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# What are the bank-specific and macroeconomic drivers of banks' leverage? Evidence from Luxembourg

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**Abstract** We investigate the leverage cycle in Luxembourg's banking sector using individual bank-level data for the period 2003 Q1–2010 Q1. One of our findings is that Luxembourg's banks have a procyclical leverage. This procyclicality is not due to marking-to-market but because Luxembourg's banks are liquidity providers to the EU banking sector. We then empirically investigate the role of bank characteristics as well as real, financial and expectation variables that proxy for macroeconomic conditions in the pre-crisis and crisis period. We find that off-balance sheet exposures have different effects in the pre-crisis and crisis period, and that the share of liquid assets in the portfolio only affects security holdings. As for macroeconomic variables, we find that the Euribor-OIS spread is a significant driver of the build-up in leverage in the pre-crisis period. The reason is that most banks in Luxembourg are either branches or subsidiaries. This makes leverage a less relevant indicator of riskiness for investors. It also implies that in times of liquidity shortages, mother companies or groups demand further liquidity from their branch or subsidiary. The downturn in leverage during the crisis can be accredited to reductions in expectations, which we proxy by an economic

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sentiment indicator. It can also be explained by increasing bond prices which induce depositors to shift their funds from bank deposits into bonds. We find no important role for GDP growth.

**Keywords** Leverage dynamics · Banking sector · GMM estimation · Crisis effect

## 1 Introduction

Many economists shared the belief that the great moderation was due to a structural change in, and a better understanding of, the processes that underlie financial markets. This belief induced easy credit to flood the markets, leading to a higher demand than supply for assets which induced asset prices to diverge from their fundamentals (Allen and Gale 2007). Banks expanded their balance sheets through increasing their leverage (Adrian and Shin 2010), thereby making themselves prone to risks of liquidity shocks or maturity mismatch. At one point, however, highly leveraged financial players suddenly noticed that their previous expectations were not met anymore and they started to unwind various financial positions which quickly led to tumbling asset prices and further worsening of balance sheets (Shleifer and Vishny 2011). Once this mechanism had achieved a certain momentum it led to the course of events that is now called the financial crisis of 2007–2009, the general causes of which are well-described in e.g. Reinhart and Rogoff (2008); Brunnermeier (2009) and Cecchetti (2009).

One of the variables that currently receives a particular attention from both regulators and investors is the leverage ratio. This ratio measures how much of a bank's own fund covers its assets, which is indicative for the level of indebtedness of a bank. The more a bank wishes to increase its profits by relying on outside funding the more susceptible it will be to bank runs or sudden shifts in liabilities or risky assets. Thus, a higher leverage may be associated with a higher level of bank default and an amplification of the effect of liability withdrawals.

It is, therefore, important to determine the causes underlying any change in leverage in order to understand why banks choose to accept the risks associated with higher leverage. This is the main objective of this study. In order to do this, we utilize individual banks' balance sheet data from the Luxembourgish banking sector, covering at maximum 153 banks and ranging from 2003 Q1–2010 Q1. We proceed in two steps. In the first step we study the basic mechanism behind leverage adjustments in Luxembourg. Our focus is on determining those balance sheet components that tend to explain most of the adjustments in Luxembourgish banks' leverage decisions.

In the second step we econometrically investigate which macroeconomic variables are significant drivers of changes in leverage as well as of its main components, namely credits and securities on the asset side and deposits on the liability side. Additionally, we also study if changes in leverage are associated with bank-specific characteristics. This we do in order to control for the possibility that banks with different business models or balance sheet structures have different leverage cycles or potentially also react differently to macroeconomic developments.

The main hypothesis is that banks target a certain level of indebtedness, or leverage, which certainly does not need to be constant but depends on their individual

willingness to take risks, assessment of the economic situation and general level of demand in the economy. For this reason the macroeconomic variables should be good indicators for capturing those bank assessments and attitudes, while the bank-specific variables reflect a bank's current structure and, therefore, its ability to react to unforeseen events.

With this in mind we also investigate whether the crisis led to fundamental changes in the way banks rely on market indicators and in the way their current balance sheet structures constrain them in future choices. For example, intuition would suggest that banks with many off-balance sheet activities would have a smaller expansion of leverage than those with few off-balance sheet activities. In contrast, during a crisis when commitments or guarantees get exercised, then banks with a large amount of off-balance sheet commitments might need to expand their balance sheets by more than other banks. One would also expect that GDP growth or security prices might be guiding banks' decisions more in a stable pre-crisis period, while during a crisis the role of expectations would predominate.

As bank-specific variables we include the loans-to-deposits ratio, which is a simple way to measure a bank's maturity mismatch; the liquid-assets-to-assets ratio (with liquid assets including cash, securities and quoted shares), which measures the percent of assets that can easily be converted into cash and thus reflects the ease with which a bank can respond to unforeseen events; the off-balance-to-assets ratio (where off-balance items include committed credits, guarantees and liquidity facilities), which allows us to assess a bank's contingent commitment to future credits. The list of macroeconomic variables includes the Euribor-OIS spread, which reflects the risk-adjusted price of lending funds on the interbank market; an economic sentiment indicator, which provides us with an assessment of the forward-looking expectations; a bond index, a proxy for changing bond prices; and European GDP growth, which is an indicator for the activity in the real sector that the internationally oriented Luxembourgish banking sector is the most active in. With these variables we, therefore, cover bank-specific conditions, the real sector, the financial sector as well as forward-looking expectations.

Our findings are as follows. Though Luxembourg's banks have balance sheets that are mainly composed of loans and deposits and are, thus, in their fundamental balance sheet structure similar to US commercial banks, their leverage dynamics are more in line with US investment banks. Indeed, in contrast to US commercial banks that are known to target a constant leverage ratio (Adrian and Shin 2010), we show that leverage in Luxembourg is inherently procyclical. Our explanation for this rests on the fact that most banks in Luxembourg are either branches or subsidiaries. In line with this argument, one of the macroeconomic variables that shows up as a highly significant driver of balance sheet expansions is the Euribor-OIS spread. We find that Luxembourg's banks strongly expand their balance sheets when the spread increases, which confirms to us that Luxembourg's banks are liquidity providers to the European banking sector. The main reason for this effect is that when market conditions worsen and it becomes more expensive for banks to borrow on the interbank market, then they increase their demand for funds from their subsidiaries or branches in Luxembourg. The econometric analysis shows that Luxembourg's banks fund these balance sheet expansions not only by increasing deposits, but also by selling securities.

Additionally, since most banks in Luxembourg are branches or subsidiaries they can, in distressed times, rely on help from their mother company or group. As a consequence, the Luxembourgish banking sector has one of the highest levels of leverage in Europe. We observe little leverage targeting and banks freely choose their level of indebtedness according to the market fundamentals or expectations. This observation is confirmed by the econometric results which show that Luxembourg's banks expand their balance sheets if expectations are good, while they shrink their balance sheets if times turn bad.

In addition, we find that the off-balance sheet exposures and the amount of liquid assets both play a crucial role for the evolution of leverage. In particular, the larger is the share of liquid assets on a bank's balance sheet the smaller is the growth of securities with a more pronounced effect during the crisis. The reason for this result can be found within the bank model that Luxembourg's banks utilize, as a large part of securities tends to be held for being able to obtain liquidity in uncertain times. The off-balance sheet activities constrain the growth of leverage in the build-up to the crisis, while they increase leverage growth during the crisis. The intuition for this draws, on the one hand, on the fact that banks with large committed credits or guarantees are constrained in the possibility to further expand their loan portfolio. On the other hand, large off-balance sheet exposures imply that during a crisis the committed credits or guarantees are exercised, which implies that these banks will have a larger growth in leverage than those with few commitments. This result links directly to the new Basel III regulations. Since these introduce an off-balance sheet augmented leverage ratio we can, first, expect not only a lower absolute exposure to off-balance sheets simply due to the regulation but, second, also a lower counter-cyclical effect on leverage from the off-balance exposure. This last point depends on how banks pay for their off-balance sheet commitments after the Basel III regulations have been imposed.[1]

The article is structured as follows. Section 2 develops upon the processes that are behind the leverage cycle. We look specifically into the adjustments of balance sheets of banks in Luxembourg, covering the period 2003 Q1–2010 Q1. In Sect. 3 we present the econometric methodology followed by a discussion of the results. Finally, Sect. 4 concludes.

## 2 The mechanics of the leverage cycle

### 2.1 The data

In order to analyse the determinants of the movements in leverage empirically we collect bank level data for the whole banking population in Luxembourg from the statistical reporting to the Banque Centrale du Luxembourg. We built an unbalanced panel dataset consisting of at maximum 153 banks for the period 2003 Q1–2010 Q1. We use this data in this section and the next one to study the evolution of leverage for banks in Luxembourg. We define leverage as total assets divided by own funds. Own funds include basic capital, assimilated capital and reserves (Tier 1 capital).

[1] Since raising equity takes time, it is likely that banks will fund their guarantees or commitments via deposits.

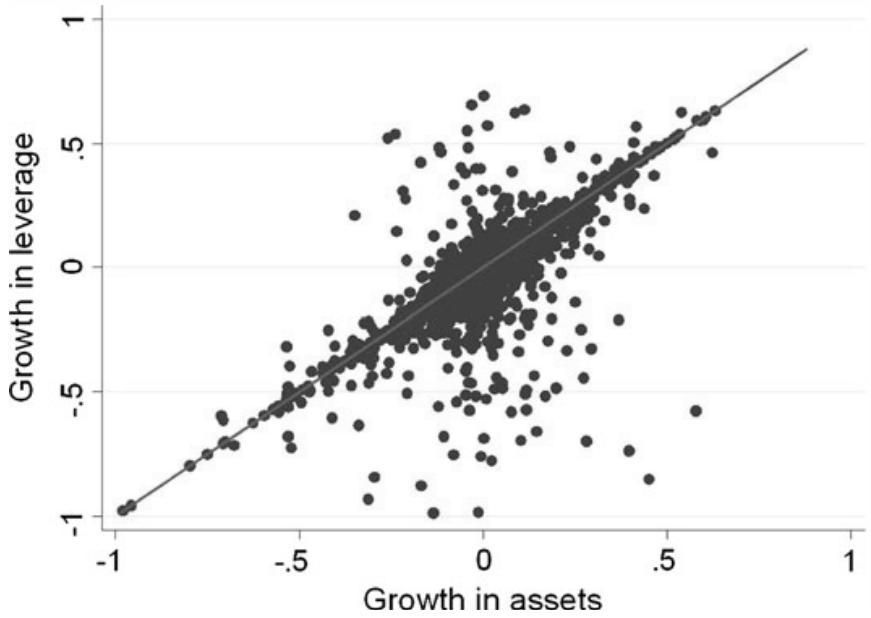


**Fig. 1** Leverage growth versus asset growth, 2003 Q2–2010 Q1

## 2.2 The procyclicality of leverage

One should find a negative relationship between total assets and leverage if banks were not to adjust their balance sheets. We denote leverage by $L$, $A$ is total assets and $D$ denotes debt, which is total liabilities excluding own funds E, implying $E = A - D$. The leverage ratio is given by

$$L = \frac{A}{A - D}. \tag{1}$$

Assume that banks are passive. If asset values increase due to, for example, a stock market boom and marking-to-market of securities then leverage decreases. Therefore, an increase in asset prices implies that

$$\frac{dL}{dA} = -\frac{D}{(A - D)^2} < 0. \tag{2}$$

However, this relationship is not found when studying the data. Instead, as Fig. 1 shows for the Luxembourgish banking sector from 2003 Q1–2010 Q1, increasing asset values are highly correlated with increasing leverage. As a consequence, leverage is procyclical.

We now compare this result to the findings in Adrian and Shin (2010). These authors find that US commercial banks target a constant leverage, while US investment banks seem to have a procyclical relationship between asset growth and leverage growth. Overall we observe that banks in Luxembourg, in common with US investment banks, have a procyclical leverage. In contrast, the balance sheet structure of Luxembourg's banks is more in line with that of US commercial banks, since Luxembourg's banks hold on average 75 % of their assets in form of credits and 85 % of their liabilities

**Table 1** Balance sheet structures of procyclical and acyclical banks

| Bank type | N | Sample medians (variables are shares of total assets) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Equity | Credits | Securities | Dep. | Dep. (MFI) | Credits (MFI) | Dep. (overn.) | Dep. (mat.) |
| Procyclical | 114 | 24.86 | 0.89 | 0.07 | 0.89 | 0.25 | 0.63 | 0.20 | 0.49 |
| Acyclical | 20 | 21.31 | 0.85 | 0.11 | 0.84 | 0.36 | 0.44 | 0.13 | 0.55 |
| KS test (*p*-value) | | 0.000 | 0.018 | 0.003 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

*Explanation* The KS test is the Kolmogorov–Smirnov test. It is a two-sample, non-parametric analysis comparing the distributions of both the procyclical and acyclical banks. H0 is that both distributions are equal.

in form of deposits. However, it would be surprising if different banking models do not induce asymmetric leverage behaviour in Luxembourg, as it is the case in the US. Unfortunately, the distinction between commercial banks and investment banks does not exist in Luxembourg. Our approach for comparison is as follows. We split our sample of banks into procyclical and acyclical banks. Procyclical are those that have a significant correlation between the growth in leverage and the growth in assets, where we define a correlation to be significant if the correlation coefficient is higher than .65 with a *p*-value below 0.05. Acyclical banks are all others. Figure 2 provides an example of a procyclical and an acyclical bank. As one can see, the acyclical bank has no significant relationship between leverage growth and asset growth, while the procyclical bank has a highly significant and positive relationship between both variables. We then compare the balance sheet structures of both samples, as shown in Table 1. Our main finding is that procyclical banks have a higher share of credits on their balance sheet, and they give a larger share of their credits to MFIs. Since credits to MFIs tend to be short-term credits, this is a likely explanation for those banks having a more procyclical balance sheet. In addition, procyclical banks have a larger share of their liabilities in the form of deposits, where furthermore they also have a larger share in overnight deposits. Acyclical banks, in comparison, have more deposits with maturity, which tend to be less affected by short-term business cycle fluctuations. Finally, acyclical banks are those that invest more in securities, with the bulk of the securities coming from government debt or debt from MFIs. These securities tend to be held for long-term investments or to safe-guard against liquidity shocks, which also makes our sample of acyclical banks less prone to unforeseen events.

A further explanation to substantiate the qualitative difference between US banks and Luxembourgish banks is that most banks in Luxembourg are either branches or subsidiaries and tend to function as liquidity providers to their mother company or group. Thus, if the liquidity needs of their mother companies or groups are procyclical, then the demand for credits from Luxembourg will be procyclical, too. Additionally, a reason why Luxembourg's banks may not target a constant leverage ratio could simply be that they do not need to. As they mostly belong to groups or have a mother company, then the market may not attach a risk premium to leverage in Luxembourg since default is unlikely for a bank that can easily be supplied with equity from its mother company. This, for example, is also supported by the fact that banks in Luxembourg

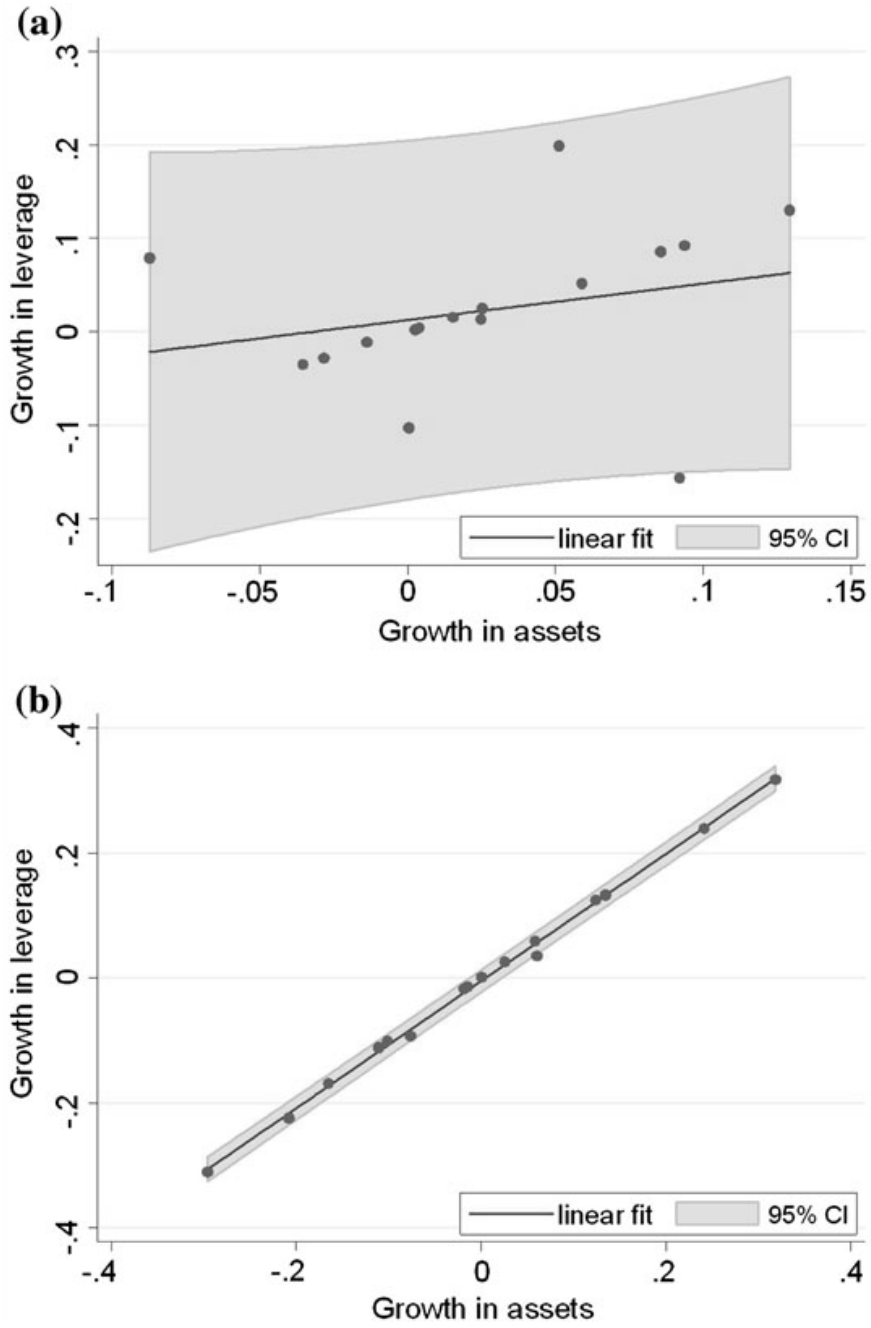


**Fig. 2** *Explanation* The confidence interval is for an individual forecast, which includes both the uncertainty of the mean prediction and the residual. (**a**) Acyclical bank, (**b**) Procyclical bank

tend to be among the most highly leveraged banks in Europe. In the econometric analysis we, however, show that there is a further explanation for the leverage decision of Luxembourg's banks.

## 2.3 The driving factors

As Fig. 3 shows, leverage in Luxembourg was procyclical during the boom of 2003 Q1–2008 Q1, increased sharply at the beginning of the financial turbulences in 2007 Q3, and then decreased to an all time low with the materialisation of the financial crisis

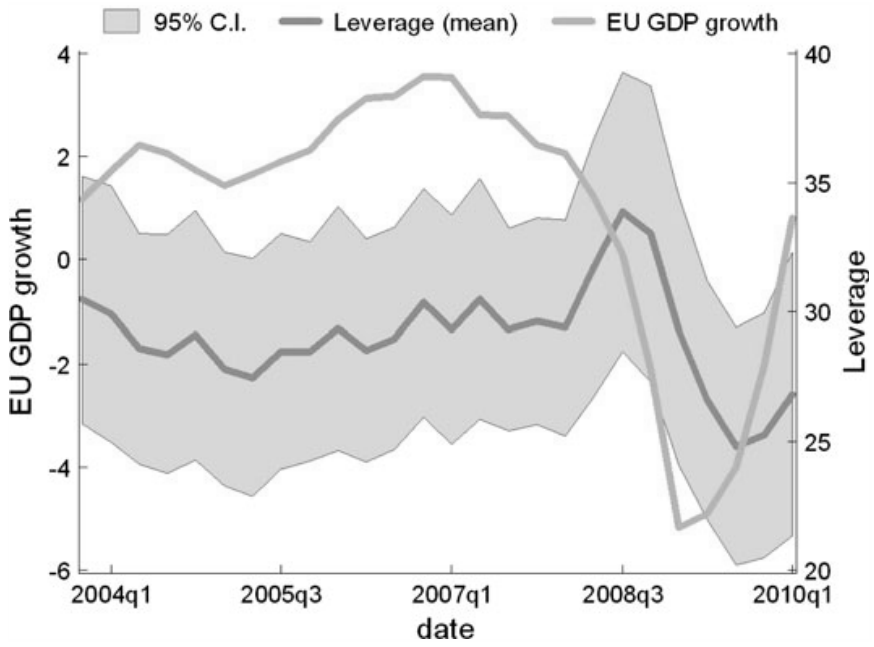


**Fig. 3** Evolution of leverage in Luxembourg, 2003 Q2–2010 Q1

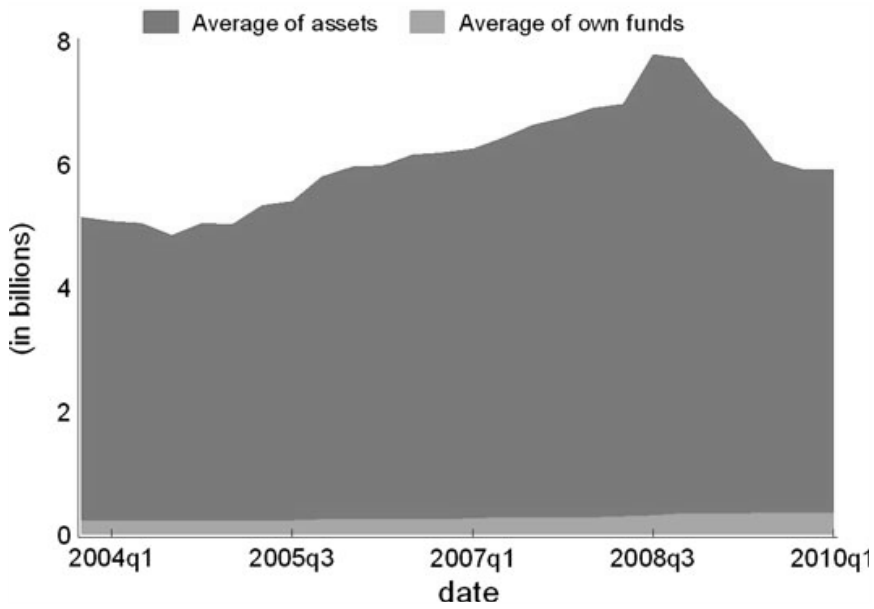


**Fig. 4** Evolution of assets and own funds

in 2008 Q3. Therefore, leverage followed closely the recent evolution in the financial markets and economic boom-bust cycle. Figure 4 demonstrates that this evolution is clearly due to a reduction in total assets after the Lehman bankruptcy, while own funds continued to grow at approximately the same rate as before the crisis. Hence, leverage is procyclical since Luxembourg's banks increased their assets faster than their own funds, leading to an increase in leverage.

Taking a closer look at the main components of assets, Fig. 5 shows that the major driver of the reduction in total assets was total credits. A somewhat more disaggregated look at credits allows us to conclude that credits to 'monetary financial institutions'

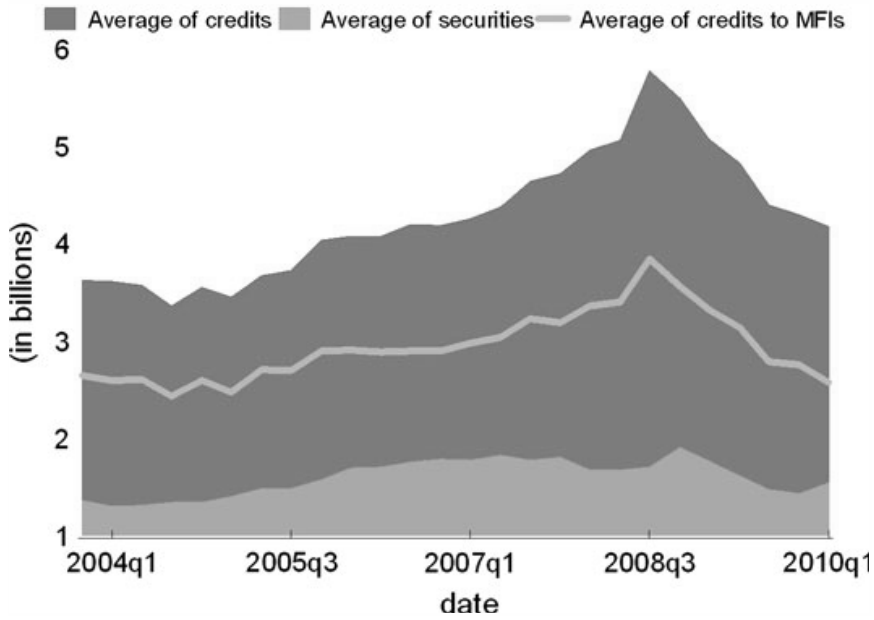


**Fig. 5** Evolution of credits and securities

(MFIs) were the main source underlying the decline in total credits. The fact that mainly credits drive assets is supported through the observation that banks' portfolios in Luxembourg are, on average, to 75 % composed of credits and to 15 % of securities. Thus, changes in assets are likely to be mainly driven by changes in credits. However, the Pearson correlation between the growth of securities and the growth of assets is 12 % ($p < 0.01$), suggesting that both are at least not moving independently. The securities portfolio of banks in Luxembourg consists, on average, to 90 % of bonds and to 10 % of shares, with 45 % of all securities coming from credit institutions and 26 % are government securities.

As Fig. 4 shows, the increase in own funds in the pre-crisis period cannot solely account for the growth in assets. Thus, the increase in assets must have come through attracting other liabilities. Similarly, since banks in Luxembourg reduced their assets from 2008 Q3 onwards while they continued to increase their own funds, then this implies that they adjusted their balance sheets by changing other liabilities. Banks in Luxembourg did this especially through shedding deposits. Figure 6 confirms this. Indeed, we observe a highly significant ($p < 0.01$) and positive correlation (82 %) between asset growth and deposit growth. Thus, deposits are the main variable of adjustment to match the asset and liability sides of banks' balance sheets in Luxembourg.

The effect of this on leverage is easily determined. Assume that deposits increase by $d > 0$, leading to an equal expansion of the loan portfolio. Then the new level of leverage changes to

$$L = \frac{A + d}{A + d - D - d} = \frac{A + d}{A - D}. \tag{3}$$

Deposits make up on average 85 % of liabilities (excluding own funds) for banks in Luxembourg. Hence, adjustments in leverage for Luxembourg's banks are largely

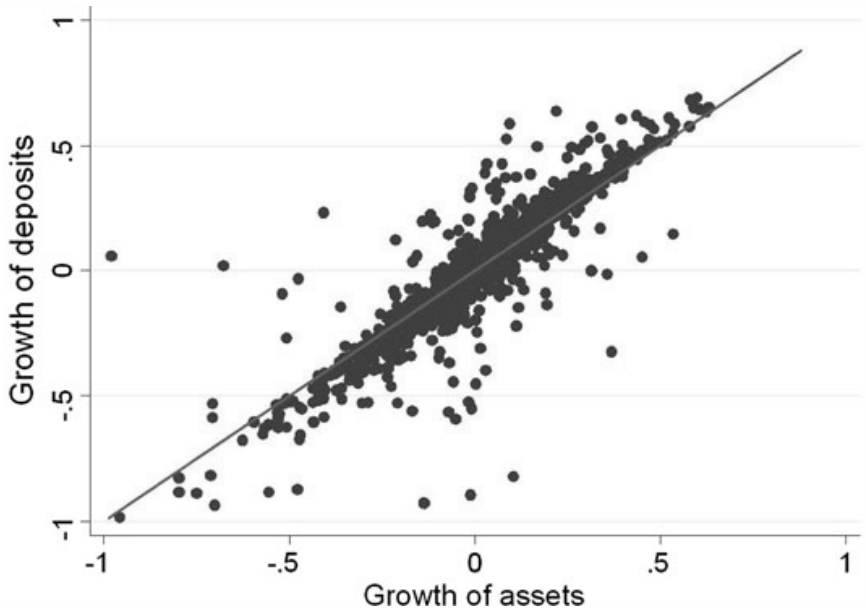


**Fig. 6** Deposits growth versus assets growth

driven by changes in deposits. For banks in Luxembourg, overnight deposits and deposits with maturity make up, respectively, approximately 35 and 57 % of total deposits[2]. In addition, deposits with maturity from monetary and financial institutions (MFIs) make up 20 % of total deposits.

A further disaggregation allows us to conclude that changes in overnight deposits and deposits with maturity are those that are strongly linked to changes in assets, while, on average, redeemable deposits and repo deposits[3] may be associated with constant assets. This last result (with respect to repo deposits) confirms Adrian and Shin (2010)'s view that repo deposits tend to be used to keep the asset side of the balance sheet constant.

## 3 Econometric analysis

### 3.1 An overview of the data

The previous section provided the foundation for our empirical study. We now present some further information on the data and the empirical approach.

#### *3.1.1 The bank-specific variables*

As bank-specific variables we include the loans-to-deposits ratio, the liquid-assets-to-assets ratio and the off-balance-to-assets ratio. The loans-to-deposits ratio is a simple

[2] Other deposit types are those that are redeemable at notice and repo deposits.

[3] However, the mean per cent of Repos in Luxembourg's banks never exceeds 2 % of total assets, while the median is always zero. Thus, most banks in Luxembourg do not rely on Repos, and the others hold unsubstantial amounts.

proxy to measure a bank's maturity mismatch. Loans tend to have a longer maturity than deposits, and increases in this ratio would indicate that a bank funds itself by issuing either more equity or debt. We expect a higher ratio to lead to stronger adjustments in leverage since most banks in Luxembourg are debt financed. The liquid-assets-to-assets ratio (with liquid assets including cash, securities and quoted shares) measures the per cent of assets that can easily be converted into cash and thus reflects the ease with which a bank can respond to unforeseen events. Banks with a low liquid assets ratio should be less able to constrain their leverage changes during a crisis than those that hold significant liquid assets. This can be shown as follows. Assume that there is a run-off of deposits of amount $x > 0$. A bank with a large number of liquid assets can compensate this run-off by selling high quality securities at a marginal haircut. Thus, their leverage changes according to $dL/dx = -1/(A - D)$. Assume now the case of a bank with few liquid assets that, when faced with a deposit run-off, needs to sell assets. This bank will only be able to sell assets at a non-negligible haircut, which we denote by a multiplicative factor $\beta > 1$. In this case, the bank will face a larger change in leverage, which will be given by $dL/dx = -\beta/(A - D)$.

Finally, the off-balance-to-assets ratio (where off-balance items include committed credits, guarantees and liquidity facilities) allows us to assess a bank's commitment to contingent credits. The higher this commitment the more liquidity banks would need in case that these committed credits or guarantees get exercised. This would, for example, be more likely in a crisis. The way banks fund these commitments then depends on the costs of raising funds relative to having to sell assets.

### *3.1.2 The macroeconomic indicators*

The list of macroeconomic variables includes a European bond index, the Euribor-OIS spread, an economic sentiment indicator and European GDP growth.

The bond index is the Bank of America Merrill Lynch 10+ Year Euro Financial Index. It consists of EURO denominated investment grade debt from financial institutions in the Eurobond or Euro member domestic markets. The index is based on the clean prices of the financial institutions' debt and, thus, changes in the index tend to be mostly due to changes in economic fundamentals, for example if there is a change in interest rates or if the credit quality of the bond's issuer changes. Hence, this index represents fundamentals more than expectations. In Luxembourg, a bond index is a potentially useful proxy of the relative return of securities on a bank's balance sheet since approximately 90 % of the securities are held in form of bonds, and around 50 % of these are bonds from credit institutions. The bond index is, therefore, a proxy for the return on the banks' securities portfolios.

The Euribor-OIS spread is derived as the difference between the 3-month Euro interbank offered rate (Euribor 3-month) and the OverNight Index Average (Eonia) rate. The Euribor 3-month rate is an average interest rate at which a selected sample of banks obtains 3-month unsecured funds in the European interbank market, while the Eonia rate is an average interest rate at which the same sample of banks obtains overnight unsecured funding on the European interbank market. The difference in

these two rates then reflects various risks that may arise during a 3-month period, which may prevent a bank from obtaining the funding that it needs to keep the current portfolio. Those risks should mainly reflect the market's assessment as well as the banks' subjective evaluations of others' default risk and it's own liquidity risk. During the financial crisis of 2007–2009 the spread should have mainly captured liquidity risk. Liquidity risk is the risk of losing one's liabilities and thereby not being able to sustain the same amount of assets on the balance sheet. It thus affects more strongly those banks that are leveraged and have a large maturity mismatch. The higher the market's expectation that banks run into liquidity problems the higher will be the risk premium that lenders on the interbank market will demand from borrowers. Also, as liquidity providers became unsure about their own liquidity needs during the crisis, they stopped lending out of a pure precautionary motive. Hence, demand for liquidity exceeded supply and this increased the Euribor-OIS spread. In this case, the Euribor-OIS spread should affect leverage for banks in Luxembourg positively since they often function as liquidity providers for their head institutions.

The economic sentiment indicator provides us with an assessment of the forward-looking expectations. We calculate this as the average of the Economic Sentiment Indicators from Belgium, Germany, France and Luxembourg. In terms of economic activity, these are the important trading partners for Luxembourg's banks. As suggested in the theoretical literature, higher expectations should induce increases in leverage through lower risk aversion and increases in expected collateral values (Bernanke and Gertler 1989; Kiyotaki and Moore 1997).

The European GDP growth allows us to control for the activity in the real sector. It is well-known that the banking sector in Luxembourg has a strong international orientation with a main emphasis on intra-group activities. Deposits from MFIs make up on average 42 % of all deposits, while credits to MFIs average 72 % of all credits. One would then expect credit demand and deposit supply to be strongly related to the general economic situation of those countries with which Luxembourg's banks hold strong economic ties. Since banks in Luxembourg are mainly active in Europe, we use European GDP growth to capture changes in deposit supply and credit demand in Luxembourg's banks.

### *3.1.3 The crisis period*

One of our objectives is to understand whether there is a differentiated impact of our variables of interest on leverage before and during the crisis. For this we study two sub-periods defined by the pre-crisis period, ranging from 2003 Q1 to 2007 Q3, and the crisis period, ranging from 2007 Q4 to 2010 Q1. Thus, we define a dummy variable called $C$, which is equal to one for the period 2007 Q4–2010 Q1 and zero otherwise, which should be able to capture crisis-specific behaviors. We note that the date 2007 Q4 coincides with the beginning of the turbulences in the real sector, where confidence, industrial production, GDP and the stock index started to decline.

An additional point is that we control for whether a bank is a branch or not. An important number of banks in Luxembourg are branches and they have a mother institution that mostly comes from the European banking sector. We control for this by

introducing a dummy that we label $B_i$ and which takes the value of one if the bank is a branch and zero otherwise.

The tables with the empirical results are relegated to the Appendix. Table 2 presents the description of the variables used in the empirical part, and Table 3 presents the summary statistics.

The basic econometric model is as follows.

$$g(LEV_{it}) = \alpha_1 + \alpha_2 g(LEV_{it-1}) + X_{it-1} \times \beta_1 + Y_t \times \beta_2 + C_t + Y_t \times C_t \times \beta_3 + X_{it-1} \times C_t \times \beta_4 + B_i + v_i + d_t + \epsilon_{it}, \quad (4)$$

where we explain the growth in leverage $g(LEV_{it})$ by the lagged growth in leverage (to account for a possible convergence in leverage), by a vector of variables $X_{it}$ that we use to model bank-specific behavior, by a vector of variables $Y_{it}$ that describes the macroeconomic condition and by unobserved fixed effects $v_i$ as well as seasonal dummies $d_t$. With these variables we, therefore, cover bank-specific conditions, the real sector, the financial sector, forward-looking expectations and also control for the crisis period.

We expect the lagged dependent variable to be correlated with the fixed effects and thus resort to the system GMM estimator (sysGMM) proposed in Arellano and Bover (1995) and Blundell and Bond (1998). This estimator is particularly well-suited to cope with a dataset that consists of a large panel but has a small time dimension, where unobservable fixed effects might correlate with endogenous regressors and finally this estimator also controls for heteroscedasticity and autocorrelation within the panels. Not controlling for these factors would lead to a bias in our estimations as there is reason to believe that each of these criteria shows up in our regressions. Theory predicts (Nickell 1981) that a significant correlation between unobservable fixed effects and a lagged dependent variable induces an upward bias in the coefficient of the lagged dependent variable if one estimates based on an OLS regression, while it leads to a downwards bias if one resorts to the within estimator (FE). An estimator that reduces this so-called Nickell bias should have a coefficient on the lagged dependent variable that is between that obtained for the OLS and the FE regression. We, therefore, present our results based on the sysGMM estimator in comparison to the OLS and the FE results. Finally, as the cross-correlations of the variables in Tables 4 and 5 show, some of these variables have a non-negligible correlation. The sysGMM estimator is suited for this case as well, since it can take care of correlated independent variables.

In addition, we provide several specification tests that need to hold if one uses the sysGMM estimator. These tests require that there is no first-order autocorrelation in the errors but we should find a significant second-order autocorrelation. We present the $p$-values of these tests as *AR(1) p-val.* and *AR(2) p-val.*, respectively. Convergence of the estimator requires that the absolute value of the coefficient on the lagged dependent variable is less than one. Finally, we have to analyze whether our instruments are valid. We resort to the Hansen test to assess the over-identification restriction. The $p$-value of the Hansen test should reject the endogeneity of instruments at a sufficiently high level.

## 3.2 The results

We now present the results from our econometric estimation based on models including the bank-specific variables and the macroeconomic conditions. We give the OLS and the FE results followed by the sysGMM estimator, on which we base our analysis. We provide the results for the sysGMM estimator for the growth in leverage and then compare these results to those for the growth in loans, deposits and securities, as we observed that these three variables are those that determine most of the changes in leverage in Luxembourg. We present the actual values of the marginal effects in brackets with the stars representing the significance levels.

For the case of leverage, loans and deposits, our interpretation of the results relies on our preferred estimator, the sysGMM. However, we show in Table 6 that we do not need to run the sysGMM estimator for the case of securities, since the lagged dependent variable shows up insignificantly. Thus, in that case we use the Hausman and Taylor estimator, which allows us to capture the role of branches. Finally, for all regressions the marginal effects during the crisis are presented in Table 8.

### *3.2.1 Bank-specific variables*

Table 7 presents our empirical results and shows the relationship between leverage and bank-specific variables. We find that leverage in Luxembourg is mean reverting ($-0.134^{***}$), with higher growth in leverage today leading to a lower growth in leverage tomorrow. This result is common to the literature (see e.g. Adrian and Shin 2010). A one percentage increase in the growth rate of leverage today reduces the growth of leverage tomorrow by approximately 0.134 %. The coefficient of the lagged-dependent variable lies within the range of the OLS ($-0.131^{***}$) and FE ($-0.175^{***}$) coefficient, suggesting that the sysGMM estimator improves upon the Nickell bias.

With respect to the bank-specific variables we find that the off-balance sheet exposure provides the most significant impacts on leverage and its components. It has statistically significantly ($P > \chi^2 = 0.000$) different effects in the pre-crisis and crisis period and also across the components of leverage. With respect to the pre-crisis period, we find the following. Leverage growth is significantly negatively affected by the off-balance sheet exposure ($-0.0109^{***}$), with both the growth in credits ($-0.0092^{*}$) and the growth in deposits ($-0.0153^{**}$) affected in a similar way. Intuitively, banks that committed to a large number of credits or guarantees know that their future balance sheets will be constrained by their contingent commitments and, as a consequence, it will not be prudent to expand their balance sheets.

During a crisis, however, another argument applies. Banks with a large share of off-balance sheet commitments tend to have a larger growth of leverage during a crisis ($0.0935^{***}$), the coefficient being significantly different from the one in the pre-crisis period. The growth in credits and deposits is affected to a similar extent ($0.0983^{*}$ and $0.08^{**}$, respectively). This is the case since banks with large amounts of committed credits need to stick to their commitments and can, therefore, not reduce their credits like banks with fewer committed credits. Therefore, they need to keep attracting more liabilities, have less flexibility in shrinking their balance sheets and consequently have a larger leverage growth compared to those banks that do not commit to so many

credits or give many guarantees. The off-balance commitments also affect the growth of securities during a crisis (0.084***). Since we included liquidity facilities as part of off-balance exposure, then this means that we also account for commitments in the form of negotiable debt securities, Note Issuance Facilities or Revolving Underwriting Facilities. For example, it is reasonable to assert that some borrowers are not able to sell their notes in crisis times. In that case the bank that committed to buying these securities needs to step in, which increases both its holdings of securities and its leverage in comparison to those banks that did not commit to those facilities.

The share of liquid assets to total assets seems to play only a role for the growth of securities (−0.221***). Here, banks that have substantial amounts of liquid assets tend to have a lower growth of securities, an effect which is further enhanced through a crisis (−0.348***). Intuitively, banks that already have a large share of liquid assets on their balance sheets do not need to increase their securities by as much as those banks that hold lower shares of liquid assets, since they are already well-structured to cope with uncertain events. Hence, they can have a lower growth rate of securities and expand their balance sheets along different lines. Furthermore, in a crisis period, with tumbling security prices, a larger share of the balance sheet of those banks will be subject to losses from marking-to-market. Also, these banks may want to minimize losses by decreasing their holdings of securities by more than banks with fewer liquid assets. On the liability side these banks match the decrease in securities by reducing their growth in deposits (−0.183*). It is, thus, those banks with many liquid assets that are facing the largest costs from marking-to-market, and consequently those that are the driving forces when it comes to inducing the second-round fire sales and loss spiral effects.

Further findings indicate that the loans-to-deposits ratio tends to have an effect on leverage that is not significantly different from zero (0.0123). Thus, assuming that the loans-to-deposits ratio is a useful measure of a bank's maturity mismatch, we find that banks' leverage decisions do not seem to be influenced by this variable. We find a weak impact on the growth of securities (−0.0551*) in the pre-crisis period and an impact on the growth of deposits during a crisis (−.0839**), suggesting that banks with a maturity mismatch have a smaller growth in securities (as they tend to hold more credits) and reduce their deposit holdings more during a crisis than other banks. Since we do not obtain a statistically significant impact on other balance sheet variables during the crisis, we expect that banks increase their equity when they reduce their deposits in case their maturity mismatch is large.

Our last findings on bank-specific variables indicate that branches do not have significantly different leverage dynamics from subsidiaries or other types of banks (0.00352). This may reflect the fact that our bank-specific variables are able to sufficiently capture potential differences between branches and other bank types, or it could mean that branches simply do not act in a different way to other banks in Luxembourg.

### *3.2.2 Macroeconomic indicators*

We now turn to the effects of the macroeconomic variables as shown in Table 7, with the marginal effects in the crisis period calculated in Table 8. In order to obtain an idea of the marginal effects of the macroeconomic variables, we study the combined

impacts of the Economic Sentiment Indicator (ESI), European GDP growth (g(EU GDP)), a bond index (bond) and the Euribor-OIS spread (spread).[4]

The results of the full model reveal that the key variable explaining the build-up of leverage before the crisis is the Euribor-OIS spread (0.0849**), as well as the bond prices. A one percentage point increase in the Euribor–Eonia spread increases the growth of leverage by 0.085 per cent. We find that both loans and deposits increase if the Euribor–Eonia spread increases (0.0648* and 0.0973**, respectively). As suggested above, this reflects, to some extent, that a non-negligible amount of banks in Luxembourg are branches or subsidiaries and in times of liquidity needs may step in to provide the requested funds for their mother companies or groups. Figure 7 helps us to complete this picture. For the period of investigation we plot the evolution of average credits on a Luxembourgish bank's balance sheet and the Euribor–Eonia spread. As the spread is a measure of the risk premia that banks attach to providing funds on the interbank market, then during the financial crisis 2007-2009 it mainly reflects liquidity risk. As we can see, credits are strongly correlated with this spread, indicating that in times of liquidity constraints, mother companies or groups increase their credit demands to their branches or subsidiaries in Luxembourg. This may be the crucial explanation for the build-up of credits in the pre-crisis period. We also consistently find that branches do not act differently to subsidiaries or other bank types (0.00352). Conclusively, whether banks are branches or subject to another type of ownership should not drive our results. The view on the build-up of credits can be further substantiated by the finding that both expectations (2.88e-06) as well as EU GDP growth (−0.0046) turn out to be insignificant drivers of the pre-crisis build-up in leverage. In contrast, we find that the strongest relationship between sentiment and leverage can be found during the crisis (0.00428*), where a decrease in sentiment is associated with a decrease in leverage. Thus, banks reduce debt (mostly in form of deposits) and shed assets when sentiment diminishes. We obtain the result that sentiment is a statistically significant driver of the deleveraging process in Luxembourg, while we do not find it to be a significant driver in the pre-crisis period. We, furthermore, obtain that the reduction in ESI during the crisis induced banks to reduce their deposits (0.0039***) and their credits (0.0053***). This also lowered their leverage (0.0042***).

As bonds make up, on average, 90 % of total securities on Luxembourgish banks' balance sheets, we expect that changes in bond prices induce banks to subsequently adjust their balance sheets, too. Our statistical results suggest that there are different incentives at work in the pre-crisis and crisis period. In the pre-crisis period, increasing bond prices induce banks to attract more deposits (0.00289***) in order to obtain more securities (0.00382***). However, during the crisis, we find that higher bond prices reduce deposits (−0.0035***), with subsequent adjustments to credits (−0.005***) and a deleveraging (0.004***). The intuition for this result rests on two observations. First, depositors may want to shift their funds out of bank deposits and into bonds, whose relative price improved and that are potentially safer. Second, it may be cheaper for banks not to roll over credits than to sell e.g. securities in order to meet the deposit

[4] We performed several robustness exercises. First, we studied the bank-specific variables alone but found no significant difference to the full model. Second, we ran constrained models by dropping insignificant variables. Again, there were no qualitative and few small quantitative differences.

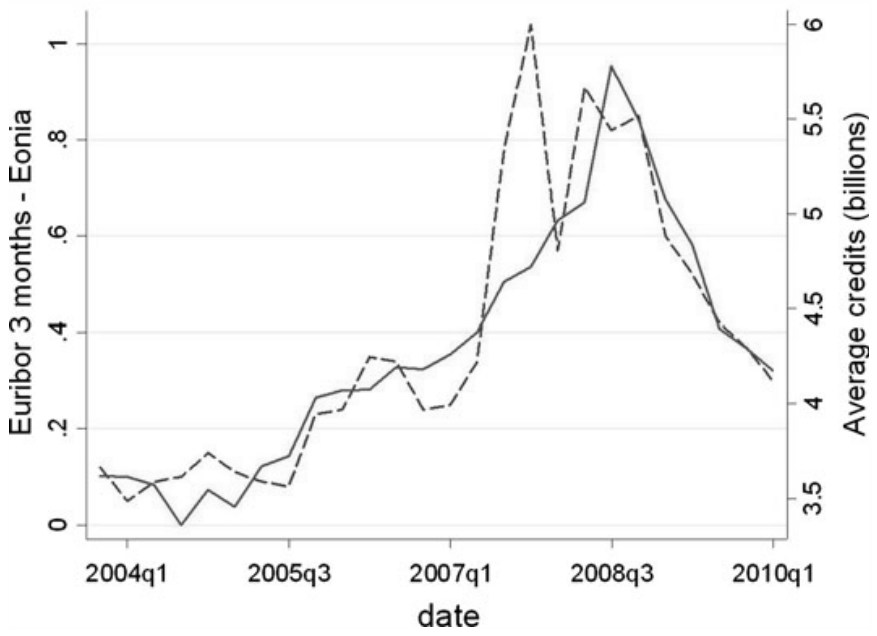


**Fig. 7** Credits and Euribor–Eonia spread. *Explanation* the *dashed line* depicts the Euribor–Eonia spread, while the *solid line* depicts the average amount of credits (in billions)

run-off. Additionally, banks may want to hold on to securities, which are viewed as relatively safe investments, and shed credits, whose riskiness increased during the crisis.

Finally, we find that the marginal effect of the crisis variable at the sample mean shows up as statistically significant for the growth in leverage ($-0.0746^{***}$), credits ($-0.0527^{**}$) and deposits ($-0.0433^{*}$) but not securities (0.0361), with the expected signs. Thus, ceteris paribus, during the crisis, banks entered a deleveraging process through shedding credits and deposits. Clearly, the reason for this is that during a crisis precautionary motives lead banks to keep holding larger amounts of securities since they represent relatively safe stores of value. A further explanation is that banks might have not been able to roll over the same amount of deposits due to liquidity problems of the lenders and default risks of borrowers.

We undertook several robustness exercises with different leverage measures. For example, one might want to use a broader measure of a bank's own funds, for example equity instead of only Tier 1 capital. However, a correlation between Tier 1 capital and total equity for banks in Luxembourg gives a correlation coefficient of 0.966. As a consequence, we would essentially expect the same results between Tier 1 leverage and total equity leverage. In contrast, other measures of leverage, like the ratio of total assets to total liabilities, should provide the same results as those above, since this would essentially only imply a re-definition of the leverage ratio. It is mathematically not too difficult to show that the coefficients from a regression using a liability-type measure of leverage should be the same after the right transformations. Instead, we would expect that differences in results are likely to show up between book-valued and risk-adjusted measures of leverage. For example, if one expects some kind of moral hazard in the risk-adjustment of banks, then the risk-adjusted assets should respond more strongly during the crisis than the book-valued ones. However, a robustness

analysis using the risk-weighted leverage ratio[5] shows that our results stay essentially the same. The only difference is that the coefficient on ESI for the sysGMM estimator for the risk-adjusted leverage is negative but insignificant, while it was positive and highly significant for leverage. We believe that this difference arises since the risk-weighting of assets might lead to a more conservative valuation of assets, while marking-to-market fully reflects investors' expectations and, as a consequence, might lead to a more volatile valuation in times of bubbles and crises. However, this argument is mostly speculative and would require a deeper analysis.

## 4 Conclusion

In this article we studied the determinants of the leverage cycle for the Luxembourgish banking system. Our purpose in this article was to explore the role of bank-specific variables as well as real, financial and expectation variables for the leverage cycle in Luxembourg. Focusing on two sub-periods, the pre-crisis period 2003 Q1 - 2007 Q3 and the crisis period of 2007 Q4 - 2010 Q1, we find that banks react according to different incentives during economic expansions and contractions.

We have shown that leverage is inherently procyclical, which is a consequence of an active management of balance sheets, with banks borrowing more during boom times to increase their assets and reducing their assets while shedding liabilities during bust times. We, furthermore, found that banks mainly change their assets by adjusting their credits and predominantly adjust their liabilities by attracting deposits. This observation stands in contrast to US commercial banks that target a constant leverage, while US investment banks have a strongly procyclical one (Adrian and Shin 2010). Since the distinction between commercial and investment banks does not exist in Luxembourg, we classified banks according to whether their leverage behavior is procyclical or acyclical and studied their balance sheet structures. We found that procyclical banks tend to hold a higher share of credits on their balance sheet, and also attract more overnight deposits from MFIs. In constrast, acyclical banks hold a larger share of government or banking sector debt on their asset side, and finance themselves with a higher share of deposits with maturity. As a consequence, acyclical banks are less prone to sudden market shocks, face lower liquidity risks and follow the financial cycle to a lesser extend.

There are additional three reasons for the procyclicality of Luxembourgish banks' balance sheets. One, most banks in Luxembourg are either branches or subsidiaries, thus they are expected to be protected by their mother companies, which is confirmed by the fact that the Luxembourgish banking sector has one of the highest levels of leverage in Europe. This leads to little leverage targeting and the standard arguments for constraining leverage, namely ratings and probability of default, are reduced in importance. Two, the procyclicality of leverage comes about since increases in the Euribor-OIS spread makes funding on the European interbank market more costly, wherefore mother companies or groups turn to their Luxembourgish branches or subsidiaries

[5] The risk-weighted asset data are only available from 2008 Q1 onwards for a subset of banks, and from 2008 Q4 for the full sample. Hence, our robustness exercise is only valid for the crisis period.

for further credits. Finally, increasing securities prices make holding securities more attractive, and we find that banks increase their holdings of securities, financed via attracting more deposits, which induces an increase in leverage.

Further results are related to the balance sheet structure of banks. We find that the larger is the share of liquid assets on a bank's balance sheet the smaller is the growth of securities. Securities tend to be held for being able to obtain liquidity in uncertain times. Thus, banks that hold higher shares of liquid assets do not need to level up their balance sheet with securities since those banks are already well-adapted to cope with uncertain events. In a crisis period, when security prices decrease, those banks will minimize losses and sell securities, which affects their portfolio by more than those banks that hold securities solely for liquidity reasons.

Finally, we found that the off-balance sheet exposures play a crucial role for leverage. The off-balance sheet activities (they include committed credits, guarantees and liquidity facilities) constrain the growth of leverage in the pre-crisis period, while they increase leverage growth during the crisis. Banks with large committed credits or guarantees would tend to constrain the expansion of their loan portfolio since they already committed to a significant amount of credits. Furthermore, large off-balance sheet exposures imply that during a crisis the committed credits or guarantees are exercised, inducing a larger growth in leverage than if the banks had fewer commitments.

As an additional remark, this result links directly to the new Basel III capital regulations. Since these introduce an off-balance sheet augmented leverage ratio we can, on the one hand, expect a lower absolute exposure to off-balance sheets simply due to the regulation itself. On the other, we might also see a more important deleveraging process as the counter-cyclicality induced through the diminished off-balance exposure is reduced.

However, Basel III intends to reduce maturity mismatches and thereby limits the likelihood of forced deleveraging. For example, the increases in credit have, up to now, come through increasing short-term deposits. This increase in short-term deposits will be penalized through Basel III and banks will need to seek greater internal funding.

As a final point, the Luxembourgish banking sector may benefit from Basel III not only through an increased resilience but also through its functioning as a liquidity provider. For example, since the interbank market gets penalized by Basel III but these regulations are to be calculated at the consolidated level, then this could increase the demand for credits from branches in Luxembourg.

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## 5 Appendix

See the Appendix Tables 2, 3, 4, 5, 6, 7 and 8

**Table 2** Variable definitions

| Variable | Definition |
|---|---|
| $g(LEV_{it})$ | Growth in leverage (leverage is assets/own funds) of bank i at time t (source: own calculations, statistical tables of BCL) |
| $g(L_{it})$ | Growth in loans of bank i at time t (source: own calculations, statistical tables of BCL) |
| $g(D_{it})$ | Growth in deposits of bank i at time t (source: own calculations, statistical tables of BCL) |
| $g(S_{it})$ | Growth in securities (debt securities and shares) of bank i at time t (source: own calculations, statistical tables of BCL) |
| $Spread_t$ | Spread between Euribor 3 month and Eonia (source: ECB statistical warehouse) |
| $ESI_t$ | Economic Sentiment Indicator, calculated as average of Belgium, France, Germany and Luxembourg (source: European Commission, Business and Consumer Confidence Surveys) |
| $Bond_t$ | Bank of America Merrill Lynch 10+ Year Euro Financial Index (source: Bloomberg) |
| $g(EU\ GDP_t)$ | Growth of EU GDP (source: ECB statistical warehouse, seasonally adjusted) |
| $\log(L_{it}/D_{it})$ | Logarithm of the loans-to-deposits ratio (source: own calculations, statistical tables of BCL) |
| $Liq_{it}/A_{it}$ | Ratio of liquid assets to assets. Liquid assets include cash, securities and quoted shares. (source: own calculations, statistical tables of BCL) |
| $OB_{it}/A_{it}$ | Ratio of off-balance sheet items to assets. The off-balance sheet items include committed credits, guarantees and liquidity facilities (like NIF's, RUF's) (source: own calculations, statistical tables of BCL) |
| $C_t$ | Crisis dummy = 1 for 2007 Q4–2010 Q1 |
| $B_i$ | Dummy = 1 if the bank is a branch (source: own calculations) |

**Table 3** Summary statistics

| Variable | Obs. | Mean | SD | Minimum | Maximum |
|---|---|---|---|---|---|
| g(LEV) | 3,152 | −0.011 | 0.18 | −0.988 | 0.689 |
| g(L) | 3,152 | 0.004 | 0.189 | −0.954 | 0.665 |
| g(D) | 3,152 | 0.004 | 0.179 | −0.986 | 0.689 |
| g(S) | 2,586 | −0.012 | 0.21 | −1 | 0.994 |
| $\log(L_{it}/D_{it})$ | 3,152 | −0.035 | 0.553 | −2.719 | 5.67 |
| Liq/A | 3,152 | 0.167 | 0.214 | 0 | 0.921 |
| OB/A | 3,152 | 0.108 | 0.201 | 0 | 1.978 |
| Bond | 3152 | 121.86 | 11.24 | 96.38 | 138.08 |
| ESI | 3,152 | 98.5 | 11.1 | 69.1 | 115.7 |
| g(EU GDP) | 3,152 | 1.139 | 2.381 | −5.18 | 3.56 |
| Spread | 3,152 | 0.377 | 0.286 | 0.05 | 1.04 |
| B | 3,152 | 0.193 | 0.394 | 0 | 1 |
| C | 3,152 | 0.363 | 0.481 | 0 | 1 |

**Table 4** Cross-correlations of macroeconomic variables

| Variables | Bond | ESI | g(EU GDP) | Spread |
|---|---|---|---|---|
| Bond | 1.000 | | | |
| ESI | 0.635 | 1.000 | | |
| g(EU GDP) | 0.665 | 0.920 | 1.000 | |
| Spread | −0.753 | −0.276 | −0.278 | 1.000 |

**Table 5** Cross-correlations of bank-specific controls

| Variables | log(L(t−1)/D(t−1)) | Liq(t−1)/A(t−1) | OB/A | Branch | C |
|---|---|---|---|---|---|
| log(L(t -1)/D(t -1)) | 1.000 | | | | |
| Liq(t -1)/A(t -1) | −0.554 | 1.000 | | | |
| OB/A | −0.047 | −0.023 | 1.000 | | |
| B | −0.023 | −0.058 | 0.027 | 1.000 | |
| C | 0.033 | −0.050 | 0.012 | −0.039 | 1.000 |

**Table 6** Specification choice for securities

| Variables | (1)<br>g(S) | (2)<br>g(S) | (3)<br>g(S) | (4)<br>g(S) | (5)<br>g(S) |
|---|---|---|---|---|---|
| Model | OLS | FE | OLS | FE | HT |
| g(S(t−1)) | −0.000177 | −0.000147 | | | |
| | (0.000216) | (0.000218) | | | |
| log(L(t−1)/D(t−1)) | 0.00127 | −0.0433 | −0.000492 | −0.0502 | −0.0495 |
| | (0.0119) | (0.0315) | (0.0118) | (0.0311) | (0.0307) |
| Liq(t−1)/A(t−1) | 0.0651** | −0.233*** | 0.0653** | −0.240*** | −0.216*** |
| | (0.0282) | (0.0703) | (0.0280) | (0.0700) | (0.0688) |
| OB(t−1)/A(t−1) | −0.0259* | −0.00639 | −0.0240* | −0.00503 | −0.00370 |
| | (0.0138) | (0.0153) | (0.0137) | (0.0153) | (0.0152) |
| log(L(t−1)/D(t−1))*C | 0.00168 | 0.0225 | 0.00435 | 0.0253 | 0.0260 |
| | (0.0209) | (0.0232) | (0.0208) | (0.0231) | (0.0228) |
| Liq(t−1)/A(t−1)*C | −0.110** | −0.117** | −0.109** | −0.115** | −0.115** |
| | (0.0469) | (0.0503) | (0.0467) | (0.0501) | (0.0496) |
| OB/A *C | 0.0948*** | 0.0865*** | 0.0932*** | 0.0843*** | 0.0872*** |
| | (0.0287) | (0.0299) | (0.0286) | (0.0298) | (0.0295) |
| B | 0.0195 | | 0.0191 | | 0.0144 |
| | (0.0119) | | (0.0118) | | (0.0252) |
| C | 0.00859 | −0.00474 | 0.00812 | −0.00517 | −0.000902 |
| | (0.0120) | (0.0123) | (0.0119) | (0.0123) | (0.0121) |
| Constant | −0.0423*** | 0.0206 | −0.0432*** | 0.0210 | 0.00892 |
| | (0.0107) | (0.0157) | (0.0106) | (0.0157) | (0.0179) |
| Seas. dummies | Yes | Yes | Yes | Yes | Yes |
| Observations | 2,575 | 2,575 | 2,586 | 2,586 | 2,586 |
| R-squared | 0.014 | 0.024 | 0.014 | 0.025 | |

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

**Table 7** The full model

| Variables | (6) g(LEV) | (7) g(LEV) | (8) g(LEV) | (9) g(L) | (10) g(D) | (11) g(S) |
|---|---|---|---|---|---|---|
| Model | OLS | FE | sysGMM | sysGMM | sysGMM | HT |
| g(LEV(t−1)) | −0.131*** | −0.175*** | −0.134*** | | | |
| | (0.0181) | (0.0248) | (0.0280) | | | |
| g(L(t−1)) | | | | −0.150*** | | |
| | | | | (0.0351) | | |
| g(D(t−1)) | | | | | −0.122*** | |
| | | | | | (0.0269) | |
| log(L(t−1)/D(t−1)) | −0.0198** | −0.0247 | 0.0123 | 0.0309 | −0.00955 | −0.0551* |
| | (0.00951) | (0.0374) | (0.0466) | (0.0652) | (0.0443) | (0.0294) |
| Liq(t−1)/A(t−1) | −0.0374* | −0.0834 | 0.0843 | −0.0331 | 0.136 | −0.221*** |
| | (0.0225) | (0.0780) | (0.122) | (0.203) | (0.118) | (0.0685) |
| OB(t−1)/A(t−1) | −0.00443 | −0.000867 | −0.0109*** | −0.00922* | −0.0153** | −0.00143 |
| | (0.0114) | (0.00979) | (0.00418) | (0.00477) | (0.00608) | (0.0151) |
| log(L(t−1)/ D(t−1))*C | 0.0340** | 0.0385** | −0.0321 | −0.0719 | −0.0744 | 0.0237 |
| | (0.0138) | (0.0169) | (0.0482) | (0.0720) | (0.0661) | (0.0228) |
| Liq(t−1)/ A(t−1)*C | 0.0735** | 0.0753** | 0.00114 | −0.0538 | −0.319** | −0.127** |
| | (0.0369) | (0.0379) | (0.109) | (0.203) | (0.146) | (0.0517) |
| OB(t−1)/A(t−1)*C | 0.0499** | 0.0547*** | 0.104*** | 0.108** | 0.0952** | 0.0855*** |
| | (0.0218) | (0.0191) | (0.0207) | (0.0529) | (0.0376) | (0.0297) |
| B | −0.000221 | | 0.00352 | −0.000270 | −0.0134 | 0.0153 |
| | (0.00800) | | (0.0107) | (0.0109) | (0.0136) | (0.0257) |
| C | 0.0455 | −0.0176 | 0.185 | −0.0109 | 0.638** | 0.944** |
| | (0.315) | (0.284) | (0.326) | (0.379) | (0.321) | (0.396) |
| ESI | −0.00110 | −0.00119 | 2.88e-06 | −0.00115 | 0.00228 | 0.00521** |
| | (0.00187) | (0.00168) | (0.00194) | (0.00202) | (0.00180) | (0.00232) |
| ESI*C | 0.00501** | 0.00505** | 0.00428* | 0.00651*** | 0.00167 | −0.00758** |
| | (0.00235) | (0.00205) | (0.00228) | (0.00246) | (0.00216) | (0.00296) |
| g(EU GDP) | −6.67e-05 | −0.000741 | −0.00464 | 0.00331 | −0.00854 | −0.0218* |
| | (0.00915) | (0.00835) | (0.00936) | (0.00955) | (0.00893) | (0.0114) |
| g(EU GDP)*C | 0.00120 | 0.00181 | 0.00588 | 0.000309 | 0.0106 | 0.0240* |
| | (0.0106) | (0.0103) | (0.0114) | (0.0114) | (0.00975) | (0.0134) |
| Spread | 0.0995*** | 0.0938*** | 0.0849** | 0.0648* | 0.0973*** | −0.0252 |
| | (0.0323) | (0.0317) | (0.0332) | (0.0386) | (0.0321) | (0.0406) |
| Spread*C | −0.0541 | −0.0372 | −0.0378 | −0.0816 | −0.109** | 0.00715 |
| | (0.0480) | (0.0498) | (0.0569) | (0.0741) | (0.0550) | (0.0616) |
| Bond | 0.00147 | 0.00140* | 0.00168* | 0.000471 | 0.00289*** | 0.00382*** |
| | (0.00107) | (0.000838) | (0.000936) | (0.00103) | (0.00108) | (0.00133) |

**Table 7** Continued

| Variables | (6) g(LEV) | (7) g(LEV) | (8) g(LEV) | (9) g(L) | (10) g(D) | (11) g(S) |
|---|---|---|---|---|---|---|
| Bond*C | −0.00510*** | −0.00475*** | −0.00569*** | −0.00548*** | −0.00640*** | −0.00137 |
| | (0.00162) | (0.00163) | (0.00168) | (0.00181) | (0.00151) | (0.00206) |
| Constant | −0.0673 | −0.0373 | −0.216 | 0.0797 | −0.621** | −0.972*** |
| | (0.280) | (0.234) | (0.277) | (0.293) | (0.286) | (0.348) |
| Seas. dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 3,152 | 3,152 | 3,152 | 3,152 | 3,152 | 2,586 |
| R-squared | 0.055 | 0.069 | | | | |
| Number of bank | | 153 | 153 | 153 | 153 | 136 |
| No. of instruments | | | 48 | 31 | 100 | |
| AR(1) *p*-value | | | 0 | 0 | 0 | |
| AR(2) *p*-value | | | 0.985 | 0.697 | 0.389 | |
| Sargan *p*-value | | | 0.290 | 0.0120 | 3.14e-05 | |
| Hansen *p*-value | | | 0.166 | 0.321 | 0.545 | |

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

**Table 8** Marginal effects in crisis period

| Model | Dep. var. | Explanatory variables | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | log(L/D) | Liq/A | OB/A | Bond | ESI | g(EU GDP) | Spread |
| (8) | g(LEV) | −.0198 | .085 | .0935*** | −.004*** | .0042*** | .0012 | .047 |
| | | (.0215) | (.0786) | (.0188) | (.0013) | (.0016) | (.0073) | (.054) |
| (9) | g(L) | −.041 | −.0869 | .0983* | −.005*** | .0053*** | .0036 | −.0168 |
| | | (.0295) | (.087) | (.051) | (.0013) | (.0016) | (.007) | (.062) |
| (10) | g(D) | −.0839** | −.183* | .08** | −.0035*** | .0039*** | .002 | −.012 |
| | | (.0405) | (.1059) | (.035) | (.0011) | (.0014) | (.006) | (.0518) |
| (11) | g(S) | −.0313 | −.348*** | .084*** | .0024 | −.0023 | .002 | −.018 |
| | | (.0273) | (.068) | (.0279) | (.0015) | (.0019) | (.0076) | (.048) |

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

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