STERILIZATION IN DEVELOPING COUNTRIES: AUTO-INSURANCE OR PRE-FINANCIAL OPENNESS POLICY?

ABSTRACT

The more the emerging countries are following the trend of liberalized markets, the more they are sterilizing their foreign reserve inflows. Therefore, Asia, Latin America emerging markets and some developing countries have raised the extent of sterilizing their foreign reserve inflows over years to varying degrees. For emerging countries, these degrees depend on the composition of balance of payment inflows, and the inflationary impact of reserve inflows, as shown by Aisenman and Glick (2008).

As for developing countries, the situation is different. In this paper, we find that monetary authorities are sterilizing their external debt in a degree, which is related in degree of indebted country.

Keyword: Foreign Reserves, Sterilization Policy, External Debt, Monetary Policy, Turkey, Lebanon
JEL: E5, G18
1-INTRODUCTION

With financial globalization and its stake, financial openness becomes unavoidable. Even countries in Asia and Latin America, victims of severe crises in the years 1990-2000, have not given up and continued to integrate but with new monetary promising.

Ozcan and Vollrath et al, (2009), Kose, Prasad, Terrones (2008), Prasad, Rogoff, Wei, Kose (2004), Mishkin (2005), and many other economists have focused the interest of financial liberalization for countries in general, and emerging markets in particular. -1 - it promotes (up to 12 times higher) growth of welfare, (Hoxha et al 2009); -2 - allows an expansion of the financial sector and an average growth of 1% of GDP (Bekeart, Harvey and Lundblad 2005). -3 - increased capital inflows, since financial liberalization leads to an investment boom associated with lower prices of capital and the "relaxation" of borrowing constraints.

However, other economists are not or less supporters, and have represented the other side of financial liberalization. Such as Kaminsky and Smuckler (2002), Ben Grama and Clévenot (2007), Williamson and Mahar (1998), Ranciere Tornell and Westermann (2006), Obsfeld (2009), and others. They accuse the financial liberalization of weakening the financial system, leading to risk-taking, increasing the probability of financial crises and thus eventually leading to a recession. But also, as explained by Benassy-Quere (2005), financial openness benefits the countries, which are (already) rich, at the expense of the poorest countries, thus increasing inequality, and makes relatively poorer the poor.

In short, despite the adverse effects of financial globalization and its risky sides, Kose and al, Eswar. Prasad, and Ashley D. Taylor (2009), Obsfelt (2009),Azenman, Chin and Ito (2008) show that the positive effects prevails the negative ones if (and only if) the following two conditions are taken into consideration:

First we must improve the quality of financial institutions (laws, transparency, corruption, reinforcement of contracts, governance). The latter, also called « creative market » has a significant effect on liberalization.
Secondly, decisions and choices of monetary policy must be consistent with countries opening. In other words, they must match with the internal economy of the country and respect the context of Mundell's Trilemma. Called by Obsfelt et al (2004), the guide of the political structure. But who says Mundell trilemma, says impossible to match both, financial integration, and stability of exchange rates with a monetary independence, hence the name of the « inconsistent Trinity ».

Thus the country that challenged "the context" and achieves the 3 objectives below, have suffered from a crisis.

The lessons of the past have shown the risky side of the financial integration combined with a fixed exchange rate and monetary independence. The crises of 1994 in Mexico, 1997 in Thailand, Indonesia and Korea, 1998 in Russia and Brazil and 2000 in Argentina and Turkey are all related to the inconsistent practice of fixed exchange rate with a trend of 'financial openness. The control of capital becomes more porous, the combination of fixed exchange rate and monetary independence were unsustainable, contrary to what Calvo and Reinhart (2001)\(^1\) and (2002) and Bordo and Flandreau (2003)\(^2\) demonstrated later.

However, South Africa that had not adopted the fixed exchange rate, has avoided this kind of crisis (afflicting emerging markets with fixed exchange rate).

Yet, in recent years, emerging countries such as China, Korea, Thai, Brazil, Mexico, Argentina and others, have adopted a policy of financial integration, accompanied by a managed exchange rate and a certain degree of monetary autonomy (the Policy Mix). Indeed, monetary authorities in emerging countries have pursued a policy which is to increase hoarding of international foreign reserves and sterilizing (that part we will detail later), which will afford the Policy Mix: a managed exchange rate with a financial openness (at a certain degree) and a higher monetary independence. In other words, the inconsistent becomes consistent.

It’s difficult to avoid challenges of financial globalization and to stay away. Therefore, countries in Asia and Latin America, once out of their crisis (post-crisis countries) have tried to reintegrate,

\(^1\) Modern floating may be accompanied by a limited monetary autonomy
\(^2\) Even under gold standard, monetary autonomy was considerable
but this time from / through the sterilization of foreign reserves. Aizenman and Glick (2008) studied in detail the behavior of these countries through this approach and measured the extent of sterilization of each country as well as explicit factors.

We will see in this article that the sterilization is desirable, but its implementation differs from a developing country and an emerging one because of the explicit factors (High public debt, dollarized debt, commercial deficit, Islamic policy, financial repression). From regression models in dollarized\(^3\) countries like Lebanon and Turkey, we obtained a significant relationship between the extents of sterilization and the rate of dollarized public debt. This article will be supplemented later by studying the more repressed and Islamic countries like Syria and Iran towards financial openness.

2-Foreign Reserves Hoarding and Sterilization: Complementary Policy.

Crisis that countries may face from the financial openness are mainly due to the volatility of short-term "inflows" and sudden stop. These can lead to a slow economic growth, costly banking crises and even social instability.

A monetary policy "insurance" is able to mitigate the adverse consequences of capital flight, especially if the country is unable to borrow internationally or the ability of domestic taxes is shrinking.

a-From hoarding reserves to “fear of loosing international reserves”

Hoarding foreign reserves are likely as a buffer stock, allows greater flexibility of exchange rates since 1990-2000. It provides domestic authority with access to hard currency to cover basic living expenses and mitigate the adverse consequences of the capital flight.

This dynamic is helpful to explain the International Reserves hoarding of post crises countries, which have been affected by severe crisis. The FR/GDP ratio has increased excessively. This hoarding was first held by East Asian countries, by Latin America countries and the oil exporting countries, and followed a trend of increasing commodity prices in the 2000s. The FR hoarding has increased from $ 1 trillion in 1996 to $ 7 Trillion in June 2008, according to data from

\(^3\) There is a distinction between full dollarization, and dollarization which means currency board.
International Monetary Fund. While in industrialized countries the FR/GDP was relatively stable around 4%; in emerging countries, FR/GDP rose from 5% to 27%. Nowadays, Reserve International is owned by global emerging markets, mostly in Asia, where reserves have increased from 5% in 1980 to about 37% in 2006. Just in China, the FR/GDP rose from 1% in 1980 to 41% in 2006 to nearly 50% in 2008.

Back to developing countries, like Lebanon, Turkey. Figure 1 shows that the ratio IR/GDP is over 50%: it is respectively 73% and 54% in Lebanon and Turkey.

With a rate of 73%, the ratio IR minus Gold / GDP is the ninth highest in the world in 2009⁴. If we add Gold to international foreign reserves, Lebanon achieved the 3rd highest rate in the world after Libya and Singapore. As for Turkey, the ratio gives a place of 94, and with Gold, it ranked at 81st place. That means that the IR reserves of Lebanon and Turkey are not most of all from gold, but of capitals inflows. In Iran, the situation is different, if we add Gold to International reserves, (IR+Gold)/GDP, Iran is ranked as 17th, but without Gold, its rank becomes the 150th⁵. Syria⁶ too, (IR+Gold)/GDP is ranked about 7th, but without Gold, it downgrades to the near last places, near 163rd place. These last places are adjacent to those held by industrialized countries like France, Spain, the Luxembourg, USA⁷.

Why Iran and Syria are less concerned by hoarding foreign reserves than Lebanon and Turkey? What are the incentives for non-industrial countries, including the emerging countries, to make the rally for foreign reserves?

Aizenman and Marion (2003), Calvo (2006), Aizenman and Lee (2008) and Cheung and Ito (2007), explained in their recent work, the various reasons for this global trend of reserve hoarding, especially for emerging countries. In general, the reserves hoarding allow the countries to protect against "sudden stop" of foreign capital, giving them a defense of the adverse side of the financial integration that Calvo (2000) considered like « an instrument » more reliable than the interest instrument. Indeed, the reserves could be served to moderate the effects in terms of

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⁴ Source: www.nationmaster.com
⁵ Source: CIA Factbook 2009
⁶ CIA Factbook, but the most recent dates are in the 80s
⁷ Idem
trade shock on the real exchange rate in the country and its exports. Hence, the name of “auto-insurance” given by these authors⁸. For example, in Korea and Russia, reserves were a force of stability during the crisis.

Before the crisis, which has cost $600 billion to Russia, the stock of reserves has largely averted a total collapse of the banking system, largely resisting the depreciation of the exchange rate. For Korea, hoarding $100 billion international reserves in the second half of 2008 was a key bailout in. The government guarantees 3 years debts, rose abroad before July 2009. These debts are more than sufficient to cover the foreign debts of Korean banks, maturing in June 2009. Korean debts totalled $80 billion. Indeed, the credibility of the bailout was reinforced by its massive stockpiles of reserves.

So, reserves can avoid relying on the International Monetary Fund and the World Bank or other international financial institutions for implicit insurance. Without forgetting one important reason, especially for major exporters such as China, Singapore and Malaysia, international reserves hoarding can produce a byproduct of managing exchange rates to promote exports by undervaluing the domestic currency.

After the post “closed countries” have won over “the fear of floating”⁹ by protecting themselves with hoarding reserves, this latter became so important that countries increase them more and more¹⁰: they express the fear of “loosing international reserves” (Aizenman 2009).

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⁸ they give another reason for the competitiveness of the detention of foreign reserves of largest countries, the "mercantilist detention" of a country will lead to a competitive detention by other countries to prevent any competitive advantage derived by the first country.

⁹ Term developed by Calvo 2000

¹⁰ Hoarding reserves has a cost and présent soe default too. This part will be trated in a separate paper . (see Aizenman 2009)
### b-Sterilization.

When a central bank decides to buy foreign reserves assets, it will either add to the fund by increasing the reserve of monetary base RM, which is potentially inflationary; or reduce its net domestic assets, which sterilize the impact on reserve of domestic monetary base. Indeed, the central bank can bring out the effects of hoarding on the monetary base in several ways including the sale of market instruments such as government bonds or use the swap or others.

In emerging countries, particularly the Latin America and Asia countries, their large hoarding of reserves have been associated with improved sterilization, especially after the financial crisis as shown in *Figure 2*. This has allowed, according to Fischer (2001) and Aizenman and Lee (2008), a greater flexibility of exchange rates, a greater monetary autonomy and a gradual financial integration. The detention policy of international reserves and sterilization are complementary in recent years.

*Figure 3* shows the evolution of reserve hoarding and sterilization compared to the Money Base for Turkey and Lebanon from 1995 to 2009 (quarterly data). Based on the work of Aizenman and Glick (2008) on Asia and Latin America, we will study the variations of FR/RM held by the Central Bank, of Lebanon and Turkey. The net domestic credit DC is defined by subtracting the FR from RM. A positive value of FR, corresponds to foreigners inflows. A negative of DC indicates that the monetary authorities reduce their domestic assets held.

In the case of Lebanon, sterilization wasn’t born in the 2000s as in most Latin American countries, but in 1995. At that date, Lebanon has recognized a positive variation in the FR/RM, with a negative variation of DC/RM: It is therefore a sterilization ‘behavior’ almost the highest in the world. At that time, as we see in *Figure 2*, the level was 3 to 4 times smaller in Thailand, Korea and China (and nonexistent in Argentina and Brazil).

Then, the sterilization was less until mid 2002 when the hoarding foreign reserves (FR/RM) has reached a rate of 2, followed by a reduction in domestic assets DC/RM of 2. It was at this time a global trend including notably China, Korea, Thailand, Mexico, with a rate slightly lower than

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11 Knowing that FR is defined by taking the dollar as base currency and adjusting with the exchange rate in order to give an assessment of measurement adjusted with changes in net foreign reserves determined in local currency.
that of Lebanon. This behavior has been taken since the third quarter of 2007, as well as Thailand and Brazil, with a rate more or less identical. (Where $\Delta RF/RM$ and $\Delta DC/RM$ are around $|1|$.

$\Rightarrow$ Note that for Lebanon, the dates while we had a high level of $\Delta FR/RM_4$ (Q3-1995, Q3-2001, Q4-2002 and Q2-2008) correspond to the dates of the engagement with new external foreign countries. These two “events” seem to be related to each other. (see figure 4)

As for Turkey, in Figure 3 sterilization was important from mid 1997 till 2001, and then, after the crisis, the trend starts to be moderate (but still positive) compared to the past and to both countries Thailand and Korea. Unlike Argentina and Brazil that have adopted sterilization after the financial crises of the late 90s and beginning 2000s, For Argentina, Foreign reserves inflows began to be remarkable modestly from 2003, the day after the financial crisis of 2001-2002, but these reserves haven’t been sterilized until mid 2004. In Brazil too, at this period, the domestic assets held by the central bank turned negative in Brazil, the reserves inflows began so to be sterilized.

$\Rightarrow$ Note that the trend of hoarding reserves and sterilizing follow the same trend of the increasing public debt and particularly the external debt (figure 4).

1-First, the positive values of $\Delta FR/RM_4$ correspond to the trend of accumulating external debt in Turkey (from 66 billion Dollar in 1996 to 100 billion dollars in 1999$^{12}$).

2-Second, because of the “Transition of the String Economy Program” TSEP supported by IMF and World Bank in 2001, $\Delta FR/RM_4$ decreases. Indeed, one of the objectives of the TSEP was to reduce the Ratio of domestic debt/GDP and External Debt / GDP

The decisions of monetary authorities regarding foreign reserves and sterilization depend on various economic factors. Therefore it would be interesting to study them.

12 In Yilanci and Ozcan 2008.
2-Extent of sterilization and key factors.

Initially, based on Aizenman and Glick (2008) work, we will express the extent of sterilization from a regression model of changes in net domestic assets held by monetary authorities, and foreign reserves, both on Reserve Money of the year before. All Variable FR and DC are measured quarterly. Be included as an explanatory variable the rate of quarterly GDP growth, which could influence on money demand. Indeed, the "rudimentary version of the monetary approach to balance of payments implies that the expansion of DC Central Bank with the rate of growth of GDP could meet growth in demand for money" without needing to hoard foreign reserves.

Thus, knowing that \( \Delta DC/RM_{-4} = \alpha + \beta + \Delta FR/RM_{-4} + \text{GDP} \), and that \( \beta \) is a parameter that determines the decisions of monetary authorities regarding sterilization, we deduce that:

- If \( \beta = -1 \), \( \Delta FR/RM \) represents a full sterilization of reserves. The Central Bank grants domestic credits to facilitate the increase of money demand (due to GDP growth), but prevents the expansion of domestic credit from foreign reserves.
- If \( \beta = 0 \), there is no practice of sterilization.
- If \( -1 < \beta < 0 \), there is a partial sterilization.
- If \( \beta < -1 \), this indicates a tighter monetary policy due to a greater interest about inflation. In this case, possession of a unit of foreign reserves will reduce domestic assets held by the Central Bank of more than one unit and therefore reduce the monetary base.
- If \( \beta > 0 \), we are in an economy of expansionary monetary policy because of concerns about "credit crunch" or exposure to a systemic crisis.

We represent the yearly coefficient of sterilization in Lebanon and Turkey in Figure 5. To be noted that in Turkey, sterilization was partial, with a downward trend (in absolute value) until 2000 when the trend was reversed and sterilization began to increase around 1 and above; like in the majority of emerging post-crisis cases. From 2007, the rates fall back but remains negative, leading to partial sterilization.

As for Lebanon, sterilization is stable (like the stable Korean trend) and around 1 in absolute value except in third quarter of 1995 and 2002, which was above 1.

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13 In Aizenman and Glick, 2008
Table I and II show the regression model of sterilization for Turkey and Lebanon with various explanatory variables. Observations are quarterly and from first quarter 1995 to June 2009. We note first that for Lebanon, as well as for Turkey (Table I-1 and Table II-1), the coefficients ΔFR/MR_{4} are negative, means that the monetary authorities reduce their assets by sterilizing their reserves. In Turkey, the coefficient is between [-1, 0], so this is a partial sterilization decision from the monetary authorities. Money demand (due to growth of GDP) is not fully operated from Central Bank credits but also from foreign reserves. In Lebanon, the coefficient is equal to -1; this is the case of full sterilization, all reserves held are sterilized without using them to meet the expansion of domestic credit.

The difference in the coefficient between Lebanon and Turkey can be explained by:

- First - Turkey authorities may prefer that the equilibrium takes place through a depreciation of the exchange rate, allowing them to keep their reserves in subsequent years more delicate.
- Second - the limited use of reserves can be justified by more intervention produced through the swap of the Fed, as seen in October 2008 in the Central Bank of Brazil, Mexico, South Korea and Singapore.
- Third - the central banks may be induced to reduce their reserves fearing that it may cause further depreciation. This applies especially to Latin American countries that have a "limited room for fiscal adjustment"

We have seen that foreign reserve hoarding is a strategy of auto-insurance for non-industrialized countries, whose aim is to benefit from financial liberalization while protecting themselves from possible risks, after. Thus, can we draw a preliminary conclusion that countries that have not yet integrated in the financial globalization like Lebanon, but have increased their international reserves (NET) to GDP and sterilizing (β = 1), are therefore in towards financial openness?

⇒ To be noted that in this model, GDP is not significant, so GDP doesn’t have impact on Money demand neither in Turkey nor in Lebanon. This can be explained, as proved before, by the fact that firstly, the GDP (of Turkey) is not constant as indicated in the hypothesis before,; and secondly, ΔDC meets the increase of RM, fairly of GDP (figure 6).
In the other hand, introducing the quarterly growth rate of inflation in the model (Table I-6), we get a significant result for Turkey. The positive coefficient indicates that an anti-inflationary policy is not implemented. In fact, Turkey suffered from the high inflation, and at many tries, to find a solution by numbers of policies like liberalizing the capital account in 1994, or by being followed by an austerity program by the IMF in 1998 and 2001. The model was not significant for the case of Lebanon/ This can be due to the lack of quarterly database for this variable. Only yearly data were available, so 13-14 observations are not enough to have a significant result.

3- Sterilization and Public Debt.

Calvo (2006) as other authors cited above have discussed the importance of holding international reserves during the "sudden stop" crises, but Calvo studies especially Latin American countries that have dollarized\(^{14}\) debts (which should repay their debts in foreign currencies) and therefore is dependent on the exchange rate (if floating regime). This weakens the economy of the country and makes it susceptible to potential financial crises. We will study the effects of debt on sterilization, while separating the domestic debt denominated in local currency and foreign debts denominated in foreign currencies.

a-Why Debts?

-Any decision monetary authorities concerning the monetary and financial economy (financial openness, or a change of regime change) should take into account debt and the debt ratio relative to its GDP (Calvo 2006). This latter represent the key barriers to economic progress and sources of macroeconomic vulnerability. Indeed Calvo and Mishkin (2003) explained how the foreign debts denominated in foreign currencies have been the result of worsening the crisis of Asian countries and Argentina, especially for flexible (managed) exchange regime like in Turkey. Later on, Calvo (2006) adds in his article that a high domestic debt is as serious and dangerous as external debts. Recent crisis (end of 1990 and begin of 2000) were define as “foreign debt crisis years”

\(^{14}\) The term is used here to mean "currency board". This is a partial dollarization and not total
Furthermore, studying the impact of debt the extent of hoarding foreign reserves and sterilizing is for developing countries should be interested, especially that the high level of Debt/GDP is “proper” to them.

In Figure 7, the ratio of Public Debt to GDP in Lebanon 160%. It is the 4th highest in the world in 2009\(^{15}\). The foreign debts exceed \(\frac{3}{4}\) of GDP. The debt / GDP in Turkey and Lebanon are very considered unsustainable but he IMF and have important macroeconomic effects that can be severe and dangerous; even if they are "protected" by the International Reserves, as might be the case of Mexico (Calvo 2006).

To see the effects of debt on the extent of sterilization of reserves, we introduce external debts in a model and will study their influence on the decision of foreign reserves. We split the total into domestic and external debt to see their effect on the sterilization. For Turkey and Lebanon, the total public debts are significant at 0% and 5% respectively in table I-2 and II-2. The coefficients are positive, that confirm that public debt used for sterilization (Coefficient \(\beta\) of \(\Delta FR/RM\) is negative).

Checking with foreign debts in table I-3 and II-3, the variable is significant at 0% for both countries with positive coefficient. The coefficient of sterilization is nearly the same. The Public debt is sterilized (The model was tested with and without GDP and the result was the same, confirming the in non-effect of GDP on sterilization in both countries). This concludes that the external debts of the public debt have a major effect, in both countries, (Domestic Debt in Turkey is more significant at18% than in Lebanon).

\(^{15}\) at the end of 2009. Source : World Bank
**b-More and more Debt**

To study "from where comes" the FR in emerging countries, and what are the components that affect the sterilization, Aizenman et al measured the rate of sterilization \( \Delta DC / RM \) only by the current account, the FDI (Foreign Direct Investment) and NFDI (No Foreign Direct Investment), without adding \( \Delta FR / RM \). (The response was different from one country to another. China’s sterilization depends mostly on NFDI. For other countries, like Brazil, Malaysia and Singapore, sterilization depends on the current account.

In the case of Turkey and Lebanon, their current account, and commercial balance are negatives; therefore model is not significant at all.

However, as we have seen previously, the Public debt and foreign reserves have mostly the same trend, so we add the Total public debt (Table I-4 and II-4) in the model, **without** \( \Delta FR/RM \) to test its influence on the decision of sterilization. We had a significant response to 1% and 0.1% for Turkey and Lebanon, and the **coefficient is negative**. The degree of sterilization of Turkey decreases too much and becomes -0.09. In Lebanon it goes down from \(-1\) to \(-0.42\); but sterilization is still important.

We conclude that foreign reserves come from Total Debt and it are using to decrease the domestic asset of central bank in different degrees. (\( \beta \) is still negative). The coefficient of GDP is negative, so it is rejected.

To know which part of the public debt influences more on sterilization, we divide public debt into External Debt and Domestic Debt: Table I-5 and II-5.

We had a negative coefficient of the variable external debt and are significant for 0.1% and 1% for Turkey and Lebanon. The coefficient of sterilization of Turkey goes smaller to -0.04. In Lebanon, the coefficient is nearly the same around \(-0.4\) but less than the beginning \(-1\).

We confirm that Turkey and Lebanon use External debt from the Total Dept as foreign reserves inflow to sterilize them, but in different degrees. The degree can be related to the degree of indebted countries. The more countries is external indebted, the more he sterilize his external debt.

We conclude that source of foreign reserves comes from external debt for Lebanon more than for Turkey. The difference can be related to the Ratio External Debt/RM. The more countries is external indebted, the more he sterilize his external debt.
Therefore, Lebanon increases its reserves “insurance” by increasing their foreign debt risk. Is this strategy of diverting the debt viable?

According to Calvo (2003), a country that has excessively external debt, hoarding reserves is not sufficient to avoid a crisis. "Nothing is more disastrous" than to open the financial market (Lebanon may look for it with is fully sterilization) while being financially crippled by a high debt ratio and dollarized; especially in a flexible exchange rate like for Turkey.

**CONCLUSION**

The more the economy is open, the more it may self recover after a crisis due to a "sudden stop" (Calvo, Izquierdo and Talvi 2002). Yet according to Williamson and Mahar (1998), Ranciere Tornell and Westermann (2006), Obsfeld (2009) and other authors cited above, financial openness makes the economy vulnerable and prone to crises. In this virtuous circle, we have a policy of reserve accumulation and sterilization that can protect themselves against the risky side of the financial openness and crises. That’s why; the post-crisis emerging countries increase their hoarding foreign reserves and sterilizing them.

For developing countries which are excessively in debt in foreign currency like Lebanon and Turkey, and have unsustainable debt according to FMI; their sterilisation behaviour is different from the one seen with emerging countries. Starting from a simple regression model, we have find that the source of foreign reserves in developing countries are mainly from external debts and neither from FDI nor NFDI nor CA as seen with emerging countries. Thus, we can conclude that, despite that the practice of sterilization seems to be similar than emerging ones; the consequences are not: the emerging countries make profit of their foreign inflows by sterilization process; whereas in Lebanon and Turkey, they divert their debts and weaknesses by sterilization process.

To confirm it, studies about the degree of financial openness, the degree of the monetary independence and the flexible (managed) exchange rate in developing countries that sterilize their foreign reserves; will be the goals of future researches.\(^{16}\)
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FIGURES

_All data for Lebanon and Turkey are in Million National Currency_

Figure 1- Net FR/GDP from 1995-2009

**Turkey**

**Lebanon**
Figure 2: ΔFR/RM-4 and ΔDC/RM-4 in Asia and Latin America
(Source Aizenman et Glick 2008)
Note: positive values correspond to foreign reserve inflows or domestic asset increases.
Figure 3 - ΔFR/RM-4 and DC/RM-4

Turkey

Lebanon
Figure 4 - External Debt (GED) and Foreign Reserves

Turkey

Lebanon
Figure 5 - Yearly Coefficient of Sterilization

Lebanon

Turkey
Figure 6- Variation of GDP, RM and DC

Turkey

Lebanon
Figure 7 - Public Debts (DT), External Debt (FR) and Domestic Debt (DD)

Turkey

Lebanon
### TABLES I\(^{17}\)-Turkey

**Table I-1**

Sterilization, Foreign Reserves and GDP

\[ \Delta DC/RM_{-4} = \alpha + \beta \Delta FR/RM_{-4} + \gamma \Delta LnGDP \]

Residuals:

<table>
<thead>
<tr>
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<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>-0.2528312</td>
<td>-0.0763121</td>
<td>0.0008677</td>
<td>0.0547595</td>
<td>0.2666729</td>
</tr>
</tbody>
</table>

Coefficients:

|                | Estimate   | Std. Error | t value | Pr(>|t|) |
|----------------|------------|------------|---------|----------|
| (Intercept)    | 0.08487    | 0.01802    | 4.709   | 1.78e-05*** |
| \( \Delta FR/RM_{-4} \) | -0.76948   | 0.04414    | -17.432 | <2e-16***  |
| \( \Delta LnGDP \) | 0.01416    | 0.22754    | 0.062   | 0.95      |

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Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1084 on 54 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared: 0.8703,  Adjusted R-squared: 0.8655
F-statistic: 181.2 on 2 and 54 DF,  p-value: < 2.2e-16

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\(^{17}\) The table reports coefficients of regressing central bank net domestic credit on net foreign reserves, measured as non-overlapping 4-quarter changes, scaled by the lagged reserves money stock \( RM_{(Q4)} \). The \( \Delta Ln(GDP) \) is the 4 quarter percent change nominal GDP. Tables 4 and 5 report coefficients of regressing central bank net domestic reserves on Growth external debt, and domestic debt and/or total debt, all measured as nonoverlapping 4-quarter changes, scaled by the Lagged reserve money \( RM_{(Q4)} \).
### Table I-2
**Sterilization, Foreign Reserves and Total Public Debt**

\[ \Delta \text{DC/RM}_{4} = \alpha + \beta \Delta \text{FR/RM}_{4} + \gamma \Delta \text{LnTD} \]

Residuals:

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
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</table>

Coefficients:

| Coefficient | Estimate | Std. Error | t value | Pr(>|t|)  |
|-------------|----------|------------|---------|--------|
| (Intercept) | 0.04052  | 0.01655    | 2.449   | 0.0176 *|
| \( \Delta \text{FR/RM}_{4} \) | -0.88487 | 0.03971    | -22.281 | < 2e-16 ***|
| \( \Delta \text{LnTD} \) | 1.84161  | 0.35206    | 5.231   | 2.81e-06 ***|

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Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.08831 on 54 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared: 0.9139,   Adjusted R-squared: 0.9108
F-statistic: 286.7 on 2 and 54 DF, p-value: < 2.2e-16

### Table I-3
**Sterilization, Foreign Debt and Domestic Debt**

\[ \Delta \text{DC/RM}_{4} = \alpha + \beta \Delta \text{FR/RM}_{4} + \gamma \Delta \text{LnGED} + \delta \Delta \text{LnDD} \]

Residuals:

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>-0.202191</td>
<td>-0.045553</td>
<td>-0.004264</td>
<td>0.058471</td>
<td>0.221668</td>
</tr>
</tbody>
</table>

Coefficients:

| Coefficient | Estimate | Std. Error | t value | Pr(>|t|)  |
|-------------|----------|------------|---------|--------|
| (Intercept) | 0.04600  | 0.01711    | 2.689   | 0.0096 **|
| \( \Delta \text{FR/RM}_{4} \) | -0.89655 | 0.04272    | -20.989 | < 2e-16 ***|
| \( \Delta \text{LnGED} \) | 1.40117  | 0.38115    | 3.676   | 0.000553 ***|
| \( \Delta \text{LnDD} \) | 0.40679  | 0.30597    | 1.329   | 0.189378 |

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.0897 on 53 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared: 0.9129,   Adjusted R-squared: 0.9079
F-statistic: 185.1 on 3 and 53 DF, p-value: < 2.2e-16
### Table I-4

**Sterilization, Total public Debt and GDP (without FR)**

\[
\Delta DC/RM_4 = \alpha + \beta \Delta TD/RM_4 + \gamma \Delta LnGDP
\]

Residuals:

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔDC/RM</td>
<td>-0.61754</td>
<td>-0.14307</td>
<td>0.02805</td>
<td>0.12742</td>
<td>1.01756</td>
</tr>
</tbody>
</table>

Coefficients:

| Estimate | Std. Error | t value | Pr(>|t|) |
|----------|------------|---------|----------|
| (Intercept) | 0.03149 | 0.04935 | 0.638 | 0.5260 |
| ΔTD/RM | -0.04692 | 0.01896 | -2.475 | 0.0165* |
| ΔLnGDP | -1.36309 | 0.51593 | -2.642 | 0.0108* |

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2645 on 54 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared: 0.2283, Adjusted R-squared: 0.1997
F-statistic: 7.987 on 2 and 54 DF, p-value: 0.000915

### Table I-5

**Sterilization, Domestic Debt, Foreign Debt and GDP (without FR)**

\[
\Delta DC/RM_4 = \alpha + \beta \Delta DD/RM_4 + \gamma \Delta GED/RM_4 + \delta \Delta LnGDP
\]

Residuals:

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔDC/RM</td>
<td>-0.56406</td>
<td>-0.14459</td>
<td>0.02905</td>
<td>0.13254</td>
<td>1.00452</td>
</tr>
</tbody>
</table>

Coefficients:

| Estimate | Std. Error | t value | Pr(>|t|) |
|----------|------------|---------|----------|
| (Intercept) | 0.008169 | 0.048881 | 0.167 | 0.86791 |
| ΔDD/RM | 0.077006 | 0.059412 | 1.296 | 0.20054 |
| ΔGED/RM | -0.095470 | 0.028606 | -3.337 | 0.00155** |
| ΔLnGDP | -1.386627 | 0.499094 | -2.778 | 0.00754** |

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2554 on 53 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared: 0.2938, Adjusted R-squared: 0.2538
F-statistic: 7.349 on 3 and 53 DF, p-value: 0.0003305
Table I-6
Sterilization, Foreign Reserves, GDP and Inflation

\[ \Delta DC/RM = \alpha + \beta \Delta FR/RM + \gamma \Delta lnINF + \delta \Delta lnGDP \]

Residuals:
- Min 1Q Median 3Q Max
-0.20748 -0.03824 -0.01465 0.05648 0.26944

Coefficients:
- Estimate Std. Error t value Pr(>|t|)
- (Intercept) 0.02663 0.02183 1.220 0.227956
- \( \Delta FR/RM \) -0.83036 0.04217 -19.690 < 2e-16 ***
- \( \Delta lnINF \) 2.16368 0.55112 3.926 0.000251 ***
- \( \Delta lnGDP \) -0.01926 0.20234 -0.095 0.924539

---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.0963 on 53 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared: 0.8996, Adjusted R-squared: 0.8939
F-statistic: 158.2 on 3 and 53 DF, p-value: < 2.2e-16
TABLES II¹⁸-Lebanon

Table II-1
Sterilization, Foreign Reserves and GDP

\[ \Delta DC/RM_{-4} = \alpha + \beta \Delta FR/RM_{-4} + \gamma \Delta LnGDP \]

Residuals:
Min  1Q  Median  3Q  Max
-1.917e-16  -3.490e-17  -2.119e-17  2.168e-18  9.910e-16

Coefficients:

|                | Estimate | Std. Error | t value | Pr(>|t|) |
|----------------|----------|------------|---------|----------|
| (Intercept)    | 0.000e+00| 2.716e-17  | 0.00e+00| 1.000    |
| \( \Delta FR/RM_{-4} \) | -1.000e+00| 3.774e-17  | -2.65e+16| <2e-16 ***|
| \( \Delta LnGDP \) | 1.183e-15| 1.322e-15  | 8.95e-01 | 0.375    |

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.418e-16 on 54 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared:  1,  Adjusted R-squared:  1
F-statistic: 3.547e+32 on 2 and 54 DF,  p-value: < 2.2e-16

¹⁸ The table reports coefficients of regressing central bank net domestic credit on net foreign reserves, measured as non-overlapping 4-quarter changes, scaled by the lagged reserves money stock RM\(_{Q4}\). The \( \Delta Ln(GDP) \) is the 4 quarter percent change nominal GDP. Tables 4 and 5 report coefficients of regressing central bank net domestic reserves on Growth external debt, and domestic debt and/or total debt, all measured as nonoverlapping 4-quarter changes, scaled by the Lagged reserve money RM\(_{Q4}\).
Table II-2
Sterilization, Foreign Reserves and Total Public Debt

\[ \Delta DC/RM_4 = \alpha + \beta \Delta FR/RM_4 + \gamma \Delta LnTD \]

Residuals:
- Min 1Q Median 3Q Max
-2.026e-16 -2.947e-17 -1.739e-17 -7.248e-19 9.665e-16

Coefficients:
- Estimate Std. Error t value Pr(>|t|)
- (Intercept) -1.471e-17 2.498e-17 -5.890e-01 0.559
- \Delta FR/RM_4 -1.000e+00 3.924e-17 -2.548e+16 <2e-16 ***
- \Delta LnTD 2.136e-15 1.295e-15 1.649e+00 0.10 .

---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.394e-16 on 54 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared: 1, Adjusted R-squared: 1
F-statistic: 3.671e+32 on 2 and 54 DF, p-value: < 2.2e-16

Table II-3
Sterilization, Foreign Debt and Domestic Debt

\[ \Delta DC/RM_4 = \alpha + \beta \Delta FR/RM_4 + \gamma \Delta LnGED + \delta \Delta LnDD \]

Residuals:
- Min 1Q Median 3Q Max
-3.366e-16 -2.474e-17 5.171e-18 2.238e-17 7.419e-16

Coefficients:
- Estimate Std. Error t value Pr(>|t|)
- (Intercept) -4.412e-17 2.247e-17 -1.963e+00 0.0549 .
- \Delta FR/RM_4 -1.000e+00 3.354e-17 -2.981e+16 <2e-16 ***
- \Delta LnGED 8.950e-16 1.964e-16 4.558e+00 3.08e-05 ***
- \Delta LnDD 5.047e-16 8.294e-16 6.080e-01 0.5455

---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.222e-16 on 53 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared: 1, Adjusted R-squared: 1
F-statistic: 3.183e+32 on 3 and 53 DF, p-value: < 2.2e-16
### Table II-4

**Sterilization, Total public Debt and GDP (without FR)**

\[
\Delta DC/RM_4 = \alpha + \beta \Delta TD/RM_4 + \gamma \Delta LnGDP
\]

Residuals:

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Values</td>
<td>-1.3714</td>
<td>-0.2459</td>
<td>0.0796</td>
<td>0.3474</td>
<td>1.0606</td>
</tr>
</tbody>
</table>

Coefficients:

| Term       | Estimate | Std. Error | t value | Pr(>|t|) |
|------------|----------|------------|---------|---------|
| (Intercept)| 0.1600   | 0.1107     | 1.445   | 0.1541  |
| \(\Delta TD/RM_4\) | -0.4260  | 0.1559     | -2.733  | 0.00846 ** |
| \(\Delta LnGDP\)  | -0.9053  | 4.5477     | -0.199  | 0.84295 |

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.4793 on 54 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared: 0.1304, Adjusted R-squared: 0.0982
F-statistic: 4.049 on 2 and 54 DF, p-value: 0.02299

---

### Table II-5

**Sterilization, Domestic Debt, Foreign Debt and GDP (without FR)**

\[
\Delta DC/RM_4 = \alpha + \beta \Delta DD/RM_4 + \gamma \Delta GED/RM_4 + \delta \Delta LnGDP
\]

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Values</td>
<td>-1.35821</td>
<td>-0.24868</td>
<td>0.07445</td>
<td>0.34836</td>
<td>1.07686</td>
</tr>
</tbody>
</table>

Coefficients:

| Term       | Estimate | Std. Error | t value | Pr(>|t|) |
|------------|----------|------------|---------|---------|
| (Intercept)| 0.1628   | 0.1156     | 1.408   | 0.1649  |
| \(\Delta DD/RM_4\) | -0.4439  | 0.2181     | -2.035  | 0.0469  * |
| \(\Delta GED/RM_4\) | -0.4163  | 0.1674     | -2.486  | 0.0161  * |
| \(\Delta LnGDP\)  | -0.9890  | 4.6290     | -0.214  | 0.8316  |

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.4841 on 53 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared: 0.1295, Adjusted R-squared: 0.08023
F-statistic: 2.628 on 3 and 53 DF, p-value: 0.05968