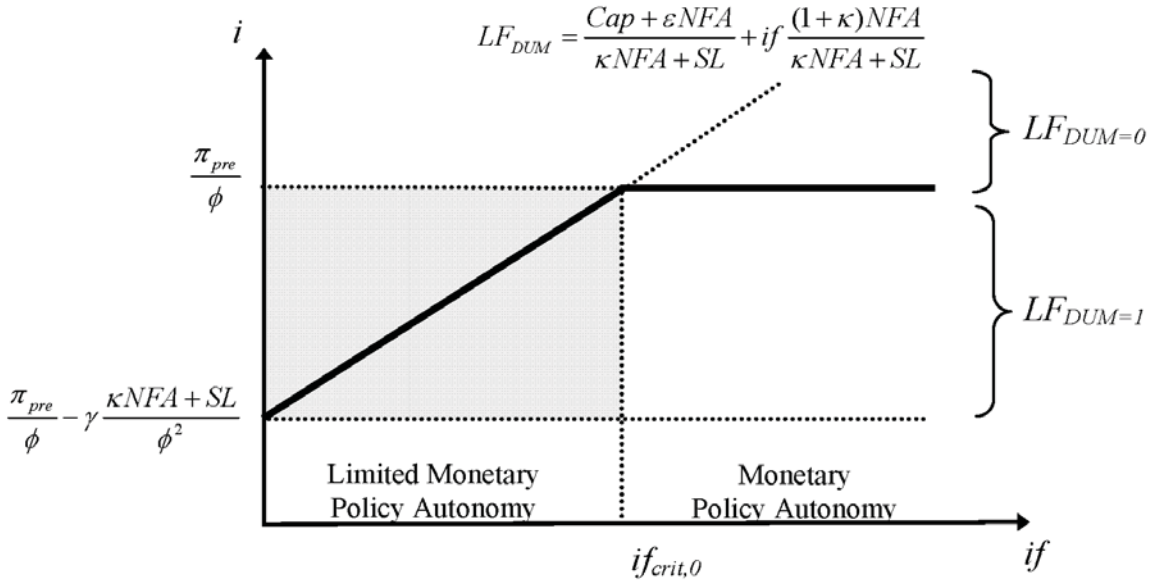
The optimum interest rate will be lower, if surplus liquidity and foreign reserves are high. Equation (12) and (13) represent the corner solutions in which either the central bank is profitable and sets the policy rate according to the inflation target (full monetary policy autonomy (12)) or – in the loss environment – trades off rising inflation with profitability (limited monetary policy autonomy (13)).

To decide whether the central bank operates in a profitable or non-profitable environment, i.e. whether eq. (12) or (13) is valid, we determine the scope of monetary policy autonomy (LF_{DUM}) based on equation (8). For simplicity assuming that the threshold T is zero, the dummy is inactive if

$$(14)\quad LF_{DUM} : i \leq \frac{Cap + \varepsilon NFA}{\kappa NFA + SL} + if\,\frac{(1+\kappa)NFA}{\kappa NFA + SL}\,.$$

To show the scope of monetary policy autonomy of the debtor central bank using market based measures to absorb surplus liquidity we plot in Figure 7 the two corner solutions for i and the dummy function against if.

Figure 7: Monetary Policy Autonomy of Free Floating Debtor Central Banks



The upper part of the function $LF_{DUM=0}$ (upper horizontal line) corresponds to the optimal policy decision if the capital of the central bank is positive above the threshold T (dummy is zero). The interest rate decision is fully independent from the foreign interest rate in the reserve currency country as long as the foreign interest rate is sufficiently high (here above $if_{crit,0}$). The optimum interest rate set by the central bank is derived according to equation (12). The interest rate is set with respect to previous inflation and the semi-interest rate elasticity of inflation.

The grey highlighted part shows the optimal policy response if the dummy is active, i.e. the central bank has generated losses from sterilization operations and appreciation of the domestic currency, which have reduced its capital below the threshold. The domestic interest rate decision becomes dependent on the foreign interest rate decision. Foreign interest rate cuts will force the debtor central bank with a freely flexible exchange rate into domestic interest rate cuts.[20] For any given amount of capital, net foreign assets, and sterilization instruments a declining foreign interest rate will lead to a declining domestic interest rate.

The domestic central bank will allow for a lower interest rate and a higher inflation to reduce the losses originating in the devaluation of foreign reserves through the appreciation of the domestic currency or to reduce costs on the remuneration of sterilization instruments. On average εNFA is zero and can be neglected. Under a given foreign interest rate if the higher the capital buffer Cap, the lower surplus liquidity SL and – depending on κ – the lower the stock of net foreign assets NFA, the larger is the scope for monetary policy autonomy as the LF_{DUM} schedule shifts upwards (see the first term) and the slope becomes steeper (see the second term).

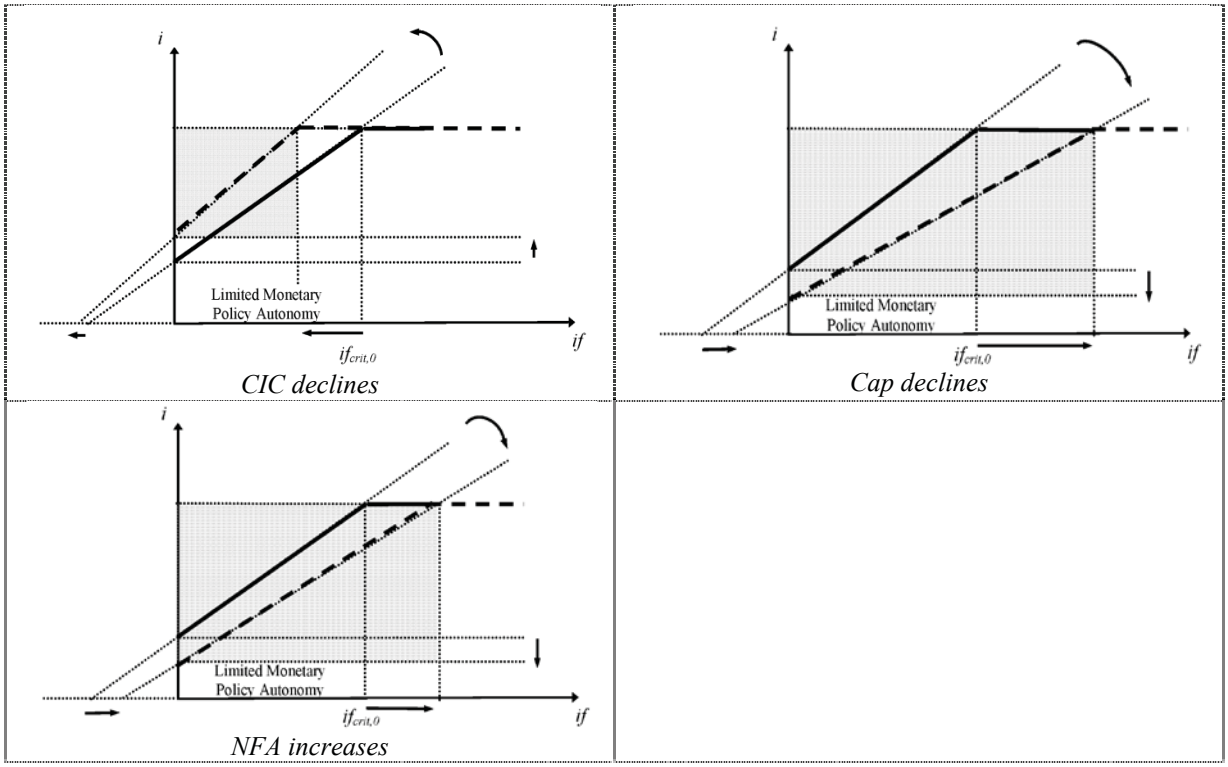
A high stock of net foreign assets implies high gross interest income but also high valuation losses in the case of an appreciating exchange rate. Therefore as long as the sensitivity of the interest rate spread on exchange rate changes κ is larger than -1, valuation losses dominate the interest revenue and the central bank is running losses on a net basis.[21] Figure 8 shows several options for the shift in the parameters of equation (14). First, monetary policy autonomy increases together with currency in circulation. If the nominal GDP grows, the demand for currency in circulation (CiC) rises what allows debtor central banks to outgrow from the debtor position and to become less dependent on monetary policy decisions in the (potential) anchor country. In Figure 8 the sloped line moves upwards and becomes steeper.

[20] In emerging markets with underdeveloped domestic financial markets interest rate cuts are likely to go along with purchases of foreign assets which would imply increasing foreign reserves despite a freely floating currency.

[21] In Figure A1 in the appendix we present evidence, that the term κ has been tended to be positive for many East Asian countries during the sample period suggesting positive returns to carry trades.

When the capital of the central bank (Cap) shrinks, (for instance due to subsequent sterilization costs), or net foreign assets increase the central banks loses monetary policy autonomy. A decline of the capital buffer shifts the sloped line downwards with the slope becoming flatter (more than in the case when NFA increases). If the volume of foreign reserves and/or the amount of the volume of sterilization instruments rise, the whole curve will be shifted downwards towards the x-axis. In an extreme scenario the domestic interest rate is compressed towards zero as it is the case for instance in Japan since the late 1990s (Goyal and McKinnon 2003).

Figure 8: Changing Structural Parameters and Monetary Policy Autonomy



All in all, the dependence of debtor central banks on the foreign monetary policy stance is contingent on (1) the degree of structural surplus liquidity, (2) the impact of changes in the interest rate differential on the exchange rate, (3) the capital buffer of the central bank and (4) the accumulated stock of foreign reserves. Next we provide empirical evidence for the impact of central bank losses on interest rate decisions in East Asia contingent on these factors. This is in particular relevant for debtor central banks with (mostly) freely floating exchange rates and market based sterilization.[22]

[22] In the period between 2000 and 2010 the average share of market based sterilization to overall sterilization of the East Asian countries with (managed) floating exchange rates ranges between more than 60 percent (Philip-

The East Asian countries, which mainly conduct market based sterilization in combination with (managed) floating exchange rates and (widely) autonomous monetary policies are Indonesia, Malaysia, Philippines, South Korea, Taiwan, and Thailand. We calculate first a benchmark target interest rate for "autonomous" interest rate decisions of the freely floating countries based on a Taylor rule. Then, we subtract the realized interest rate from the Taylor rule benchmark. We normalize it to a scale of -1 (above target) to +1 (below target) by dividing the difference between the Taylor rule interest rate and the actual interest rate with the highest absolute value during the observation period:[23]

$$(15)\quad TRI_t = \frac{TR_t - i_t}{\max\left|TR - i\right|},$$

with the Taylor interest rate (*TRI*) being derived from the original Taylor (1993) rule.[24] An index value greater (smaller) than zero means that the actual policy rate is too low (high) compared to the Taylor rule benchmark.

Secondly, we calculate a loss index, which shows based on equation (8) the central bank losses given the assumption that central banks would have set the Taylor interest rate. The lower the equity of the central bank and the yield on net foreign assets and the higher the Taylor rule interest rate and the amount of surplus liquidity the higher the potential loss. Again we normalize the index to a spectrum from -1 (large gains) to +1 (large losses) by using the maximum absolute value of the numerator during the observation period as denominator:

pines, Indonesia) to nearly 95 percent (Thailand). In China the share is only 29 percent. The measure is calculated as $100 - 100 \times (NFA_t - CIC_t - RR_t) / (NFA_t - CIC_t - Cap_t)$. The term *RR* denotes the amount of required reserves of commercial banks held at the central bank. If central banks have net claims to the government this is seen as indication for monetary financing of the government via the central bank or financial restructuring based on the central bank, which increases the surplus liquidity. Then, these claims are added to the numerator of the fraction leading to $100 - 100 \times (NFA_t + NCG_t - CIC_t - RR_t) / (NFA_t - CIC_t - Cap_t)$.

[23] The subscript *t* denotes the time index.

[24] The Taylor rule is given by $TR_t = \pi_t + r^* + 0.5(\pi_t - \pi_t^*) + 0.5(y_t - y_t^*)$ with π_t as the inflation rate, r^* as the implied equilibrium (real) interest rate, π_t^* as the inflation target, y_t as the log real GDP and y_t^* as the log of potential output. We assume a constant equilibrium real interest rate of 2 percent for each country. In case the inflation target is unknown we use a linear trend of actual inflation.

$$(16)\ Loss_t = -1 \times \left(\frac{Cap_t - (TR_t SL_t - (if_t - \hat{e}_t) NFA_t)}{\max \left| Cap - (TR\ SL - (if - \hat{e}) NFA) \right|} \right).$$

If both indices are positive, this suggests that the central bank keeps interest rates lower than warranted to avoid losses.

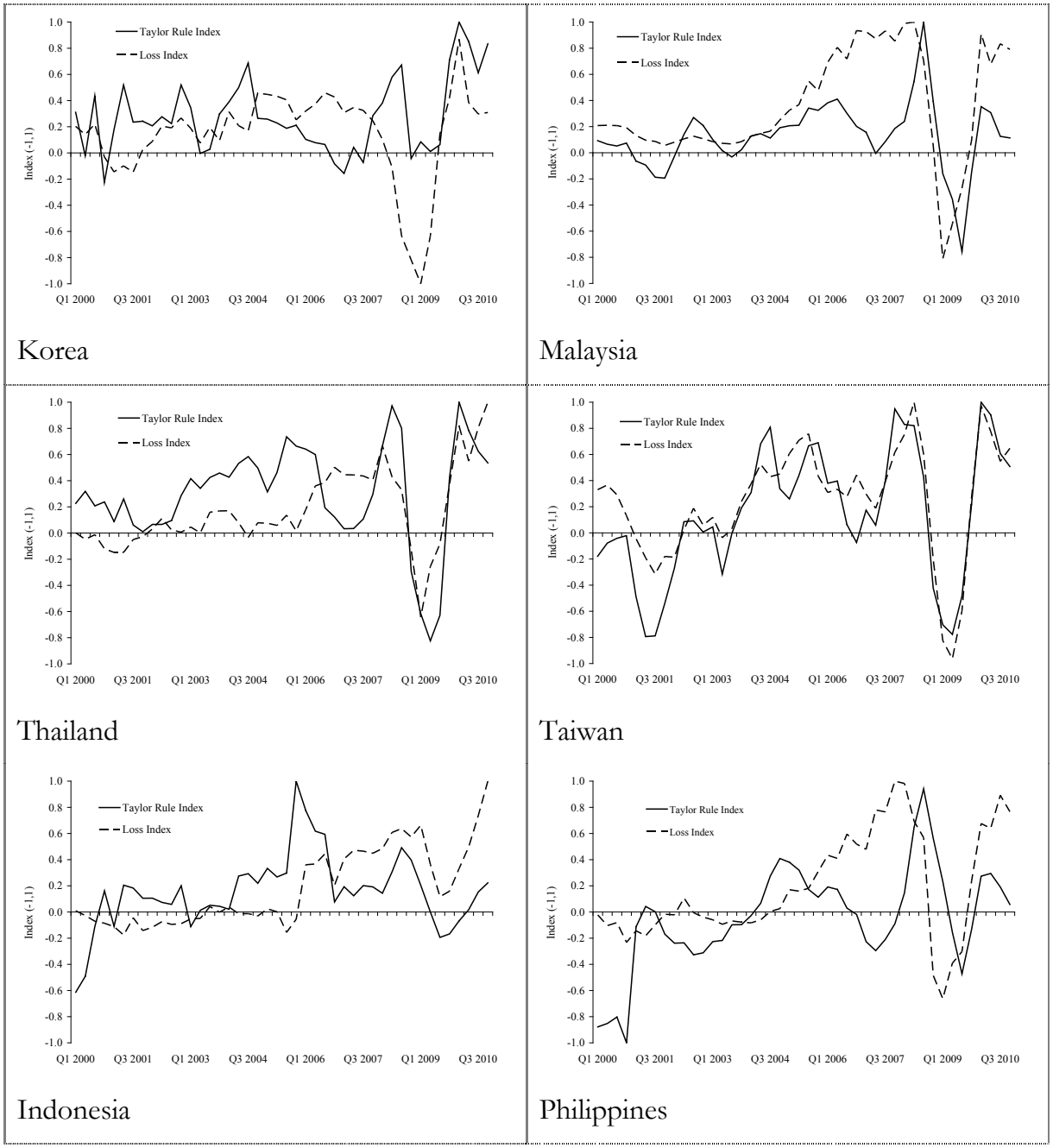
Both indices are calculated for the period from 2000 to end of 2010 based on quarterly data. We observe a comparatively close correlation between the deviation of the realized interest rate from the Taylor rule and the loss index. The correlation is most evident for Taiwan (middle right panel of Figure 9) where the central bank interest rate decisions seem highly sensible to possible losses originating in sterilization costs and revaluation of foreign reserves. As losses threaten to emerge the central bank seems to cut interest rates below the Taylor-rule target to minimize or avoid these losses. In periods of a reversal of capital flows into the safe havens such as during the start of the subprime crisis, interest rates rise above the Taylor target (to dampen capital outflows), while at the same time revaluation gains on foreign reserves are realized via the depreciation of the domestic currency.

For Korea (upper left panel in Figure 9) in most periods both indices are positively correlated. Since the end of 2001 the loss index started to increase together with the fall of the policy rate below its Taylor benchmark indicating limited monetary policy autonomy. An exception is the period from the end of 2004 to 2007 in which the loss index remains high, but the policy rate mainly followed the Taylor rule. This corresponds to the time period, when the Bank of Korea has followed an autonomous policy but at the same time has faced massive losses on the foreign assets due to strong appreciation of the domestic currency against the dollar.

A similar pattern of periods with different responses of the policy rate to central bank losses can be observed for Thailand (middle left panel of Figure 9), where a close correlation between the indices except for the years 2006/07 can be observed. Again, similar to the Korean case, the years 2006/2007 were characterized by policy autonomy but high central bank losses due to appreciation pressure on the Thai bath. The

central banks of Indonesia and the Philippines (lower Panels of Figure 9) exhibit time-varying responses of interest rate decisions on central banks losses.

Figure 9: Taylor Rule Index and Loss Index (a)



Source: IMF: IFS, national sources, own calculations. Note: shaded areas mark loss making years.

5. Conclusion

In this paper, we defined surplus liquidity and related it to the monetary policy challenges of central banks in East Asia. They face a policy dilemma. High capital inflows put appreciating pressure on their exchange rates. Interventions in the foreign exchange market aim to avoid an appreciation, but lead to an increasing stock of foreign reserves. They therefore can lead to monetary easing beyond the pre-defined targets of price stability. To control surplus liquidity, central banks can opt for more or less market-oriented sterilization measures. Market-based measures lead to increasing interest rates and fuel additional capital inflows turning sterilization attempts ineffective. Non-market based measures such as unremunerated required reserves can help to escape the dilemma, if capital inflows are successfully shielded off. Unremunerated reserve requirements lead to distortions in the domestic financial system, what restricts the effectiveness of monetary policy.

Another way to try to escape the policy dilemma is to let the exchange rate float. We show, however, that debtor central banks then still depend on the past accumulation of foreign reserves, what triggers new reserve accumulation. Sterilization costs and valuation losses emerge, if the interest rate differential to the reserve currency country is positive and the exchange rate appreciates. Given that the central bank care about these losses, the degree of autonomy is limited as interest rate cuts are likely to limit central bank losses. The degree of monetary policy autonomy of debtor central banks will then hinge on the foreign monetary policy stance, on the degree of structural surplus liquidity, the impact of changes in the interest rate differential on the exchange rate, the capital buffer of the central bank and the stock of previously accumulated foreign reserves.

Thus, flexible exchange rates allow for more monetary policy autonomy in the first place, but when sterilization costs and revaluation losses on foreign reserves emerge, this autonomy is undermined. Reducing the structural surplus liquidity and thus restoring monetary policy autonomy can take place only gradually over time, as it mainly depends on the evolution of the liquidity absorbing factors such as currency in circula-

tion. A prerequisite is a higher interest rate level in the large industrial countries, which provide international currencies to the world monetary system.

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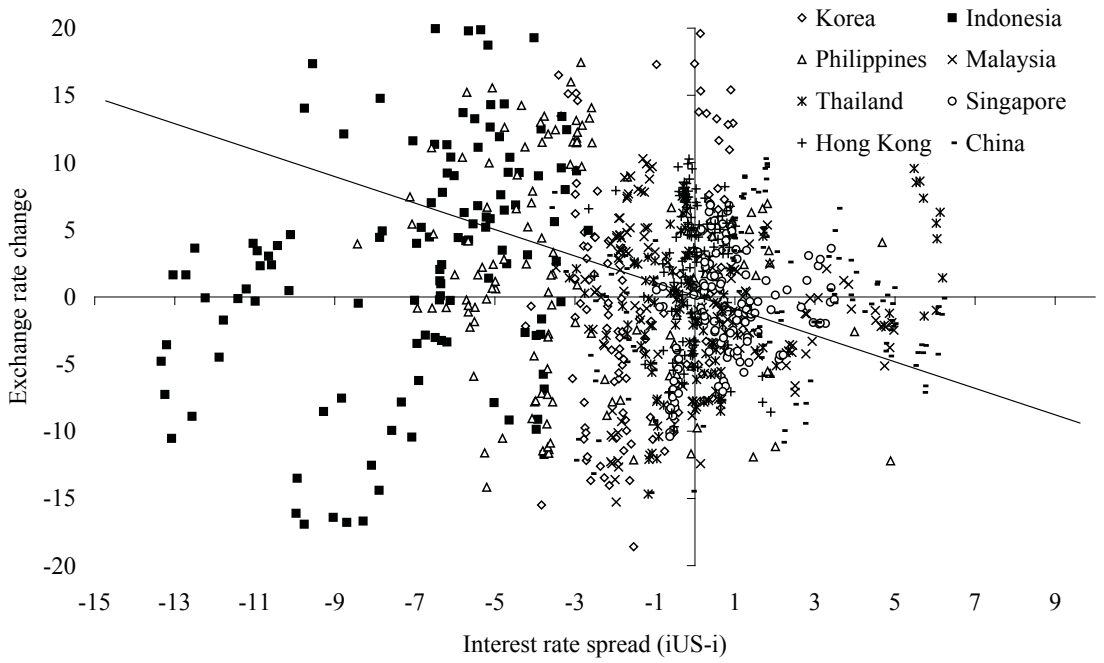
Appendix

Figure A1: Interest Rate Spread and Exchange Rate Changes



Source: IMF: IFS, national sources.

The straight line indicates the theoretical relationship between exchange rate changes (positive means depreciation) and the foreign and domestic interest rate differential if UIP would hold. As obvious the actual realizations are very volatile and the empirical trend of the link between exchange rate changes and the interest rate spread even would suggest a reverse correlation indicating protracted carry trades.