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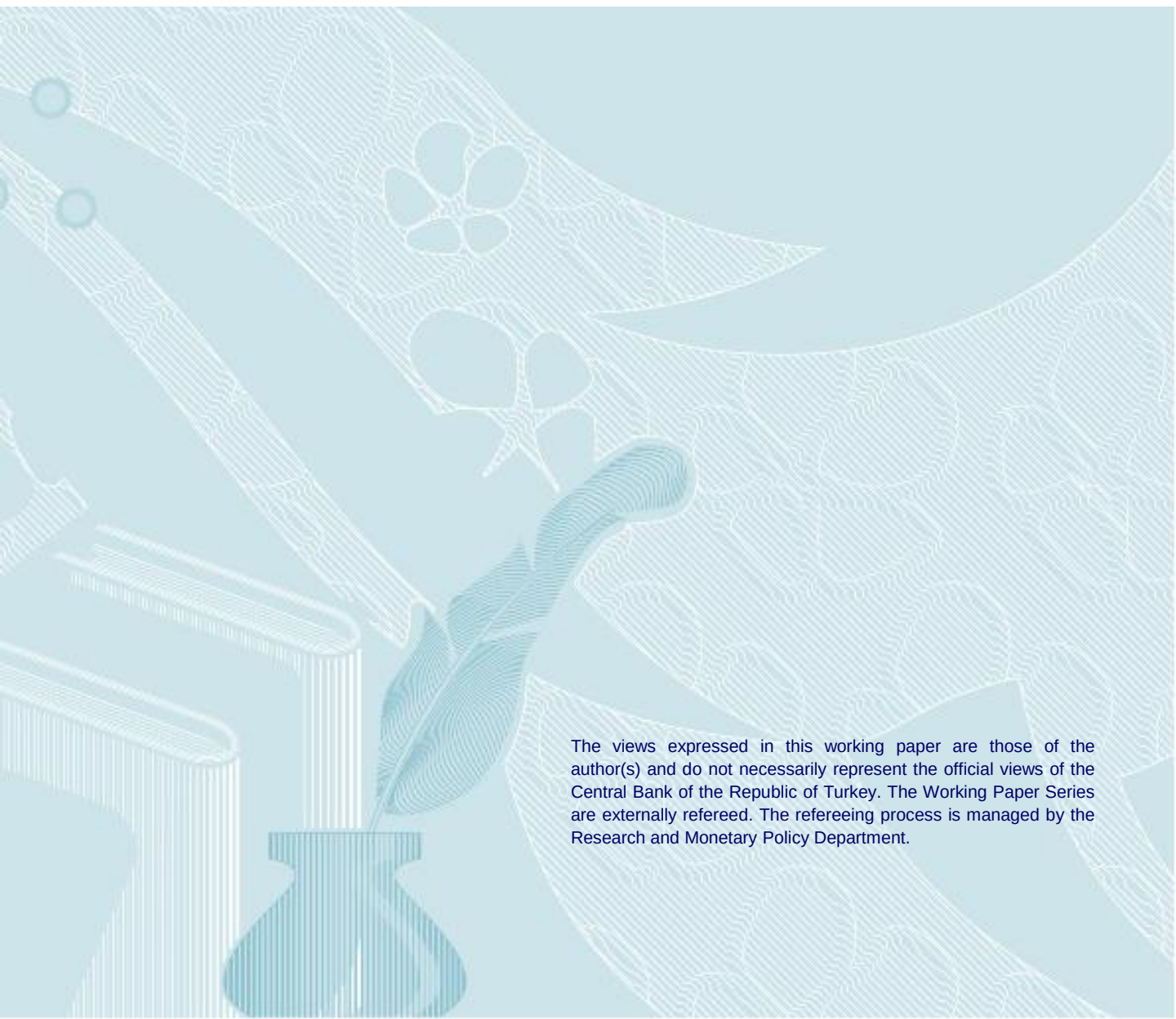

Non-core Liabilities as an Indicator of Systemic Risk and a Liquidity Stress Test Application on Turkish Banking System

by

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Abstract: *We provide a detailed classification of core and non-core liabilities for the Turkish banking system à la Shin and Shin (2010). We further carry out a two-stage liquidity stress test similar to Van Den End (2010) where we simulate inflow and outflow factors as well as the network topology of mutual liabilities between financial institutions. Our results indicate that Turkish banking system with relatively low level of non-core liabilities is to a great extent robust to liquidity shocks. Nevertheless, the level of non-core liabilities should be monitored closely considering its pro-cyclical behaviour over the business cycle and its strong correlation with credit growth.*

Keywords: Financial stability, non-core liabilities, liquidity stress test, network topology.

JEL Codes: C15, E44, G21, G28, G32

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1. Introduction

Liquidity crises are sudden events with widespread impacts on the banking system. The latest crisis reveals that the most unreliable source for banks during a liquidity freeze is unsecured wholesale funding. A dry-up in these funds- usually combined with a decline in market liquidity- can easily result in a quick contamination of the liquidity shock. The impact might even propagate through fire sales of assets and lead to further disruption in funding in an interconnected financial system. We argue that a classification of liabilities among the source of funding à la Shin and Shin (2010) provides us with a valuable indicator of systemic risk in this sense. Accordingly, first objective of this paper is to provide a definition of the *non-core* liabilities of the Turkish banking system.

Second, we exhibit the procyclical behaviour of the level of non-core liabilities. Especially during booms, when credit demand growth exceeds deposit growth, banks look for alternative sources of funding. One widespread consequence of this attempt is a surge in short-term foreign currency denominated debt. Besides, another significant phenomenon is the proliferation of cross-lending between domestic banks. Both of these developments increase risks related with maturity and currency mismatches. We examine the behaviour of the level of non-core liabilities and its sub-items in US, Korea and Turkey in a comparative framework. Moreover, we discuss macro-prudential policies against the proliferation in non-core liabilities applied by these countries in the post-crisis period.

Third, we concentrate on the assessment of liquidity risk. The revived interest in liquidity risk in the post-crisis period highlights the funding structure of the banks as much as the corresponding asset allocation. Financial Stability Forum (2008) suggests that risks associated with liquidity should be more thoroughly incorporated into the new generation stress testing frameworks. From this standpoint, recent advances in the liquidity stress testing framework consider alternative time and cross sectional dimensions[4]. In this respect, this study employs a two-stage liquidity stress test based on Van Den End (2010) to assess the robustness of the Turkish banking system. We carry out a stochastic analysis via Monte Carlo simulation of shocks on liquidity related items. We examine the impact of a simultaneous freeze in the market for rollover of noncore liabilities and a deterioration of market liquidity on the banks. We further extend the analysis by increasing the domestic interbank market size under alternative market structures to gauge the contagion effect arising from bilateral exposures. Our findings indicate that Turkish banking system is to a great extent robust to liquidity shocks, whereas a higher level of non-core liabilities and higher interconnectedness in the financial system increase the severity of these shocks.

The structure of the paper is as follows. Next section defines core and non-core liabilities and provides a detailed description of these aggregates for Turkey. Third section examines the development of Turkish non-core liabilities and their decomposition, in comparison with US and Korean counterparts. Fourth section describes the liquidity stress test and reports the results. Fifth section sums up the results and contains concluding remarks.

2. Core and Non-Core Liabilities

The proliferation in global liquidity in the post-crisis period works as a push-factor in overheating of the recipient economies due to buoyant credit demand[5]. Emerging markets, rather than the advanced ones, seem more at stake as being recipients of these capital flows. Figure 1 depicts the average change in credit-to-GDP ratio for 13 advanced countries and 12 emerging markets. A first look at the graph suggests that the global financial crisis marks a brief period of slowdown in credit for both country groups.

[4] See Van den End (2010) and Schmeider et.al (2011).

[5] Pradhan et.al (2011) study documents the measures taken by recipient emerging markets to prevent overheating and to provide financial stability. IMF (2011) draws attention to the global risks of soaring capital flows and suggests an international regulatory and supervisory framework to manage capital flows in order to mitigate their potentially harmfull cross-border effects.

However, emerging markets exhibit signs of a quick recovery after the first quarter of 2010 unlike the advanced countries that display a negative trend until the second quarter of 2011[6].

Figure 1: Total Credits

Change in total credits / GDP

(q-o-q change, 4-quarters moving average, indexed as 2008Q3=100)

Note: Advanced countries include Australia, Austria, Belgium, Denmark, Finland, France, Greece, Malta, Singapore, Spain, Switzerland, UK and USA. Emerging markets include Brazil, Chile, Croatia, Czech Republic, Georgia, Hungary, Mexico, Poland, Russia, South Africa, Thailand and Turkey.

Source: Central banks and/or government statistical agencies

In response to these vulnerabilities, macro-prudential perspective that becomes eminent in the post-crises era drives central banks to keep an eye on financial stability in addition to their traditional price stability objective[7]. Those macro-prudential policies have a *time dimension* and a *cross-section dimension* according to Borio (2010). On the one hand, the interest in time dimension lies on the development of the systemic risk over time at the financial sector. Countercyclical buffers are popular policy tools to prevent financial failures in that sense. On the other hand, the focus of cross-sectional dimension is on the accumulation of risk in the financial network at a particular point in time. Alternative policies highlight the correlation of exposures among institutions and aim to reduce negative externalities through individual actions.

Alternative approaches to produce financial stability measures include balance sheet indicators, market-based indicators, early warning indicators, macro stress testing approach and Vector Auto-regression framework.[8] Our focus is on both defining a balance sheet indicator (time dimension) and conducting a stress test in order to assess the effect of a liquidity shock considering alternative levels of this indicator (cross sectional dimension).

We follow a strand of literature which focuses on the role of balance sheet linkages among banks which is supposed to play a key role in systemic breakdown. As discussed above, a popular view blames the recent flow of capital for the swelling of financial system in emerging markets and asks for tighter

6 Hilbers et.al (2005) examine effects of rapid credit expansion in emerging markets and provides a survey of prudential policies conducted by selected emerging markets.

7 BIS (2010a) provides a survey of recent central bank macro-prudential policies. IMF (2012) examines the interaction between macroprudential policies and monetary policies in depth.

8 See Borio and Drehman (2009) and Galati and Moessner (2010) for a review of these indicators and alternative macroprudential policy frameworks.

regulations. As the argument goes, the principal intermediary for most of these capital flows in developing or underdeveloped markets is the banking sector. Hence, the resilience of the domestic banking sector is particularly important due to its heavy involvement in channelling foreign funds into the economy.

Above explanation is an appealing one when banks are regarded as *passive* intermediaries which channel these excess flows to credit demanding domestic households. However, a more recent conjecture raised by Hahm, Shin and Shin (2012) suggests examining the liability structure of the banks in a more comprehensive manner. This view assumes a critical and *active* role to banks in the amplification of financial shocks. Banks apply to less reliable and volatile sources of funding during credit booms in order to meet the credit demand of households, which intensifies the vulnerability of the banking sector against systemic risks. Therefore, a classification of liabilities of banks according to the reliability and stability of funds can provide us a good indicator of the robustness of the financial system.

The main difference between core and non-core liabilities is expressed by the holder of the claim. According to this distinction, core liabilities are liabilities to the domestic household sector such as demand and time deposits. These funds are more reliable and relatively stable sources for banks. Household deposits follow a relatively smooth growing trend, in line with the growth level of the household wealth. However, during booms when credit demand growth exceeds deposit growth, banks look for other sources of funding. One widespread consequence of this attempt is a surge in the short-term foreign currency denominated debt. Besides, another significant phenomenon is the proliferation of cross-lending between domestic banks. These two constitute non-core liabilities of the banks, which are more volatile and have a short-term nature compared to core liabilities.

Table 1 documents a more detailed description of core and non-core liabilities for the Turkish banking system[9]. Core liabilities are mainly composed of household's claim on the banking sector, whereas non-core liabilities consist of liabilities to financial institutions. The table also provides a distinction of these liabilities according to their maturity structure.

Liabilities of the banks can be roughly categorized as: (i) *deposits* (ii) *payables to central bank* (iii) *payables to money market* (iv) *payables to securities market* (v) *payables to banks* (vi) *funds from repo transactions* (vii) *securities issued* (viii) *subordinated debt* and (ix) *shareholder's equity*.

Deposits constitute the largest portion of the liabilities in Turkish banking system[10]. Owner of these deposits can be households, corporate sector or financial institutions. Household deposits are clasified as core liabilities whereas deposits from financial institutions display a non-core character. Interbank deposits are reported in *payables to banks* item in the balance sheet. *Payables to central bank*, *payables to money market* and *payables to securities market* items constitute very small portions of liabilities.

Claims of nonfinancial corporations on banks are examined in an intermediate region between core and non-core liabilities in Table 1. While these deposits are more reliable than that of non-financial institutions they are still less stable than that of the household sector. This is especially the case when firms play the role of a surrogate financial intermediary. One example of this is illustrated by Shin (2012) for China where banks are not allowed to access international markets. Instead, Chinese firms directly borrow from abroad and deposit the proceeds into domestic financial system as collateral. Hence, the procyclical increase in corporate deposits might imply a high level of open position for these firms[11]. For

[9] There are alternative data sources (such as bank templates or balance sheet items) to construct noncore liabilities at different time periods. We conclude that publicly avalibale balance sheet items provide an adequete level of data precision.

[10] As of June 2012 deposits constitue 56 per cent of total liabilities.

[11] Another example is Japanese firms in 1980s. After the liberalization of securities markets, many Japanese firms that traditionally provide financing through bank credits had the opportunity to raise funds through securitization. Hattori et al. (2009) argues that this development increased the vulnerability of banking sector in line with two reinforcing factors. First, large firms which constitute the highest quality credit

Turkey, CBRT (2012) reports that the open position of the corporate sector displays an increasing trend over the last years which implies vulnerability against domestic currency depreciation[12]. The Hence, while we treat corporate deposits in the middle region in the meantime, it is of the essence to monitor the developments of these aggregates in conjunction with the liability structure of the corporate sector.

We propose two alternative definitions, a narrow and a broad one, for noncore liabilities. Narrow definition includes all items on the last column of Table 1, excluding *security issuance.* Broad definition covers *security issuance* which displays relatively less of a noncore character[13]. *Payables to banks* and f*unds from repo transactions* among banks constitute principal form of noncore funding[14]. Essential part of non-core liabilities is *payables to banks* denominated in foreign currency[15].

Banks conduct their *domestic currency* repo transactions mostly with central bank and *foreign currency* repo transactions mostly with other banks. We exclude r*epo with central bank* from non-core liabilities. This segregation is based on a financial stability perspective. As the argument goes, while banks allocate their domestic currency repo funding from the central bank to credits, this source of funding is not as unreliable as loans from other banks in case of a stress scenario.

Noncore liabilities eventually consist of domestic and foreign currency denominated *payables to banks* and *repo transactions* as well as the *securities issued*. Two appropriate monetary aggregates to compare these amounts would be M2 or M3. The first one includes demand and time deposits and therefore provides us a good proxy for liabilities of the banking sector to depositors. The latter one includes repo transactions and liquid money market funds as well[16].

Table 1: Core and Non-Core Liabilities

<table>
<tr><th></th><th>Core Liabilities</th><th>Intermediate</th><th>Noncore Liabilities</th></tr>
<tr><th></th><th>Households</th><th>Non-financial Corp's.</th><th>Financial Institutions</th></tr>
<tr><td>Short Term</td><td>Demand deposits
Short-term deposits (<1 month)</td><td>Demand deposits
Short-term deposits (<3 months)</td><td>Demand deposits
Funds from repo transactions
Short-term payables to banks</td></tr>
<tr><td>Medium Term</td><td>Medium-term deposits (1 month-1 year)</td><td rowspan="2">Medium and long-term deposits</td><td>Medium and long-term deposits
Medium and long-term payables to banks</td></tr>
<tr><td>Long Term</td><td>Long-term deposits
(>1 year)</td><td>Securities issued
Other borrowings from banks</td></tr>
</table>

customers of the banks lowered their borrowing demand. Second, deposits of the banks have increased which urged them to find new, and possibly lower quality, credit customers.

[12] As of February 2012, 58 percent of the Turkish corporate debt is in foreign currency whereas a majority of these has a long-term nature (CBRT, 2012). At the same date, foreign currency deposits constitute 41 percent of the total deopsits of the Turkish coporate sector. (source www.brsa.org.tr, monthly interactive bulletin).

[13] The holder of these securities is households, firms as well as banks. Hence, first, some of these liabilities have a long-term nature. Second, from a holder of claim perspective, they have less of a noncore characteristic. However, BCBS framework does not take those as reliable sources during stress since they are issued by financial institutions. BRSA allowed Turkish banks to issue bonds and bills after 2009. After this date there is a steady increase in this figure but it constitutes only an insignificant 0.014 per cent of noncore liabilties as of June 2012. Therefore, those are covered in a broad definition of noncore liabilities in our study.

[14] As of June 2012, these two items constitute 80 per cent and 20 per cent of noncore liabilities, respectively.

[15] 66 per cent of noncore liabilities as of June 2012.

[16] Securities issued included in broad definition of noncore liabilities is also covered by M3 after May 2011. Therefore, the denominator should be M3 once the broad definition is employed.

3. Developments of Non-Core Liabilities

Figures 2 to 4 depict non-core liabilities of the banking system as a ratio of M2, as well as their decomposition, for US, Korea and Turkey, respectively. Our definition of non-core liabilities for US and Korea is similar to Shin and Shin (2010) study. *Repo* is the outstanding stock of repo transactions of primary dealers for US. *Financial commercial papers* are included for US whereas Korean data comprises *debt securities* as a non-core funding source for the financial intermediaries. Moreover, *certificate of deposits* that are held as a substitute for government securities in carry trades are also included in Korean case.

A first look at US and Korean ratios in Figures 2 and 3 suggests the procyclical behaviour of non-core liabilities over business cycles. Credit booms that mostly take place in an expansionary phase of the economy also mark an increase in the level of non-core liabilities. The ratio of non-core liabilities to M2 increases up to 48 per cent in US and 43 per cent in Korea before the crisis. However, the global financial crisis results in a plunge in the ratio in both countries, which is consistent with the conjecture that these funds are not reliable, especially in times of stress. Three year after the crises, the ratio hovers around 25 per cent in both countries.

The contraction in non-core liabilities after the crisis is partially due to the countercyclical policies conducted by the financial authorities in these countries. Dodd-Frank Act (2010) that describes a macro-prudential framework for the post-crisis US financial system imposes a higher burden on financial institutions whose share of non-deposit liabilities is higher[17]. While, at first place, this regulation is regarded as a fiscal measure, Shin (2011a) highlights that this tax on non-core liabilities also works as *a prudential tool in dampening the procyclicality of the financial system, especially for emerging economies.*

Korean financial authority also imposed a Macro-Prudential Stability Levy on non-deposit foreign currency liabilities at the end of 2010[18]. Shin (2011b) points out that this levy carries the characteristics of an *automatic stabilizer* owing to the procyclical behaviour of foreign borrowings, similar to the US regulation mentioned above[19]. In a recent working paper, Bruno and Shin (2013) conducts a cross-sectional panel study and shows that the sensitivity of Korean economy to global liquidity conditions decreased compared to the other similar economies after the implementation of macroprudential policies.

Despite the similarity plunge in the post-crisis period, the sources of the increase in the non-core liabilities *in good times* are different for these countries. Figure 2 reveals that the main determinant of the expansion on non-core liabilities in US is the repo transactions. The financial commercial papers display a stable trend. The growth of repos before the crisis points out the heavy reliance of US banks to unstable short-term financing during the upturn of the cycle. This results in a build-up of liquidity risk which undermines financial resilience towards shocks. The sudden liquidity dry-up during stress times might give rise to fire sales of assets, which can easily spread up in the system. As the argument goes, uninsured short-term funding in good times stands out as an explanation of the propagation mechanism during financial shocks[20].

Figure 3 suggest that, an important part of noncore liabilities consists of debt securities and foreign borrowing for Korea. High level of capital flows into Korea during the boom period works as one

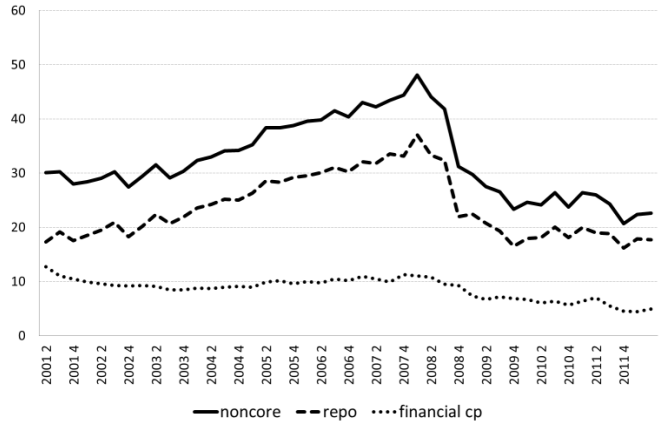
[17] Moreover, the act suggests a comprehensive study of definitions of core and non-core deposit liabilities.

[18] Details of this levy are announced in a press release by Financial Services Commission dated December 20, 2011 which can be accessed through the website www.fsc.go.kr.

[19] IMF (2010) emphasizes the effectiveness of balance sheet indicators to measure the risk of the financial sector. They also argue that a levy on wholesale funding, short-term debt or foreign funding would help to lower the costs associated with systemic risks.

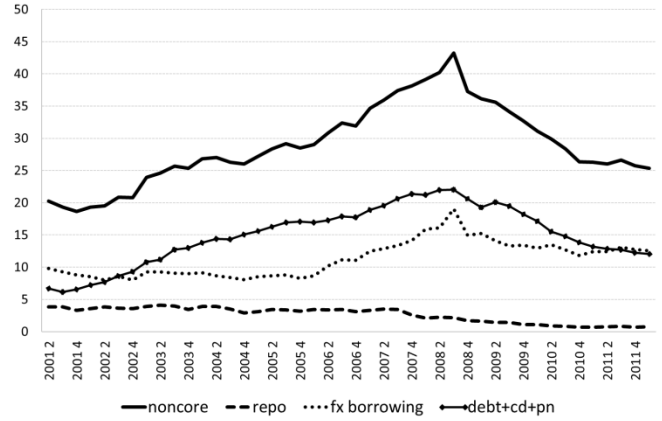
[20] Gorton and Mertick (2012) provide a survey of US repo market transactions during the recent crisis and show that repo runs were mainly conducted by foreign and domestic hedge funds as well as foreign financial institutions.

Figure 2: US Non-core liabilities and constituents as a fraction of M2



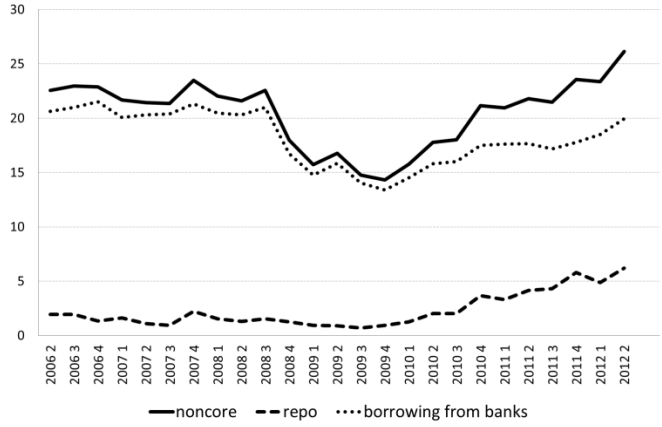
Notes: Repo is the outstanding stock of repo transactions of primary dealers taken from Federal Reserve Bank of New York, Primary Dealer Statistics. M2 and seasonally adjusted outstanding financial commercial paper data is available at Board of Governors.

Figure 3: Korean non-core liabilities and constituents as a fraction of M2



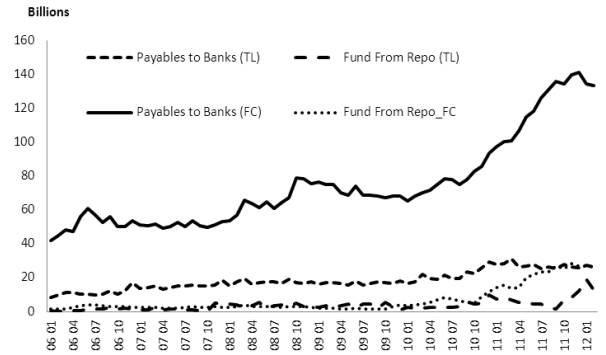
Notes: Data is provided by Bank of Korea. Debt includes debt securities and certificate of deposits. Pn stands for promissory notes.

Figure 4: Turkish non-core liabilities and constituents as a fraction of M2



Notes: Data source is Central Bank of Turkey. Bank borrowing data is adjusted for exchange rate.

Figure 5: Currency decomposition of non-core liabilities of Turkish banking system

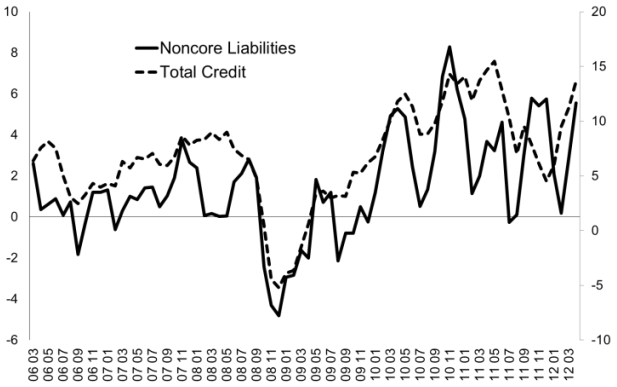


Source: CBRT

Figure 6: Non-core Liabilities and Total Credit

left axis: non-core liabilities, right axis: total credit

change, 3-months average, adjusted for the exchange rate, millions of TL

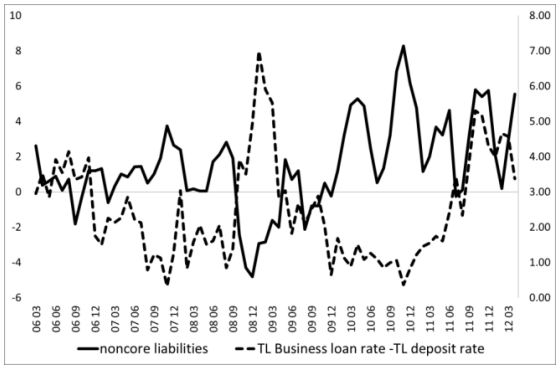


Source: CBRT and BRSA.

Figure 7: Non-core Liabilities and Cost of Credit

left axis: noncore liabilities, change, 3-months average, adjusted for the exchange rate, millions of TL

right axis: TL business loan rate-TL deposit rate, per cent



Source: CBRT

of the main factors behind the substantial increase in the noncore liabilities of the banking sector. Repo transactions show a relatively low and stable trend.

Unlike US and Korean cases, non-core liabilities to M2 series for Turkey suggest a relatively stable trend in the pre-crises period (Figure 4). The ratio is between 20-25 per cent and to a great extent motivated by foreign borrowings. The contraction in non-core liabilities takes a little bit longer than a year after the crisis. Later on, the ratio goes up and exceeds its pre-crisis levels. The currency decomposition of non-core liabilities in Figure 5 illustrates that foreign borrowing constitutes the bulk of the bank borrowing. Moreover, foreign exchange repo transactions display an increase in the last quarters mostly due to the liquidity policies conducted by central bank in this period.

Figure 6 shows the strong co-movement of the non-core liabilities and total credits in Turkey. Especially after the crises, non-core liabilities seem to lead credits. This relation suggests that non-core funding sources are an intrinsically important element for the recent credit growth in Turkey. Recent literature on the relationship between non-core liabilities and credit growth supports this conjecture. Hahm et. al (2012) suggest that the power of non-core liabilities in predicting currency and credit crisis is above that of credit to gdp ratio, employing a panel analysis of emerging and developed countries. A recent working paper by Kılınç et.al (2013) suggest a robust relationship between non-core liabilities and credits for Turkey. Their results point out a robust relationship between non-core liabilities and credit growth. Employing VAR analysis, they suggest credit growth as a pulling factor for the proliferation in non-core liabilities of the banking sector. Moreover, they argue that this relationships also holds in the long run by the help of a Vector Error Correction framework. Özen et. al (2013) also focuses to non-core liabilities as a potential indicator of systemic risk accumulated in financial markets over time. They compare the response of non-core liabilities to external financial stress in 1990s and 2000s and conculde that the relationship is much more significant in the latter era for Turkish financial markets.

Figure 7 shows the negative relationship between the non-core liabilities and the cost of credit. Especially, before the crises, the change in non-core liabilities provides a mirror image of the interest rate on credits. In this period, the pass-through form a marginal increase in source of funding to the interest rates is very high. The relationship is still strong after the crisis whereas other policies conducted by financial authorities to curb credits seem to be in effect as well.

As discussed above, a high level of noncore liabilities to M2 ratio indicates increasing systemic risk. However, this increase does not seem worrisome for the Turkish banking sector at present for a couple of reasons as discussed by Financial Stability Report of CBRT (2011). To begin with, the share of non-core liabilities in overall liabilities side does not exceed 15 per cent. Similarly, a strong loan to deposit ratio assures that most of the credit is financed through core liabilities by Turkish banking sector[21]. Furthermore, measures undertaken by the central bank to increase maturity extension of liabilities have been instrumental recently. [22] This paper further provides a quantitative analysis to test the resilience of banking sector that display an increasing level of non-core liabilities in the next section.

4. Liquidity Stress Test

Noncore liabilities are intrinsically unstable funds obtained from peer institutions. Hence, it is methodologically essential to consider *contagion effects* while examining the potential risks carried by a surge in these funds over the financial system. In this spirit, this section proposes a *liquidity* stress test to assess the robustness of the system, concentrating on both the asset-liability structure of banks and cross-

[21] As the argument goes, a loan to deposit ratio below 100 percent is an indicator of low liquidity risk determined by refunding structure since it shows that loans are financed with more stable funds such as deposits. As of December 2011, loan to deposit ratio is 86.7 percent for Turkey, which is much lower than the EU average of 113.3 percent.

[22] See CBRT (2011) and CBRT (2012) for a review of the latest macro-prudential policy framework.

exposure across them. We study the effect of a liquidity shock under different levels of noncore liabilities, considering alternative market network structures.

The underlying distinction between funding liquidity and market liquidity can help trace effects of a liquidity shock on both assets and liabilities side of the balance sheet[23]. *Funding liquidity* is defined as the ability of a bank to settle obligations in time. On the other hand, *market liquidity* indicates the ability of an asset to be traded in the market in a short time with minimum loss of value (Drehmann and Nikolaou, 2010). Banks having hard times with funding might end up in fire sales of assets which might result in an immediate shrinkage of market liquidity[24]. This process might further have feedback effects via margin calls where funding conditions could deteriorate due to value loss of securities placed as collateral in repo transactions.

Latest crisis reveals that liquidity shocks can easily propagate to the entire system in such a manner. This experience underscored the need to put emphasis on *liquidity* as much as the *solvency* conditions which has been the focus of contagion literature so far[25]. Basel Committee on Banking Supervision (BCBS) (BIS, 2010b) recently proposed two new measures for funding liquidity as a part of its post-crisis regulatory framework (Table 2). First one is the *Liquidity Coverage Ratio* (LCR) which requires a bank to hold adequate level of high-quality liquid assets against a potential liquidity squeeze for one-month period. The second measure, *Net Stable Funding Ratio* (NSFR) focus on longer-term liquidity needs. The last column of Table 2 contains the short-term liquidity measure employed in our stress-test framework, *Liquidity Requirement Ratio* (LRR), which is based on the regulations by Turkish authority, Banking Regulation and Supervision Agency (BRSA, 2006)[26,27].

Tables 3 to 5 demonstrate a detailed comparison of the LCR and LRR templates in terms of item categorizations and the factors assigned to each of the items[28]. While both measures are constructed with a cash flow perspective, there are differences in item sets due to country-specific issues[29]. For both ratios, a value that is lower than one indicates potential liquidity problems for the bank. The tables document the applied factors as one minus *hair-cut ratios* for asset side and *run-off rates* for liabilities side. On assets side, hair-cut ratios assign the possible loss of value of a particular asset or the fraction of assets that may not result in cash inflow during stress. On liabilities side, run-off rates represent the ratio of liability items which may emerge as a non-renewable funding source during a liquidity dry-up.

Table 2: Definition of Liquidity Measures

BCBS-LCR	BCBS-NSFR	BRSA-LRR
$\frac{\text{Stock of high-quality liquid assets}}{\text{Total net Cash out Flows (30-day)}}$	$\frac{\text{Available amount of stable funding}}{\text{Required amount of stable funding}}$	$\frac{\text{Stock Assets+Cash in Flows (30-day)}}{\text{Total Cash Out Flows (30-day)}}$

LCR: Liquidity Coverage Ratio; NSFR: Net Stable Funding Ratio; LRR=Liquidity Requirement Ratio.

[23] The literature lacks a coherent precise definiton of liquidity which might lead to misbehavior of models (Derman, 2011) or misleaded policy responses (Domanski et. al, 2011). For a definiton of market liquidity in Turkey see Yıldırım (2011).

[24] Drehmann and Nikolaou (2010) explores this relationship further and suggest extracting information on the future funding liquidity risk through the open market operation bids of financial institutions. Brunnermeier, Gorton and Krishnamurthy (2012) define a liquidity mismatch index as the difference between the market liquidity and funding liquidity, in other words, liquidity of assets and the liquidity promised through liabilities.

[25] Goodhart (2008) states that despite the complementary nature of solvency and liquidity issues for a sound banking system, these two have not been paid similar attention by regulators in due course of recent history. The initial Basel agreements in 1980's, suggested measures to strengthen capital positions which resulted in a reversal of the downward trend in capital adequacy ratios. However, there was no consensus on these days on the principles relating to liquidity risk or maturity transformation.

[26] LRR is calculated for two different time horizons (1-week and 1 month) and alternative currencies (for foreign currency and total of domestic and foreign currencies). To save space, we present the results of the version that is comparable with BIS: one-month, total of domestic and foreign currencies.

[27] A recent case study by Bonner and Eijffinger (2012) examines the impact of a similar liquidity rule on Dutch interbank market.

[28] The BCBS framework is not finalized yet, so we use the Basel Committee document dated December 2010 in our comparisons.

[29] It is worth to mention that LRR is constructed in 2005, five years before the related BCBC guidelines.

Our stress test is a *Liquidity at Risk* (LaR) type model where the outputs are ratios of cash flows rather than amounts. At the preliminary stage, we simulate hair-cut and run-off rates under beta distribution. Then, we apply those to the corresponding items in BRSA's liquidity template. We compare cash inflows and out-flows under 1000 scenarios with a probabilistic approach. At the second stage, we explore the contagion effect via interbank linkages by employing RAS algorithm using banks' total exposures within the interbank market.

As Shin and Shin (2010) mentions, credit growth that is higher than deposit growth can be traced by an increase in non-core liabilities. This eventually leads to an increase cross-exposure across banks. To capture this behaviour we consider probability-based scenarios of hair-cuts and run-off rates that apply to various sizes of interbank funding with a parallel increase in loans.

Our approach has a conservative nature in three respects. First, hair-cuts and run-off rates are lower-bounded by the BRSA rates while designed in a way to capture the possible funding and market liquidity feedback-loops as experienced in the recent crisis. Second, loss-given-default values are selected as 100 per cent. Third, possible policy reactions by relevant authorities which might mitigate adverse effects of a shock are excluded from the analysis.

The algorithm is similar to the two-stage liquidity stress test by Van den End (2010) with some modifications. Initial values are taken from the BRSA template for the liquidity ratio of banks[30]. This template includes the amount of the items and corresponding applied ratios. First stage consists of simulation of the possible distributions of hair-cuts (w_h) for market liquidity and possible cash-inflows with run-off rates (w_r) for funding liquidity with the assumption that all the relevant risk factors deteriorate against the liquidity conditions. In fact, initial rates determined by BRSA are already very conservative as can be seen from Tables 2 to 4. However, further increasing hair-cut ratios for the securities portfolio help us to capture the possible mark-to market values of the assets. In the second stage, the contagion channel via domestic interbank market is incorporated with two iterations.

At the first stage, we stress the hair-cut and run-off rates provided in the BRSA template based on Monte Carlo simulation by drawing random variables from a beta distribution. In this respect, our study differentiates from Van Den End (2010) such that he takes random draws from a normal distribution, divides them by 3 and transforms to log-normal distribution which is very widely preferred due to its skewed nature. However, log-normal distribution is bounded below but not bounded above. Hence, Van Den End (2010) generates random weights that have conditional log-normal distribution given that they fall in the interval [0, 1]. Instead, we employ beta distribution which is already bounded by above as well, where the asymmetric structure is also captured by the appropriate shape parameters. Second, while Van Den End (2010) assumes the legal rates as 0.1 tail events[31], we employ the BRSA legal rates as the lower bound. Hence we condition on the case that the financial system is currently on a level of stress which is characterized by the supervisory rates[32].

Our analysis is built on Excel/VBA platform, and we call the *betainv* worksheet function on Microsoft Excel 2010 with w_h, w_r ~beta(p, α, β, A, B), where p stands for probability, α and β are the shape parameters, A and B are the lower and upper limits of distribution, respectively. The parameter p is the uniform random variable which takes values between 0 and 1, which is generally acquired via mixed congruential generators (Ross, 2006). For each template item, different values are assigned for A and B, depending on the legal figures assigned in BRSA template. Each set of shape parameters, (α,β)

[30] These templates are available at Annexes of Regulation on Measurement and Evaluation of Liquidity Adequacy of Banks (available at http://www.bddk.gov.tr/WebSitesi/english/Legislation/Legislation).

[31] That corresponds to 3 standard deviation tail events.

[32] In fact, the LRR=f(w_h, w_r) figures are already higher than the legal thresholds. We employ higher shocks given that the banks are already facing a stress condition.

corresponds to a different asymmetric distribution where appropriate ones are employed for alternative levels of funding and market liquidity shocks. Some interactions among the asset and liability items are also covered in the stress test.

After generating the weights w_h, w_r, for a thousand times, we calculate the corresponding LRRs for each bank. For each scenario, the illiquid banks that cannot meet their short term obligations are the ones with LRR smaller than a 100 per cent[33]:

$$\mathrm{LRR_{k,i}} = \frac{Asset\ i\ x\,(1-\mathrm{w_h}\ i\ )}{Liability\ i\ x\,\mathrm{w_r}\ i} \leq 100\%\ st\ k \in\ 1,..48\ .$$

In the second round, the contamination across banks is studied via their cross claims within a 30-day horizon, in a similar fashion with the first stage exercise. The interbank exposures are constructed as N×N, exposure matrix, E:

$$E = \begin{matrix} 0 & \dots & e_{1j} & \dots & e_{1N} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ e_{i1} & \cdots & 0 & \cdots & e_{iN} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ e_{N1} & \dots & e_{Nj} & \cdots & 0 \end{matrix}$$

where, e_{ij} denotes the exposure of bank i vis-à-vis bank j. The sum of a particular row, $A_i = \sum_j^N e_{ij}$, is equal to the assets of bank i in the interbank lending market, whereas the sum of a particular column, $L_i = \sum_i^N e_{ij}$, gives us the interbank liabilities.

As a bank j becomes illiquid then the banks which have interbank exposure to this bank j are adversely affected. LRR of each bank is recalculated by subtracting the obligations of the illiquid banks from the receivables of the lender banks. This exercise is carried out for 1000 simulations for 48 banks. The liquidity ratios are updated in the second round first iteration as:

$$\mathrm{LRR_{k\neq j}} = \frac{Asset\ i\ x\,(1-\mathrm{w_h}\ i\ )-e_{jk}}{Liability\ i\ x\,\mathrm{w_r}\ i}.$$

The cross-claims are estimated from financial statements of banks. Due to limitations in data precision, total receivables and payables figures related to interbank are used to extract information on bilateral exposures. In such cases, one widely employed candidate for constructing hypothetical interbank structures is Maximum Entropy (ME) [34]. This method utilizes RAS algorithm which provides an even distribution of exposures among the interbank market[35]. Initially, a benchmark case applies ME method using actual L_i and A_i values. Later on, different market structures are simulated by altering the value of these sums[36].

Despite the advantages of ME method, Mistrulli (2011) shows that this method might lead to an underestimation of the severity of financial contagion under different market structures. To understand these dynamics, we refer to the classification of Allen and Gale (2000) and define alternative interbank structures in terms of closeness of connections. *Completeness* in the interbank market means that each bank has a direct exposure to all other banks, $e_{ij} \neq 0\ \forall i \neq j$. *Connectedness* means that even though one bank does not have direct exposure to one particular bank directly, it has an indirect connection to this

[33] The critical value is 80% for the FX only case.
[34] See Upper and Worms (2004) for an example.
[35] See Miller and Blair (1985) and Blien and Graef (1991).
[36] According to our observations, the structure of the sums of receivables and payables among banks are evenly distributed whereas the main spirit embedded in the totals is very much preserved.

bank[37]. Allen and Gale (2000) argue that even though there is no monotonic ordering among these alternative market structures, incomplete markets are more prone to contagion relative to complete ones. As the argument goes, liquidity crisis might be contained in a specific region of the network in a complete interbank market while the contamination would be quicker in an interconnected structure[38].

Alternatively, Nier et.al (2008) points out a non-linear structure for the impact of the degree of interbank linkages on contagion. They argue that while the effect of risk diversification through developed network linkages is ambiguous at low degree of connectivity, the effect is positive after a certain threshold level of interconnectedness[39]. Mistrulli (2011) argues that severity of contagion might be overstated by ME method depending on market size, heterogeneity in bank size and the loss rate.

In a recent study on contagion, Gai et.al (2011) carries out a comparative exercise with alternative distributions that define different levels of concentration. Their baseline Poisson configuration assumes a uniform distribution of the network links. A more realistic alternative for their focus countries, UK and US, is the geometric distribution which defines a relatively higher network concentration. Their results suggest that the latter fat-tailed structure paves the way for contamination of a liquidity shock. These revealed contagion dynamics within a concentrated network helps us to understand the triggering role played by big financial institutions which heavily rely on repo during financial crisis.

Sachs (2010) compares impact of alternative levels of entropy in network design on contagion and concludes that distributional assumptions are of essence to study the stability of the system as well as the interconnectedness.

In our study, we apply the RAS algorithm to the asset and liability sums that correspond to *actual exposures*, a *concentrated structure* and a *complete banking system*. Figure 8 reports the results of the two-stage stress scenario in terms of the asset share of illiquid banks in whole banking system[40]. In each histogram, y-axis gives the number of simulations and x-axis indicates the frequencies in certain intervals. Different colours correspond to alternative contagion cases and interbank market sizes. The black bars indicate no contagion case with initial actual interbank market size. The dark grey bars labelled with *x* show contagion case with initial actual interbank market size. The other two cases examine the impact of hypothetical increases in interbank market on the sector during stress. The grey-striped bars labelled with *2x* show contagion case with interbank market size doubled. The grey-dotted bars indicated with *5x* describe the contagion case with interbank market size quintupled. Sum of each coloured bars among the x-axis amounts to the total number of simulations, 1000.

The first row of Figure 8 illustrates the result of the baseline stress scenario with actual data. This baseline scenario corresponds to a concentrated structure in line with the fact that the assets of the largest ten banks (out of 48) constitute eighty per cent of the total assets in the whole system. The system overall has a disconnected and incomplete structure where the interbank claims of some small banks is close to zero. However, locally, among the largest ten banks, there is a relatively more connected and less concentrated structure.

[37] For example, $e_{ij} = 0$, but $e_{ik} \neq 0$ and $e_{kj} \neq 0$, so that bank j has indirect exposure to bank i, through bank k.

[38] Obviously, this does not necessarily mean that complete market structures are immune from contagion. Allen and Gale (2000) emphasize this by stating that endogenous patterns of exposures through the network are main determinants of contagion dynamics.

[39] Another possible structure is the money center model examined by Freixas et.al (2000) where liquidity problems of a bank with a key position in the lending market might easily turn into a systemic collapse. They further discuss the possible moral hazard effects of a bailout of these too-big-to-fail institutions by the monetary authority in such a network design.

[40] One caveat of our analysis, along with many others in the literature, is that the network distibution via Ras algorithm considers domestic interbank market only. While assuming away cross-border links leads to an underestimation of both the probability and the severity of contagion, this choice comes as a result of data availability. Nevertheless, we apply 100% run-off rates to the foreign borrowings, which designates a considerable stress scenario in terms of funding liquidity. A recent working paper by Kalbaska (2013) examines the robustness of the banking systems against cross-border contagion effects between 2006-2011 for 20 countries using BIS aggregated data on cross-border exposures. Her reuslts suggest that Turkish banking system is completely immune to cross-border contagion effects.

A first look at the black bars in the top row suggest asset share of illiquid banks amounts to at most 14 per cent of the whole system in almost three-fourths of the simulations in the baseline scenario. Only one-tenths of the total simulations each suggest the share to be between 14-28 and 28-42 per cent. These results are almost the same when we include the contagion effect by the interbank exposures with their actual sizes (the dark grey bars labelled with *x*) and when we double the interbank market size (grey-stripped bars labelled with *2x*) in the same graph. This similarity in terms of asset share of the illiquid banks is mostly due to the small interbank size. While some small banks are hit by the shocks, contagion effect is not that significant in terms of asset share in a relatively small market.

An extreme case where the interbank market size is quintupled is illustrated with the grey-dotted bars indicated with 5x. The asset share of illiquid banks comes up to 28 per cent in majority of the simulations in this scenario with extensive shocks. This hypothetical case shows that as the interbank market size increases contagion effect becomes more visible.

The second row of Figure 8 analyses a more connected and more concentrated structure. We increase the concentration by increasing the exposure to the selected large banks with critical liquidity ratios, while decreasing the exposure to the others. The results are similar with the initial scenario for the first three cases with no contagion case, actual and double interbank sizes. However, the extreme scenario with quintupled interbank case implies a less severe contagion, compared to the actual exposures case. To understand this difference we focus on the role of systemically important financial institutions[41]. On the one hand, Gai et al. (2011) shows that when systemically important financial institutions are hit by the shocks, the effect on the system is expected to be large.[42] On the other hand, as discussed in Nier et al. (2008) under heteregenous market structures, these banks might have a higher liquidity shock absorption capacity compared to the others which moderates the impact of the shock in the first round. Accordingly, the impact of the shock in the second round is not acute since banks that are linked to these ones are not affected adversely. Our results suggest that this latter effect dominates with a relatively less severe impact in the end, compared to the first scenario.

The third row presents the case for an even more connected structure. In actual case, there are some small banks with no claims at all in the interbank market. We apply the RAS algorithm to distribute claims among these banks. Hence, we have a relatively more connected and less concentrated structure. The impacts are quite similar with the initial baseline scenario in all cases in this new structure.

All in all, the asset share of these illiquid banks does not exceed 14 per cent in most of the plausible scenarios even against very harsh shocks with a little scope for contagion. This suggests a fairly resilient network structure for Turkish banking system where the impact of financial contagion does not seem to be much catastrophic.

5. Conclusion

Devastating effects of the global financial crises highlighted the need for a well-designed macro-prudential policy framework in the post-crisis era. An integral part of this new policymaking for financial authorities is constructing new indicators for monitoring the financial system. In this respect, noncore liabilities to M2 ratio, suggested by Shin and Shin (2010), stands as a good candidate for two main reasons. First, the procyclical nature of this ratio helps the financial authority to monitor the potential amplification effect of the credit growth in an expansionary period. Second, this ratio helps the authority to focus on the potential harmful effects of the wholesale funding through foreign borrowing, which is a

[41] A very recent study by BIS (2012) covers the assessment methodology of SII's and suggests principals for dealing with these institutions at national level.

[42] Gai et al. (2011) suggest that two types of banks increase the vulnerability of the system. First type of the banks with high level of repo activity (i.e. higher non-core liabilities) are more prone to initial shocks. Second type is the big lenders in the interbank market that can easily amplify this initial impact.

significant phenomenon after the liquidity injection of the advanced country central banks in the post-crises era.

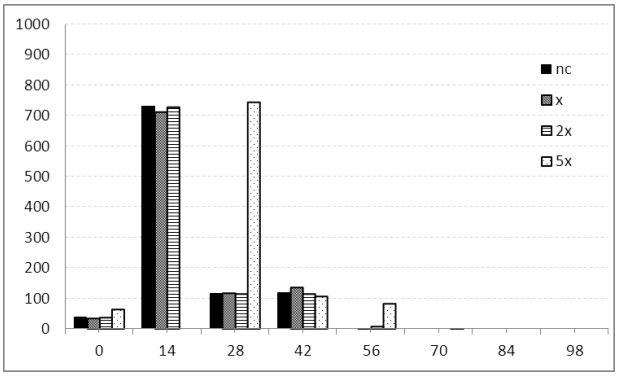
The level of non-core liabilities to M2 ratio of the Turkish banking system is currently at moderate levels, albeit increasing. Moreover, the main determinant of this aggregate is the foreign borrowing which is correlated with the recent credit growth. Our proposed indicator could be monitored within the framework of macro-prudential policies which aim to mitigate the potential harmful effects of excessive credit growth with a focus on the source of funding by financial intermediaries. In these respect our paper is in line with the recent literature on Turkish financial markets such as Ozen et.al (2013) or Karasoy et. al (2013).

The result of the liquidity stress test points out relatively robust funding conditions for the Turkish banking sector in the meantime. The asset share of the banks that would suffer from illiquidity in case of a stress is fairly small. Moreover, as stated in the Financial Stability Report (CBRT, 2012), financial linkages between Turkish banking sector with its European counterparts is low, which helps the sector to be relatively insulated from the balance sheet impairing operations of these foreign banks.

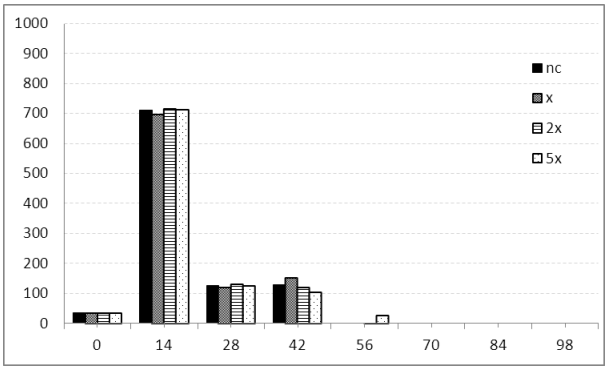
Figure 8: Results of the liquidity stress test

y-axis: number of simulations, x-axis: asset share of illiquid banks
nc: no contagion case, x: interbank market size

a) actual exposures



b) a more connected and more concentrated structure



c) complete structure (more connected but less concentrated)

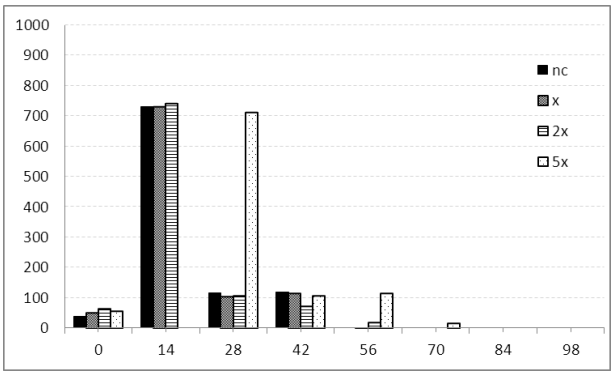


Table 3: BCBS and BRSA Risk Factors along with the applied ratios for Stress Tests

Stock of high quality assets	BCBS Factor	Turkey
Level 1 Assets		
Cash	100 %	100%
Qualifying marketable securities from sovereigns, central banks, public sector entities, and multilateral development banks[1] with following conditions: -0% risk weight under Basel II Standard. App. -traded in large deep markets -a reliable source of liquidity -not an obligation of a financial institution.	100 %	95%. In BRSA template: *Liquidity bills issued by the CBRT* and *Government securities classified as first class by the treasury and issued by country central governments, central banks or by guarantee of them.* These are categorized into (i) securities held for trading and securities available for sale and (ii) securities held to maturity with similar hair-cuts, whereas the template figures reflect the mark to market values for the former. Considering that the held to maturity securities could be used for repo like funding as well, we incorporated market liquidity into our stress test by further increasing the haircuts to 15% for both categories.
Qualifying central bank reserves. In BCBS framework, central bank reserves are not subject to any hair-cut ratio to the extent that these reserves can be drawn down in times of stress.	100 %	In BRSA template, excess reserves, other deposits or liquidity likes at the central bank are not subject to any hair-cut as well. On the other hand, required reserves are assigned a 30% hair-cut proportional to the deposit withdrawal rate. In our stress test we further increase this rate up to 40% in line with the time deposits.
Non-0% risk-weighted sovereigns, sovereign or central bank debt securities issued in domestic currencies by the sovereign or central bank in the country in which the liquidity risk is being taken or in the bank's home country. [1]	100 %	Government securities issued by other central governments, central banks or guarantee of them could have a zero or non-zero risk weight. In any case these are assigned 20 % haircut in BRSA template and have maximum hair-cut of 30% in our stress test.
Non-0% risk-weighted sovereigns, domestic sovereign or central bank debt securities issued in foreign currencies, to the extent that holding of such debt matches the currency needs to the bank's operations in that jurisdiction[1].	100 %	Regardless of the risk weight, issues in foreign currency, mostly Eurobonds for Turkey are assigned to have 5% hair-cut whereas our stress test further increases this factor to 15 % for domestic sovereigns and 30 % for other sovereigns.
Level 2 Assets		
Sovereign, central bank, and PSE assets qualifying for 20% risk weights.	85%	In BRSA template there is no difference in hair-cuts according to their ratings. In a conservative manner, a 20% haircut is assigned to other country issues, though these could include securities below 20% risk weight. In practice, banks in Turkey hold low risk weighted securities. Accordingly, our stress test framework applies up to 30% hair-cut rates.
Qualifying corporate bonds rated AA- or higher	85%	The corresponding factors in BRSA template are 90% for financial institutions and 80% for non-financial institutions. Stress test assigns up to 20% and 30% haircuts for financial and non-financial institutions, respectively.
Qualifying covered bonds rated AA- or higher includes financial institution	85%	Banks have small amount of issue of asset backed securities on the liabilities side in the other resources-others debts w/100% hair-cut. As for the assets, it is not common for banks to hold covered bonds in their asset portfolios.
Calculation of 40% cap of liquid assets	Binding?	A cap for Level 2 assets is applicable in BCBS (2010, pp.9) framework which is not applicable for our framework due to low level of Level 2 assets in Turkish banks.

Source: BIS (2010b), BRSA template, Own elaborations. (1) CBRT collateral haircuts for third tranche have 15% for liquidity securities, <1 year DIBS 15%, >DIBS % 30 and Eurobond 30%.

In addition to the market liquidity, the ratios cover the funding liquidity in a following fashion as illustrated in Table 4.

Table 4: Cash outflows

Cash Outflows	BCBS Factor	Turkey
Retail Deposits	Demand deposit • Stable deposits 5% • Less stable deposits 10% Time deposit • 0% (>1 month) • Similar to demand deposit if < 1 month	Savings Deposits[1]: Demand deposit • BRSA 20% and Stress test 20-30% Time deposit • BRSA 30% and Stress test 30-40%
Unsecured Wholesale Funding (From non-natural persons and not collateralised).	Small business (similar to retail) • Stable 5% • Less stable 10% Legal entities w/operational relationships 25% Corporate banks in an institutional network 25% Non-financial corporates, sovereigns, central banks and PSEs 75% Other legal entity customers (Banks, securities firms, insurance companies, etc.) 100%	Official, Commercial and Other Entities' Deposits: Demand deposit • BRSA 30% and Stress test 30-40% Time deposit • BRSA 50% and Stress test 50-60% Bank Deposits: Demand deposit • BRSA 40% and Stress test 40-50% Time deposit • BRSA 100% and Stress test 100% Banks, Overseas Head Offices and Branches 100% (TL and foreign currency mostly correspond from domestic banks and foreign banks, respectively.) In Turkey the interbank market mostly depends on a blind broker system within Central Bank, which significantly mitigates the contagion effect from the confidence loss of banks to each other. On the other hand, bank-by-bank loans are non-zero though they are small in amount so in our analysis the cross exposures are subject to stress test.
Secured funding:	Secured funding • Backed by level-1 assets 0% • Backed by level-2 assets 15% • backed by assets that are not eligible for the stock of highly liquid assets, with domestic sovereigns, domestic central banks, or domestic public sector entities as a counterparty 25% • all others 100% Funding from repo have no hair-cut if it is backed by level 1 assets whereas the corresponding receivables with level 1 assets are not counted as cash inflow as the reverse repo will roll-over.	Payables to Money Markets 100% Payables to CBRT 100% Funds from Repo Transactions 100% Payables to Securities Market 100% BRSA template assumes funding from these as cash outflows whereas the corresponding receivables are considered without any hair-cut. Though BRSA and BCBS approaches work in an opposite fashion, both has a self-consistent logic.
Additional requirements	Derivatives • 3-notch downgrade (100%) • Market valuation changes (jurisdictions) • Valuation changes of collateral (20%) ABCP, SIVs, Conduits, etc. Committed lines • Retail and small business clients • Non-financial corporate, sovereigns and central bank, and PSEs; credit facilities. • Non-financial corporate, sovereigns and central bank, and PSEs; liquidity facilities. • Other legal entity customers, credit and liquidity facilities.	Derivatives on the asset side have no hair-cut whereas the ones on the liability side have a 100% run-off rate, in line with the BCBS approach. As for the committed lines, the ones which are not used by right-holders are not considered as cash inflow at all, but if the bank commits to open a line, -even it is not used by other parties- those lines should be included as outflow. In BRSA template, run-off rates for: commitments for spending limits on credit cards is 15%; credit allocation commitments with extension guarantees is 10%, underwriting is 10%, letter of credits and guarantees issued for supply of cash is 5% and other non-cash credits and commitments is 2%. We further stress these items throughout our analysis. The banking system in Turkey does not have a shadow banking system with structured products.

Source: BIS (2010b), BRSA template, Own elaborations. (1) Special current accounts and participation accounts are parallel to BRSA template and further stressed in line with the similar accounts.

The netting of cash flows for the denominator requires including the cash inflows. The related table is below:

Table 5: Cash inflows

Cash Inflows	BCBS Factor	Turkey
Reverse repos and securities borrowing, with the following as collateral:	*Level 1 Assets (0 %) *Level 2 Assets (15 %) *All other Assets (100 %)	The main logic while assigning the factors is the rollover approach rather than the counterparty risk. The ability to continue to transact repurchase, reserve repurchase and other securities financing transactions is limited to transactions backed by high-quality liquid assets or with the bank's domestic sovereign, PSE or central bank. The collateral could be used for netting if only it is not included in the stock of liquid assets. Receivables from money markets 100%. Receivables from reverse repo transactions 100 %. In Turkey, the securities used for repo transactions are generally the government securities which are included in level 1 assets. However, as indicated above the methodology here works different from the BCBS approach whereas in the end the asset liability balance provides consistency in both approaches.
Credit or liquidity facilities	0 %	As mentioned before, BCBS does not include cash inflows from committed credit or liquidity facilities. In BRSA template the lines are considered in the *other* category under loans.
Operational deposits held at other financial institutions	0 %	In BRSA banks, overseas head offices and branches are taken without any hair-cut. In our stress test we apply a factor on these items to include the contagion impact that could possibly come from the illiquid banks via this item as well as the performing loans to the financial sector.
Other inflows by counterparty:	-Amounts receivable from retail counterparties: 50 % - Amounts receivable from non-financial wholesale counterparties, from transactions other than those listed in the inflow categories above: 50 % - Amounts receivable from financial institutions, from transactions other than those listed in the inflow categories above: 100 %	BCBS determines the inflow by counterparty. Scenario assumes that banks will receive all fully performing contractual inflows from retail and business customers and they are assumed to extend loans to them at a rate of 50% so the net is 50% inflow. As for the wholesale inflows, banks are assumed to receive fully performing contractual cash inflows, and they will continue to extend loans to wholesale clients. All in all, the inflows from financial institutions will be 0% and 50% for all others, including non-financial corporate, sovereigns, central banks and PSEs. Deposits held for operational purposes in financial institutions have 0% inflow. In BRSA case, haircuts for loans other than for financial institutions are taken in general %10. Principal for other loans 55%. In our stress test we apply some penalty to receivables from financial institutions and % 20 for others. The principal for the other loans have 65% hair-cut.
Net derivative receivables	100 %	If a net receivable exists, it receives a 100% inflow factor. In our case this is similar.
Other contractual cash inflows	National jurisdiction	

References:

Allen, F. and Gale, D., (2000), "Financial contagion", *Journal of Political Economy*, 108, 1–33.

BIS, (2010a), "The global crisis and financial intermediation in emerging market economies", *BIS Working Papers*, 54.

BIS, (2010b), *Basel III: International framework for liquidity risk measurement, standards and monitoring*, Basel Committee on Banking Supervision.

BIS, (2012), *A framework for dealing with domestic systemically important banks*, Basel Committee on Banking Supervision.

Blien, U. and Graef, F., (1998), "Entropy Optimizing Methods for the Estimation of Tables", in:

Balderjahn et al. (1998): "Classification, Data Analysis and Data Highways", Proceedings of the 21st Annual Conference of the Gesellschaft für Klassifikation, Berlin etc.: Springer: 3-15

Bonner, C. and Eijffinger, S.C.W, (2012), "The impact of the LCR on the interbank money market", *CEPR Discussion Papers*, 9124.

Borio, C., (2010), " Implementing a macroprudential framework: Blending boldness and realism" keynote address for the BIS-HKMA research conference on "Financial Stability: Towards a Macroprudential Approach", Honk Kong SAR, 5-6 July 2010.

Borio, C. and Drehmann, M., (2009), "Towards an operational framework for financial stability: 'fuzzy' measurement and its consequences", *BIS Working Papers*, 284.

BRSA, (2006), *Regulation on Measurement and Evaluation of Liquidity Adequecy of Banks, Official Gazette, Nr. 2633.*, http://www.bddk.org.tr/websitesi/english/Legislation/8840likidite.pdf.

Brunnermeier, M.K., Gorton, G. and Krishnamurthy, A., (2012), "Risk Topography", *NBER Macroeconomics Annual 2011*, 26, 149-176.

Bruno, V. and Shin, H. S., (2012), "Assessing Macroprudential Policies: Case of Korea". *NBER Working Papers, 19084*.

CBRT, (2011), *Financial Stability Report*, Central Bank of the Republic of Turkey, May.

CBRT, (2012), *Financial Stability Report*, Central Bank of the Republic of Turkey, May.

Derman, E., (2011), Models.Behaving.Badly.: Why Confusing Illusion with Reality Can Lead to Disaster, on Wall Street and in Life, Free Press.

Dodd-Frank Act, (2010), *Dodd–Frank Wall Street Reform and Consumer Protection Act*, Public Law 111-203, US Government Printing Office.

Domanski, D., Fender, I. And McGuire, P., (2011), "Assessing global liquidity", *BIS Quarterly Review*, December, 57-71.

Drehmann, M. and Nikolaou, K., (2010), "Funding Liquidity Risk: Definitions and Measurment", *ECB Working Papers*, 1024.

Financial Stability Forum, (2008), *Report of the Financial Stability Forum on Enhancing Market and Institutional Resilience*, Financial Stability Board.

Freixas, X., Parigi, B., Rochet, J.C., (2000), "Systemic risk, interbank relations and liquidity provision by the central bank", *Journal of Money, Credit and Banking*, 32, 611–638.

Gai, P., Haldane, A. and Kapadia, S., (2011), "Complexity, concentration and contagion", *Journal of Monetary Economics*, 58, 453–470.

Galati, G. And Moessner, R. (2010), "Macroprudential policy – a literature review", *De Nederlandsche Bank Working Paper*, 267.

Goodhart, C., (2008), "Liquidity risk management", Banque de France, *Financial Stability Review*- Special issue on liquidity, 11, February.

Gorton, G.B. and Metrick, A., (2012), "Who ran on repo?" , *NBER Working Papers*, 18455.

Hahm, J.H, Shin, H.S. and Shin, K., (2012), "Non-core Liabilities and Financial Vulnerability", forthcoming in *Journal of Money Credit and Banking*.

Hattori, M., Shin, H.S. and Takahashi, W., (2009), "A Financial System Perspective on Japan's Experience in the Late 1980s" *IMES Discussion Papers*, No. 2009-E-19, Bank of Japan.

Hilbers, P., Otker-Robe, I., Pazarbasioglu, C. and Johnsen, G., (2005), "Assessing and Managing Rapid Credit Growth and the Role of Supervisory and Prudential Policies", *IMF Working Paper*, 05/151.

IMF, (2010), *A Fair and Substantial Contribution by the Finanacial Sector*, Final Report for the G-20, June, International Monetary Fund.

IMF, (2011), *Recent Experiences in Managing Capital Inflows—Cross-Cutting Themes and Possible Policy Framework*, International Monetary Fund.

IMF, (2012), *The Interaction of Monetary and Macroprudential Policies: Background Paper*. International Monetary Fund.

Kalbasa A., (2013), "From Sovereigns to Banks: Evidence on Cross-border Contagion (2006-2011)", mimeo, University of Siena.

Kilinc, Z., Karasoy, H. G., & Yucel, E. (2013). Non-Core Bank Liabilities and Credit Growth: Evidence From an Emerging Economy. *International Finance Review*, *14*, 71-90.

Miller, R. E. and Blair, P.D., (1985), Input-Output Analysis: Foundations and Extensions. Englewood Cliffs , NJ : Prentice-Hall.

Mistrulli, P.E., (2011), "Assessing financial contagion in the interbank market: Maximum entropy versus observed interbank lending patterns", *Journal of Banking & Finance*, 35, 1114–1127.

Nier, E., Yang, J., Yorulmazer, T. and Alentorn, A., (2008), "Network models and financial stability", *Bank of England Working Papers*, 346.

Özen, E., Sahin, C., & Unalmis, I. (2013). External Financial Stress and External Financing Vulnerability in Turkey: Some Policy Implications for Financial Stability. *Central Bank Review*, *13*(Special Issue on Systemic Risk), 65-74.

Pradhan, M., Balakrishnan, R. Baqir, G. Heenan, S. Nowak, Oner, C. and Panth, S., (2011), "Policy Responses to Capital Flows in Emerging Markets", *IMF Staff Discussion Note*, 11/10, April.

Ross, S.M., (2006), *Simulation*, Elseiver Academic Press.

Sachs, A., (2010), "Completeness, interconnectedness and distribution of interbank exposures a parameterized analysis of the stability of financial networks." *Deutsche Bundesbank Discussion Papers*, 08/2010, Series 2,.

Schmieder,C., Hesse, H. Neudorfer, B. Puhr,C. and Schmitz, W.S., (2011), "Next Generation System-Wide Liquidity Stress Testing", *IMF Working Papers*, 12/3.

Shin, H.S. and Shin, K., (2010), "Procylicality and Monetary Aggregates", *NBER Working Papers*, 16836.

Shin, H.S., (2011a), *Non-Core Liabilities Tax as a Tool for Prudential Regulation*, policy memo.

Shin, H.S., (2011b), *Global Liquidity*, Remarks at the IMF conference on "Macro and Growth Policies in the Wake of the Crisis", Washington DC, March 7-8, 2011.

Shin H.S., (2012), *Procyclicality and the Search for Early Warning Indicators*, Remarks at the at the IMF conference on "Financial Crises: Causes, Consequences, and Policy Response", Washington DC.

Upper, C. and Worms, A., (2004), "Estimating bilateral exposures in the German interbank market: Is there a danger of contagion?" European Economic Review, 48, 827–849.

Van den End, J. W., (2010), "Liquidity Stress Tester: Do Basel III and Unconventional Monetary Policy Work?" *De Nederlandsche Bank Working Paper*, 269.

Yıldırım, B.D., (2011), "Measuring and analyzing Financial Market Liquidity of Turkey", *Central Bank Review*, 11, 11-28.

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