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RISK, CAPITAL BUFFER AND BANK LENDING

A GRANULAR APPROACH TO THE ADJUSTMENT OF EURO AREA BANKS

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In 2012 all ECB publications feature a motif taken from the €50 banknote

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Abstract

We develop a partial adjustment model in order to estimate the factors contributing to banks' internal target capital ratio, lending policy and holding of securities. The model is estimated on a panel of listed euro area banks and country specific macro-variables. Firstly, banks' internal target capital ratios are estimated by using information on banks' riskiness and earnings capacity. Secondly, the impact of banks' capital gap on the credit supply and the security portfolio is estimated while controlling for the macroeconomic environment. An increase in bank' balance sheet risk is shown to increase the target capital ratios. The adjustment towards higher equilibrium capital ratios has a significant impact on banks' assets. The impact is found to be more sizeable on security holdings than on loans, thereby suggesting a pecking order.

Keywords: banks, euro area, capital ratios, credit supply, partial adjustment model

JEL Classification: G01, G21

Non-technical summary

Banks are at the core of the euro area economy, channelling funds from sectors with surplus to sectors with needs, thereby supporting investment and economic growth. When fulfilling this role, banks also act as buffers, endorsing the risk associated with the lending activity. Hence, banks' own funds should be commensurate to their exposure to adverse conditions. This necessary condition support banks' capacity to lend should risks materialise and assets be impaired, resulting in losses depleting capital. Since the beginning of the financial crisis, banks in the euro area have become under stress, as it has become evident that banks entered the crisis with a lack of capital. Banks usually operate above the minimum capital ratios set by the banking supervisors, as they maintain an additional capital buffer that together with the regulatory capital forms banks' own internal capital target. This target is not observable to the general public however. To close the capital gap to this target, banks may either increase their own funds or reduce their exposures. Whatever route banks choose, banks' adjustment is likely to weigh negatively on the supply of credit and positively on the cost of financing for the economy at large. Hence, the monitoring of banks' capital gap and implied deleveraging pressures are of relevance for the conduct of monetary policy.

Two recent studies concentrate on determining banks' capital buffer and adjustment towards the internal target capital ratios in the US and in the UK, providing evidence on the importance of banks' capital on credit growth. Nonetheless, to the best of our knowledge, the role and significance of euro area banks' capital gaps has remained unexplored. Thus, this paper adds to the literature by disentangling the factors determining euro area banks' internal target capital ratios and analysing whether the banks' adjustment towards their targets has an impact on the banks' assets in general and on lending and security holdings in particular.

Our data set covers the panel data on euro area listed banks and country specific macroeconomic variables from the first quarter of 2005 to the last quarter of 2011, thus covering the years of financial crisis in the euro area. First of all, banks are shown to take into account the riskiness of their business while determining their internal target capital ratios. On an aggregate level, we find that the capital gap of euro area banks amounts to 2.0 p.p. of risk weighted assets in the middle of 2008 and remains positive at the end of 2010. Secondly, we found empirical evidence that undercapitalized banks tend to restrict the provision of loans to the economy, as the relatively higher cost of bank equity leads banks to deleverage in order to reach target capital ratios and to close the existing capital gap. According to the estimates, the closure of a 1 p.p. capital gap dampens loans growth in a range of 2.0 to 2.3 p.p. in the medium-term. The impact on security holdings is found to be larger, around 5.8─7.1%. This suggests a pecking order for deleveraging, so that banks reduce first their riskier asset and non-core portfolio exposures before shrinking lending to the economy.

1. Introduction

During the latest financial crisis, banks' core capital proved to be insufficient to cover impairment losses arising from both loan and security portfolios. Consequently, several banks needed to strengthen their capital base and reduce their exposure. In order to reduce the risk of similar crises in the future and to enhance the resilience of the banking sector, a new regulatory framework, the so-called Basel III package, was set, implying more stringent capital requirements for financial institutions (BIS, 2010a). However, banks operate above minimum capital ratios with an additional time-varying capital buffer (ECB, 2007), which, together with the regulatory capital, forms banks' internal target capital ratio.

In the case of a capital shortfall, banks seek to adjust their balance sheet to close the gap and reach the internal target. They do so by increasing core capital, adjusting the security portfolio, reducing the risk exposure or shrinking lending to the economy. Since increasing capital is costly, especially during downturns when it is most needed to absorb losses, banks' adjustment is likely to weigh negatively on the supply of credit, shift up the cost of financing for the economy at large, and exert adverse effects on economic activity.[1] Hence, the monitoring of banks' capital gap and implied deleveraging pressures are of relevance for the conduct of monetary policy.

The determinants of banks' capital buffer and adjustment process towards the target capital ratios have been discussed with a renewed interest in the academic literature since the beginning of the financial crisis (see for instance, Berger et al., 2008; Memmel and Raupach, 2010). Francis and Osborne (2009) and Berrospide and Edge (2010) use a partial adjustment model to analyse empirically the banking sectors in the US and the UK respectively. However, to the best of our knowledge, there is no corresponding analysis for the euro area. Focusing on the euro area and the latest financial crises, this paper adds to the literature by disentangling the factors determining euro area banks' internal target capital ratios and analysing whether the banks' adjustment towards their targets has an impact on banks' asset in general and on lending and security holdings in particular. We don't aim at modelling the adjustment process itself but concentrate on the consequences of the adjustment. Our granular dataset of the banking system covers a large panel of euro area listed banks as well as country specific macroeconomic variables from the first quarter of 2005, prior to the crisis, to the last quarter of 2011.

Overall, several risk indicators are shown to increase the target capital ratio. We find that a substantial part of the movements in internal target capital ratio reflects the changes in banks' risks and earnings development associated with economic conditions. On an aggregate basis, we find an undercapitalisation in terms of Tier 1 capital ratio standing close to 2.0 p.p. in the middle of 2008 with a shortfall remaining at the end of 2010. Similar results are obtained for total capital ratio. Turning to the impact of banks' adjustment on assets, estimates indicate that the closure of a 1 p.p.

[1] See BIS, 2010b; Kashyap et al., 2010; Miles et al., 2010 as well as Ötker-Robe et al., 2010.

capital gap dampens loans growth in a range of 2.0 to 2.3 percentage points in the medium-term. The impact on security holdings is found to be larger, around 5.8─7.1%, thereby suggesting a pecking order for deleveraging.

The rest of the paper is organised as follows. The academic literature related to banks' internal capital targets and the impact of changing capital buffers on lending is reviewed in Section 2. The dataset is presented in Section 3 together with stylised facts on developments in the euro area banking sector since 2005. The partial adjustment model and the estimation results are discussed in Section 4. Section 5 concludes.

2. Review of the academic literature

Banks usually operate above minimum regulatory capital requirements in order to minimise the probability of reaching the regulatory limit of solvency ratios should they face adverse developments. Together with the regulatory solvency capital banks' voluntary capital buffer forms banks' internal capital target that varies over time, reflecting partly their reaction to market pressures and assessments of the risks in the assets, including loans and security portfolio. The strategy choices of banks' management partly aim at adjusting to the internal target, having consequently implications on banks' asset composition.

Many papers have analysed banks' capital structure and their adjustment towards the desired capital levels. In general, banks are shown to have entity-specific targets and speed of adjustment towards desired capital levels.[2] For instance, Memmel and Raupach (2010) show that private commercial banks as well as banks with a high share of liquid assets tend to adjust their capital ratio more quickly. The authors also show that banks that record high asset volatility tend to have higher capital ratio. Brewer et al. (2008) indicate that larger banks have lower equilibrium capital ratios than smaller banks. The authors found that the equilibrium equity leverage ratio is higher in countries where the banking sector is relatively small and where regulatory practices prompt corrective action and good corporate governance.

Since the beginning of the latest financial crisis, banks have faced intensified pressures from markets, regulators and policy makers to move towards higher capital levels (see for instance BIS, 2010a or EBA, 2011). The impact of changes in bank capital on bank lending has previously been subject to wide attention, especially in relation to the implementation of higher regulatory capital requirements (Basel I, II and III).

Some empirical papers suggest that in the US, Basel I regulatory framework led to slightly decreasing lending (and business lending, in particular), and some papers provided evidence that the risk-based capital standards were a significant factor in explaining the credit crunch of the early

[2] See, for instance, Gropp and Heider, 2010; Jokipii and Milne, 2008; Memmel and Raupach, 2010 and Brewer et al., 2008.

1990s.[3] Disentangling the impact of supply factors related either to the regulations with changes in capital requirements or to other factors, from demand factors, is nevertheless difficult as both contribute to loan growth.[4] For instance, using a structural model and data on large US commercial banks, Furfine (2000) shows that while changes in capital regulation were a necessary ingredient to explain the shifts in commercial bank portfolios and the witnessed decline in the loan growth, increases in risk-based and leverage capital requirements also played a role.

Similarly, Basel II requirements have been shown to increase the volatility of bank lending, especially for undercapitalised and less liquid banks (ECB, 2009; Jacques, 2008). Also the latest analysis on the forthcoming implementation of Basel III have concluded that the increase in capital requirement could exert a negative impact on banks' lending volumes and a positive impact on spreads (BIS, 2010b, 2010c; King, 2010).

Bank-specific characteristics have also been shown to influence bank credit supply. German banks that were more affected by the US financial crisis and losses from the subprime exposures are shown to have rejected relatively more loan applications and thus restricted lending more than the less exposed banks (Puri et al., 2010).[5] The analysis by Peek and Rosengren (1995b) and Brinkmann and Horvitz (1995) suggest that the lending of poorly capitalized banks increases less than that of better-capitalized competitors owing to reductions in bank capital. A similar effect is found by Hancock et al. (1995) as well as Peek and Rosengren (1997, 2000) who conclude that banks with binding capital constraints cut back lending more quickly in reaction to unanticipated drops in capital. Furthermore, Spanish banks with weaker capital and liquidity ratios as well as European and US banks with low solvency ratios, larger share of market-based funding and non-interest income are shown to reduce lending more strongly than other banks. (Jimenez et al., 2011; Gambacorta and Marques-Ibanez, 2011)

Several findings suggest that an individual bank's response to changes in capital is conditioned to bank's size. The results of Puri et al. (2010) are particularly strong for smaller and more liquidity-constrained banks as well as for mortgage loans. Hancock and Wilcox (1998) also show that small banks shrank their portfolios considerably more than large banks in response to the decline in their own bank capital.

The existence of a negative link between the capital gap and lending has been confirmed by theoretical models. For example, based on a static model Thakor (1996) shows that capital

[3] See Bernanke and Lown, 1991; Hancock and Wilcox, 1993, 1998; Hancock et al., 1995; Berger and Udell, 1994; Berger et al., 1995; Hall, 1993; Wall and Peterson, 1995; Peek and Rosengren, 1995a and Brinkmann and Horvitz, 1995.

[4] Factors such as regulatory pressures (Wall and Peterson, 1995; Peek and Rosengren, 1995a), decreasing capital owing to loan losses (Peek and Rosengren, 1995a, 1995b), changes in bankers' assessment of risk climate (Shrieves and Dahl, 1995), reduction in demand due to the recession (Bernanke and Lown, 1991; Hancock and Wilcox, 1993) and growth of alternative sources of financing (Berger and Udell, 1994) have also been cited as a source for decreasing loan growth. Moreover, market discipline and other factors as well as definition issues may play a role (Jackson et al., 1999).

[5] Furthermore, Ivashina and Scharfstein (2010) show that banks that were more vulnerable to credit-line drawdowns, more reliant on short-term debt and had limited access to deposit financing reduced their lending more than their counterparts during the latest financial crisis.

requirements linked solely to credit risks raise the cost of lending relatively to alternative investments, thus increase credit rationing and reduce aggregate demand.

Using partial adjustment models and estimates on banks' target capital ratios, Berrospide and Edge (2010) and Francis and Osborne (2009) examine how banks' capital targets impact on banks' lending. By analysing US banks, Berrospide and Edge (2010) find relatively modest effects of bank capital on lending and a more important role for factors such as economic activity and the perceived macroeconomic uncertainty. Francis and Osborne (2009) concentrate in UK banks and find that banks with surplus (shortfall) of capital relative to their target tend to record higher (lower) credit growth. In this paper, we implement a similar approach on a euro area dataset. We analyse the determinants of the target capital ratio on a bank-by-bank basis, whether banks have a capital surplus or deficit and the impact of banks' adjustment on the availability of loans and holdings of securities.

3. Data and stylised facts

In this section, we present the dataset that takes into account both the granularity of the euro area banking sector and the macroeconomic and financial market dimensions of the economy in which each bank operates.

3.1 Bank data

Our dataset is based on the balance sheets and income statements of euro area listed banks available from Datastream of Thomson Reuters. It refers to 51 listed banks domiciled in Germany, France, Italy, Spain, Belgium, Austria, and Portugal. Data are collected at the consolidated group level, including a bank's foreign subsidiaries and branches. In order to avoid double counting, separately reported foreign subsidiaries of a bank group are not included in the sample.

While some observations are available from 2003 onwards, our estimation period extends from the first quarter of 2005 until the fourth quarter of 2011 in order to ensure a reasonable data coverage. Although the majority of banks report balance sheet and income statements on a quarterly basis, some banks publish bi-annual data. In this case, missing quarterly observations are interpolated in order to ensure a large sample.

For each bank in the sample, the data on a bank's balance sheets as well as on income statements are used to compute bank-specific indicators that reflect the riskiness of assets and the earning capacity of the bank. We extract information on risk weighted assets (RWAs), total assets, retained earnings and return on equity (ROE), provisioning, net loans and security holdings. In addition, the solvency ratios[6], both total capital and Tier1 capital ratio, are used in the estimations.

[6] The solvency ratios are defined as regulatory Tier 1 (or total) capital over the risk-weighted assets.

In terms of number of the banks and time span, our dataset is smaller than the coverage of official balance sheet items (BSI) statistics compiled on a monthly basis by the Eurosystem.[7] However, the BSI data do not include neither regulatory concepts such as risk weighted assets or solvency ratios nor income statements. This lack of information severely limits possibilities to rely on BSI data in the analysis. Moreover, BSI data are only available at the aggregated level for the euro area as a whole and the euro area countries, lacking information on individual banks. Given that the average for a country can reflect many individual combinations of bank-specific situation, granularity is a necessary dimension to analyse properly the adjustment of banks.

The total assets of listed euro area banks included in the sample constitute approximately 43% of the total asset of all euro area credit institutions recorded in BSI statistics.[8] Nonetheless, our sample appears to be representative of the euro area banking sector, as the structure of the aggregated balance sheets is broadly similar across two data sources (see Table 1). In particular, over the period of 2005─2011, several main balance sheet items such as loans, deposits, capital and reserves as well as wholesale funding exhibit similar relative importance.

[TABLE 1]

Moreover, the development between individual balance sheet series correlates strongly positively. The main difference appears in the share of investments/securities holdings, reflecting the fact that the sample includes several pan-European banks with a large trading and investment business, while the BSI balance sheet statistics also incorporate unlisted small and medium-sized banks that do not usually have investment banking in their business model. In addition, this item is defined differently across the datasets, making it difficult to draw strong conclusions.

[CHART 1 AND TABLE 2]

Taking a long-term perspective, the balance sheets of euro area listed banks grew from 2003 to 2008. The rise interrupted in 2009, owing to the financial crisis, and in 2009 and 2010, total lending declined by around 5% per year. Turning to solvency ratios, both the Tier 1 and total capital ratios of listed euro area banks remained relatively stable from 2005 until the end of 2008 after which the solvency ratios started to increase (see Chart 1). Over the estimation period, Tier 1 capital ratio stood at 8.6% and total capital ratio at 11.4%, on average. (See Table 2 for summary statistics on several bank specific variables used.)

Looking at the dispersion among the sample, the capital ratios of banks in the sample were rather close to each other until the beginning of the financial crisis, while from 2009 onwards, the

[7] See http://www.ecb.europa.eu/stats/money/aggregates/bsheets/html/index.en html.

[8] To improve consistency between the two datasets, the BSI statistics used in the comparison refer to credit institutions only and do not include money market funds or Eurosystem.

improvement of the ratios has been quicker for the upper part of the distribution as well as for an average bank than for the lower part of the distribution. Nevertheless, throughout the sample period banks' ratios remained above the regulatory minimum, on average. Given broadly stable risk-weighted assets from 2009 onwards, the increases in banks' Tier 1 and total capital ratio were mainly driven by developments on the liability side of banks' balance sheet. In addition to the new capital raised from market sources via issuance of shares, banks benefited from public authorities' capital injections and resorted also to internal capital accumulation in the form of retained earnings. Indeed, after having recorded losses in 2008, the listed euro area banks returned to profitability in the second half of 2009. It is only towards the end of the sample period that the importance of reshuffling of assets towards less risky exposures and deleveraging pressures grew.

3.2 Other data sources

In addition to the information on banks' financial statements, other statistical data sources are used to capture the riskiness of bank's balance sheet, bank's credit standard policy, loan demand factors and the macroeconomic conditions of individual countries. In the estimation, the country-level data on different indicators and macro variables are associated with each individual bank according to the location of the bank's headquarter.

Firstly, we add expected default frequencies (EDFs) computed by Moody's for each bank in the sample. EDFs provide an estimate of the probability that a bank will default within one year, and therefore represent the riskiness of the institution perceived by the market. From the beginning of the 2000s, the expected default frequencies of euro area listed banks have remained stable at a low level, before increasing abruptly in the wake of the financial crisis (see Chart 2). This is true for the mean and the dispersion measured by the inter-quartile, as the EDFs of the higher risk banks increased much more than those of the lower risk banks. Especially, the perceived risks increased much more for the higher part of the distribution, the weakest banks, than for the strongest banks in the beginning of 2009.

[CHART 2]

Secondly, we include the country specific statistics on credit standards as available from the Bank Lending Survey (BLS) compiled by the ECB.[9] In this survey, the senior loan officers report on the importance of factors such as the perceptions of risks related to the industry or firm-specific outlook, the expectations regarding the economic activity and the impact of changes in the bank's own funding conditions on current and future developments in bank's credit standards applied to the approval of loans and credit lines to enterprises. Moreover, the loan officers share their views on the expected loan demand by firms. Since the onset of the financial crisis, euro area aggregate credit

[9] For more information on the euro area BLS, see http://www.ecb.europa.eu/stats/money/surveys/lend/html/index.en html.

standards and expectations regarding the demand have co-moved with the macroeconomic developments. The credit standards tightened heavily in 2008−2009, while demand exhibited cyclical behaviour, increasing in 2005−2007 and declining during the crisis. The aggregate figures nevertheless mask country difference that can be substantial.

Finally, to control for macroeconomic conditions, the dataset includes quarterly macroeconomic variables which are country specific. Gross domestic product (GDP) is taken from Eurostat in nominal and real terms.[10] The annual growth in stock prices is calculated on the basis of Euro Stoxx 50 index, reflecting the development of the 50 largest companies by capitalisation, as available from Thomson Datastream.

4. Estimation based on a partial-adjustment model

Macroeconomic and bank specific shocks affect the banks' internal target capital ratio to which banks adjust through changes in asset management strategy, lending policy and holdings of securities. The main goal of forthcoming section is to provide an analysis of the deleveraging forces for the listed euro area banks. In line with a partial-adjustment model, the empirical approach is developed in two separate steps.

In the first step, we concentrate on the relationship between risk and target capital ratio. Bank specific risk indicators are used to estimate a target capital ratio for each entity, while controlling for the bank's capacity to generate income and account for some structural characteristics such as the size. To account for risk, both market evaluation and bank accounting items are considered. Based on the estimated parameters, a bank's time varying capital gap between the desired (unobserved and internal) target capital ratio and the actual (observed) capital ratio is then computed for each time period. In the second step, the adjustment of loans and securities is explained by using the estimates on the bank's capital gap and variables related to macroeconomic environment.

The methodology broadly follows that of Francis and Osborne (2009) and Berrospide and Edge (2010), with some differences. The former focus on UK banks over the period 1996–2007 and implement GMM to estimate target capital ratio in the first step and OLS with fixed effects in the second step as there is no lagged dependent variable is the second step equations. Berrospide and Edge (2010) focus on US banks over the period from 1992Q1 to 2009Q3 by estimating OLS with fixed effects for both steps. We apply a GMM method with fixed effects in both steps.[11] While our estimation period, from the first quarter of 2005 up to the last quarter of 2011, is somewhat shorter than that considered by the authors above, it covers the years of the latest financial crisis. This period may contain structural breaks, due to, for instance, the implementation of Basel II, the set-up of Basel III and the public capital injections during the financial crisis. However, it is not possible to

[10] More information on GDP data at http://epp.eurostat.ec.europa.eu/portal/page/portal/national_accounts/introduction.
[11] For more information on the estimation method, see Baltagi, 2008.

take these factors properly into account given the publicly available data and the relatively short sample of seven years.

4.1 Estimating target capital ratio

The first step focuses exclusively on the link between the target capital ratio and the riskiness of the bank's balance sheet, the bank's earning capacity and the degree to which a bank is exposed to market discipline. Bank's internal time-varying target capital ratios, $k^*_{i,t}$, which are not known to the public, are estimated with an equation incorporating a bank-specific risk indicator, $RISK_{i,t}$, and a variable that captures the capacity to accumulate income, $INC_{i,t}$ (see equation 1). Other factors such as market pressures, business model, bank's strategy and specificities of the market in which the bank operates, are included in $\alpha_{i,}$, an effect normally distributed across banks.

$$k^*_{i,t} = \alpha_i + \theta_1 RISK_{i,t} + \theta_2 INC_{i,t} \quad (1)$$

Owing to market frictions and adjustment costs, it takes several periods for banks to adjust from current capital levels towards their internal targets. Hence, a partial-adjustment model is applied in order to describe how a bank closes a gap between their capital ratio in the previous period, $k_{i,t-1}$, and their internal target capital ratio, $k^*_{i,t-1}$. This process is presented in equation (2): the observed change in publicly disclosed capital ratio $\Delta k_{i,t}$ is a function of the gap between the internal target and (observed) capital ratio ($k^*_{i,t-1}$ - $k_{i,t-1}$) in the previous period. This gap is closed at the speed λ which lies between 0 and 1. In addition, an error term, $\varepsilon_{i,t}$, captures idiosyncratic shocks during the adjustment.

$$\Delta k_{i,t} = \lambda(k^*_{i,t-1} - k_{i,t-1}) + \varepsilon_{i,t} \quad , 0 < \lambda < 1 \quad (2)$$

Substituting (1) into (2) and rearranging gives the equation (3), which is estimated using the panel of euro area listed banks.

$$k_{i,t} = \lambda\alpha_i + (1-\lambda)k_{i,t-1} + \lambda\theta_1 RISK_{i,t-1} + \lambda\theta_2 INC_{i,t-1} + \varepsilon_{i,t} \quad (3)$$

The equation (3) is estimated in an unrestricted form for both regulatory solvency ratios (Tier 1 capital ratio and total capital ratio) as dependent variables. By construction, the lagged values of the capital ratio, incorporated as an explanatory variable to account for the lagged adjustment, is expected to correlate positively with the capital ratio.

Several combinations of explanatory variables are tested to account for the two types of channels affecting the target capital ratio, namely a set of variables referring to the bank's income capacity and a set related to the bank's risks. Indicators referring to the bank's income capacity include return on equity (ROE) and retained earnings over total assets. The coefficients are expected to be positive

as bank's earnings support the capacity to accumulate capital through retention.[12] To reflect the riskiness of the bank, we consider indicators based on balance sheet items, namely loan loss provisioning over total assets and total investments over total assets, as well as indicators based on the market's view on the bank's situation, i.e. expected default frequency (EDF) and log-odds EDFs.[13] In all the cases, risk is expected to exert a positive impact on target capital ratio as the riskier is the bank's balance sheet the higher should be the capital buffer that a bank holds to cover for its exposures.[14] The estimations are run over the period 2005Q1-2011Q4, 28 quarters per bank, with GMM.

The results for the target capital ratio measured with Tier 1 ratio are presented in Table 3. Overall, the estimated coefficients are in line with *a priori* expectations. The lagged dependent variable has a positive sign and is statistically significant, in line with the partial adjustment model that assumes some delays in the closure of the capital gap.

[TABLE 3]

Regarding income indicators, return on equity (ROE) and quarterly change in retained earnings over total assets exert a positive impact on capital ratios although the coefficient fails to be statistically significant. This positive (but not significant) correlation between profitability and solvency ratios is in line with the results of Berrospide and Edge (2010). The authors report the bank holding companies' tendency to increase capital when profits, measured with return on assets, rise. The fact that the coefficient is not significant may reflect the fact that the income indicators also reflect bank's cost of capital, as mentioned by Francis and Osborne (2009). Turning to risk indicators, the ratios of loan loss provisions over total assets correlate positively with Tier 1 capital ratio and are statistically significant. Berrospide and Edge (2010) and Francis and Osborne (2009) show that larger charge-off rates and provisions support higher capital ratios. Meanwhile, total investments over total assets, another measure of risk, exhibit a positive relationship with Tier 1 capital ratio. The relationship is not significant at 10%, however.

In addition to above mentioned indicators, expected default frequencies (EDFs) are significant and positively related to the solvency ratios, meaning that a rise in expected default frequency is associated to an increase in bank's capital. This can be interpreted as markets' ability to relate the bank's risks correctly to its future capital position, representing also markets' view on the riskiness of a certain bank and on banks' need to raise more capital to cover their risk exposures.

[12] In principle, profitability ratios could also exert a negative impact on the capital ratio given that they also reflect the implicit cost of capital in a sense that a part of the profits will be paid out to the stakeholder. However, as banks usually keep a part of their profits as retained earnings, we expect higher net income to result in a higher capital ratio.

[13] Log-odds ratios, LOR, are obtained as LOR = log((EDF)/(1-(EDF)).

[14] However, credit risk and market perceptions may exhibit pro-cyclical behaviour. For instance, loan losses tend to increase during economic downturns, depleting banks' capital position and solvency ratios. Also EDFs started to increase only at the beginning of the financial crisis (see Chart 2). Hence, these indicators may be negatively correlated with capital ratios. The lag of capital ratio is introduced in the first step regressions so as to reduce the impact of cyclicality.

[TABLE 4]

The results obtained for Tier 1 capital ratio apply also to a large extent to total capital ratio (see Table 4). In both cases, lagged dependent variable and indicators for risk enter the equations with positive signs. Overall, the positive relationship between target capital ratios and the various risk indicators confirms the view that banks with higher risk in their balance sheet also tend to hold more capital.

4.2 Deriving the capital gap

Based on the estimated equations, target capital ratios are computed for each individual bank. As the estimation is done for both Tier 1 capital ratio and total capital ratio, the target capital ratios are derived for both ratios. The capital gap, $GAP_{i,t}$, for each individual bank i at time t is derived as follows:

$$GAP_{i,t} = 100 * \left(\frac{k^*_{i,t}}{k_{i,t-1}} - 1 \right) \tag{4}$$

where $k^*_{i,t}$ represents the bank's target capital ratio at time t and $k_{i,t-1}$ is the bank's actual capital ratio at time t-1. Equation (4) thus presents the deviation of a bank's actual capital ratio in period t-1 from the target at time t. A positive (negative) value of the capital gap represents a capital shortfall (surplus) relative to the long-run target level of the capital ratio.

[CHART 3]

Chart 3 presents the capital gap (expressed as percentage points, i.e. the needed capital over risk-weighted assets) and its distribution across euro area banks over time. The gap on the left-hand side is based on Tier 1 capital ratio and on total capital ratio on the right-hand side. Comparing the two set of results, the gaps estimated for both capital ratios are quite similar. At the beginning of the estimation period, both capital gaps are positive, indicating that banks lag behind their internal targets. Gaps subsequently start to widen as the financial crisis deepens in 2007-2008, reaching their highest point of around 2.0% from the middle of 2008 until the middle of 2009. From then onwards, capital gaps start to narrow. While the median gap based on total capital ratio turns negative in the beginning of 2010, the median gap based on the Tier 1 capital ratio remains positive longer, until the first quarter of 2011. Overall, the estimations suggest that more than a half of the individual institutions do not have capital shortfall in the beginning of 2011. Still, a high heterogeneity remains in the euro area banking sector at the end of 2011. This result is important since banks with capital shortfall cannot expect banks with capital surplus to compensate for their deficit at the sector wide level. Hence, the situation can be more adverse than suggested by the mean capital gap.

4.3 Estimating the adjustment towards the target capital ratio

Banks have several possibilities to close the capital gap. They can adjust the liability side or the asset side of their balance sheet. On the liability side, they can issue new equity or increase retained earnings. On the asset side, they can reduce the amount of loans, the size of their portfolio, their risk exposure, or their overall asset. In practice, banks are likely to adjust by using a combination of these measures. In this paper, the focus is on the part of the adjustment that operates through the asset side in order to shed light on the widely disputed issue of deleveraging.

Thus, in the second step of the estimation, we use the obtained capital gap while controlling for macro variables. A dynamic panel model is estimated with General Method of Moments for two different balance sheet items, $item_{i,t}$, namely for total loans and total securities (see equation 5).

$$\Delta \log(item_{i,t}) = \alpha_i + \beta Gap_{i,t-1} + \delta_1 \Delta \log(GDP_{j,t-1}) + \delta_2 X_{j,t-1} + \varphi \Delta \log(item_{i,t-1}) + \varepsilon_{i,t} \qquad (5)$$

The explained variables, loans and security holdings, are expressed in quarterly change while, depending on their nature, the explanatory variables are expressed in growth rates or level. Regarding the capital gap of a bank, $Gap_{i,t-1}$, we use the two alternative variables based on the target Tier 1 capital ratio and the target total capital ratio.[15] In both cases, the capital gap, measured as a difference between the bank's target and the actual capital ratio, is expected to have a negative impact. If the capital ratio of a bank is below its target, the gap is positive (see Equation 4) and the growth in the balance sheet items should be adversely affected since banks partly deleverage to increase their solvency ratios.

Macroeconomic conditions which affect a bank's assets through the demand channel are also included in the model. These variables refer to the economic activity in the country where the bank's headquarter is located.[16] In order to control for macroeconomic conditions, the annual growth rate of gross domestic product ($GDP_{j,t-1}$) in the country j in which the bank i's headquarter is located is included in the model. GDP growth is expected to have a positive impact on asset growth and loan growth.

Other exogenous variables ($X_{j,t-1}$) are incorporated to account for either supply or demand channels. First, we include information from the ECB bank lending survey. In the survey, banks reply to questions concerning the perceived changes in loan demand and questions on banks' own credit standards (indicating supply factors). Loan demand is expected to correlate positively with the loan

[15] We use equations 1 and 2 in table 1 to calculate the Tier 1 capital gap. Similarly, when deriving capital gap for total solvency ratio, equations 1 and 2 in table 2 are used. These equations incorporate the changes in retained earnings over total assets, expected default frequencies (EDFs), and loan loss provisioning over total assets as explanatory variables.

[16] The combination of bank-specific capital gap with country-specific macro variables reflects the lack of publicly available data which do not enable to consider the geographical dispersion of exposure at the institutional level. Indeed, internationally active banks may not be only affected by the developments in the home country. Still, individual banks' capital gaps are defined at the bank group level representing a group's capital shortfall/surplus in relation to its overall risk position (including foreign lending).

growth, while for a tightening (easing) of credit standards is expected to dampen (increase) loan growth and thus to be associated with a negative sign. Second, we include stock prices to reflect overall financing conditions in the economy. These are expected to correlate positively with the explained variables. Finally, the dynamic model also includes the lag of the dependent variable, $item_{i,t-1}$ as well as an error term.

The results for the estimations on balance sheet adjustments are presented in Table 5 (where the capital gap is calculated on the basis of Tier 1 ratio) and Table 6 (where the capital gap is based on total capital ratio). The left hand side of the tables presents the adjustment effect for net loans, while the right hand side of the tables contains results for the adjustment of the security portfolio.

[TABLES 5 AND 6]

Starting with the adjustments of net loans, loans excluding inter-bank loans, the capital gap enters the estimations with a negative sign, as expected, and is statistically significant in explaining the development of the loan book. Moreover, GDP growth and demand of loans by non-financial corporations (NFCs) prove to be significant in explaining loan growth. As expected, the credit demand factors and GDP growth correlate positively with loan growth. The credit standards applied by banks on loans to NFCs appear to exert a negative impact on loans, reflecting the adverse effect of a tightening of credit supply, but fail to be statistically significant.

Turning to the adjustment of the securities portfolio, a bank's capital gap, a shortfall of capital with respect to the target, exert a negative and significant impact on security portfolio. Although GDP fails to be statistically significant, its coefficient remains positive. Banks are likely to rely more on market prices than on demand indicators to decide on their investment portfolio. Indeed, the annual growth of stock prices correlates positively with a bank's securities portfolio, reflecting possibly the fact that swift changes in market environment and investor expectations influence positively on banks' decision to invest in securities.

Overall, the estimates suggest that capital gap played an important role in explaining loans offered by the euro area banking sector through the estimation period. Compared to a situation in which banks' actual capital ratio would not deviate from the target, a 1-percentage-point capital shortfall is estimated to reduce annual loan growth by 2.0 to 2.3 percentage points over the medium-run.[17] Given that at the trough of the financial crisis, the capital gap is estimated to have reached 2 p.p., the adjustment to higher target capital ratio could have lower loan growth by more than 4% in cumulated terms.

The estimated adjustment based on Tier 1 target seems somewhat higher than those based on total capital ratio target. The result reflects the distinct composition of the capital on which the capital

[17] The response is computed by dividing the coefficient on the capital gap by 1 minus the coefficient on the lagged dependent variable.

ratios are based. While Tier 1 capital is more narrowly defined and contains mainly equity capital that is more readily available to absorb losses, total capital includes also other capital-like instruments. When the risks materialised, the Tier 1 equity capital acts as a first line of defence and is more severely affected as it buffers against the losses. Therefore, the capital gap between the target Tier 1 capital and the actual Tier 1 capital induces larger changes in a bank's balance sheet than differences between the target and actual total capital ratios.

Our estimates suggest that the deleveraging of loans is relatively stronger in the euro area than in the UK or in the US as the estimated impact in this paper is more pronounced than that of Berrospide and Edge (2010) and Francis and Osborne (2009). The former find that a 1 percentage point increase in the capital ratio of US banks leads to an increase of 0.7−1.2 percentage points in annualized loan growth in the long term, while the later suggest that the total effect of changes in regulatory requirements of UK banks is approximately 1.2 percentage points. The differences in the results may be partly explained by the estimation periods. Francis and Osborne (2009) use data from 1996 to 2007 and Berrospide and Edge (2010) cover 1992Q1−2009Q3, while we cover the years of the financial crisis during which most of the deleveraging took place in the euro area.

Based on the estimations, the long run elasticity of the securities portfolio is higher than that of net loans.[18] The estimated elasticity for securities varies around 5.8─7.1 percentage points, well above the corresponding elasticity for loans. This supports the view that, since the onset of the financial crisis, the euro area banks have deleveraged assets along a "pecking order", reducing securities holdings more than loan supply. This finding, also reported by Shrieves and Dahl (1992) and Jacques and Nigro (1997), can be explained by several factors. First, as the maintenance of customer relationships is an important part of the prevailing banking business model, credit institutions would be reluctant to jeopardise important client relationships by refusing to roll-over existing loans or to grant new ones. Secondly, banking sector has received support via a number of government schemes that include conditions to maintain a minimum level of credit growth to the private sector. Thirdly, loans are typically rather illiquid assets, and shedding existing loans from the balance sheet is difficult, particularly during a crisis when the securitisation and syndication markets are at a standstill.

As a robustness test, the second-step estimations are run by defining all explanatory variables in levels.[19] These estimations confirm the previous results, indicating a capital gap, GDP, credit supply, demand factors and stock prices as significant variables. Moreover, the long-term impact on securities portfolio is again found to be more pronounced than on net loans, standing at around 3.4 for securities and 2.4−2.8 for net loans.

[18] The medium-term impact on security holdings is calculated in a similar fashion as for loans.

[19] In this case, instead of equation 5, we estimate the following equation: $item_{i,t} = \alpha_1 + \beta Gap_{i,t-1} + \sum_{j=1} \delta_{1,j} GDP_{t-j} + \sum_{j=1} \delta_{2,j} X_{t-j} + \varphi\ item_{i,t-1} + trend + \varepsilon_{i,t}$.

5. Concluding remarks

Owing to the pressures to increase solvency ratios, banks may cut down lending or otherwise adjust their balance sheets in order to decrease their risk-weighted assets to restore their capital ratios. Indeed, the recent financial crisis has highlighted the importance of financial intermediaries' characteristics and equity capital as determinants for the provision of credit to borrowers.

In reality, banks try to operate above minimum capital requirements and maintain an additional capital buffer, which together with the regulatory requirements form the bank's internal capital target. In the short to medium term, the actual capital ratios can differ from the target value, and the resulting capital gap can trigger a bank's adjustment process. Therefore, banks' capital gap and implied deleveraging pressures are of relevance for the conduct of monetary policy.

In this paper, we have estimated a partial adjustment model in a panel context using various indicators to examine the impact of risk in bank's balance sheet on bank's internal target capital and the implications that the closure of the capital gap have on bank lending and securities holdings. Our paper adds to the literature by concentrating on the euro area banks and by providing evidence on the impact of deleveraging forces during the latest financial crisis, while previous studies have disentangled the effects in the US and the UK banking sectors over different time periods, during which such pressures may have been more difficult to detect.

We found empirical evidence that undercapitalized banks tend to restrict the provision of loans to the economy, as the relatively higher cost of bank equity leads bank to deleverage in order to reach target capital ratios. The movements in internal target capital ratio reflect the changes in bank's risks and earnings development, although the estimated range of the impact remains large. Based on the estimates, we find an undercapitalisation in terms of Tier 1 capital ratio, standing close to 2.0 p.p. in the beginning of 2008 and a still negative gap at the end of 2010. The results for total capital ratio are similar. Regarding the closure of the capital gap, we found evidence on deleveraging as the impact on lending could have been significant in the euro area. Estimates indicate that the closure of a 1 p.p. capital gap dampens loans growth in a range of 2.0 to 2.3% in the long-term. Given that at the trough of the financial crisis, the capital gap is estimated to have reached 2 p.p., the adjustment to higher target capital ratio could have lower loan growth by more than 4% in cumulated terms. The impact on security holdings is found to be larger, around 5.8−7.1%, thereby suggesting a pecking order for deleveraging.

References

Baltagi, B. H., 2008. *Econometric analysis of panel data*. Wiley.

Berger, A. N., DeYoung, R., Flannery, M. J., Lee, D., Öztekin, Ö., 2008. How do Large Banking Organisations Manage Their Capital Ratios? *Journal of Financial Services Research*, 34, 123-149.

Berger, A. N., Udell, G. F., 1994. Did Risk-based Capital Allocate Bank Credit and Cause a "Credit Crunch" in the United States? *Journal of Money, Credit and Banking*, 26(3), 585-628.

Berger, A. N., Herring, R. J., Szegö, G. P., 1995. The role of capital in financial institutions. *Journal of Banking and Finance*, 19, 393-430.

Bernanke, B. S., Lown, C. S., 1991. The Credit Crunch. *Brookings Papers on Economic Activity*, 2, 205-247.

Berrospide, J. M., Edge, R. M., 2010. The Effects of Bank Capital on Lending: What Do We Know, and What Does it Mean? *International Journal of Central Banking*, 6(4), 5-54.

BIS, 2010a. Group of Governors and Heads of Supervision announces higher global minimum capital standards. *Press release of Basel Committee of Banking Supervision*, 12 September 2010 http://www.bis.org/press/p100912.htm.

BIS, 2010b. Assessing the macroeconomic impact of the transition to stronger capital and liquidity requirements. *Final Report of Macroeconomic Assessment Group*, December 2010, http://www.bis.org/publ/othp12.pdf.

BIS, 2010c. Results of the comprehensive quantitative impact study. *Basel Committee on Banking Supervision*, December, http://www.bis.org/publ/bcbs186.pdf.

Brewer, E. III, Kaufman, G.G., Wall, L. D., 2008. Bank Capital Ratios Across Countries: Why Do They Vary? *Journal of Financial Services Research*, 34, 177-201.

Brinkmann, E. J., Horvitz, P. M., 1995. Risk-Based Capital Standards and the Credit Crunch. *Journal of Money, Credit and Banking*, 27(3), 848-863.

EBA, 2011. 2011 EU Capital Exercise. *European Banking Authority (EBA)*, 8 December 2011, http://www.eba.europa.eu/capitalexercise/2011/2011-EU-Capital-Exercise.aspx.

ECB, 2007. Bank capital in Europe and the US. *Financial Stability Review*, December 2007, 155-162.

ECB, 2009. Is Basel II pro-cyclical? A selected review of the literature. *Financial Stability Review*, December 2009, 143-150.

Francis, W., Osborne, M., 2009. Bank regulation, capital and credit supply: Measuring the impact of Prudential Standards. *Bank of England Occasional Paper*, 36.

Furfine, C., 2000. Evidence on the response of US banks to changes in capital requirements. *BIS Working Paper*, 88.

Gambacorta, L., Marques-Ibanez, D., 2011. The bank lending channel: evidence from the crisis. *Economic Policy*, 26(66), 135-182

Gropp, R., Heider, F., 2010. The Determinants of Bank Capital Structure. *Review of Finance*, 14, 587-622.

Hall, B. J., 1993. How Has the Basle Accord Affected Bank Portfolios? *Journal of the Japanese and International Economies*, 7, 408-440.

Hancock, D., Laing, A. J., Wilcox, J. A., 1995. Bank capital shocks: Dynamic effects on securities, loans and capital. *Journal of Banking and Finance,* 19, 661-677.

Hancock, D., Wilcox, J. A., 1993. Has There Been a "Capital Crunch" in Banking? The Effects on Bank Lending of Real Estate Market Conditions and Bank Capital Shortfalls. *Journal of Housing Economics* 3, 31-50.

Hancock, D., Wilcox, J. A., 1998. The "credit crunch" and the availability of credit to small business. *Journal of Banking and Finance*, 22, 983-1014.

Ivashina, V., Scharfstein, D., 2010. Bank lending during the financial crisis of 2008. *Journal of Financial Economics*, 97, 319-338.

Jackson, P., Furfine, C., Groeneveld, H., Hancock, D., Jones, D., Perraudin, W., Radecki, L., Yoneyama, M., 1999. Capital requirements and bank behaviour: The impact of the Basle accord. Basel Committee on Banking Supervision, *Working Papers*, 1/1999.

Jacques, K. T., 2008. Capital shocks, bank asset allocation, and the revised Basel Accord. *Review of Financial Economics*, 17, 79-91.

Jacques, K. T., Nigro, P., 1997. Risk-Based Capital, Portfolio Risk, and Bank Capital: A Simultaneous Equations Approach. *Journal of Economics and Business*, 49, 533-547.

Jiménez, G., Ongena, S., Peydró, J-L., Saurina J., 2012. Credit Supply and Monetary Policy: Identifying the Bank Balance-Sheet Channel with Loan Applications, *American Economic Review,* August, Vol. 102, No. 5, 2301-26.

Jokipii, T., Milne, A., 2008. The cyclical behaviour of European bank capital buffers. *Journal of Banking and Finance*, 32, 1440-1451.

Kashyap, A. K., Stein, J. C., Hanson, S., 2010. An Analysis of the Impact of "Substantially Heightened" Capital Requirements on Large Financial Institutions. *mimeo*.

King, M. R., 2010. Mapping capital and liquidity requirements to bank lending spreads. *BIS Working Papers*, No 324.

Memmel, C., Raupach P., 2010. How Do Banks Adjust Their Capital Ratios? *Journal of Financial Intermediation*, 19(4), 509-528.

Miles, D., Yang, J., Marcheggiano, G., 2010. Optimal bank capital. *Bank of England Discussion Paper* 31.

Peek, J., Rosengren, E., 1995a. Bank regulation and the credit crunch. *Journal of Banking and Finance*, 19, 679-692.

Peek, J., Rosengren, E., 1995b. Neither a Borrower nor a Lender Be. *Journal of Money, Credit and Banking,* 27, 625-638.

Peek, J. and Rosengren, E., 1997. The International Transmission of Financial Shocks: The Case of Japan. *The American Economic Review*, 87, 495-505

Peek, J. and Rosengren, E., 2000. Effects of the Japanese Bank Crisis on Real Activity in the United States. *The American Economic Review*, 90, 30-45

Puri, M., Rocholl, J., Steffen, S., 2010. Global retail lending in the aftermath of the US financial crisis: distinguishing between supply and demand effects. *Journal of Financial Economics*, 100(3), 556-578.

Shrieves, R. E., Dahl, D., 1992. The relationship between risk and capital in commercial banks. *Journal of Banking and Finance*, 16, 439-457.

Shrieves, R. E., Dahl, D., 1995. Regulation, Recession and Bank Lending Behaviour: The 1990 Credit Crunch. *Journal of Financial Services Research*, 9, 5-30.

Thakor, A. V., 1996. Capital Requirements, Monetary Policy and Aggregate Bank Lending: Theory and Empirical Evidence. *The Journal of Finance*, 51:1, 279-324.

Wall, L. D., Peterson, D. R., 1995. Bank holding company capital targets in the early 1990s: The regulators versus the markets. *Journal of Banking and Finance,* 19, 563-574.

Ötker-Robe, I., Pazarbasioglu, C., Buffa di Perrero, A., Iorgova, S., Turgut, K., Le Leslé, V., Melo, F., Podpiera, J., Sacasa, N., Santos, A., 2010. Impact of Regulatory Reforms on Large and Complex Financial Institutions. *IMF Staff Position Note*, November 3, 2010.

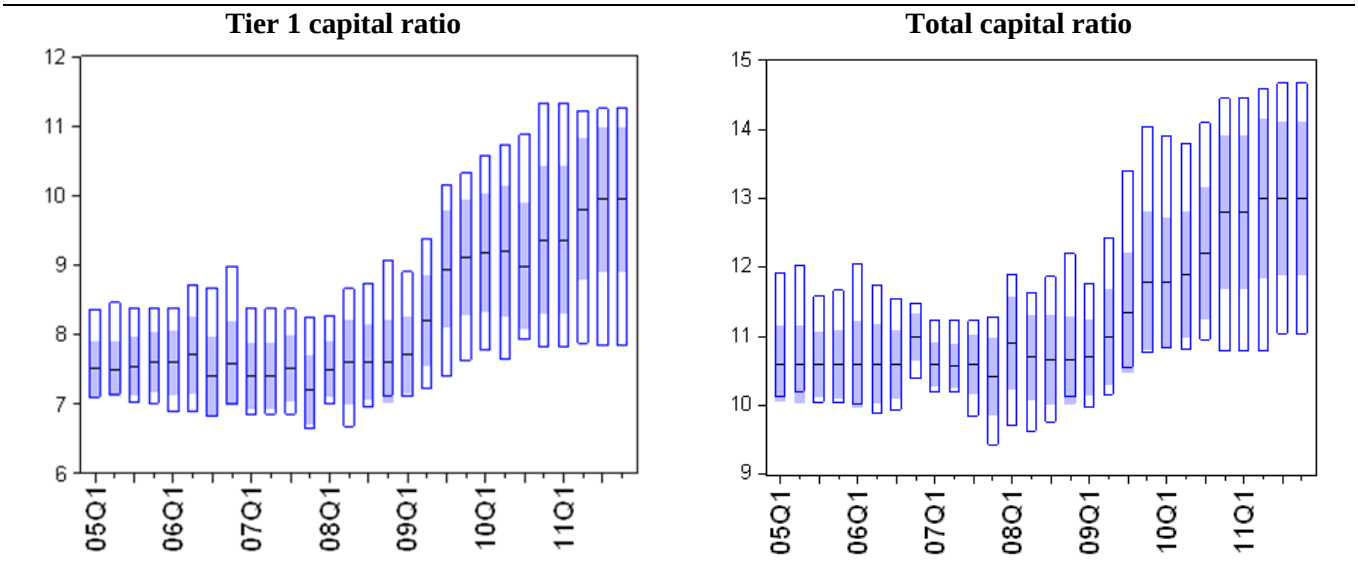
APPENDIX - TABLES AND CHARTS

Table 1 – Balance sheet structure of listed euro area banks included in the sample and of euro area credit institutions (2005Q1–2011Q4, %)

Assets	Average		Correlation	***Liabilities***	Average		Correlation
	Listed banks	Credit institution			Listed banks	Credit institution	
Loans	39.3	39.8	98.9	Capital and reserves	3.9	6.0	98.6
Interbank loans	8.9	20.0	70.5	Deposits	36.5	32.2	97.7
Total investments / securities holding	41.5	17.8	89.2	Interbank funding	18.5	21.5	62.3
Cash	1.5	0.2	72.6	Wholesale funding	13.1	16.6	91.3
Other assets	8.8	22.3	44.7	Other liabilities	28.1	23.8	96.8

Source*: Authors' calculations based on MFI balance sheet statistics (ECB) and Datastream of Thomson Reuters.*
Notes*: Data on listed euro area banks is at group level, while data on credit institutions includes parent banks, branches and subsidiaries separately. For data on listed euro area banks, other assets are defined by deducting cash, total investment and total (net) loans from total assets. Similarly, other liabilities are defined by deducting deposits, total debt and common shareholder equity from total assets. Interbank funding is approximated with short-term debt as reported by Datastream. In MFI balance sheet statistics, holding of securities refer to securities issued by euro area residents, while securities issued by non-euro area residents are classified under the external assets. Other assets contain external, fixed and remaining assets, while other liabilities include total deposits to central government, external and remaining liabilities.*

Chart 1 – Tier 1 ratio and total capital ratio for listed euro area banks (%)



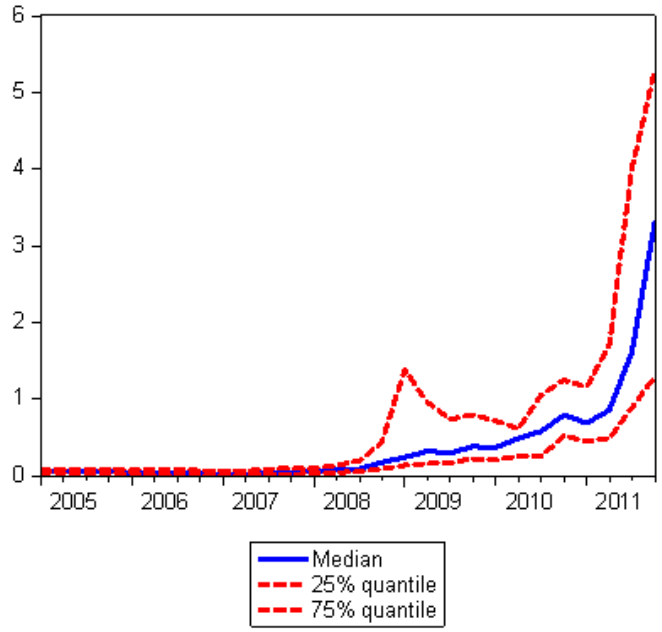
Source: *Authors' computations based on Datastream.*
Notes: *Individual capital ratios are calculated according to supervisors' current regulations and definitions and reported by banks. A capital ratio is calculated by dividing Tier 1 capital or total capital with risk-weighted assets. The horizontal line in the bars represents the median of the distribution and the blue area the 95% interval confidence. The limits of the boxplots indicate the first and the third quartile of the distribution.*

Table 2 – Summary statistics of some bank-specific variables used in the estimation *(2005Q1–2011Q4, %)*

	Average	Median
Return on equity (ROE)	8.67	9.92
Risk weight	64.50	67.41
Expected Default Frequency (EDFs)	0.68	0.10
Tier1 capital ratio	8.57	7.55
Total capital ratio	11.41	10.76

Source: *Authors' computations based on Datastream.*

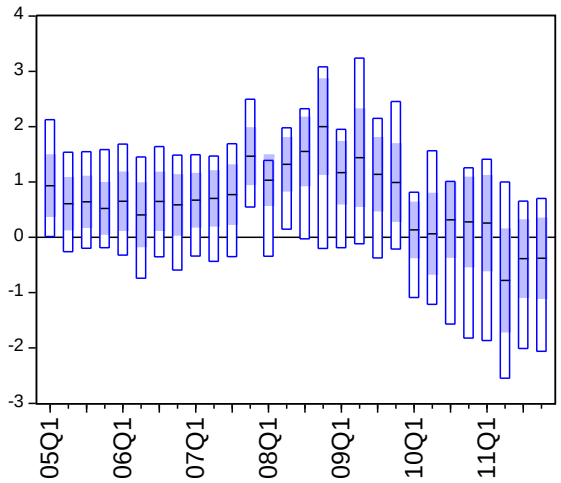
Chart 2 – Expected Default Frequency (EDF) of listed euro area banks *(probability of default within the next twelve months, percentages)*



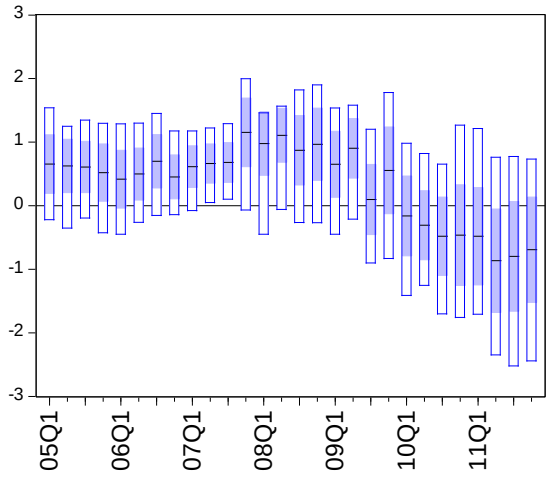
Sources: *ECB calculations based on Moody's KMV.*
Notes: *EDF values are based on the information from the interval between 0.02% and 20% as there is not enough information at the tails to derive precise values of EDFs.*

Chart 3 – Estimates of the capital gap for banks included in the sample *(p.p.)*

a) Tier 1 capital ratio



b) Total capital ratio



Source: *Authors' calculations.*
Notes: *Latest observation is 2011Q4. The capital gap is expressed in terms of percentage points (i.e. the needed capital over risk-weighted assets). A positive value indicates a capital shortfall, indicating that banks' actual capital ratio is below the target. The horizontal line in the bars represents the median of the distribution and the blue area the 95% interval confidence. The limits of the boxplots indicate the first and the third quartile of the distribution.*

Table 3 – Determinants of target Tier 1 capital ratio

	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5
Lagged capital ratio	0.86	0.83	0.77	0.86	0.94
	[0.03]***	[0.03]***	[0.03]***	[0.03]***	[0.02]***
Change in retained earnings over total assets	0.07	0.03	0.03	..	..
	[0.07]	[0.07]	[0.06]	..	..
Provisioning over total assets	1.32	..	..	1.38	..
	[0.40]***	..	..	[0.40]***	..
Expected default frequency (EDF)		0.08	..	..	..
	..	[0.02]***	..	..	..
Log-odds EDFs		..	0.15	..	..
	..	..	[0.02]***	..	..
Change in return on equity	..	..	..	0.01	0.01
	..	..	..	[0.01]	[0.01]
Total investments over total assets	..	..	..	..	0.13
	..	..	..	..	[0.09]
Constant	1.05	1.35	2.94	1.09	0.51
	[0.21]***	[0.23]***	[0.38]***	[0.22]***	[0.13]***
No. of observations	756	728	728	756	756
Cross section	27	26	26	27	27
Sargan J-test statistics	5.81	4.98	2.57	3.70	6.94

Notes: *Estimation period covers 2005:1─2011:4. Standard deviation of the estimate under the point estimate into bracket. (*), (**), (***) indicates statistical significance at 10%, 5%, 1%. The Sargan J-statistics indicates the validity of the model. The critical value for Sargan J-test is 41.34 (42.56) with 28 (29) degrees of freedom at significance level of 5%, indicating that all instruments are valid.*

Table 4 – Determinants of target Total capital ratio

	Equation 1	Equation 2	Equation 3
Lagged capital ratio	0.67	0.60	0.52
	[0.05]***	[0.05]***	[0.06]***
Change in retained earnings over total assets	0.15	0.09	0.10
	[0.13]	[0.13]	[0.13]
Provisioning over total asset	2.03	..	..
	[0.76]***	..	..
Expected default frequency (EDF)	..	0.18	..
	..	[0.04]***	..
Log-odds EDFs	..	..	0.28
	..	..	[0.04]***
Constant	3.59	4.50	7.34
	[0.51]***	[0.59]***	[0.90]***
No. of observations	756	728	728
Cross section	27	26	26
Sargan J-test statistics	15.11	10.26	6.41

Notes: *Estimation period covers 2005:1─2011:4. Standard deviation of the estimate under the point estimate into bracket. (*), (**), (***) indicates statistical significance at 10%, 5%, 1%. The Sargan J-statistics indicates the validity of the model. The critical value for Sargan J-test is 41.34 (42.56) with 28 (29) degrees of freedom at significance level of 5%, indicating that all instruments are valid.*

Table 5 – Balance sheet adjustments based on Tier 1 capital gap

	NET LOANS	SECURITIES
Capital gap	-2.78	-8.2
	[1.66]*	[3.35]**
Lagged nominal GDP growth	0.44	0.14
	[0.17]***	[0.13]
BLS credit demand NFCs realised	0.07	..
	[0.02]***	..
Annual growth in stock prices	..	0.09
	..	[0.05]**
Lagged explained	-0.31	-0.41
	[0.16]**	[0.17]**
Constant	6.60	11.01
	[2.06]***	[4.00]***
Long run impact of the capital gap	2.126	5.816
No. of observations	624	648
Cross section	26	27

Notes: *Estimation period covers 2005Q1 to 2011Q4. Standard deviation reported under the point estimate into brackets. (*), (**), (***) indicates statistical significance at 10%, 5%, 1%. Net loans exclude interbank loans. NFCs stand for non-financial corporations. Two dots mean that the variable was not used in the model.*

Table 6 – Balance sheet adjustments based on Total capital gap

	NET LOANS		SECURITIES
	Equation 1	Equation 2	Equation 1
Capital gap	-2.93	-2.74	-10.00
	[1.23]**	[1.05]***	[4.04]**
Lagged annual growth in real GDP	..	0.66	..
	..	[0.25]***	..
Lagged nominal GDP growth	0.61	..	0.12
	[0.24]**	..	[0.15]
BLS credit demand NFCs realised	0.06	0.08	..
	[0.02]**	[0.02]***	..
Annual growth in stock prices	..	..	0.13
	..	..	[0.05]**
Lagged explained	-0.29	-0.33	-0.42
	[0.16]*	[0.17]*	[0.19]**
Constant	5.09	4.98	5.61
	[1.05]***	[0.98]***	[2.02]***
Long run impact of the capital gap	2.262	2.061	7.050
No. of observations	648	648	648
Cross section	27	27	27

Notes: *Estimation period covers 2005Q1 to 2011Q4. Standard deviation reported under the point estimate into brackets. (*), (**), (***) indicates statistical significance at 10%, 5%, 1%. Net loans exclude interbank loans. NFCs stand for non-financial corporations. Two dots mean that the variable was not used in the model.*