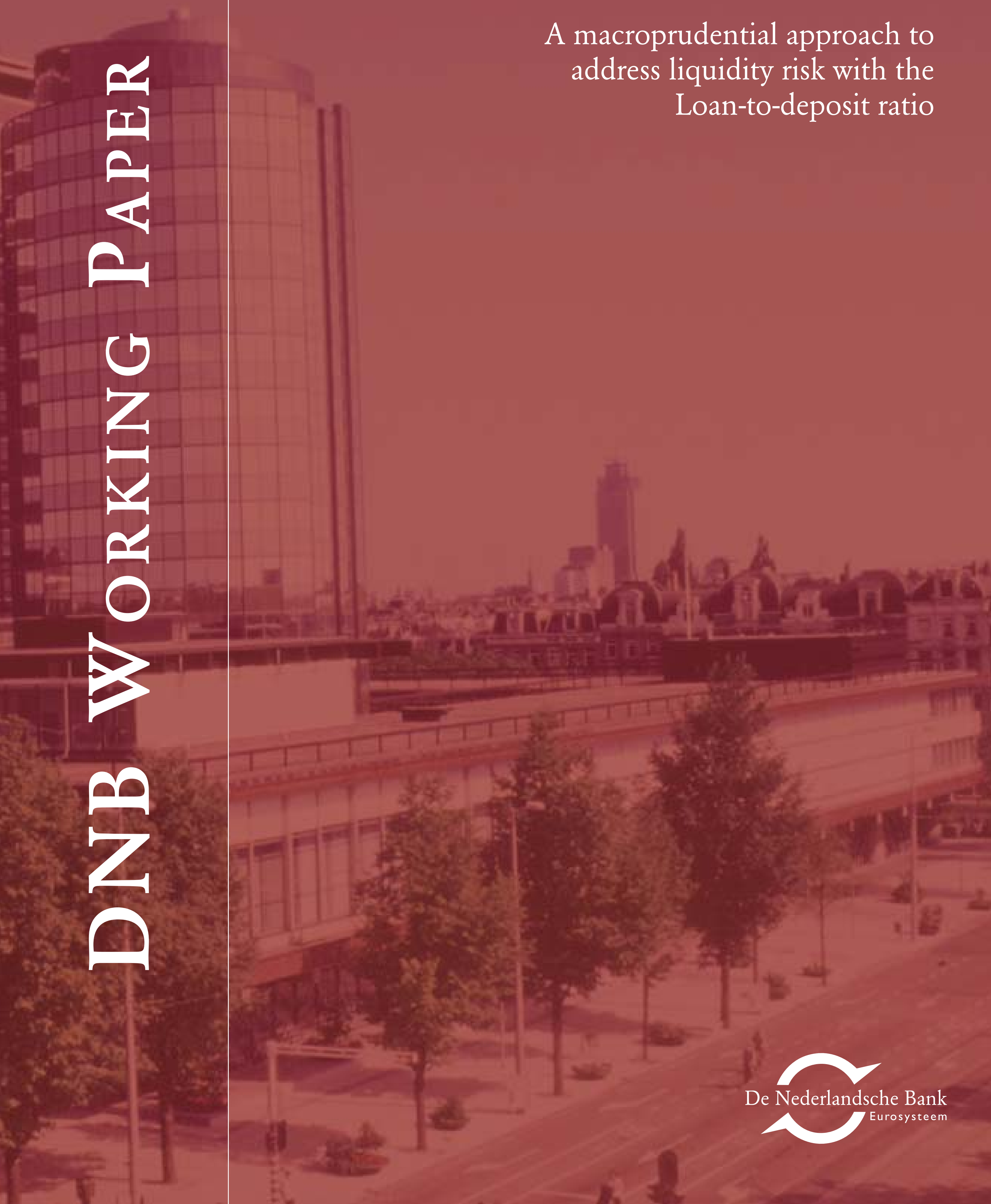
DNB Working Paper

No. 372 / February 2013

Jan Willem van den End

A macroprudential approach to address liquidity risk with the Loan-to-deposit ratio

DNB WORKING PAPER



De Nederlandsche Bank
Eurosysteem

A macroprudential approach to address liquidity risk with the Loan-to-Deposit ratio

Jan Willem van den End *

* Views expressed are those of the author and do not necessarily reflect official positions of De Nederlandsche Bank.

Working Paper No. 372

February 2013

De Nederlandsche Bank NV
P.O. Box 98
1000 AB AMSTERDAM
The Netherlands

A macroprudential approach to address liquidity risk with the Loan-to-Deposit ratio

Jan Willem van den End[*a]

March 2013

Abstract

This paper maps the empirical features of the Loan-to-Deposit (LTD) ratio with an eye on using it in macroprudential policy to mitigate liquidity risk. We inspect the LTD trends and cycles of 11 euro area countries by filtering methods and analyze the interaction between loans and deposits. We propose that the trend of the LTD ratio is maintained within an upper and lower bound to avoid bad equilibria. To manage the LTD ratio between the boundaries we formulate two macroprudential rules. One that stimulates banks to issue retail deposits in an upturn and one that incentivizes banks to create loanable funds to support lending in a downturn, facilitated by a sufficiently long adjustment period.

Key words: Financial stability, Banks, Liquidity, Regulation

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

---

[*] De Nederlandsche Bank, Economics and Research Division, P.O. Box 98, 1000 AB Amsterdam. The author would like to thank Clemens Bonner, Leo de Haan, Miguel Mendonca Boucinha, Peter van Els, Maarten Gelderman, Jan Kakes and Jan Willem Slingenberg for valuable comments on earlier versions.

a Corresponding author. Phone +31 20 5242834, Fax +31 20 5242526, Email w.a.van.den.end@dnb.nl.

1. Introduction

Deposit-taking and lending by banks are closely related. Both activities reflect the liquidity transformation function of banks and share a similar overhead (Kashyap et al, 2002). Hence it is useful to analyze loans and deposits in tandem, as is done through the Loan-to-Deposit (LTD) ratio. It is a core indicator for liquidity mismatch risk. The LTD ratio measures the coverage of loans with stable funding, usually deposits from households and non-financial companies. When loans exceed the deposit base, banks face a funding gap for which they have to access financial markets. So a high funding gap implies a high dependence on market funding, which can be more volatile and/or expensive than retail funding, in particular if it concerns unsecured market funding.

The macroprudential dimension relates to the link between funding mismatches at the bank level and system wide liquidity risk. If a substantial share of banks operates with a funding gap, adverse shocks to market funding can strain the banking sector as a whole, affecting credit supply and economic growth. Some studies investigate the link between the liquidity ratios and stress, by using the LTD ratio - among other variables - as signalling indicator for liquidity problems at banks (for instance Le Leslé, 2012 and Betz et al., forthcoming). Our paper goes one step further by linking the LTD ratio to macroprudential policy and funding restrictions in particular.

The policy measures focus on the funding side of banks' balance sheets (i.e. the denominator of the LTD ratio), since the numerator is influenced by other macroprudential instruments, like the countercyclical capital buffer and loan-to-value limits. According to Goodhart et al. (2013) no single regulatory tool is going to be sufficient to address the multiple sources of systemic risk. Their model for instance suggests that capital alone is unlikely to be sufficient to contain the problems arising during a crisis. This underlines the added value of funding measures based on the LTD ratio to mitigate systemic liquidity risk.

The LTD ratio can be used by the macroprudential authority to address both structural (long-term) and cyclical (short-term) liquidity risks. The structural dimension refers to the mismatch between loans and customer deposits following from the business models of banks. Their funding mix reflects structural developments of retail and wholesale funding markets. These show up in the trend of the LTD ratio. The macroprudential authority could target a long-term trend level of the ratio at which the banking sector functions well and does not face excessive funding risks or impaired intermediation (both presenting a bad equilibrium). The crisis showed that this can pay off: economies where banks had relatively low LTD ratios weathered the crisis relatively well (Cecchetti et al, 2011).

The LTD ratio will fluctuate around its trend as a reflection of short term financial cycles. The ratio tends to rise in good times, when market funding is abundantly available to finance credit growth. The ratio usually levels off in stressed market conditions, when wholesale funding is substituted for retail savings and credit growth diminishes. In a sense the LTD ratio resembles the leverage ratio (assets to equity), which also has strong pro-cyclical features (Adrian and Shin, 2008). A specific feature of liquidity cycles is that they are usually driven by the mutually interacting forces of market and funding liquidity (Brunnermeier and Pedersen, 2009).

After a short discussion of macroprudential policy issues with regard to liquidity risk in Section 2, the applied concepts and methods are explained in Sections 3 and 4. The structural and cyclical dimensions as well as a breakdown of changes in the LTD ratio in a loan and deposit component are analyzed empirically in Section 5. This provides a better understanding of the timing and desired macroprudential policy reactions, as formulated in Section 6. The final section concludes.

2. Policy issues

Loan and deposit cycles can be influenced by monetary policy. Reserve requirements affect deposit taking by banks and their ability to supply loans. Chadha and Corrado (2012) show that an incentive to hold a higher fraction of reserves to deposits helps to constrain lending in a boom. Lowering reserves in a downturn can prevent a fall in lending. We focus on macroprudential policy options to prevent pro-cyclical bank lending or funding, in particular countercyclical restrictions to the LTD ratio. Particularly in a currency union macroprudential policy has value added in steering the national financial cycle, since monetary policy is based on the conditions in the currency area as a whole.

The LTD ratio complements the liquidity ratios in the Basel III framework, the Liquidity Coverage Ratio (LCR) and Net Stable Funding Ratio (NSFR). The LCR focusses on liquidity risk over a short term horizon, while the NSFR focusses on structural liquidity mismatches. The two ratios take into account stressed values of liquid assets and liabilities, whereas the LTD ratio is a ratio between the unweighted values of loans and deposits. Hence the LTD ratio includes the intrinsic characteristics of loans and deposits, independent of contractual or assumed maturities. This makes the LTD ratio less prone to interpretation and simpler to understand. This is particularly useful in times of stress when market participants more likely trust straightforward indicators.

Unlike the LCR and NSFR there is no (micro- or macroprudential) international regulation that sets quantitative limits to the LTD ratio, mainly because the relation between loans and deposits depends on the structure of the domestic financial system. Hence, limits to the LTD ratio are usually not part of supervisory regulation. As far as we know, two regulators prescribe limits to the LTD ratio. Until this year the Chinese supervisor has applied an upper limit of 75% for Chinese banks, whereas the US authorities set a lower bound to bank's statewide loan-to-deposit ratios (Federal Reserve Board, 2012). The latter should prevent banks from issuing deposits in another state, while not investing these funds locally.

Our paper is a first attempt to develop a macroprudential framework for the LTD ratio. While there have been proposals to use the LCR and NSFR as macroprudential indicators (Jobst, 2012) or instruments (Van den End and Kruidhof, forthcoming), to our knowledge there are no studies on the macroprudential use of the LTD ratio. In practice, in some countries it is used for macroprudential reasons, for instance in some IMF programs which establish indicative targets for the LTD ratio.[1]

Something to take into account when using an indicator like the LTD ratio as an instrument is Goodhart's law, i.e. once the ratio is made a policy target it will lose information content. In particular it says that any observed statistical regularity will tend to collapse once pressure is placed upon it for control purposes (Chrystal and Mizen, 2001). However, this is less an issue in our approach, since the link between the LTD ratio as indicator and the funding restrictions that we propose as policy tool is not based on an estimated relationship but is an identity by itself. Moreover, the final objective of preventing liquidity stress is also influenced by other transmission channels, next to the funding gap.

3. Concepts

The LTD ratio depends on portfolio choices of households, non-financial firms and banks. The demand for deposits and loans by households and firms relates to the optimization of their balance sheets. As in the Markowitz portfolio framework, optimizing agents base their decisions on the risk and return characteristics of loans and deposits, relative to other assets and liabilities. For instance, if deposit rates are relatively low, agents have an incentive to invest their funds in alternative investments. While this applies in normal times, in stress situations risk motives may dominate price incentives. Agents may then prefer safe deposits, even if deposit rates are low.

Berg (2012) explains the relationship between loans and deposits in the context of the financial flow model. In that approach deposits can create loans, since an increase of deposit funding improves the liquidity position of banks and thereby their room to extend loans (loans are the monetary counterpart of deposits). Vice versa, bank loans tend to create deposits, since the funds received by a borrower will end up in a deposit, either in the account of the borrower or in the account of his counterparty who receives a payment. This does not mean that it is a closed system in which loan growth equals deposit

[1] For instance in the EU/IMF programs of Ireland and Portugal.

growth by definition. Banks can use alternative (wholesale) sources to fund their lending, while firms and households can invest in alternative assets. There can also be leakages from the non-financial to the financial sector or to foreign agents.

The LTD ratio also depends on the portfolio choices of banks in the context of their liquidity management. Based on the model of Goodhart et al. (2013) we formulate two constraints that a bank faces. The first constraint relates the potential uses of funds (retail lending L_r, wholesale lending L_w, financial market assets B) to its sources of funds (equity E, retail deposits D_r, wholesale deposits D_w, central bank borrowing CB and securities issued S),

$$L_r + L_w + B \quad \leq \quad E + D_r + D_w + CB + S \qquad (1)$$

The second constraint relates retail lending to a bank's retail funding (D_r) and market funding obtained by securitization of retail loans (S^{sec}),

$$L_r \quad \leq \quad D_r + S^{\sec} \qquad (2)$$

with $S^{\sec}$ being part of S. The constraint assumes that a bank funds its retail lending with retail savings and/or securitization to limit its liquidity risk. The LTD ratio is presented by $\frac{L_r}{D_r}$. $\overline{L}_r$ and $\overline{D}_r$ are the steady state levels of loans and retail deposits, related to equilibrium LTD ratio ($\overline{LTD}$) at which the intermediation process functions normally and the risk of a bad equilibrium is low.

At low levels of the LTD ratio it is likely that $L_r < \overline{L}_r$ (and/or $D_r > \overline{D}_r$, which is most likely a cyclical phenomenon, see Section 5). It can result from insufficient or impaired financial intermediation. Banks may hoard liquidity - and hold B instead of L - if they are risk averse. There can also be structural reasons why banks use retail deposits to finance other assets than loans. Such portfolio choices can relate to the structure of the economy and/or domestic financial system and for instance reflect a lack of profitable lending opportunities.

At high levels of the LTD ratio it is likely that $D_r < \overline{D}_r$ (and/or $L_r > \overline{L}_r$, which is most likely a cyclical phenomenon, see Section 5). As a consequence D_r is insufficient to cover retail loans (L_r). This may be compensated by the securitization of loans (S^{sec}) as an alternative funding source. Securitization can be a relatively stable funding source if it concerns self-funding assets, such as mortgages with low loan-to-value ratios and annuity repayment.

4. Empirical methods

In this section we investigate the empirical regularities of the LTD ratio. These are useful ingredients for the macroprudential policy approach, which we calibrate on the structural and cyclical features of the LTD ratio and on the effects of its subcomponents, loans and deposits.

4.1 Trend and cycles

The structural dimension is analyzed by the long-term trend in the LTD ratio. This is based on the one-sided Hodrick-Prescott (HP) filter with a high smoothing parameter (λ = 400,000). This captures long-term financial trends that are driven by structural developments in the financial sector. Similarly the HP filter is used to determine the trend of the credit-to-GDP ratio as macroprudential instrument for setting countercyclical capital buffers (Drehmann et al., 2011).

The cyclical dimension is analyzed by two methods. The first method takes the deviation of the LTD ratio from the HP-filtered trend as the cycle. We take the deviation from the HP-trend with λ = 400,000, which is the fourth power of the λ that is commonly used in business cycle models. Hence our method implies that financial cycles are four times longer than standard business cycles, which according to the literature seems appropriate (Drehmann et al., 2011).

The second method uses a band-pass filter to isolate the cycle. The Christiano-Fitzgerald filter captures the cycle that corresponds to a chosen frequency interval. We set the lower bound of the interval at 5 years, which according to Drehmann et al. (2012) captures medium-term financial cycles (the upper bound is not fixed). The band-pass filter assumes a symmetric cycle with equally long upward and downward phases.

4.2 Arithmetical break-down of effects

The numerator (loans, *L*) and denominator (deposits, *D*) have a distinct effect on the LTD ratio. These effects are isolated by an arithmetical break-down of the change of the ratio. If numerator *L* increases with *l* and denominator *D* with *d*, than:

$$\frac{(L+l)}{(D+d)} - \frac{L}{D} = \frac{(Dl - Ld)}{D(D+d)} \qquad (3)$$

The term on the right hand side of Equation 3 results from multiplying the first term on the left hand side by *D*, the second term by (*D*+*d*) and some rearranging of the terms. The term on the right hand side can be decomposed in a numerator effect by assuming d=0 and in a denominator effect by assuming l=0.

$$\frac{l}{D} \quad \text{, numerator effect } (d=0) \tag{4}$$

$$\frac{Ld}{D(D+d)} \quad \text{, denominator effect } (l=0) \tag{5}$$

Subtracting the numerator and denominator effects from the right hand side of Equation 3 delivers the interaction effect,

$$\frac{ld}{D(D+d)} \quad \text{, interaction effect} \tag{6}$$

The interaction effect is a pure arithmetical effect. It may underestimate the broader, economic interaction between loans and deposits, as explained in the context of the financial flow model in Section 3 (see Annex 2 for a further exploration of the broader interaction effect).

4.3 Data

The structural and cyclical dimensions, as well as the decomposition of the LTD drivers are analyzed with data of 11 EMU countries and the EMU total (constructed by aggregating loans and deposits of the 11 member states). For each country the sample includes loans and deposits of banks outstanding to non-financial counterparties (households and firms) in the euro area on a monthly basis in 1998-2012. In practice, definitions of the LTD ratio differ widely with regard to the type of assets and liabilities included and the jurisdiction of loans and deposits (some definitions exclude foreign deposits). Avoiding regulatory arbitrage could be a reason for using a broad definition of loans and deposits, which for instance includes derecognized securitized loans in the numerator or debt securities issued to retail customers in the denominator.

Consolidated banking data have a broad coverage of loans and deposits, which is an advantage. However for several reasons, consolidated statistics are a less useful data source for the LTD ratio. First, they do not have a detailed break-down of loans and deposits to counterparties, i.e. households and firms. Second, long and comparable series of consolidated data are not available for the countries we analyze. Third, calculating the LTD ratio with consolidated data implicitly neglects the risk that cross-border deposits can be ring fenced in crises. For these reasons we use data from the monetary statistics as published by the ECB to calculate the LTD ratio, with loans adjusted for sales and securitization[2]. While the monetary statistics do not include loans and deposits of branches and subsidiaries outside the euro area, they do cover activities of foreign entities in the home market. This fits with the reciprocity principle of the countercyclical capital buffer, implying that national authorities are responsible for setting capital buffers to credit exposures in their jurisdiction (BIS, 2010).

5. Outcomes

5.1 Stylized facts

Table 1 shows a wide dispersion of LTD ratio across EMU countries. While Italy, Ireland and Netherlands have an average ratio above 140%, the mean ratios of Belgium and Greece are below 100%. The dispersion is also wide within countries (measures across time, not across banks), as shown by the large difference between minimum and maximum LTD ratio within countries. A high LTD ratio could be associated with high volatility since a high funding gap makes the business of banks - of which the main parts are captured by the LTD ratio - more sensitive to market fluctuations.

Table 1. Descriptive statistics LTD ratios (monthly data, 2008-2012)
Measured across time, not across banks

	DE	FR	IT	GR	ES	PT	NL	BE	IR	AT	FN	EMU
Mean	100,3	116,4	157,3	86,2	118,6	132,6	145,5	76,7	153,1	108,3	129,9	117,3
Median	101,1	116,5	157,7	84,6	117,0	140,7	149,9	78,2	152,0	108,8	138,8	118,7
Stdev	9,9	7,4	18,8	32,6	9,7	20,4	11,5	5,4	22,6	3,0	18,1	5,2
Min	82,8	102,8	110,0	47,8	93,9	74,2	114,4	65,8	113,2	99,5	91,1	103,5
Max	114,9	131,3	201,3	174,9	134,0	153,2	165,7	85,6	200,6	114,3	153,4	125,5

5.2 Trend and cycle

The long-term (HP filtered) trend of the EMU average LTD ratio increased from the end of the 90s until 2005 and decreased afterwards (Figure 1.a). This reflects the increased access of banks to wholesale funding in the run up to the crisis on the back of financial innovations like securitization. The crisis urged banks to change their funding mix towards more stable sources of funding, which

[2] Adjustments for sales and securitization are not available for loans to non-financial companies and households in our time sample. The ECB Statistical Data Warehouse (SDW) publishes growth rates of total loans to non-financial institutions excluding governments, adjusted for sales and securitization. We apply this correction factor (based on growth rates) to loans of companies and households.

shows up in an increase of the denominator and decline of the LTD ratio. Most countries fit the euro area wide trend, although the turning point to a downward trend differs across countries (Figures 1.b-c). The trends in the LTD ratios of Greece, Belgium and Austria show an obvious different pattern.

Figure 1.a. Trend of LTD ratio EMU
LTD ratio in percentage points (times 100)

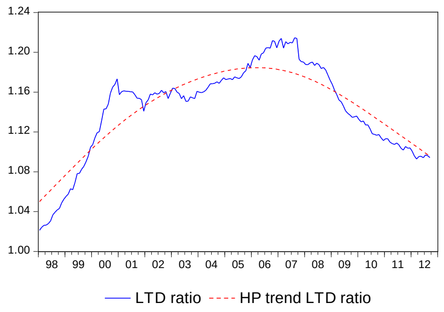


Figure 1.b-c. Trends (HP filter) of LTD ratios EMU countries

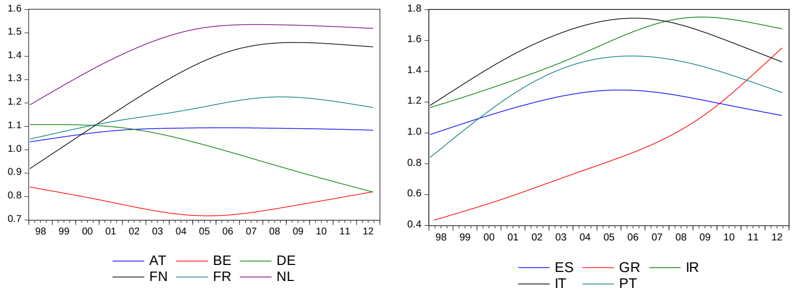


Figure 2.a shows the cycle of the EMU LTD ratio, based on the trend deviation and band-pass filter. The peaks and troughs of the cycle, as determined by both methods, match closely. Measured as deviations from trend, upward phases of LTD ratios in the country sample span 32 months on average and downward phases 38 months. In this respect the LTD ratio differs from financial cycles in general, which have shorter contractions relative to expansions (Drehmann, 2012). One reason for the different cyclical pattern is that it concerns a ratio of two financial variables.

Figure 2.a. Cycle of LTD ratio EMU
Cycle of LTD ratio in percentage points (times 100)

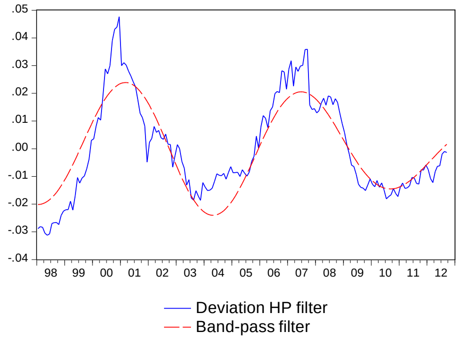
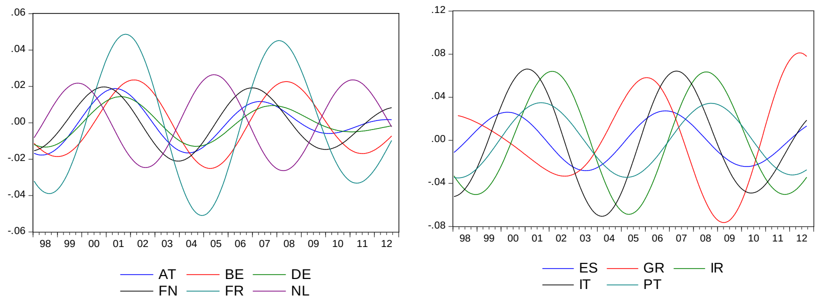


Figure 2.b-c Cycles (band-pass filter) LTD ratios EMU countries



Figures 2.b-c suggest that the LTD cycles are quite synchronized across EMU countries. The Dutch and Greece LTD ratios are most out of synch, which is confirmed by the formal measure of synchronicity φ presented in Table 2 (the cycles are completely synchronous to the euro area reference cycle if $\varphi = 1$, see Annex 1 and Mink et al., 2012). Graphical inspection suggests that the LTD cycles of most countries also have similar amplitudes. We formally measure co-movement by variable γ, which expresses the total distance between the cycle of a country and the reference cycle (there is

completely co-movement with the reference cycle if $\gamma = 0$, see Annex 1). Table 2 shows that co-movement is low for Italy, Greece and Ireland in particular.

Table 2. Measures of cycle similarity (monthly data, 2008-2012)

	DE	FR	IT	GR	ES	PT	NL	BE	IR	AT	FN
Synchronicity (φ)	0,86	0,81	0,93	0,38	0,74	0,75	0,33	0,74	0,72	0,90	0,83
Co-movement (γ)	-0,36	-0,88	-1,23	-1,83	-0,57	-0,77	-1,08	-0,59	-1,59	-0,26	-0,27

Note: measures for synchronicity and co-movement as defined by Mink et al, 2012. The LTD cycle of the euro area average is used as reference cycle.

5.3 Decomposition

Figure 3 decomposes the numerator and denominator effects of the LTD ratio for the euro area. It shows that loan growth (numerator effect) is driving the cyclical upswing and dominates the change of deposits. This is confirmed by the outcomes in Table 3, which show that the difference between the average numerator effect in upward and downward phases is significantly positive in most countries, indicating that loan growth is stronger in an upswing. The significant negative difference between the average denominator effects in upward and downward phases in most countries confirms that the change of deposits is stronger in downward phases of the LTD cycle. These results suggest that an expansion of loans is partly financed by non-deposit funding, which raises the LTD ratio. In downturns the denominator effect becomes more dominant, suggesting that the decline of the LTD ratio is primarily driven by increasing deposits. One explanation for this is that the funding side can more easily be adjusted than the loan book, which has a longer maturity on average. This makes the loan book quite sticky, in particular in downturns.

Figure 3. Numerator, denominator effect EMU
Numerator and denominator effects as percentage
(12 months moving averages)

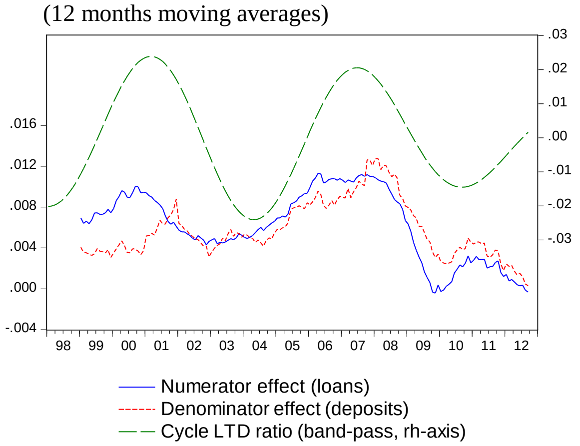


Figure 4. Interaction effect EMU
Cycle of LTD ratio in percentage points (times 100)
(12 months moving averages)

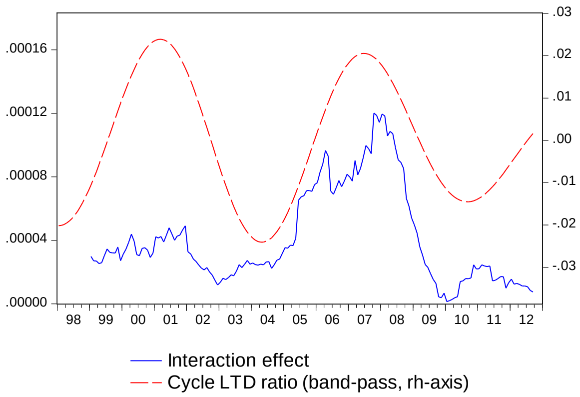


Table 3. Difference between numerator and denominator effects

(effects in terms of 12 months moving averages, times 100)

	DE	FR	IT	GR	ES	PT	NL	BE	IR	AT	FN	EMU
Numerator effect												
upward	0,22	0,78	1,14	0,84	1,15	1,34	0,99	0,54	2,02	0,54	0,96	0,68
downward	0,12	0,46	1,10	0,91	1,18	0,57	1,13	0,21	0,32	0,41	1,03	0,55
Difference (up - down)	0,10***	0,32***	0,04***	-0,06*	-0,03**	0,77***	-0,15***	0,33***	1,71***	0,13***	-0,08*	0,12***
Denominator effect												
upward	0,29	0,51	0,68	-0,25	0,89	0,77	0,61	0,42	1,49	0,41	0,64	0,52
downward	0,35	0,63	1,20	0,60	1,22	0,60	1,08	0,33	0,45	0,49	0,76	0,65
Difference (up - down)	-0,06**	-0,13***	-0,52***	-0,85***	-0,33***	0,17***	-0,48***	0,08***	1,03***	-0,08**	-0,12**	-0,14***

Note: means of effects times 100. T-test for mean differences in upward vs downward phases, ***, **, * denoting significance at 1%, 5%, 10% confidence level.

The interaction effect is stronger in upward phases (Figure 4). This indicates that the mutually reinforcing effect between loans and deposits tends to drive the LTD ratio up. However, the low level of the effect suggests that the interaction between loans and deposits is not an important driver behind the LTD ratio (it concerns the pure algebraic effect as derived in Equation 3; the wide interaction effect is explored in Annex 2).

6. Macroprudential policy rules

6.1 Structural policy

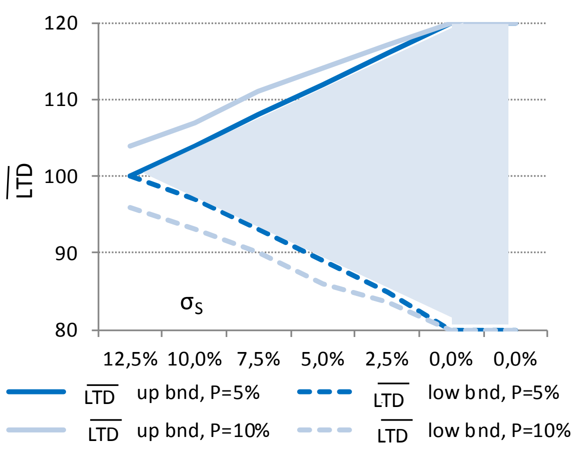
Macroprudential policies can influence the trend level of the LTD ratio by structural measures. The policymaker can define an upper and lower bound of the LTD ratio, which reflect market failures (bad equilibria) that should be prevented. An upper bound of the LTD ratio (with $D_r < \overline{D}_r$ and/or $L_r > \overline{L}_r$) can be associated with unsustainable business models of banks that excessively rely on market funding. A lower bound of the LTD ratio can be associated with impaired intermediation by banks, due to liquidity hoarding and deleveraging ($L_r < \overline{L}_r$ and/or $D_r > \overline{D}_r$). The boundaries are reference points for policy measures.

It is hard to pinpoint particular values for the boundaries, since they may vary by country (depending on the structure of the local financial system) and by bank (depending on the business model). Moreover the values of the boundaries depend on the definition of the LTD ratio. There is some historical evidence on critical boundaries. A multiple country analysis, based on a broad definition of loans and deposits, suggests that an LTD ratio over 120% are presumptive indicator for a banking crisis and LTD ratios of 80% are associated with impaired financial intermediation (ECB, 2012).

The target (or equilibrium) level of the LTD ratio ($\overline{LTD}$) between the boundaries could be based on the risk tolerance of the macroprudential authority and the volatility of market funding, which will depend on the structure of the financial system. This approach assumes that the LTD ratio is maintained within the lower and upper bounds by calibrating $\overline{LTD}$ on the available market funding (S), its volatility (σ_S) and probability (P) that the LTD ratio crosses the lower or upper bound. The macroprudential authority sets $\overline{LTD}$ to bring P in line with his risk tolerance. To keep the LTD ratio below the upper bound at probability P, the target level for $\overline{LTD}$ should be lowered proportional to σ_S (vice versa $\overline{LTD}$ should be raised proportional to σ_S to keep the ratio above the lower bound). Figure 5 shows a range of simulated $\overline{LTD}$ ratios that meet these conditions, at hypothetical values of S=100, σ_S=10%, P=5%, upper bound=120 and lower bound=80. The macroprudential authority chooses $\overline{LTD}$ within this range, given LTD = $\overline{LTD}$ + σ_S.[3] It assumes that changes in the LTD ratio are entirely driven by fluctuations in market funding, which go in tandem with rising loans in an upturn and rising retail deposits in a downturn.

In the theoretical situation that σ_S=0 the equilibrium level could be set at the upper or lower bound. A rational choice will be $\overline{LTD}$ =100, which gives most leeway to control both an upswing and downswing of the LTD ratio. However the authority could prefer an alternative $\overline{LTD}$ level within the range, if the possibilities to influence the LTD ratio in an upturn and downturn are not similar. At a certain high volatility level σ_S, the authority has no flexibility to choose between equilibrium LTD levels (this is the point where $\overline{LTD}$ associated with the upper and lower bounds meet at 100%, see Figure 5). This could be solved by lifting the risk tolerance, i.e. accepting a higher probability that the LTD ratio crosses the upper or lower bounds. Figure 5 shows that at P=10%, the range of equilibrium levels $\overline{LTD}$ that keep the LTD ratio below the upper bound (above the lower bound) is wider.

Figure 5. Equilibrium LTD ratio vs. volatility market funding

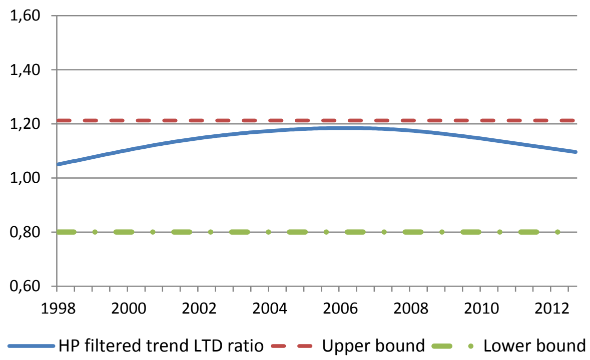


[3] LTD is simulated by taking 10,000 random draws for σ_S from a normal distribution.

As an illustration, Figure 6 compares the HP filtered trend of the actual LTD ratio of the euro area to a hypothetical equilibrium value of 100% (assuming $\overline{L}_r$, $\overline{D}_r$ = 100), an upper bound of 120% and a lower bound of 80%. It shows that the LTD trend ratio has stayed within the boundaries during the sample period. After hitting the upper bound in 2006, the trend LTD ratio has declined thereafter. In 2012 half of the euro area countries still had a trend ratio of more than 120% (Finland, Greece, Ireland, Italy, Netherlands, Portugal, see Figures 1.b-c). While critical levels of lower and upper bounds may vary by country, depending on the structure of the local financial system, very low or high levels may not be sustainable in the long run. A very low LTD ratio may reflect an insufficient level of financial development, while a very high LTD level may reflect an overextended financial sector.

Figure 6. Boundaries LTD ratio EMU

LTD ratio in percentage points (times 100)



The trend of the LTD ratio could be kept within the bounded area by wide ranging structural measures that affect loans (L_r), deposits (D_r) and the intermediation process in general.

i) Guidance or incentives in microprudential supervision to change banks' business models towards more traditional, deposit based lending. An example of such an incentive is the supervisory assessment of the sustainability of banks' financing model, as regularly conducted by DNB.

ii) Changes in regulation that influence funding and lending (e.g. by micro and macroprudential measures that restrict lending, or foster the use of stable funding sources).

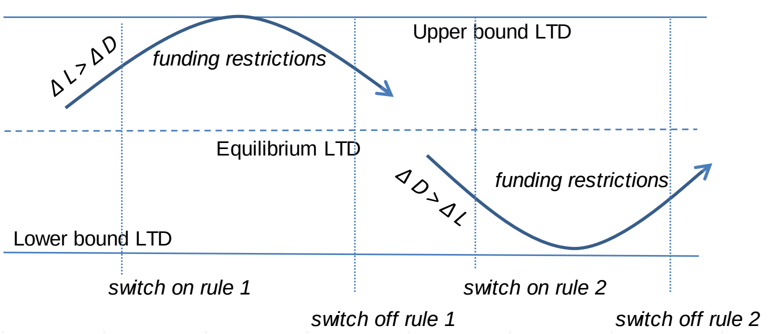
iii) Repairing monetary transmission by structural reforms of ill-functioning banks (reforms should aim at writing-off and/or disposal of bad loans and recapitalization to support the flow of credit).

iv) Influencing market structures by reforms that aim at particular market segments, for instance the retail savings market. Policy measures like tax changes can influence the distribution of savings between pension funds, insurance companies and banks.

6.2 *Countercyclical policy*

Macroprudential policy can influence the cycle of the LTD ratio between the upper and lower bounds. The stylized facts in the previous section show that loan growth is dominant in an upturn, raising the LTD ratio to the upper bound. In a downturn deposit growth is dominant, reducing the LTD ratio to the lower bound. These regularities can be used to apply countercyclical measures (see Figure 7). First, the LTD ratio can be used as indicator for other macroprudential instruments. For instance, if the LTD ratio rises in an upturn, the countercyclical capital buffer can be increased and loan-to-value ratios restricted, while those measures may be relaxed in a downturn. Second, macroprudential policy can be inferred from the LTD ratio itself. We propose two rules for influencing the LTD-cycle by countercyclical funding restrictions.

Figure 7. Stylized LTD cycle



The first rule is applied when the system nears the upper bound. This is typically associated with credit growth financed by wholesale funding, which is abundantly available in cyclical upswings. The rule requires banks to fund new lending (ΔL_r) with an increasing share of stable deposits (ΔD_r) and is designed as a function of the LTD ratio and target ratio $\overline{LTD}$,

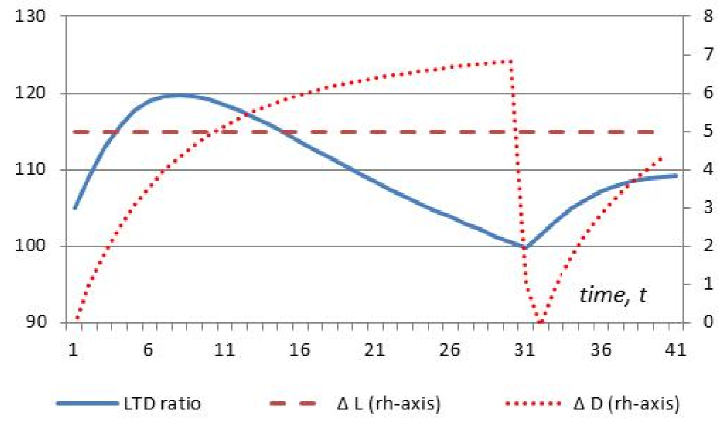
$$\Delta D_{r,t} = (1-\alpha)\,\Delta D^{x}_{r,t} + \alpha\,(\Delta L_{r,t-1}\,(1+\left(\frac{LTD_{t-1}-\overline{LTD}}{100}\right))\;\log(\lambda t)) \tag{7}$$

where $D^{x}_{r,t}$ is the autonomous growth of retail deposits (independent of policy measures), t stands for time and α and λ are adjustment parameters. The rule is designed like solvency rules in macroeconomic models for public debt (see Johnson, 2001 for an overview). A caveat for applying such rules to banks is that they do not take into account alternative reactions by banks. They may take other actions to close their funding gap than assumed by the rule. The ceteris paribus condition is nonetheless applied to illustrate the effects of funding restrictions on a macro level.

The macroprudential authority sets the parameters of the rule ($\overline{LTD}$ and the adjustment parameters), dependent on its risk assessment. If it wants to keep the LTD ratio further away from the upper bound, it can apply a higher α. If it wants banks to adjust more rapidly towards the target LTD ratio it can raise parameter λ. These decisions can be based on the volatility of market funding σ_S. The funding requirement is switched off when the LTD ratio reaches $\overline{LTD}$. Figure 8 shows how the rule works, when the LTD ratio is simulated over time, assuming $\overline{LTD} = 100$, α = 0.5, λ = 0.4, $D^x_{r,t} = 1$ and ΔL_r = 5 (the latter two are constant growth terms). It assumes that the rule is switched on at the start of an upward phase of the LTD cycle (this condition is imposed in Equation 7, by setting t=0 each time the rule is switched on). The rule is switched off when the LTD ratio returns to 100%, as shown by the drop in ΔD_r at t = 30.

Figure 8. Anti-cyclical rule in upward phase

LTD ratio in percentage points



$\overline{LTD}$=100, α = 0.5, λ=0.4, ΔD^x=1, ΔL=5.

The policy rule can be a recommendation to the microprudential supervisor. He could charge fees to banks that do not issue retail deposits in line with loan growth, or impose funding restrictions aimed at the target LTD ratio. Since loans tend to create deposits by themselves - as explained in Section 3 - the rule has an inherent logic. However, it could have adverse side-effects. Increased competition for retail funding can stir up saving rates and affect other sectors that also rely on retail savings. This will be less an issue in an upturn than in a downturn, when banks more likely scramble for stable funding. A rise of interest rates could even be supportive to monetary and macroprudential policy in an upturn. Adverse side-effects should be taken into account when applying the instrument, either by adjusting its design (possibly by avoiding a hard limit or defining long enough adjustment periods when the upper bound is not hit yet) or by applying it in conjunction with other instruments, for instance the countercyclical capital buffer to restrains loan growth in an upturn.

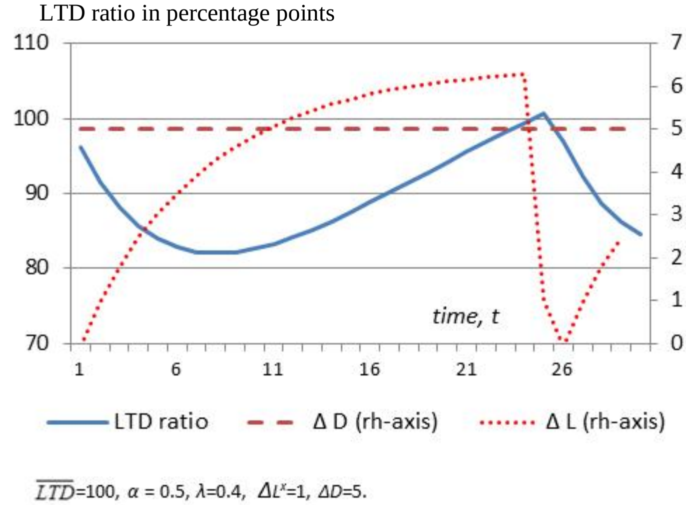
The second countercyclical rule is applied when the system nears the lower bound, due to impaired intermediation of deposits into loans. To avoid such a bad equilibrium, banks are given an incentive to match an increasing fraction of new deposits with loanable funds (L_r). This is defined as bank funding that is available for lending, i.e. new credit supply. The rule for the downturn is a function of the funding gap ($\overline{LTD} - LTD_{t-1}$) and adjustment parameters α and λ. The rule stimulates that the increase of demand deposits (ΔD_r) is increasingly matched with supply of new loans (ΔL_r). The rule is written as,

$$\Delta L_{r,t} = (1-\alpha)\,\Delta L^x_{r,t} + \alpha\,(\Delta D_{r,t-1}\,(1+\left(\frac{\overline{LTD} - LTD_{t-1}}{100}\right))\ \log(\lambda t\,)) \qquad (8)$$

where $L^x_{r,t}$ is the autonomous growth of loanable funds (independent of policy measures). The rule is illustrated in Figure 9, where the LTD ratio is simulated over time, assuming $\overline{LTD} = 100$, $\alpha = 0.5$, $\lambda = 0.4$, $L^x_{r,t} = 1$ and $\Delta D_r = 5$ (the latter two are constant growth terms). It assumes that the rule is switched on when the LTD ratio falls below 100%, at the start of each downward phase of the LTD cycle (this condition is imposed in Equation 8, by setting $t = 0$ each time the rule is switched on). The rule is switched off when the LTD ratio returns to 100%, as shown by the drop in ΔL_r at $t = 25$.

Figure 9. Anti-cyclical rule in downward phase

LTD ratio in percentage points



The supervisor can foster the supply of loanable funds by urging banks to repair their balance sheets, recapitalize and issue more stable funding (term funding or secured funding). This could require a sufficiently long adjustment period to limit adverse price effects in those markets. If the decline of the

LTD ratio would have detrimental economic effects and banks are not able to obtain stable funding, there is a case for the central bank and/or government to step in. They can take various measures aimed at bank's funding, to foster credit supply. The central bank has a natural role to support the monetary transmission. Depending on the situation it can take unconventional monetary policy measures, for instance by providing long-term repo funding to banks and/or widen the collateral framework by accepting credit claims. A funding for lending scheme, which provides long-term funding at favorable terms, is particularly targetted at new lending. The government may contribute to that by guaranteeing long term bank debt (as was done in 2008-2009 by many European countries). Such measures can enhance the supply of loanable funds and support banks' lending.

In practice, an upper bound might be sufficient to prevent bad equilibria. A lower bound would probably not be needed since impaired intermediation usually follows from a correction of excessive liquidity risks which the upper bound may prevent. The countercyclical capital buffer could also contribute to that, although it primarily aims at credit and not at liquidity risk. Moreover, from a liquidity risk perspective it is less worrisome that banks approach the lower than the upper bound, particularly if a declining LTD ratio owing to strong deposit inflows is not associated with falling lending. This underscores that judgement - based on analysis of the loan and deposit components - remains an important element in macroprudential decisions with regard to the LTD ratio.

6.3 Stability properties

The stability properties of the macroprudential rules are illustrated by several sensitivity tests. We apply different values for α, λ, ΔL_r $\Delta D^x_{r,t}$ in the rule for the upward phase in the LTD ratio (Equation 7; the conclusions are similar for the rule formulated for the downward phase). Figures 10-13 show that the stability of the rule is quite robust to changing the parameter values. At different values of α, λ, ΔL_r $\Delta D^x_{r,t}$ the LTD ratio converges to $\overline{LTD}$ in the long run. This is due to the condition that the rule is switched off at an LTD ratio of 100. Figure 10 shows that a higher α reduces the maximum value of the LTD ratio (and also reduces the adjustment period), while Figure 11 shows that a lower λ prolongs the adjustment period (and as a consequence also raises the maximum value). The LTD ratio is also sensitive to changes in the autonomous increase of lending (ΔL_r in Figure 12) and retail deposits ($\Delta D^x_{r,t}$ in Figure 13). The stability properties of the rule also hold if various parameters are changed simultaneously. Only when very low values of α, λ, $\Delta D^x_{r,t}$ and high values of ΔL_r are implied simultaneously the LTD ratio keeps on rising and does not converge to $\overline{LTD}$. The macroprudential authority can prevent this by controlling the adjustment parameters α and λ.

Figure 10. Sensitivity for alpha
LTD ratio in percentage points

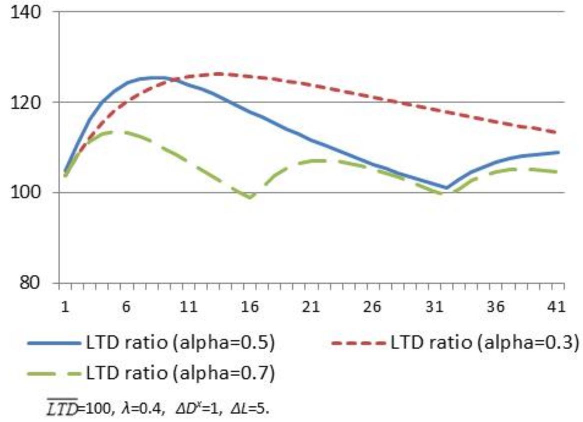


Figure 11. Sensitivity for lamda
LTD ratio in percentage points

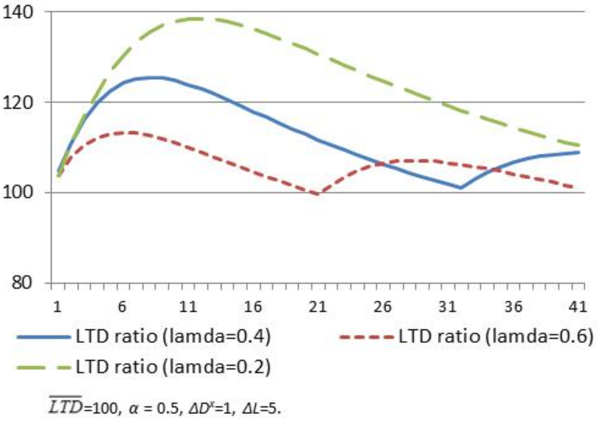


Figure 12. Sensitivity for ΔL
LTD ratio in percentage points

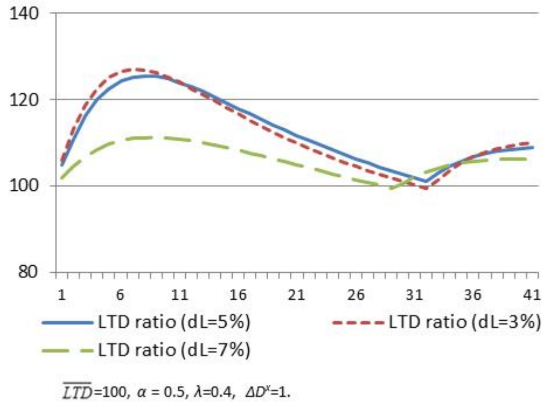
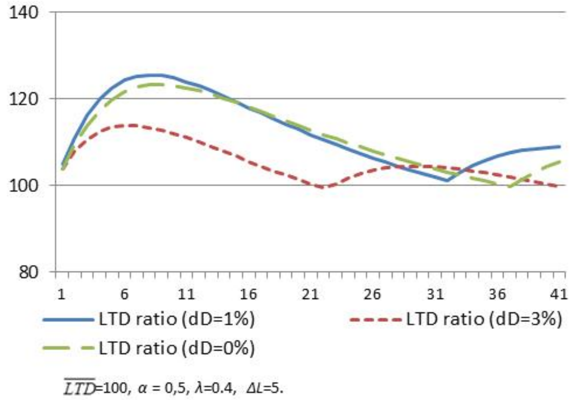


Figure 13. Sensitivity for ΔD
LTD ratio in percentage points



7. Conclusion

Building on research that investigates the indicator properties of the Loan-to-Deposit ratio for liquidity risk, our paper links the empirical regularities of the ratio to macroprudential policy. Decomposition analysis of the numerator and denominator of the LTD ratios in 11 EMU countries shows that loan growth is dominant in an upturn, raising the LTD ratio to the upper bound. In a downturn deposit growth is dominant, reducing the LTD ratio to the lower bound. The interaction effect between loans and deposits is statistically significant and is stronger in upward phases of the LTD cycle.

Based on these findings, the macroprudential authority may want to influence the cycle of the LTD ratio between an upper and lower bound. The boundaries reflect market failures (bad equilibria) which should be prevented. Destabilizing cycles of the LTD ratio between the upper and lower bounds can be counterbalanced by macroprudential rules. We formulate a rule which stimulates banks to issue retail deposits in an upturn and a rule that provides incentives to create loanable funds in a downturn. The first rule discourages banks to use market funding when it likely is easily available. To some extent it is in line with the financial flow model, which says that loans tend to create deposits by themselves. The second rule deals with situations in which banks have abundant retail savings owing to a flight to quality. The rule encourages banks to lend their deposits to households and non-financial firms. Besides the cycle of the LTD ratio, the trend level of the LTD ratio can be influenced by structural policy measures, which influence market structures or the financial intermediation process more fundamentally.

The policy rules focus on the denominator of the LTD ratio (i.e. the funding side of the balance sheet), since the numerator is influenced by other macroprudential instruments, like the countercyclical capital buffer and limits to the loan-to-value ratio. While measures taken at the funding side of banks have added value to mitigate systemic liquidity risk, coordination issues could arise when multiple macroprudential instruments are applied. This is an important subject for future research.

References

Adrian, T. and H.S. Shin (2008), Liquidity supply, Monetary Policy, and Financial Cycles, Federal Reserve Bank of New York Economic Policy Review, 14(1), 1-7.

Berg, S.A. (2012), The declining deposit to loan ratio - What can the banks do?, Staff memo 28/2012, Norges Bank.

Betz, F., S. Oprică, T. A. Peltonen and P. Sarlin (forthcoming), Predicting Distress in European Banks, Working Paper.

BIS (2010), Guidance for national authorities operating the countercyclical capital buffer.

Chadha, J. S. and L. Corrado (2012), Macro-prudential policy on liquidity: What does a DSGE model tell us?, Journal of Economics and Business, 64.

Brunnermeier, M. K. and L.H. Pedersen (2009), Market Liquidity and Funding Liquidity, Review of Financial Studies 22(6), 2201-2238.

Cecchetti, S.G., M.R. King and J. Yetman (2011), Weathering the financial crisis: good policy or good luck?, BIS Working Papers, 351.

Chrystal, K.A. and P. D. Mizen (2001), Goodhart's Law: Its Origins, Meaning and Implications for Monetary Policy, Paper prepared for the Festschrift in honour of Charles Goodhart to be held on 15-16 November 2001 at the Bank of England.

DNB (2012), Overview of Financial Stability in the Netherlands, 15, March 2012.

Drehmann, M., C. Borio and K. Tsatsaronis (2011), Anchoring Countercyclical Capital Buffers: The role of Credit Aggregates," International Journal of Central Banking, 7(4), 189-240.

Drehmann, M., C. Borio and K. Tsatsaronis (2012), Characterising the financial cycle: don't lose sight of the medium term!, BIS Working Papers 380.

ECB (2012), Financial Stability Review, June 2012.

Federal Reserve Board (2012), Banking Agencies Issue Host State Loan-to-Deposit Ratios, Press release, June 29, 2012.

Goodhart, C.A.E., A.K. Kashyap, D.P. Tsomocos and A. Vardoulakis (2013), An Integrated Framework for Analyzing Multiple Financial Regulations, International Journal of Central Banking, 9(1).

Jobst, A.A. (2012), Measuring Systemic Risk-Adjusted Liquidity (SRL), A Model Approach, IMF Working paper 12/209.

Johnson, R (2001), Fiscal reaction rules in numerical macro models, Federal Reserve Bank of Kansas City.

Kashyap, A.K., R. Rajan, and J.C. Stein (2002), Banks as Liquidity Providers: An Explanation for the Coexistence of Lending and Deposit- Taking, The Journal of Finance 57(1).

Le Leslé, L. (2012), Bank Debt in Europe: Are Funding Models Broken?, IMF Working Paper 12/299.

Mink, M., Jacobs, J. P.A.M. and J. de Haan (2012), Measuring coherence of output gaps with an application to the euro area, Oxford Economic Papers, 64(2), 217-236.

Van den End, J.W. and M. Kruidhof (forthcoming), Modelling the liquidity ratio as macroprudential instrument, Journal of Banking Regulation.

Annex 1. Measures of cycle similarity

The measures of cycle similarity we use are taken from Mink et al. (2012). They define synchronicity between the business cycle (g_i) of an individual country i and the reference cycle (g_r) in period t as,

$$\varphi_{ir}(t) = \frac{g_i(t)g_r(t)}{|g_i(t)g_r(t)|} \tag{1.1}$$

When averaged over a time interval and transformed to a uniform scaling, φ shows the fraction of time that the output gap of country i has the same sign as the output gap of the reference cycle. Hence, measure φ ranges between 1 and 0 (a value of 1 indicates complete similarity).

The co-movement measure γ_i expresses the distance between the cycle of a country and the reference cycle, and scales this distance by the overall sum of these output gaps,

$$\gamma_{ir}(t) = -\frac{n|g_i(t) - g_r(t)|}{\sum_{i=1}^{n}|g_i(t)|} \tag{1.2}$$

The minus sign makes that the measures for co-movement and similarity move in the same direction, i.e., an increase in the measure signals an increase in similarity. Measure φ ranges between 0 and -n (a value of 0 indicates complete co-movement).

Annex 2. Simulation of interaction effects with panel-VAR model

To analyze this broad interaction effect between loans and deposits, we estimate a small panel Vector Autoregressive model (p-VAR). The model treats the variables in the system as endogenous and allows for unobserved individual heterogeneity by including fixed effects. It reads as follows:

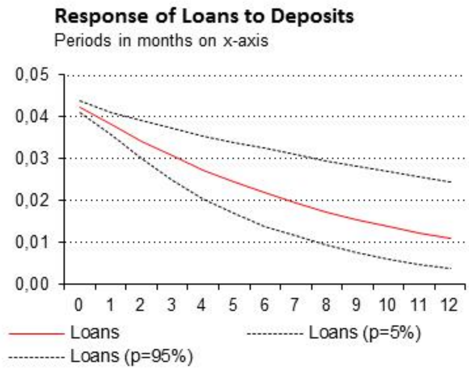
$$\begin{bmatrix} D_{it} \\ L_{it} \\ Y_{it} \end{bmatrix} = A_i + B(L) \begin{bmatrix} D_{it} \\ L_{it} \\ Y_{it} \end{bmatrix} + \varepsilon_{it} \tag{2.1}$$

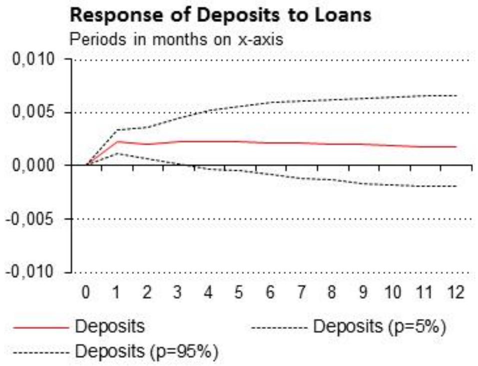
where D_t is the annual growth rate of deposits, L_t the annual growth rate of loans and Y_t a vector containing GDP growth and the change in interest rates (government bond yields, which usually are the basis of loan and deposit rates) for each country *i* and month *t*. Matrix A_i contains country-specific fixed effects, *B(L)* is a matrix polynomial in the lag operator whose order is 2 and ε_{it} is the error term. The coefficients of the p-VAR model are estimated by system Generalised Method of Moments (GMM).[4] The decomposition of the residuals is conducted by Choleski decomposition. The identifying assumption is that variables that come earlier in the ordering affect the following variables contemporaneously, as well as with lags, while the variables that come later affect the previous variables only with lags. We assume that deposits are more exogenous than loans and therefore deposits appear first in the ordering of the variables. Interest rates are included after loans and GDP growth after interest rates.

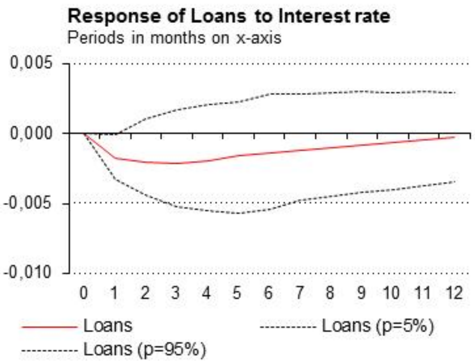
To examine the interaction between loans and deposits we use impulse-response functions that are derived from the p-VAR model. The impulse responses of show a significant interaction effect: both loans and deposits respond significantly positive to shocks in the other variable (the effects are significantly different from zero, see Figure A, upper panels). The response of loans to a shock in deposits is stronger than vice versa, underlining the importance of deposit funding for loan supply.[5] We also find significant negative responses of loans and deposits to a shock in interest rates (middle panels Figure A). While it is obvious that loan demand falls if interest rates rise, it is less obvious that deposits react similarly. Risk motives apparently dominate price incentives, with households and firms preferring safe deposits, even if deposit rates are decreasing. The response of loans and deposits to a shock in GDP is positive, but not significant.

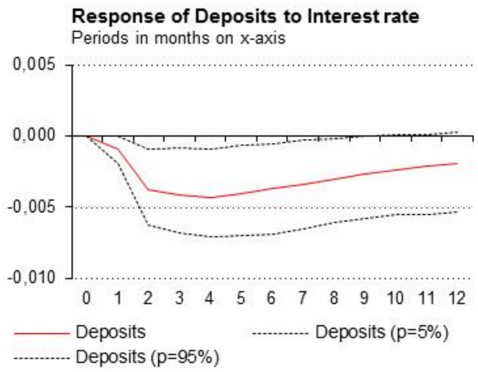
[4] For more details we refer to Love and Zicchino (2006), whose Stata code we gratefully used for the estimation.

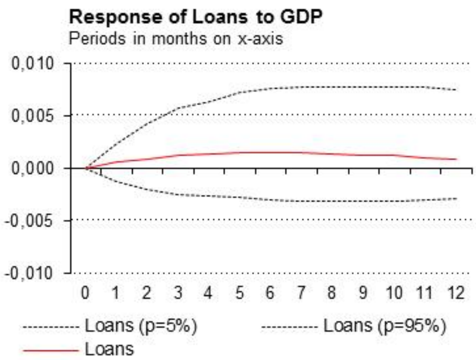
[5] The relative strength of the response of loans to a shock in deposits is underlined by simulations which include loans as first variable in the panel VAR. Than the interaction effect running from deposits to loans remains significant, which is not the case anymore for the response of deposits to a shock in loans.

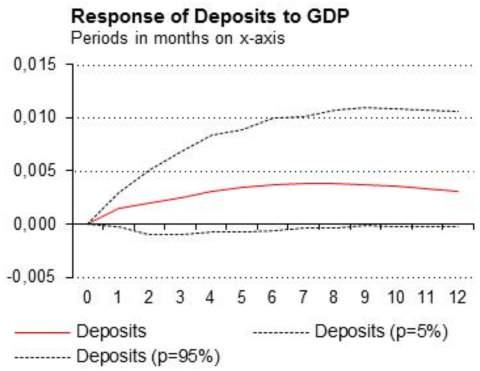

Response of Loans to Deposits
Periods in months on x-axis
0,05
0,04
0,03
0,02
0,01
0,00
0 1 2 3 4 5 6 7 8 9 10 11 12
Loans
Loans (p=5%)
Loans (p=95%)


Response of Deposits to Loans
Periods in months on x-axis
0,010
0,005
0,000
-0,005
-0,010
0 1 2 3 4 5 6 7 8 9 10 11 12
Deposits
Deposits (p=5%)
Deposits (p=95%)


Response of Loans to Interest rate
Periods in months on x-axis
0,005
0,000
-0,005
-0,010
0 1 2 3 4 5 6 7 8 9 10 11 12
Loans
Loans (p=5%)
Loans (p=95%)


Response of Deposits to Interest rate
Periods in months on x-axis
0,005
0,000
-0,005
-0,010
0 1 2 3 4 5 6 7 8 9 10 11 12
Deposits
Deposits (p=5%)
Deposits (p=95%)


Response of Loans to GDP
Periods in months on x-axis
0,010
0,005
0,000
-0,005
-0,010
0 1 2 3 4 5 6 7 8 9 10 11 12
Loans (p=5%)
Loans (p=95%)
Loans


Response of Deposits to GDP
Periods in months on x-axis
0,015
0,010
0,005
0,000
-0,005
0 1 2 3 4 5 6 7 8 9 10 11 12
Deposits
Deposits (p=5%)
Deposits (p=95%)

Previous DNB Working Papers in 2013

No. 367 **Andrea Colciago and Lorenza Rossi**, Firm Entry, Endogenous Markups and the Dynamics of the Labor Share of Income
No. 368 **Dirk Broeders, Paul Hilbers and David Rijsbergen**, What drives pension indexation in turbulent times? An empirical examination of Dutch pension funds
No. 369 **Luca Arciero, Ronald Heijmans, Richard Heuver, Marco Massarenti, Cristina Picillo and Francesco Vacirca**, How to measure the unsecured money market? The Eurosystem's implementation and validation using TARGET2 data
No. 370 **Stijn Claessens and Neeltje van Horen**, Impact of Foreign Banks
No. 371 **Gabriele Galati, Federica Teppa and Rob Alessie**, Heterogeneity in house price dynamics