DOCUMENT

DE TRAVAIL

N° 499

BANK CAPITAL ADJUSTMENT PROCESS

AND AGGREGATE LENDING

Thibaut Duprey and Mathias Lé

July 2014

BANQUE DE FRANCE

EUROSYSTÈME

DIRECTION GÉNÉRALE DES ÉTUDES ET DES RELATIONS INTERNATIONALES

DIRECTION GÉNÉRALE DES ÉTUDES ET DES RELATIONS INTERNATIONALES

BANK CAPITAL ADJUSTMENT PROCESS

AND AGGREGATE LENDING

Thibaut Duprey and Mathias Lé

July 2014

Bank Capital Adjustment Process and Aggregate Lending *

Thibaut Duprey†

Mathias Lé‡

*The opinion expressed herein may not reflect the view of the Banque de France nor the Autorité de Contrôle Prudentiel et de Résolution. Any comments are warmly welcome. We wish to thank Christophe Hurlin, Jean Imbs, Claire Labonne, Jean-Stéphane Mesonnier, Moritz Schularick, Fabrizio Spargoli and Yanos Zylberberg for valuable comments as well as seminar participants at the Paris School of Economics, the Banque de France, the ADRES conference, the 7th Financial Risk Forum, the 3rd MoFiR workshop and the 2014 SoFiE conference on "systemic risks and financial regulation".

†Banque de France and Paris School of Economics. E-mail : `thibaut.duprey@gmail.com`.

‡Autorité de Contrôle Prudentiel et de Résolution and Paris School of Economics. E-mail : `mathias.le@acpr.banque-france.fr`.

Résumé

Le présent article propose une nouvelle mesure micro-fondée permettant de quantifier la capitalisation agrégée des secteurs bancaires en considérant à la fois la discipline de marché et les contraintes réglementaires. Cette mesure permet d'étudier l'impact des déficits de capitaux au niveau microéconomique sur le volume de prêt agrégé au niveau macroéconomique. (i) Notre indicateur est cohérent avec l'approche qualitative de l'enquete trimestrielle de la BCE sur la distribution du crédit. (ii) Cet indicateur est corrélé avec les fluctuations futures du volume de prêts agrégé, particulièrement lorsqu'un système bancaire se trouve sous-capitalisé. (iii) L'ajustement des banques qui sont contraintes par leur niveau de capital impacte principalement les prêts aux agents non financiers sur le marché domestique. Ainsi notre mesure suggère que (a) les exigences de capital contra-cycliques pourraient être moins efficaces lorsque les contraintes de marché s'avèrent plus importantes, et (b) l'évolution des bilans bancaires à plus basses fréquences peut aider à détecter les vulnérabilités et les retournements dans le cycle du volume de prêts agrégé.

Mots-clefs : cible de capital des banques, panel dynamique, enquête auprès des banques sur la distribution du crédit, volume de prêt agrégé, indicateur avancé de crise.
Code JEL : C23, E51, G01, G21.

Abstract

This paper proposes a new micro-founded measure to quantify the aggregate capitalisation of banking sectors taking into account both market discipline and regulatory constraints. It allows studying the connection between micro capital shortfalls from an implicit bank specific capital target and macro impacts of capital shortages on aggregate lending. (i) Our quantitative country-wide index of bank capitalisation is consistent with the qualitative reports of the ECB Bank Lending Survey. (ii) This index correlates with future fluctuations in aggregate lending, especially when a banking system is under-capitalised. (iii) The adjustment of capital constrained banks mostly impact loans to domestic non-financial agents. Thus our measure suggests that (a) countercyclical capital requirements may be less effective if market constraints are more important, and (b) slow moving balance sheet variables can help detect vulnerabilities and reversals in the lending cycle.

Keywords : implicit bank capital target, dynamic panel model, bank lending survey, aggregate lending, early-warning indicator.
JEL Classification : C23, E51, G01, G21.

Executive summary

We investigate the extent to which a banking system facing both regulatory and market capital constraints has real consequences for the economy. Our approach tackles two issues so far largely unexplored. First capital constrained banks may not impact aggregate lending if their lending activity can be absorbed by competitors. This degree of substitutability across financial intermediaries is indeed one of the five broad measures used to identify systemic institutions (BCBS, 2013). Second, most banks hold a buffer above the time-invariant regulatory minimum, but may nonetheless feel capital constrained. Our estimation strategy allows recovering a bank specific and time-varying targeted capital ratio so that one can investigate capital needs throughout the cycle. Deviations from the targeted capital ratio may have a non-trivial impact on lending even if banks meet their regulatory requirements.

Our index captures one of the potential source of lending fluctuations – namely capital constraints related to implicit targets – as well as one of the potential source of excessive risk-taking – namely the inappropriate provisioning of bank capital as lending growth accelerates. To that extent, the measure is likely to be useful both for predicting credit tightening and signalling looming weaknesses. The measure shows that most European countries experienced an important reduction of their aggregate bank capitalisation between 2005 and 2007 and became largely under-capitalised from 2008 onwards. As revealed by the Bank Lending Survey, our indicator of aggregate capitalisation is consistently and significantly correlated with banks' anticipations about lending standards' tightening driven by their capital position. On average, when banks' capital position deteriorates by 1 percentage point of risk weighted Tier 1 capital compared to their target, the growth rate of aggregate lending decreases by about 0.9 percentage points. This relation between aggregate capital shortages and fluctuations in aggregate lending is driven by under-capitalised banking systems and is mostly relevant for aggregate lending to domestic non-financial agents.

The policy implications are twofold. First the bank capital channel should not only focus on minimum capital requirements but also take into account the perception of the bank and market participants as to the correct level of bank capital. Indeed an increase in the market pressure to hold more capital, irrespective of the regulatory minimum, can limit the ability of banks to expand credit and the resulting balance sheet adjustment may trigger a banking or real crisis. As such, countercyclical bank capital requirements may not be sufficient to avoid a credit crunch. Second, our aggregate measure of a banking system capitalisation suggests that bank balance sheet variables, so far largely overlooked, should also be considered for financial stability purposes in order to monitor credit cycle reversals, along with the usual credit or housing variables.

1 Introduction

During the recent financial crisis, we observed an important procyclical de-leveraging process in the banking sector (Adrian and Shin, 2010) despite the large capital infusions from governments (Ivashina and Scharfstein, 2010; Puri et al., 2011). The credit supply started to slowdown leading to a credit crunch in some countries. As a consequence, Basel III regulation emphasises minimum capital requirements that turned out being too low (Admati et al., 2010) and excessively pro-cyclical (Repullo and Suarez, 2013).

Against this backdrop, the present paper investigates the extent to which an under-capitalised banking system facing *both* regulatory and market capital constraints has real consequences for the economy. Despite the importance of the question, the literature remains relatively open in terms of moving from the analysis of individual bank capital regulation to the study of aggregate effects on the macroeconomy once compensation effects are taken into account. We focus on the impact of individual bank capital adjustment on the aggregate lending using a sample of European countries. Importantly, we examine the fluctuations of capital ratios around a bank specific *implicit target*. Indeed, for most banks, the regulatory capital requirement is not binding. It does not mean however that these banks are not capital constrained. Market forces are very likely to constrain banks to hold an institution-specific buffer over the regulatory minimum. As a consequence, each bank targets an implicit level of capital ratio resulting from market discipline and bounded below by regulatory requirements.

In this paper we want to assess the informational content of the fluctuations around these implicit targets to characterize and possibly predict fluctuations of aggregate lending. It is important because a banking system whose banks have a high enough regulatory capital ratio may nonetheless have large deviation from their individual target, that is to say market discipline may lead to potentially large fluctuations in the credit supply. From a macro-prudential perspective, these fluctuations around the target must be tracked and monitored as minimum capital requirements themselves are not sufficient measures of capital constraints.

We implement a stepwise empirical strategy. In a first step, we investigate the bank capital adjustment process at the bank level in a *partial* adjustment framework that is rationalized by a simple cost-benefit analysis with adjustment costs. We thus estimate these bank-specific *implicit targets* as well as the adjustment speed by using (i) a set of observables from bank balance sheets, (ii) a bank-specific time-invariant component and (iii) yearly fixed effects. It allows us to compute for each bank and for each period what we called the *deviation* from the estimated optimal target, i.e. the difference between the effective capital ratio and its predicted implicit target.

In a second step, we build an indicator reflecting the under- or over-capitalisation of banking systems at the country level by aggregating these individual deviations. Using an aggregate measure allows us to overcome possible compensation effects at the bank level whereby lending reductions by some banks could be absorbed by unconstrained competitors. We can thus investigate the relations between aggregate capitalisation and changes in aggregate lending, lending between sectors (MFI versus non-MFI) and across counterparties (domestic versus other countries). Our index captures one of the potential source of lending fluctuations – namely capital constraints related to implicit targets – as well as one of the potential source of excessive risk-taking – namely the inappropriate provisioning of bank capital as lending growth accelerates. It can be understood as being the flip side of excessive lending growth captured for instance by the credit-to-GDP gap. To that extent, the measure is likely to be both a good predictor of future credit tightening as well as a good predictor of crises.

Our main findings are the following. First, our aggregate capitalisation measure indicates that most European countries experienced an important reduction of their aggregate capitalisation index between 2005 and 2007 and became largely under-capitalised from 2008 onwards, which is the most basic feature we expect from this measure.

Second, our indicator of aggregate capitalisation is consistently and significantly correlated with the Bank Lending Survey. This survey provides "*information on supply and demand conditions in the euro area credit markets and the lending policies of Euro area banks*".[1] In particular, banks in a given country report to tighten their lending standards because of capital constraints precisely at the time when our measure indicates that this country is under-capitalised.

Third, and most importantly, we capture an economically and statistically significant relation between our aggregate capitalisation index relying on balance sheet information at the end of year $t-1$ and the change in aggregate lending between the end of year $t-1$ and the end of year t. When the aggregate capitalisation index decreases by 1 percentage point, the growth rate of aggregate lending decreases by 0.918 [confidence bands 0.267-1.568] percentage points, which corresponds to roughly 15% of the average change in aggregate lending. Alternatively, a change in the aggregate capitalisation index by one standard deviation induces a change in the growth rate of aggregate lending corresponding to 35% of its standard deviation.

Fourth, this relation between aggregate capital deviations and fluctuations in aggregate lending is mostly relevant for aggregate lending to non-MFI – i.e. households, corporate sectors and governments – and in particular to *domestic* non-MFI. Given that lending to non-MFI represents 67% of the aggregate lending in the European countries, among which 86% is domestic lending, it is important for national supervisors to closely

1. Only data aggregated at the country level are available at http://www.ecb.int/stats/money/surveys/lend/html/index.en.html

monitor these fluctuations in the aggregate capitalisation of banks.

Last, we observe that these co-movements are mainly driven by under-capitalised banking systems. In countries/periods where banks are below their target on average, the growth rate of aggregate lending tends to decrease significantly. We do not observe such a pattern during episodes of aggregate over-capitalisation. Indeed, when banks have a capital surplus, and even if the demand for loans is low, they can easily reduce their excess capital via other channels (equity buy-back for instance). Conversely, banks facing a capital shortage are more prone to deleverage by cutting their lending to the private sector rather than raising (costly) additional capital. Overall these results are consistent with the idea that market discipline, on top of regulatory constraints, induces important and procyclical adjustments towards implicit bank capital targets.

We contribute to the literature in at least two ways. On the one hand, this new measure of the adequate capitalisation of a banking sector is simple, easily replicable and can be computed on any sample of banks' balance sheet statements. More importantly, our measure is a useful complement to other recent indicators about the impact of capital shortfall (MES and SRISK for instance Acharya et al., 2012) for three related reasons. First, it is based on balance sheet statements, while most of the recent indicators rely on market data on the subset of publicly traded banks. Second balance-sheet based measures are more appropriate to gauge slow moving changes in banking systems soundness that are likely to impact the credit cycle, while market based indicators available at a higher frequency are more appropriate to identify market risk and changes of market's perceptions. Last, our indicator features mean reversion by construction and thus might better be able to capture endogenous efforts by banks to adjust their capitalisation to a time-varying target, while existing measures of individual bank capitalisation do not usually estimate capitalisation needs through the cycle.

On the other hand, the aggregate capitalisation indicator proposed in this paper is an interesting example of a bridge between micro and macro-prudential analyses. We identify endogeneous fragilities at the micro level and aggregate them in order to assess how these micro fragilities can translate into aggregate risk. For instance, consider a case where all the banks are slightly under-capitalised and another case where one bank is largely under-capitalised while the others are slightly over-capitalised. A micro-prudential analysis will mainly detect a problem in the second case while the first situation could also have important consequences for the real economy.

The findings of the paper have two important policy implications. First the bank capital channel should not only focus on minimum capital requirements but also take into account the perception of the bank and market participants as to the correct level of bank capital. Indeed an increase in the market pressure to hold more capital, for a constant regulatory requirement, would limit the ability of banks to expand credit and the resulting balance sheet adjustment could trigger a banking or real crisis. As such, countercyclical bank capital requirements may not be sufficient to avoid a credit crunch. Second, our aggregate measure of a banking system capitalisation suggests that bank balance sheet variables should also be considered for financial stability purposes in order to monitor credit cycle reversals, along with credit or housing variables.

The next section reviews the literature[2] that tries to estimate the impact of capital shortfall on bank lending. Section 3 and 4 respectively describe the data and the methodology used in the paper. Section 5 displays the results of the paper and section 6 concludes.

2. Readers familiar with this literature can skip it.

2 Relevant literature

2.1 Capital constraints and individual bank lending

Effect of capital constraints on individual bank lending volumes. The existing literature already extensively investigated the effects of capital constraints on individual bank lending volumes. The most clear cut evidence is the quasi-natural experiment used by Peek and Rosengren (1997). As a result of the implementation of Basel I regulation, latent gains on common equity holdings could qualify as Tier 2 capital. Thus as Japanese stock markets kept rising in the 1980s, branches of Japanese banks were left with capital in excess of the regulatory minimum which allowed them to expand their activities in the USA. But when stock market collapsed between 1989 and early 1992, many Japanese banks struggled to meet the 8% minimum requirements and had to cut on their lending activities overseas; a 1%pt reduction in the capital ratio of the Japanese parent led to a 6% decline in lending by US branches. Another compelling evidence is given by Houston et al. (1997) who look at the evolution of bank lending after capital shocks orthogonal to the demand side as they focus on those that occurred at other banks owned by the same bank holding company.

Effect of bank capital on output via lending spreads. An alternative is to focus on the effect of bank capital on lending spreads. Indeed, the frictions associated with raising new external equity finance are likely to be greater than the ongoing costs of holding equity on the balance sheet, such that lending spreads should reflect this temporary increase in funding costs. But in the long run, Kashyap et al. (2010) find that the impact of a ten percentage-point increase in the capital requirement is associated with a modest increase of the range of 25 to 45 basis points on loan rates.

Several studies tried to investigate the effect of regulatory capital constraints in the framework of the new Basel III recommendations to tighten capital requirements. A few studies focus on the overall long term impact, which includes the effect of a reduction in the probability of a banking crisis when banks are better capitalised (Barrell et al., 2009; BCBS, 2010a). But most studies focus on the cost of tighter capital regulation in the short run, during the transition phase. In particular, the standard transmission channel for those quantitative impact studies goes from increased capital that translates into larger lending spreads and thus increases the cost of credit. The Macroeconomic Assessment Group (MAG, 2010) performs a meta-analysis of various DSGE or VAR models and rely exclusively on aggregate data; they find a cost during the transition period of -0.19% (absent any reaction of the monetary authorities) on the GDP of Eurozone countries for an additional percentage point of bank capital. At the other end of the spectrum, the IIF (2011) finds a impact of -3% on GDP for the Eurozone. In a more long term prospective, Angelini et al. (2011) find a median effect of -0.12% on GDP for an additional percentage point of bank capital.

But most of those studies rely on the hypothesis that banks aim at keeping constant their return on equity (ROE) and thus abstract from any behavioural dynamics in the adjustment of their capital structure. Thus Admati et al. (2010) argue that higher capital holding must go hand in hand with a lower cost of external finance and a lower riskiness of bank capital, which should eventually decrease the market required ROE. Kashyap et al. (2010) rely on a step-wise procedure; they project the market beta as well as the idiosyncratic return volatility to get their response to changes in book to market equity ratio, which then allows them to adjust the cost of equity accordingly, before converting this cost one to one into lending spreads. Their conclusion is that frictions associated with capital adjustment, more than the level of equity itself, is likely to impact lending rates. Both papers suggest that bank capital choices should come as a result of a dynamic process with frictions to adjust in the short run; to some extent, this is the route taken by the present paper with a partial adjustment process of bank capital updated each period subject to frictions preventing a full adjustment.

Effect of bank capital on the cross-section of lending. The third approach is to look at the evolution of lending in the cross-section of banks as capital position evolves. Bernanke and Lown (1991) is one representative example of this literature that compares the reaction to capital shocks of lending by different groups of banks. They focus on small and large banks in New Jersey during the 1990-1 recession and conclude that the capital position is largely uncorrelated with lending by large banks, while the reverse is true for small banks.

More recently Francis and Osborne (2012) focus on the effect of regulatory capital requirement on lending and balance-sheet management. For this purpose, they take advantage of a specific feature of the UK regulatory framework. Indeed, in addition to the 8% capital ratio of Basel II, the FSA and the Bank of England have established bank-specific and time-varying capital requirements. In other words, the regulator monitors each bank and asks them to implement an individual capital ratio reflecting their idiosyncratic risk-taking. It allows the authors to estimate a partial adjustment model [3] of bank capital that depends on bank-specific features, including the individual capital requirement set by the regulator. Thus they estimate the unobserved internal capital target of banks and find that these bank specific capital requirements matter for the bank capital target, and banks even hold a buffer on the top of it. Their results support the idea that banks holding a capital surplus face less constraints in their ability to lend and grow, and that banks rather adjust the composition than the volume of their assets' portfolio.

The effect of bank capital on lending is also investigated by Berrospide and Edge (2010). They use the US data on Bank Holding Companies to estimate a classical loan

3. The partial adjustment formulation was proposed by Flannery and Rangan (2006) for firms.

growth equation taking into account both supply and demand factors in which they focus on the capital variable. They compare two distinct ways of modelling the channel going from capital to lending. First they use the Hancock and Wilcox (1993) and Hancock and Wilcox (1994) framework in which bank capital impacts bank lending through the divergence between the actual level of capital and the desired level of capital. This methodology is similar to the one of Francis and Osborne (2012). Second, they build on the Bernanke and Lown (1991) framework in which the capital-to-asset ratio affects loan growth directly. The rationale for using this second specification is related to the possible identification issues present if the target capital-to-asset ratio is misspecified. Conversely, using the deviation from internal targets offers the advantage of mitigating potential endogeneity issues because most of these endogenous relations are captured in the target component. They find a significant but relatively small effect of bank capital on lending : their estimated elasticity of lending with respect to capital goes from 0.7 to 1.86.

Effect of banks' own perception of their capital constraints. An alternative way to quantify the link between capital and lending uses qualitative surveys reflecting banks' own assessment. Bassett and Covas (2013) propose to exploit the bank-level responses to the Federal Reserve"s Senior Loan Officer Opinion Survey on Bank Lending Practices. [4] They report that an increase of minimum regulatory capital from 6% to 8.5% is associated with a rise in the probability that a bank tightened lending standards by 40%. Similarly loan growth by banks reporting a tightening of their lending standards due to capital concerns appears to be 4 percentage points lower than loan growth of banks that do not feel capital constrained. A similar route using the French Bank Lending Survey is taken by Labonne and Lame (2014).

The relevant question is now to bridge the gap between micro evidences of the impact of bank capital on bank lending with the macroeconomic impact on the overall economy. The most challenging question is probably the extent to which capital constraints in the banking sector favour a migration of activities to the shadow banking sector, raising concerns about the ability to monitor the evolution of risks. The somewhat less heroic but nonetheless significant contribution of this paper is to analyse the impact of bank capitalisation on overall macroeconomic conditions and investigate to which extent the gap between micro and macro analysis can be driven by some compensation effect between financial institutions, for which data are available, which de facto excludes off-balance sheet items that belong to the shadow banking sector.

4. However, banks participation to this type of survey is typically not systematic overtime, and for the US version only banks reporting a change in their lending standards are included.

2.2 The bank capital adjustment trade-off

Bank leverage choices can be understood as an adjustment cost story with costs/benefits to deviate from an optimal level. [5]

The choice of leverage and the adjustment process of banks differs sensibly from the one of firms, which have been extensively analysed (Byoun, 2008; Faulkender et al., 2012a; Flannery and Rangan, 2006) for at least two reasons. First, contrary to firms, banks have access to a very large source of funding, namely deposits. As shown by Diamond and Dybvig (1983), the demand deposit contract creates liquidity on both sides of the balance sheet. In the presence of a deposit insurance scheme, deposits are under-priced and banks have strong incentives to operate with a larger leverage ratio (Lé, 2013). Second, unlike non-financial corporations, banks are subject to a very strict capital regulation which creates an external constraint on the targeted leverage as well as on the adjustment dynamic towards this targeted leverage.

Regulating leverage means that the Modigliani-Miller (thereafter MM) does not hold as it implies that one is not indifferent between debt and equity capital as funding sources. Two reasons can explain this imperfect substitutability. First in most countries, there are standard tax distortions that favours debt over equity. Second, in the specific case of banks, the guarantees that debt-holders derive from explicit or implicit government support also induce a preference for debt over equity. Nevertheless, regulating capital may suppose the MM theorem is not completely irrelevant as one can hope that, as leverage decreases (keeping the portfolio allocation constant), the bank riskiness would be spread over a larger equity cushion which should imply lower risk-premium, so that there indeed exists some degree of substitution between debt and equity. So there should be a positive relationship between the risk borne by capital and leverage (Kashyap et al., 2010, Admati et al., 2010).

Due to the specific nature of banks, it seems reasonable to consider that a bank may want to reach a target capital or leverage ratio resulting both from market discipline and from regulatory constraints. To that extent, it is convenient to think in terms of adjustment costs depending on whether the bank is above or below its target. First if the bank is over-capitalized/under-leveraged, i.e. holds capital in excess over its target, the bank faces an opportunity cost : it could save some costs by reducing its capital level because MM does not hold. So the bank has no incentives to remain above its targeted capital ratio : the bank can increase its return on equity at no cost and leverage up either by repurchasing shares, increasing its risk taking or its assets (see for instance the contemporaneous paper by Kok and Schepens (2013) on the asymmetric channels of adjustment towards the target). Second, if the bank is under-capitalized/over-leveraged,

5. We propose here a simplistic derivation which helps understand the key mechanism at stake. It shows that a profits maximising bank naturally implies an estimation strategy based on a partial adjustment model (see Appendix A).

i.e. has a capital deficit with respect to its target, it may face both regulatory and market constraints, the stigma generated by the former intensifying the pressure by the latter. This translates into higher uncertainty and riskiness leading to higher interest rates on debt which should push banks to de-leverage. This mechanism is the focus of a full fledge macro model in Duprey (2014) from which the same type of bank capital target as the one we focus on here can be recovered.

3 Data

We use two main data sources. To examine the capital adjustment dynamics at the micro-level, we use Bankscope. Bankscope is a well-known proprietary database collecting balance sheet statements across a large sample of countries. The coverage goes from 1985 until today, but the most comprehensive dataset is only available from 1995 until the year 2011. We make some important restrictions before running our analysis.

First, we only consider commercial banks, savings banks, cooperative banks and bank holding companies. Second, we only use the *consolidated balance sheet statements* as it is more likely that the bank capital adjustment takes place at the group level than within each subsidiaries.[6] It will also makes the analysis more consistent given that the MFI statistics we used in the aggregate analysis (see just below) are collected by the ECB on a consolidated basis within a country but excluding consolidation across national boundaries.[7] Finally, it worth to note that banks providing only unconsolidated statements are far much smaller than those providing consolidated statements : the average size of the former is only 0.021% of the average size of the latter. As said in the introduction, we only keep banks operating in countries belonging to the European Union. We also exclude banks with less than 5 observations for econometric purpose, as well as few observations reporting irrelevant information.[8] An extensive presentation of the main issues concerning the Bankscope dataset as well as some preliminary treatments can be found in Duprey and Lé (2014). Finally, because Tier 1 capital ratios, which is our main variable of interest, are sometimes missing in Bankscope, we complement the Bankscope data with Tier 1 ratios taken from Bloomberg when necessary.

To run the macro-level analysis, we use the aggregated balance sheet of Monetary Financial Institutions (MFI) of the European Union provided by the ECB.[9] These data are broken down into loans provided *domestically*, those provided to *other European Union countries* and those provided to counterparts located *outside the European Union*.[10] ECB data also distinguish between lending to MFIs and non-MFIs.[11] Table 12 in appendix provides detailed decomposition of aggregate lending along these various dimensions.

Note also that the MFI statistics include data from Credit Institutions as well as

6. However we use unconsolidated statements to fill gaps in the series when consolidated statements are not available

7. See https://www.ecb.europa.eu/pub/pdf/other/manualmfibalancesheetstatistics201204en.pdf?297b4dfd01572b9c47539166c784ff5e

8. We drop observations which feature a growth rate below -100% and discard observations with growth rates above 100% as it is likely to be driven by exogenous reasons like M&A.

9. https://www.ecb.int/stats/services/escb/html/index.en.html or http://sdw.ecb.europa.eu/browse.do?node=2019173

10. For the specific case of Denmark, ECB statistics only provide domestic lending aggregates and non-EU aggregate lending. Hence, we will exclude it from the aggregate analysis

11. Loans to non-MFI, whether domestic or located in the other European Union countries, include loans to households, corporate sector and governments.

Money Market Funds.[12] Ideally, we would like to abstract from the latter because we have no equivalent data in Bankscope. However, the Euro area stock of loans granted by Money Market Funds (MMF) amount to roughly 0.5% of the one granted by Credit Institutions in 2013.[13] While we cannot exclude some heterogeneity at the country level, these figures indicates that the share of loans granted by MMF can be considered as negligeable in our analysis.

The matching between the micro balance sheet statements and the aggregated statistics is imperfect however. In the graph 1, we plot the ratio of the total loans from our sample at the country-year level over the aggregate lending provided by the ECB. For various reasons the aggregation of micro balance sheets does not match perfectly the aggregated statistics coming from the ECB. Among the reasons for which the match can be lower than 100%, there are consolidations issues[14] and composition effects in Bankscope.[15] In contrast, the representativeness can sometimes be higher than 100%. This can be explained because we include bank holding companies in the sample. Indeed these entities are likely to consolidate assets from non-bank business (insurance for instance, like ING group in Netherland). It can also be the case with some large commercial banks. We prefer to include these bank holding companies because we could otherwise miss a large part of the banking sector like Dexia in Belgium for instance.[16]

In table 1, we report the evolution of the representativeness of Bankscope averaged across the whole sample of countries over times. The matching is quite low before 2000 and it then lies between 50% and 75% but with a lot of heterogeneity across countries.[17] For instance, the match is almost perfect for Spain whereas it is very low for Germany, which could be explained by small cooperative banks that do not seem to published consolidated statements. Overall, after a parsimonious treatment, we are able to capture

12. More precisely, it also includes "other MFIs" which is said to be relatively small. See page 9 of the 2012 manual: https://www.ecb.europa.eu/pub/pdf/other/manualmfibalancesheetstatistics201204en.pdf?297b4dfd01572b9c47539166c784ff5e.

13. see data on MMF : http://sdw.ecb.europa.eu/browse.do?node=8257806

14. The numerator of the ratio is computed by summing loan data from Bankscope at the country-year level. We only keep consolidated statements, i.e. data excluding within group transaction (even if we sometimes complete bank time-series with unconsolidated data when consolidated ones are missing). This restriction may lead to an underestimation because some banks report only unconsolidated statements (as it is the case for a lot of German banks). In addition, the denominator – i.e. the aggregate lending provided by the ECB – is based on consolidated data but with two important restrictions. First only within country consolidation is allowed. Second, consolidation across sectoral boundaries is not permitted. Hence, aggregate data from ECB includes within group transactions with any counterparties from others countries as well as transactions with domestic non-MFI counterpaties.

15. In particular, it is well-known that the coverage of Bankscope within countries tends to increase over time. This feature largely explains the increasing representativeness that we observe in the graph

16. The results of this paper are entirely robust to the exclusion of these entities.

17. Concerning the case of Finland where the aggregate assets of the Finish banking sector around the years 2000 are larger than the size of the banking sector as reported by the ECB, it is entirely driven by Nordea Bank Finland Plc whose perimeter changed drastically due to major mergers & acquisitions outside the core banking activities. Then in 2002 it de-merged into five entities, one of which continued the banking business under the same name Nordea Bank Finland Plc.

roughly 70% of the aggregate lending provided by MFI within the European Union with this micro-level sample of banks. Overall, this imperfect matching between the Bankscope dataset and the ECB data must be considered in the context where no alternative banks' balance sheets data provider are available at the European level.[18] To our knowledge, we are among the first to run this exercise to gauge the representativeness of Bankscope data (see for example Bhattacharya, 2003).

We also use additional series in the aggregate analysis. We obtain the GDP in constant local currency of 2005 from the UN dataset, the inflation rate from the World Bank dataset and the VSTOXX from Bloomberg. We also impose a minor restrictions on the sample for aggregate analysis. We first drop countries for which we have not at least five years where both aggregate lending and aggregate capitalisation are non-missing. We then drop data from the Denmark because we have no aggregate lending data available. Descriptive statistics for both bank-level and country-level data are provided in table 2.

18. There is no dataset similar to the US Call Report available for the European countries

4 Empirical Strategy

In this section, we present our empirical strategy. First, we describe the methodology we use to estimate the bank specific implicit targets (4.1). We then explain briefly how we build the aggregate indicator of banking capitalisation which is the central measurement of this paper. Finally, we present the framework to analyse the aggregate relations between aggregate lending and a country's banking sector capitalisation (4.2).

4.1 Estimating the implicit target

The partial adjustment process

The first step consists in estimating the implicit target of banks using micro data. As explained previously, there are many reasons suggesting that the capital ratio of banks likely fluctuates around an unobserved target resulting from the combination of market forces and regulatory constraints. At each period t, banks observe the deviation at the end of period $t-1$ and try to close this gap during the next period, i.e. between t and $t+1$. Any deviation from the target should impose some cost to the banks, by increasing their funding costs for instance. But the adjustment may also be a costly process because of imperfect information and market frictions. Depending on this cost-benefit analysis, banks adjust more or less rapidly and they are likely to adjust only partially toward the implicit target.

Because we do not observe this implicit target, we have to approximate it. For this, we build on the literature [19] and we estimate it as a linear combination of some important (lagged) factors affecting the capital ratio (those factors that the market is likely to use to determine what it considers as the adequate level of capitalisation for a given bank), a bank fixed effect and an aggregate fixed effect. As suggested by the model (see equation 13 in Appendix A for a microfounded forward looking version) we estimate the target in a partial adjustment framework.

Denote by $k_{i,c,t}$ the capital ratio of bank i in country c at time t and $k^*_{i,c,t}$ the targeted capital ratio of bank i in country c at time t. A partial adjustment model specify that, at each period t, the bank tries to close a proportion λ of the gap between its targeted capital ratio at time t and the effective capital ratio at time $t-1$:

$$k_{i,c,t} - k_{i,c,t-1} = \lambda \cdot (k^*_{i,c,t} - k_{i,c,t-1}) + \epsilon_{i,c,t} \qquad (1)$$

Assuming that the market-required capital ratio can be correctly approximated by some observable characteristics of banks, as well as by a bank-specific time-invariant

19. For instance see Hancock and Wilcox (1993); Flannery and Rangan (2006); Berger et al. (2008); Faulkender et al. (2012b); Lepetit et al. (2012).

unobserved component ν_i and by a set aggregate time fixed effects θ_{t-1}, we model the targeted capital ratio as :

$$k^*_{i,c,t} = \beta \cdot \mathbf{X}_{i,c,t-1} + \theta_{t-1} + \nu_i \tag{2}$$

Note that the targeted capital ratio at time t depends on observables factors at time $t-1$. It makes sense because the change in capital ratio occurring *during* the year t depends on factors observed *at the end* of year $t-1$. Taken together, these two equations can be rewritten :

$$\begin{aligned} k_{i,c,t} &= (1-\lambda) \cdot k_{i,c,t-1} + \lambda \cdot (\beta \cdot \mathbf{X}_{i,c,t-1} + \theta_{t-1} + \nu_i) + \epsilon_{i,c,t} \\ k_{i,c,t} &= (1-\lambda) \cdot k_{i,c,t-1} + \tilde{\beta} \cdot \mathbf{X}_{i,c,t-1} + \tilde{\theta}_{t-1} + \tilde{\nu}_i + \epsilon_{i,c,t} \end{aligned} \tag{3}$$

The latter equation is the one we estimate. We assume that we can reasonably approximate the targeted capital ratio by using a limited but important set of bank capital determinants as well as bank-specific time-invariant component and a set of time fixed effects. The presence of bank fixed-effect in the target capital ratio is essential. Many papers have recently shown that capital ratios fluctuates mainly around a bank-specific time-invariant component, which can be viewed as a long term target (Lemmon et al. (2008), Gropp and Heider (2010) and Berrospide and Edge (2010)). We nonetheless include a set of bank balance sheet variables as well as macro covariate to allow for a more flexible dynamics of the capital ratio of banks.

First, we include *the size* (the log of total assets) because markets are very likely to require different levels of capitalisation depending on the size of the banks. Second, the optimal leverage ratio of banks strongly should depend on *the liquidity* of the assets held by banks (share of liquid assets). [20] In addition, *the source of funding* (deposits-to-assets ratio) as well as *the efficiency* (cost-to-income ratio) of banks should also affect the capital ratio required by market forces. *The profitability* of banks (ROAA) should also exert some crucial influence on the optimal capital ratio of banks required by the market. The riskiness of the assets held by banks should also influence the targeted level of capital. We proxy this dimension by the magnitude of the *Loan Loss Provision*. We also include a dummy if the bank's Tier 1 capital is currently below the required 4%. Indeed the distance to the regulatory minimum is likely to interact with market pressures, in such a way that being close to the minimum capital requirements could send a bad signal that should convince market participants to increase the pressure on banks' recapitalisation

20. Some recent papers have shed light on the relation between liquidity and capital (Calomiris et al., 2012).

and thus be associated with a larger capital target. Last, the GDP growth rate as well as the rate of inflation are included in the determinant of the bank target as capturing two key characteristics of the business cycle.

Estimation issues

Equation (3) is a dynamic panel model which raises some important estimation issues due to the presence of the lagged term for the capital ratio. It is well-known (Bond, 2002) that OLS estimator is biased upwards while Fixed Effects estimator is biased downwards (where the bias decreases when the time-span increases). The solution consists in estimating equation (3) with GMM. Following the recent work of Flannery and Hankins (2013) on the estimation of dynamic panel in corporate finance as well as most of the recent literature (Allen et al., 2008; Faulkender et al., 2012a and Lepetit et al., 2012), we favour the (two-steps) system GMM estimation method (Blundell and Bond, 1998) over the difference GMM estimation method.[21] We will run different types of system-GMM in order to ensure the robustness of this estimation.[22]

With the set of estimated parameters of equation (3), we can recover the targeted capital ratio $\widehat{k}^*_{i,c,t}$ in equation (2) and we finally build the estimated deviation of the observed capital ratio from the estimated targeted capital ratio as:

$$\widehat{Dev}_{i,c,t} = k_{i,c,t-1} - \widehat{k}^*_{i,c,t} \tag{4}$$

The deviation can also be seen as a sort of quasi-residual, i.e. the unexplained part of the effective capital ratio once we accounted for time varying individual determinants, a time-invariant bank-specific component and aggregate fluctuations. When negative (resp. positive), the deviation from the target denotes a situation where the bank is under-capitalised (resp. over-capitalised) compared to what would be implicitly required by market and regulatory forces. Importantly, we define the deviation at period t, $\widehat{Dev}_{i,c,t}$, as the difference between the actual capital ratio at (the end of) period $t-1$ and the targeted capital ratio at period t, which is based on observables at (the end of) period $t-1$. That is to say, when choosing the magnitude of its adjustment during period t, i.e. between the end of periods $t-1$ and t, the bank considers the difference between its capital ratio and its target at the end of the period $t-1$.

Another crucial issue when estimating the target concerns the time dimension of the sample. If we estimate the determinants of the targeted capital ratio by running equation

21. We use the `xtabond2` command developed by Roodman (2006).

22. In particular, we will use the orthogonal deviation in place of the first-differencing transformations. We will also collapse the instruments set to make sure that our estimation does not suffer from instruments proliferation and over-identification problems. See Roodman (2006) as well as Roodman (2009) for more details on these issues.

(3) on the whole sample going from period $t - m$ to period $t + n$, we implicitly consider information at times $t + 1$, $t + 2$, ... $t + n$ – i.e. future information – for estimating the adjustment process and the targeted capital ratio at time t. There are many reasons for which we would like to restrict the information set to past and current data only. In particular, one of the objectives of this paper consists in building an aggregate indicator having good properties for identifying the fluctuations of lending and which could possibly be used for predicting forthcoming shortage of aggregate lending. In a sense, by including future information, it artificially creates a relation between the indicator at time t and future lending at time $t + 1$ or $t + 2$. For example, we do not want the estimated target in 2005 to include any information about the 2008 financial crisis. To overcome these concerns, we estimate the adjustment process described in equation (3) by using only past and current information. Precisely, we estimate the adjustment process and the resulting targets of time $t + 1$ on a sample restricted to data going from year $t - n$ to t, that is to say by excluding data from year $t + 1$ to $t + n$.

The targeted Tier 1 capital ratios $\widehat{k}^*_{i,c,t}$ defined in equation (2) are thus varying across banks and over time according to (i) the changes in the determinants $X_{i,c,t-1}$ of the target and (ii) the changes in the coefficients $\widehat{\beta}_t$ which are now time-dependent.

Building the Aggregate Capitalisation Index

Based on the estimated individual target capital ratios and deviations, we build an aggregate indicator reflecting the capitalisation of each banking system as a whole. We choose to build the simplest indicator by averaging individual deviations at the country-year level. Because we do not want to give equal importance to small and large banks with equal deviations, we weight these individual deviations. We can alternatively use the bank total assets, the total risk-weighted assets, or the ratio of assets over GDP as weights. In addition, we also compute higher order moments like the standard deviation, the skewness and the kurtosis of individual deviations.

Denoting by $w_{i,j,t-1}$ the individual weights at the end of period $t - 1$, the aggregate measure of capitalisation writes:

$$AggDev_{c,t} = \frac{\sum_{i}^{I} w_{i,c,t-1} \cdot \widehat{Dev}_{i,c,t}}{\sum_{i}^{I} w_{i,c,t-1}} \tag{5}$$

When using total assets as weight, this aggregate deviation can be viewed as the total capital shortfall/surplus scaled by the size of the banking system. When negative (resp. positive), the aggregate capitalisation measure indicates that the banking system is under-capitalised (resp. over-capitalised) on average.

4.2 Aggregate deviation and changes in aggregate lending

4.2.1 Baselines Regressions

With this indicator, we are able to quantify the aggregate capital position of a country at each period. Above all we are interested in relating fluctuations of this aggregate capitalisation index with aggregate lending fluctuations. The main question we ask is : could this aggregate indicator of banking capitalisation be helpful and relevant to identify and quantify future lending fluctuations? Beyond the extensive graphical analysis we provide in the beginning of the next section, we run the following econometric model[23] to assess the relation between fluctuations of the aggregate capitalisation index and fluctuations of credit at the country-year level :

$$\Delta\% AggLending_{c,t} = \alpha + \beta \cdot AggDev_{c,t} + \gamma \cdot \mathbf{Z}_{c,t} + \theta \cdot \mathbb{1}_t + \delta \cdot \mathbb{1}_c + \epsilon_{c,t} \quad (6)$$

where $Z_{j,t}$ denotes a vector of control variables, $\mathbb{1}_t$ year fixed effects and $\mathbb{1}_j$ country fixed effects. Standard errors are clustered at the country level, i.e. we allow for within country correlation in error terms.

We are estimating whether different magnitudes of aggregate deviation are correlated with fluctuations in the growth rate of lending once we control (i) for other important factors likely to affect aggregate lending like changes in GDP growth rate or changes in the VSTOXX, (ii) for time-invariant country-specific effects and (iii) for time-varying common fluctuations. Before presenting the results, we will briefly discuss the main control variables used as well as what we are capturing with this specification. Due to the imperfect coverage before 2000 (see table 1), we run this aggregate analysis on a sample restricted to year 2000-2011.

By controlling for the GDP growth, we try to abstract from the effect of changes in the demand for credit on aggregate lending fluctuations (see discussion below). We include inflation in the set of covariates because, the aggregate lending being a nominal variable, we do not want the growth rate of aggregate lending to be mechanically driven by changes in the level of prices. The VSTOXX tries to control for aggregate risk appetite, that is to say financial stress episodes with regimes of high market volatility. In addition, we control for the size of the banking sector as it is well known to be heterogeneous across countries. We also include the change in a country's rating that could influence banks refinancing conditions via a country's implicit guarantees. Finally, we control for changes in the representativeness of our sample that could unnecessarily affect the results

In the vector of control variables, we also include the within country standard devia-

23. As we use regression results to construct our *AggDev* measure, we do robustness checks using a system bootstrap. All results are confirmed.

tion of capital deviations from individual targets. Indeed, for the same weighted aggregate deviation, the consequence on the credit supply could be different whether this aggregate capital deviation is driven by an important deviation from a unique large bank or by an accumulation of small deviations.

4.2.2 Identifying Asymmetric Patterns

We also investigate separately the effect for the under-capitalised banking systems and the over-capitalised ones. We are interested in knowing whether the relation between aggregate lending and aggregate deviation is symmetric. Hence we regress:

$$
\begin{aligned}
\Delta\% AggLending_{c,t} = \ & \alpha + \beta_1 \cdot AggDev_{c,t} \cdot \mathbb{1}_{AggDev_{c,t}>0} \\
& + \beta_2 \cdot AggDev_{c,t} \cdot \mathbb{1}_{AggDev_{c,t}<0} \\
& + \mu \cdot \mathbb{1}_{AggDev_{c,t}>0} + \gamma \cdot \mathbf{Z}_{j,t} \\
& + \theta \cdot \mathbb{1}_t + \delta \cdot \mathbb{1}_c + \epsilon_{c,t} \qquad (7)
\end{aligned}
$$

β_1 captures the effect of under-capitalisation episodes on aggregate lending. We expect it to be positive, indicating that more under-capitalised banking systems are associated with slower growth of credit. β_2 reflects the effect of being over-capitalised on the aggregate provision of loans by banks. We also expect it to be positive, meaning that when banks are above their target on average, the aggregate lending is expanding. But the effect should be less marked because banks cannot force agents to borrow while they can prevent them from getting funds: the extent of the increase in lending is possibly more sensitive to changes in the demand than the supply of credit.

As discussed in the section describing the data, we are able to analyse separately the change in aggregate lending to MFI and to non-MFI. We are also able to analyse whether aggregate lending varies more or less according to the geographical counterparty, *i.e* domestic vs. non-domestic lending. We will hence regress four distinct regressions, each corresponding to one of these cases : lending to domestic MFI, non domestic MFI, domestic non-MFI and non-domestic non-MFI.

4.2.3 Supply vs. Demand shifts

After having presented our estimation strategy, we have to discuss an important point concerning what we capture with the specifications (6) and (7) and what we do not. Changes in aggregate lending have two sources. First, the provision of loans may change because banks are adjusting their balance sheets under constraints. They are likely to increase their lending when they are above their target and decrease it when their actual ratio is lower than their implicit target. This is a supply shift. But, it is equally possible that aggregate lending changes as a result of shifts in the demand from economic agents. In this case, it is a demand-driven shift.

In our framework, these two effects are difficult to disentangle. The effect of aggregate deviation on changes in aggregate lending primarily reflects supply shifts : banks are constrained by their implicit target and must adjust their effective capital ratio accordingly during the next period. But it is also possible that another factor influences simultaneously the aggregate deviation and the demand for lending, that would introduce spurious correlations. For instance, a slowdown of economic activity may affect the profitability of banks, and hence their implicit target, as well as the investment opportunities of firms lowering the demand for credit. We try to address this issue in several ways.

We would like to stress first that the goal of this paper is not to identify precisely the separate effects of demand shocks vs. supply shocks (contrary to Berrospide and Edge, 2010 or Mésonnier and Stevanovic, 2012 for instance). Rather we want to understand the information content that an aggregate indicator relying on micro data may convey for fluctuations in aggregate lending, whatever be the source of variations. Second, we control for important factors by including GDP growth rate, VSTOXX or changes in S&P rating. It should help to get rid of changes in demand for credit, changes in monetary policy or financial stress episodes (Berrospide and Edge, 2010). Given that we also control for time fixed-effects, as soon as factors affecting both aggregate deviation and change in aggregate lending are common to all European countries, it is taken into account by these dummies. In the same vein, country fixed-effects ensures that we control for all time-invariant unobserved factors.

Finally and most importantly, readers have to keep in mind that in our framework, (i) the aggregate deviation is implicitly lagged with respect to changes in aggregate lending and (ii) the targeted capital ratios and deviations only include past and current information. We assess the relation between the magnitude of aggregate deviation at the end of period $t-1$ and the change in aggregate lending during the period t. Hence, we capture changes in demand for credit affecting aggregate lending at time t insofar as they materialize on aggregate deviations one period before, i.e. at time $t-1$. The timing is indeed crucial for the analysis. What we argue is that we build an aggregate indicator reflecting the average bank capitalisation of a banking system based on balance sheet information at time $t-1$ that is highly correlated with fluctuations of aggregate lending coming in the very next years (t and $t+1$). As such, we provide a useful tool for monitoring short-term credit cycles that can be used for financial stability and lending cycles analysis.

5 Results

First we briefly document the micro level analysis about the capital adjustment process in section 5.1. Then section 5.2 displays some descriptive statistics about individual targets, individual deviations as well as aggregate deviations. In order to gauge the relevance of our aggregate deviation measure, we then compare it to the Bank Lending Survey in part 5.3. Last, we present the main results in sections 5.4 and 5.5, namely the relation between our indicator and the growth rate of aggregate lending as well as its ability to detect bank vulnerabilities.

5.1 The micro-level bank capital adjustment

The partial adjustment regression given by equation (3) is estimated for years $t \in [2000; 2012]$, each estimation including only information up to year t. Results for these estimations can be found in tables 4 and 5. As the results of this micro analysis are roughly similar when using the full sample, we compare and discuss the different specifications based on regressions performed on the full sample. These results can be found in table 3.

The first column presents the one-step system-GMM. The second one displays the results from the two-step system-GMM (the preferred specification). Column 3 replaces the first-differencing by the forward orthogonal deviation helping to maximise the sample size in case of unbalanced sample with gaps. Finally the fourth column collapses the instruments set in order to ensure that the GMM estimation does not suffer from instruments' proliferation.

The coefficient for the lagged dependent variable is equal to $(1 - \lambda)$ where λ denotes the adjustment speed. This adjustment speed is almost unchanged across the various types of GMM regressions (table 3) as well as over time (tables 4 and 5). They all indicate an adjustment speed of roughly 20%. It means that each period banks close on average 20% of the gap between their actual capital ratio and their targeted capital ratio. While slightly lower, it is in line with the literature. We also observe that the more profitable the bank is, the lower its implicit target. This could reflect the ability of banks to generate enough cash to be able to absorb potential negative shocks that would otherwise impact the capital position of the bank. On the contrary, larger banks, less efficient banks as well as banks breaching the regulatory ratio have higher targeted capital ratios. Importantly, coefficients for determinants of the target are not very different across the various specifications. They do not vary a lot over time either. It means that our estimated deviations does not differ in a sensible way depending on the specification we use. Accordingly and for sake of simplicity, we will favor the classical two-step system-GMM, i.e. the estimation from column 2.

Most of the coefficient in tables 4 and 5 appears to be insignficant and this could be a source of concerns. We thus test the joint significance of these variables excluding the lagged dependent variables as well as the time dummies. In most regressions we can reject the null of no joint significance of these bank level variables despite their apparently low individual significance. Furthermore, previous papers have shown that the majority of variation in leverage ratios of non-financial corporations is driven by an unobserved time-invariant effect (see Lemmon et al. (2008) notably). This pattern seems to be present in the capital adjustement process of bank too (Gropp and Heider (2010) and Berrospide and Edge (2010)).[24] Most of the volatility of the Tier 1 ratio can be accounted for by bank fixed-effects : bank capital ratios tend to fluctuate mainly around a bank specific long-term target. Consequently, the low significance of most coefficient does not nullify our partial adjustment framework but it confirms that the most important component of the targeted capital ratio is bank-specific and largely time-invariant.

Two crucial ingredients are required when running a GMM estimation. First, the estimation may not be correct if you have serial correlation in the first-differenced errors at an order higher than one.[25] Second, as in most instrumental variable estimations, you have to avoid instrument proliferation that could over-fit endogenous variables, failing to expunge their endogenous components. Hence you have to run an over-identification test. Our results show that we cannot reject the null of absence of serial correlation in the first-differenced errors at order 2 (AR Test) nor can we reject the null of joint validity of all instruments (Hansen Test) for all four specifications.

We test the robustness of this first-step estimation by running the two-step system-GMM with various sets of determinants for the target. Results are presented in table 15 in appendix. Overall, the adjustment speed and the estimated coefficient are almost the same in all these regressions. The AR2 test and the Hansen test indicate that serial correlation at order 2 and over-identifications are never a source of concerns.

5.2 Descriptive Statistics and Graphical Analysis

In this section we present and discuss descriptive statistics at the micro and the aggregate level. Table 6 presents summary statistics for the actual Tier 1 capital ratio as well as for various variables of interest.

On average, banks have Tier 1 capital ratio of 11% (median at 9%), and targeted Tier 1 capital ratio of 12% (median at 10%). Consequently, the average deviation between actual Tier 1 ratio and targeted Tier 1 ratio is equal to 0 percentage point (median at 0 ppt) : on average banks set their capital ratio almost at the targeted level. Among the banks, 56.4% are under-capitalised. The average magnitude of under-capitalisation (resp. over-capitalisation) is -0.04 (resp. +0.03). Hence, when under-capitalised (resp. over-capitalised), banks are 4 ppts (resp. 3 ppts) below (resp. above) their target on

24. In particular, the speed of adjustment toward the target appears to be just marginally affected by the inclusion of time-varying determinant in addition to fixed effects

25. Such a serial correlation would render some lags invalid as instruments. See Roodman (2006).

average.

Now, we turn to the aggregate measurement of deviation. The average deviation at the country-year level weighted by the total assets of each bank is -1 ppt (median at 0 ppt). It means that countries are on average slightly under-capitalised. The average magnitude of country under-capitalisation (resp. over-capitalisation) is -3 ppts (resp. +3 ppts).

Figures 2 and 3 display the evolution of our index averaged across countries (the latter being weighted by relative banking systems' importance). Keep in mind that the aggregate capitalisations plotted on these graphs at time t provide information about the health of the banking system at the end of the year immediatly preceding. These graphs show that the whole European Union seems to be over-capitalised before the start of the crisis, i.e. years before 2007. However from 2005 to 2007 even if our indicator averaged across European banking systems denotes an over-capitalisation, it also captures an important and continuous reduction in the capitalisation of banking systems. The expected capital shortage during the years 2008 and 2009 becomes increasingly negative indicating a strong deterioration in the capitalisation of European banking systems. Then, banks remain under-capitalised but they seem to reduce the gap between their actual capital ratio and their implicit target, what could be largely explained by government supports as well as the recapitalisation imposed by supervisors.

The statistics presented in tables 13 and 14 in appendix C confirm this graphical analysis. We observe that at least 75% of the countries suffer a negative change in their aggregate capitalisation index in 2006 against less than 25% one year before. The average change across all the sample is -0.01 ppts in 2006 against +0.01 ppts in 2005 and 25% of the countries incur a negative change of at least 0.02 ppts. At the end of 2007, at least 50% of the banking systems are under-capitalised. Hence even if a majority of countries remained over-capitalised until the end of 2007 according to our indicator, most of these countries suffer a strong reduction of their aggregate banking capitalisation at the eve of the 2008 financial crisis.

This pattern is entirely consistent with the narrative of the financial crisis. Before the crisis materialises, banks became increasingly less capitalised making them much more fragile to financial shocks. Then, banks were strongly affected by the financial crisis and most of them became highly under-capitalised after taking their losses. As of 2009, under both the markets' and the regulators' pressure, they start to recapitalise themselves (largely assisted by the governments' capital infusion). In our opinion, this ability to capture the banking systems under-capitalisation during the crisis is what we basically expect from a relevant indicator aiming at reflecting banking system soundness. More interestingly, our indicator seems to have the scope to partly capture the build-up of fragility within the banking system before the crisis materializes, i.e. as soon as of

2006 (see more extensive discussion in section 5.5).[26]

5.3 Assessing the Relevance of the Aggregate Deviation

In order to assess the relevance of our quantitative measure of the capitalisation of a banking sector, we want to relate it to an easy to grasp qualitative measure of bank capitalisation. The Eurosystem has developed a quarterly survey of bank lending in the euro area in order to enhance its knowledge of the various channels of bank lending variation, both on the supply and demand side, and possibly build an advanced indicator of the expected credit market developments. Among other questions related to the supply conditions, the following question is of interest here: "*Over the past three months, how have the following factors affected your banks credit standards as applied to the approval of loans or credit lines to enterprises?*". Among the possible factors, the following balance sheet constraint is suggested :"*Costs related to your banks capital position*", which is the one we use here as an indicator of the intensity of the bank capital constraint channel.[27]

The main interest of this survey lies in the fact that it asks about the perception of about 90 banks from all Euro area countries on the appropriateness of their current capital position. Thus it both includes their concerns about the actual capital ratio with respect to the regulatory minimum, as well as their "*perception of the additional capital buffer they should hold in order to keep operating under the current market conditions*". That is to say it includes the possible market capital constraints arising from their expected cost of debt funding conditional on their current leverage position for instance.

Two issues arise due to the specific nature of the survey. First the survey is not part of the mandatory information disclosure to the regulator. As it relies on a discretionary decision of banks to answer or not, the individual bank level responses may not be balanced. But only country aggregates are publicly available[28] in order to keep bank names anonymous and preserve incentives for bank to truly report their perception of the evolution of the credit market. Despite this limitation, aggregate results are closely monitored and they are generally considered as good predictors of possible change in the lending conditions (Lacroix and Montornès, 2009). Then as it is a quarterly survey (while our aggregate indicator is provided at a yearly frequency) and because the question of interest is backward looking over the last three months, we have to be careful when comparing both series.

On the one side, our aggregate measure of year t is based on the deviation of the capital position of banks computed at the end of the year $t-1$. On the other side,

26. We also plot the evolution of aggregate capitalisation at the country level in appendix B.2. While we observe some heterogeneity, the pattern is similar during the crisis for most countries.

27. Monthly results from the survey as well as the methodology and the questionnaire can be found at `https://www.ecb.europa.eu/stats/money/surveys/lend/html/index.en.html`

28. see the ECB statistics webpage `https://www.ecb.int/stats/money/surveys/lend/html/index.en.html`.

the publication of BLS statistics in January of year t provides information about banks' capital position during the last quarter of year $t-1$. Hence, we decide to compare our aggregate measure of year t with the BLS statistics published in January of year t.[29]

Table 8 displays the correlations between these two measures for countries participating to the BLS survey. The first column uses the responses form BLS in the first quarter, the second column uses responses from BLS averaged over the year and the last column displays the correlation between the change in our indicator and the change in Q1 BLS responses. All correlations for available countries are highly negative (with some exceptions), which means that banks tend to tighten more their credit standards (positive number, i.e. the relative share of banks reporting tightening increases) in countries where the banking system is more under-capitalised (negative number).[30] So the good matching between our aggregate measure and the BLS index confirms that our measure is relevant and well-suited to capture the aggregate capital position of a banking system.

5.4 Aggregate Deviation and Credit Supply

In the previous section, we have seen that our measure (i) captures well the narrative of the 2008 crisis and (ii) proves to be consistent with an important self-declarative study run by ECB. In this section, we analyse to which extent different levels of aggregate deviation are associated with different growth rates of aggregate lending.

5.4.1 Graphical Analysis

Figures 2 and 3 plot on the same graph the evolution of our index averaged across countries and the evolution of the growth rate of aggregate lending. The same picture for aggregate lending to non Monetary Financial Institutions (non-MFI) can be found in figures 4 and 5. Figures 3 and 5 reproduce the previous graphs by using banking system's importance to weight observations.

We observe that our indicator of aggregate deviation and the growth rate of aggregate lending displays important comovements whether we use the weights or not. An aggregate under-capitalisation (resp. over-capitalisation) is almost systematically associated with a lower (resp. higher) growth rate of lending. The correlations between the two measures are respectively 0.79 and 0.70 with and without weights. This pattern is entirely confirmed when considering only lending to non-MFI. The correlation between the average aggregate deviation and the average growth rate of lending is 0.78 (0.67 when weighted

29. Alternatively, because the end of year position may result from shocks occurring during the three first quarters, we could take the yearly average of the quarterly data from the BLS.

30. In addition we report a selection of graphs superimposing the evolution of our measure of aggregate deviation against the qualitative indicator of the BLS survey (when available) in appendix B.2. These graphs confirm that both measures are in line : when banks report a tightening of their credit standards because of costs related to their capital position, countries are generally considered as under-capitalised according to our aggregate indicators.

by banking system's importance). Nevertheless the apparent contemporaneity of both measures should not be overstated as our indicator is calculated using data available one year before the change in aggregate lending materialise.

5.4.2 Econometric Analysis

Now we can turn to the econometric analysis. In table 9, we present the results of the specification of equation (6). We alternatively use the growth rate of aggregate total lending, aggregate lending to MFI and aggregate lending to non-MFI. The first three columns only control for country and year fixed-effects and we then introduce control variables in the last three columns. The coefficient associated with our aggregate deviation measure is economically and statistically significant when considering the three types of aggregate lending. These results indicate that when the aggregate capitalisation index changes by 1 ppt, the growth rate of aggregate lending changes by 0.918 [0.267-1.568] ppts, which correspond to roughly 10-15% of the average change in aggregate lending (7%). Alternatively we can say that a one standard deviation change in the aggregate capitalisation index (0.05) is associated with a change corresponding to 35% of one standard deviation of the growth rate of aggregate lending, which is all but negligeable. Another way to understand the relative economic importance of this effect is to compare it with the coefficient associated with the GDP growth rate: it appears that a 1 ppt change in the aggregate banking capitalisation has just a slghtly lower effect on the fluctuations of lending as a 1 ppt change in the growth rate of the economy.

The R-square indicates that we are able to explain around 60% to 70% of the variation in aggregate lending with our specification (but just 20% in the case of lending to MFI). Hence, our specification appears to be much more suited to explain the fluctuations of aggregate lending to non-MFI. Given that the aggregate lending to non-MFI represents 67% of the total lending within the European Union (see table 12), it indicates that deviations from the implicit target are associated with important and direct effects on the economy through changes in lending. Concerning the control variables, we observe that the growth rate of GDP and inflation are significantly and consistently associated with the growth rate of aggregate lending : the higher the economic growth and the faster the changes in prices level, the higher the growth rate of credit.

In table 10, we run the same analysis by decomposing lending growth depending on the residence and the nature of the counterparties. We thus compare domestic and non-domestic lending for both lending to MFI and non-MFI. The relation between our aggregate capitalisation index and the growth rate of aggregate lending that we have previously captured seems to come first and foremost from domestic aggregate lending to non-MFI. From table 12, we know that 86% of the lending to non-MFI is directed towards domestic agents. It thus confirms that deviations from implicit targets are of crucial interest for national supervisors, given that the adjustment seems to occur mainly through domestic lending which represents 58% of the total lending within the European Union.

We now distinguish over/under-capitalised banking systems. We can reasonably suspect that under-capitalised banking systems are likely to have stronger and more significant comovements with aggregate lending fluctuations because banks are more likely to cut their lending to the private sector in case of capital shortage whereas they cannot force firms and households to borrow in case of capital surplus. Tables 11 and 16 present the results of the specification of equation 7. The relation between the aggregate deviation measure and the fluctuations of aggregate lending to non-MFI appears to be mostly – if not entirely – driven by under-capitalised banking systems: when the average deviation of under-capitalised banks increases by 1 ppt, i.e. when their capital position relative to their implicit target worsens, then the growth rate of aggregate lending to non-MFI decreases significantly by about 1.378 [0.626-2.131] ppts.[31] In contrast, the relation between over-capitalised banking systems and fluctuations of aggregate lending to non-MFI is not statistically different from zero and the coefficient associated with over-capitalised banking systems is almost three times lower than the one of under-capitalised banking system. Here again, the magnitude of the effect is roughly similar to the one of GDP fluctuations.

5.4.3 Robustness Checks

We run some additional regressions to ensure the robustness of these results. First, we include not only current control variables but also lagged ones. We want to make sure that once we control for past changes in business cycle, inflation and volatility, our results remain unchanged. Indeed, our aggregate capitalisation index at time t reflecting mainly banks' capital position at the end of time $t-1$, we also want to control for business cycle fluctuations at this period to purge our aggregate capitalisation index from any contemporaneous change in other variables. Results can be found in tables 17 and 18 in appendix C.

Then we replicate the baseline regression and we include the lagged value for the growth rate of aggregate lending (the dependent variable). We want to test whether our aggregate indicator continues to provide valuable information on the lending cycles once we control for the possible autoregressive component of the lending cycle. Indeed, we argue that our indicator is able to provide valuable information about lending fluctuations *to come*. But it could also be the results from the combination of (i) the correlation

31. As previously, this impact of aggregate under-capitalisation on lending to non-MFI mostly goes through a reduction in lending to domestic customers (see table 16 in appendix C), which may be partly due to the specificity of the recent crisis but also to the ability of global banks to reallocate capital and lending across the world so that those banks would reduce first loans on mature and more competitive markets to maximise returns in other markets.

between our indicator and contemporaneous lending fluctuations and (ii) the persistence in the lending fluctuations from one period to another. Results can be found in tables 19 and 20 in appendix C.

Because we argue that the usefulness of our indicator lies mainly in its timing, namely its ability to capture fluctuations in the lending occurring at time t using balance sheet information at time $t-1$, we re-run our baseline regression with the lagged aggregate capitalisation index : now we assess whether our aggregate capitalisation index based on information at time $t-2$ is economically and significantly correlated with fluctuations in aggregate credit at time t. Results are reported in table 21 in appendix C.

Finally and most importantly, we have to be careful when using the Tier 1 capital ratio. This risk-weighted leverage measurement has been subject to various changes during the period covered, in particular the adoption of Basel 2.5 and Basel 3 rules. Nonetheless, we think that it is the ratio which is the more likely to be targeted by banks, especially because it is the regulatory ratio. To ensure that our results are not contaminated by these possible changes in the Tier 1 capital ratio occurring during the period under study, we re-run both the first-stage and the aggregate analysis with the more classical *Capital-to-Assets ratio* whose definition is time-invariant. In table 21 we present the aggregate regression using this raw leverage measure.

It appears that all these robustness checks entirely confirm the main findings of the paper, namely the usefulness of this aggregate capitalisation index based on micro balance sheet data to quantify forthcoming lending fluctuations and its potential for monitoring financial stability and lending cycles.

5.5 Aggregate Deviation and Indicator of Bank Vulnerability

Our index captures one of the potential source of excessive risk-taking, namely the inappropriate provisioning of bank capital as asset growth accelerates, as well as one of the potential source of lending fluctuations, namely capital constraints related to implicit target. To that extent, it is likely to be both a good predictor of future credit tightening as well as a candidate measure of the vulnerability to a crisis.

We try to gauge the usefulness of our indicator as an early warning indicator of possible future crises, even if we are limited by the yearly frequency of our measure and the fact that we mostly get observables around the last 2008 crisis. As outlined by Jorda et al. (2010) or Borio and Drehmann (2009), unusually strong increases in credit supply have often preceded banking crises and as such can be seen as a good indicator of the extent of the fragility of the banking sector. So far, three indicators have been singled out by the literature as having the ability to signal future systemic crises, all related to some notion of an excess supply of credit, namely the credit to GDP gap (BCBS, 2010b), the debt service ratio (Drehmann and Juselius, 2012) or the non-core liability ratio (Hahm et al., 2012).

Transmission mechanism. The transmission mechanism could be as follows. An excess in the growth of credit that is not sustained by a growth of equity base of banks but rather funded excessively by short term or non-core liabilities would widen the gap between the long term ratio of bank capital and its current Tier 1 ratio, or in other words it would increase the deviation of bank capital from its implicit target. Henceforth our indicator of banking system under-capitalisation is likely to reflect *ex ante* a higher vulnerability of a banking sector to adverse shocks on its asset side, shocks that are all the more likely to occur if the under-capitalisation indeed reflects an excessive lending boom and thus the possible burst of a bubble leading to a banking crisis. In addition the dynamic nature of the partial adjustment model of bank leverage that we use here suggests that in the case of a balance-sheet recession (Koo, 2011) of the type we face today, where agents and banks minimize their debt burden to stay afloat rather than maximise their profits, the bank capital adjustment process would amplify the initial shock. If banks are away from their implicit target, when a shock materializes they would have an incentive to adjust their balance sheet by closing approximately 20% of their capital shortfall each year according to our estimates. As shown in the previous section, this could be associated with a significant effect on aggregate lending to the economy over the next year(s) which is likely to exacerbate a banking crisis and turn it into a systemic banking crisis.

Before/after analysis around crisis events. We first do a before/after analysis around crisis events (banking and debt crises). For that purpose we use the most recent crisis database for European countries compiled at the ECB (Babecky et al., 2012). Graph 6 shows that during the years preceding a crisis, the median aggregate capitalisation index[32] decreases from a positive number 4 years before the crisis to reach a median zero aggregate deviation the year before. In other words, more than 80% of the banking sector in Europe was well capitalised two years before the crisis, while already more than 50% of the countries experienced capital shortages one year before the outbreak of the crisis. The same pattern is observed for Southern and Eastern Europe countries (see graph 11 in appendix C), but it is even more clear-cut for Northern Europe countries[33] (see graph 10 in appendix C). All of them were well capitalised on aggregate 4 years before the crisis with a median capital ratio in excess of 2 ppts with respect to the targets. That is to say, with a possible reallocation of capital between banks of these countries, all banks would have been holding excess capital. But the year before the banking crisis started, at

32. Calculated only with data available at the time (backward looking), so that it does not include the future stance of the crisis.

33. Countries included in the Northern Europe group are: Germany, France, Belgium, Denmark, Finland, United Kingdom, Luxembourg, the Netherlands, Norway, Sweden.

least half of the countries were experiencing aggregate captial shortage. Interestingly, the Northern Europe countries are much more homogeneous than Eastern Europe countries.

Heatmap of capital shortages across Europe. Last we display the heatmap implied by our empirical strategy and find it quite in line with the evolution of the banking sector over the last decade. Figure 7 displays the evolution of the aggregate capitalisation index at the country level distinguishing between banking systems with more or less than two thirds of individual banks being over/under-capitalised. The darker the colour, the weaker the capital position of the banking sector of the country and the larger the share of banks individually under-capitalised. Hence the heatmap convey different information simultaneously : the magnitude of the over/under capitalisation and its dispersion within a banking system.

We observe that from 2004 to 2006 the aggregate capital position of banking sectors was relatively good, with most countries having individually solid banks. From 2007 onward, the picture reverses and all countries we cover here find themselves in 2009 with a high measure of under-capitalisation where most individual banks are themselves having troubles. Throughout the first wave of the crisis, only Luxembourg and Finland have a banking sector still holding a positive capital buffer at the aggregate. As of 2012, all countries except Luxembourg and Latvia feature an aggregate under-capitalisation of their banking sector, with more than 90% of their banking institutions being capital constrained.

Nevertheless, there is potentially room for compensation as some banks have improved their leverage with respect to their target. Figure 12 in appendix B displays the same evolution by distinguishing between banking systems with more or less heterogeneity in terms of the capitalisation of their banks. The idea is that when there is relatively little variation in the index in the cross-section of banks, associated with aggregate under-capitalisation at the country level, this is likely to be more problematic for the country as the scope for substitution at the micro level between lending by capital constrained and constrained-free banks is rather limited. Despite the overall under-capitalisation, the heterogeneity across banks represented by the colour red in figure 12 increased, with possibly banks less constrained being able to expand their lending activities. In contrast, in 2011 countries like Spain, Sweden, Portugal, Italy, Hungary, Cyprus or Belgium had mostly undercapitalised banks with little room for compensation at the micro level across banks.

6 Conclusion and Policy Implications

The present paper investigates the extent to which an under-capitalized banking system has real consequence for the economy. Despite the importance of the question, the literature remains relatively open in terms of moving from the analysis of individual bank capital regulation to the study of aggregate effects on the macroeconomy. As such our paper is an interesting and valuable example of a bridge between micro and macro-prudential analysis.

Our main findings are the following. First, our aggregate capitalisation measure indicates that most European countries observed an important reduction of their aggregate capitalisation index between 2005 and 2007 and became under-capitalised in 2008-2009. Second, our indicator of aggregate capitalisation is consistently and significantly correlated with the qualitative answers about capital constraints reported in the European Bank Lending Survey. Third, and most importantly, we capture an economically and statistically significant relationship between our aggregate capitalisation index at the end of year $t-1$ and the change in aggregate lending between the end of year $t-1$ and the end of year t. On average, a change by 1 percentage point in the aggregate deviation from the implicit target is associated with a change in the growth rate of aggregate lending by 0.37-1.71 percentage points in the next period. We observe that these correlations are mainly driven by under-capitalised banks that affect mostly domestic aggregate lending to non-MFI, *i.e.* households, corporate sectors and governments. Last we show that our capitalisation index, albeit computed at a yearly frequency, can successfully signal a reversal in the lending cycle up to 2 years before its materialisation and can thus be though of as an early warning indicator. The aggregate capitalisation index decreases on average from a positive figure 4 years before the crisis to reach, at the start of the crisis, a median negative deviation from the targeted tier 1 capital ratio of 3 percentage points.

The policy implication of the paper is that minimum capital requirements are not sufficient measures of capital constraints. Market discipline, as captured by our bank specific, balance-sheet based and time-varying target capital ratio, can induce an important and rapid adjustment of bank balance sheets that negatively impacts aggregate lending. As a result, the deviation of bank capital from its capital target should be closely monitored for at least four reasons. First, given that lending to non-MFI represents 67% of the aggregate lending within the European countries and that 86% of this lending to non-MFI consists in domestic lending, it is important for the supervisor to monitor these fluctuations of aggregate capitalisation of resident banks. Second, a banking system whose banks have a high enough regulatory capital ratio may nonetheless have large deviations from their target, inducing potentially large fluctuations in the credit supply. Third, an increase in the speed of adjustment required by market participants or a shift of the market discipline could excessively increase bank capital requirements, which would go against effort to make regulatory capital constraints more counter-cyclical. Deviation from the capital target, and not necessarily leverage as suggested by Adrian and Shin (2010), would be a source of procyclicality. Fourth, if on average a banking sector is undercapitalised, it means that it was percieved as lending too much compared to its capital base, which may signal a future burst of the bubble.

Thus, two points should be devoted more attention. On the one side, countercyclical bank capital requirements required by Basel III may not be sufficient to avoid a credit crunch: bank capital adjustments can be an endogenous source of shocks to the macroeconomy. On the other side, bank balance sheet variables should also be considered for financial stability purposes in order to monitor credit cycle reversals, along with credit or housing variables.

References

Acharya, V., R. Engle, and M. Richardson (2012) "Capital Shortfall: A New Approach to Ranking and Regulating Systemic Risks,"Technical Report 3. 1

Admati, A., P. DeMarzo, M. Hellwig, and P. Pfleiderer (2010) "Fallacies, Irrelevant Facts, and Myths in the Discussion of Capital Regulation: Why Bank Equity is not Expensive," Stanford GSB Research Paper No. 2063. 1, 2.1, 2.2

Adrian, T. and H. S. Shin (2010) "Liquidity and leverage," *Journal of Financial Intermediation*, Vol. 19, No. 3, pp. 418–437. 1, 6

Allen, B., R. DeYoung, M. Flannery, D. Lee, and O. Öztekin (2008) "How Do Large Banking Organizations Manage Their Capital Ratios?" *Journal of Financial Services Research*, Vol. 34, No. 2, pp. 123–149. 4.1

Angelini, P., L. Clerc, V. Cúrdia, L. Gambacorta, A. Gerali, A. Locarno, R. Motto, W. Roeger, S. Van den Heuvel, and J. Vlcek (2011) "Basel III: long-term impact on economic performance and fluctuations," Banque de France working paper No. 323. 2.1

Babecky, J., T. Havranek, J. Matiju, M. Rusnak, K. Smidkova, and B. Vasièek (2012) "Banking, Debt, and currency crises : early warning indicators for developed countries," ECB Working Paper No. 1485. 5.5

Barrell, R., E. Davis, T. Fic, D. Holland, S. Kirby, and I. Liadze (2009) "Optimal regulation of bank capital and liquidity: how to calibrate new international standards," UK Financial Services Authority, Occasional Paper Series, No. 38. 2.1

Bassett, W. and F. Covas (2013) "A New Look at the Relationship Between Capital Constraints and Bank Lending," Working Paper, Federal Reserve Board. 2.1

BCBS, Basel Committee on Banking Supervision (2010a) "An assessment of the long-term economic impact of stronger capital and liquidity requirements," LEI Report. 2.1

——— (2010b) "Guidance for national authorities operating the countercyclical capital buffer," December, BCBS Document No. 187. 5.5

——— (2013) "Global systemically important banks: updated assessment methodology and the higher loss absorbency requirement," BCBS Paper No. 255. (document)

Berger, Allen, Robert DeYoung, Mark Flannery, David Lee, and Özde Öztekin (2008) "How Do Large Banking Organizations Manage Their Capital Ratios?" *Journal of Financial Services Research*, Vol. 34, No. 2, pp. 123–149. 19

Bernanke, B. and S. Lown (1991) "The credit crunch," Brooking Papers on Economic Activity, No. 2. 2.1

Berrospide, J. and R. Edge (2010) "The Effects of Bank Capital on Lending: What Do We Know, and What Does It Mean?" *International Journal of Central Banking*, Vol. 6, No. 4. 2.1, 4.1, 4.2.3, 5.1

Bhattacharya, Kaushik (2003) "How good is the BankScope database? A cross-validation exercise with correction factors for market concentration measures," BIS Working Papers 133, Bank for International Settlements. 3

Blundell, R. and S. Bond (1998) "Initial conditions and moment restrictions in dynamic panel data models," *Journal of Econometrics*, Vol. 87, No. 1, pp. 115–143. 4.1

Bond, S. (2002) "Dynamic panel data models: a guide to micro data methods and practice," *Portuguese Economic Journal*, Vol. 1, pp. 141–162. 4.1

Borio, C. and M. Drehmann (2009) "Assessing the risk of banking crises - revisited," *BIS Quarterly Review*, pp. 29–46. 5.5

Byoun, S. (2008) "How and When Do Firms Adjust Their Capital Structures toward Targets," *The Journal of Finance*, Vol. 63, No. 6, pp. 3069—3096. 2.2

Calomiris, C., F. Heider, and M. Hoerova (2012) "A Theory of Bank Liquidity Requirements," mimeo. 20

Diamond, D.W. and P.H. Dybvig (1983) "Bank runs, deposit insurance, and liquidity," *Journal of Political Economy*, Vol. 91, No. 3, pp. 401—419. 2.2

Drehmann, M. and M. Juselius (2012) "Do debt service costs affect macroeconomic and financial stability?" *BIS Quarterly Review*, pp. 21–34. 5.5

Duprey, T. (2014) "A DSGE Model for Financial Stability," Banque de France Working Paper. 2.2

Duprey, T. and M. Lé (2014) "Bankscope dataset: getting started," Technical Document. 3

Faulkender, M., M. J. Flannery, and J. M. Hankins, K. W.and Smith (2012a) "Cash flows and leverage adjustments," *Journal of Financial Economics*, Vol. 103, No. 3, pp. 632–646. 2.2, 4.1

Faulkender, Michael, Mark J. Flannery, Kristine Watson Hankins, and Jason M. Smith (2012b) "Cash flows and leverage adjustments," *Journal of Financial Economics*, Vol. 103, No. 3, pp. 632–646. 19

Flannery, M. and K. W. Hankins (2013) "Estimating Dynamic Panel Models in Corporate Finance," *Journal of Corporate Finance*, Vol. 19, p. 1–19. 4.1

Flannery, M. and K. Rangan (2006) "Partial adjustment toward target capital structures," *Journal of Financial Economics*, Vol. 3, No. 79. 3, 19

Flannery, Mark J. and Kasturi P. Rangan (2006) "Partial adjustment toward target capital structures," *Journal of Financial Economics*, Vol. 79, No. 3, pp. 469–506. 2.2

Francis, W. and M. Osborne (2012) "Capital requirements and bank behavior in the UK: Are there lessons for international capital standards?" *Journal of Banking and Finance*, Vol. 3, No. 36. 2.1

Gropp, R. and F. Heider (2010) "The Determinants of Bank Capital Structure," *Review of Finance*, Vol. 14, pp. 587–622. 4.1, 5.1

Hahm, J.-H., H. Shin, and K. Shin (2012) "Non-Core Bank Liabilities and Financial Vulnerability," Working Paper, NBER, 18428. 5.5

Hancock, D. and J. Wilcox (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*, Vol. 1, No. 3. 2.1, 19

——— (1994) "Bank capital and the credit crunch: The roles of risk-weighted and unweighted capital regulations," *Real Estate Economics*, Vol. 1, No. 22. 2.1

Houston, J., C. James, and D. Marcus (1997) "Capital market frictions and the role of internal capital markets in banking," *Journal of Financial Economics*, Vol. 46, pp. 135–164. 2.1

IIF, Institute of International Finance (2011) "The cumulative impact on the global economy of changes in the financial regulatory framework." 2.1

Ivashina, V. and D. Scharfstein (2010) "Bank lending during the financial crisis of 2008," *Journal of Financial Economics*, Vol. 97, No. 3, pp. 319–338. 1

Jorda, O., M. Schularick, and A. Taylor (2010) "Financial Crises, Credit Booms, and External Imbalances: 140 Years of Lessons," NBER Working Paper No. 16567. 5.5

Kashyap, A., J. Stein, and S. Hanson (2010) "An Analysis of the Impact of "Substantially Heightened" Capital Requirements on Large Financial Institutions," University of Chicago and Harvard Working Paper. 2.1, 2.2

Kok, C. and G. Schepens (2013) "Bank reactions after capital shortfalls," ECB Working Paper No. 1611. 2.2

Koo, R. (2011) "The world in balance sheet recession: causes, cure, and politics," *Real-world economics review*, Vol. 58. 5.5

Lé, M. (2013) "Deposit Insurance Adoption and Bank Risk-Taking : the Role of Leverage," PSE Working Paper. 2.2

Labonne, C. and G. Lame (2014) "Credit Growth and Bank Capital Requirements in the French Banking Sector," forthcoming Banque de France Working Paper. 2.1

Lacroix, R. and J. Montornès (2009) "Analyse de la portée des résultats du Bank Lending Survey au regard des données de crédit," *Bulletin de la Banque de France*, Vol. 178. 5.3

Lemmon, M., M. Roberts, and J. Zender (2008) "Back to the Beginning: Persistence and the Cross-Section of Corporate Capital Structure," *Journal of Finance*, Vol. 63, No. 4. 4.1, 5.1

Lepetit, Laetitia, Amine Tarazi, and Nadia Zedek (2012) "Bank Regulatory Capital Adjustment and Ultimate Ownership Structure: Evidence from European Commercial Banks," Working Papers hal-00918577, HAL. 19, 4.1

MAG, Macroeconomic Assessment Group (2010) "Assessing the macroeconomic impact of the transition to stronger capital and liquidity requirements." 2.1

Mésonnier, J.-S. and D. Stevanovic (2012) "Bank leverage shocks and the macroeconomy: a new look in a data-richenvironment," Document de Travail Banque de France No. 394. 4.2.3

Peek, J. and E. Rosengren (1997) "The international transmission of financial shocks: The case of Japan," *American Economic Review*, Vol. 87, No. 4, pp. 495–505. 2.1

Puri, M., J. Rocholl, and S. Steffen (2011) "Global retail lending in the aftermath of the US financial crisis: Distinguishing between supply and demand effects," *Journal of Financial Economics*, Vol. 100, No. 3, pp. 556–578. 1

Repullo, R. and J. Suarez (2013) "The Procyclical Effect of Bank Capital Regulation," *Review of Financial Studies*, Vol. 26, No. 2, pp. 452–490. 1

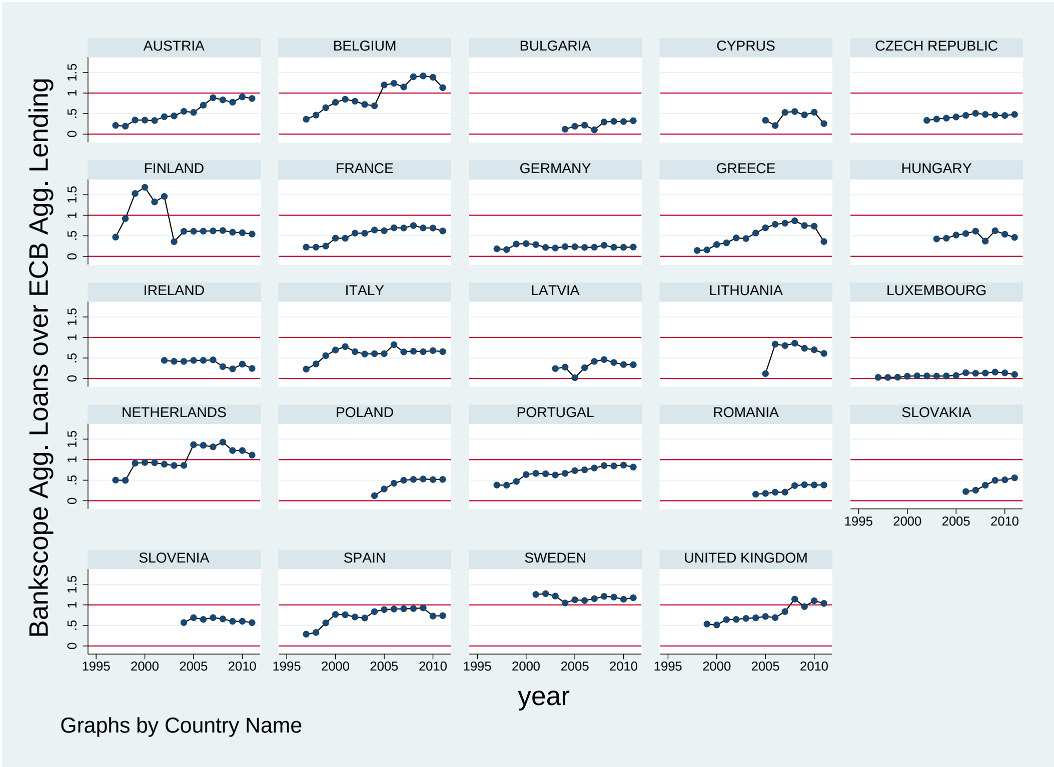
Roodman, D. (2006) "How to do xtabond2: an introduction to "Difference" and "System" GMM in Stata," Center for Global Development Working Paper, 103. 21, 22, 25

Roodman, David (2009) "A Note on the Theme of Too Many Instruments," *Oxford Bulletin of Economics and Statistics*, Vol. 71, No. 1, pp. 135–158. 22

7 Figures

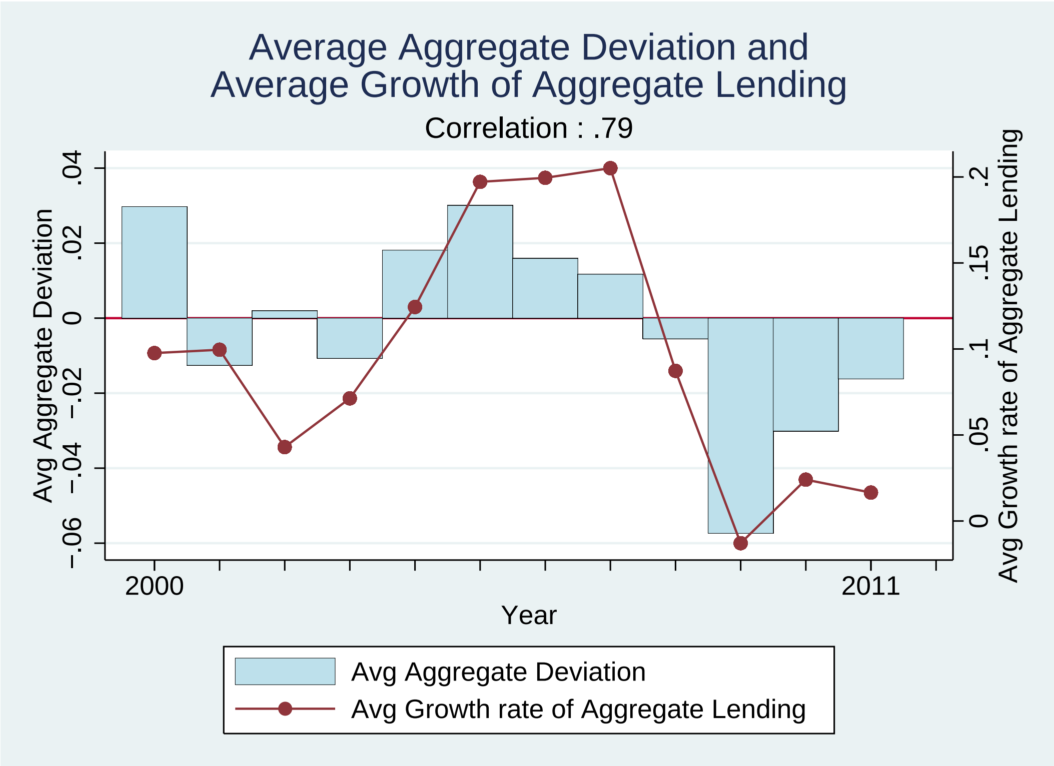
7.1 Representativeness of the sample

Figure 1: Banking loans reported by Bankscope over aggregate lending as reported by the ECB



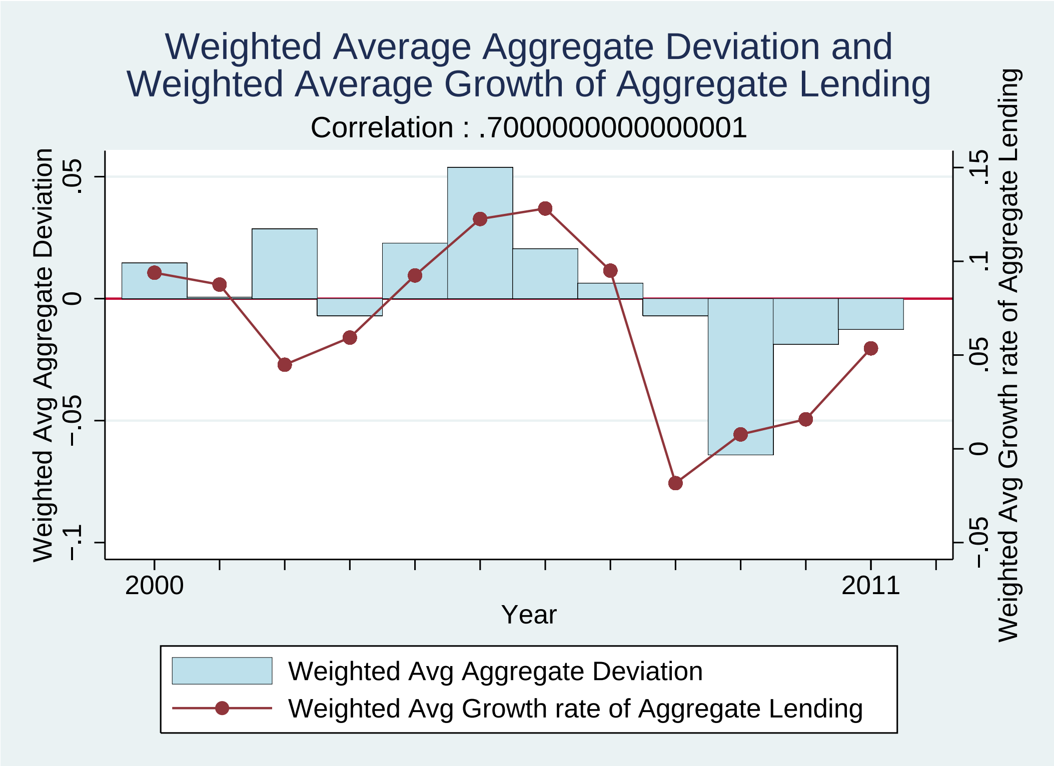
7.2 Aggregate Deviation and Growth rate of Aggregate Lending and lending to non-MFI

Figure 2: Evolution of the capitalisation index and the evolution of the growth rate of aggregate lending averaged across countries



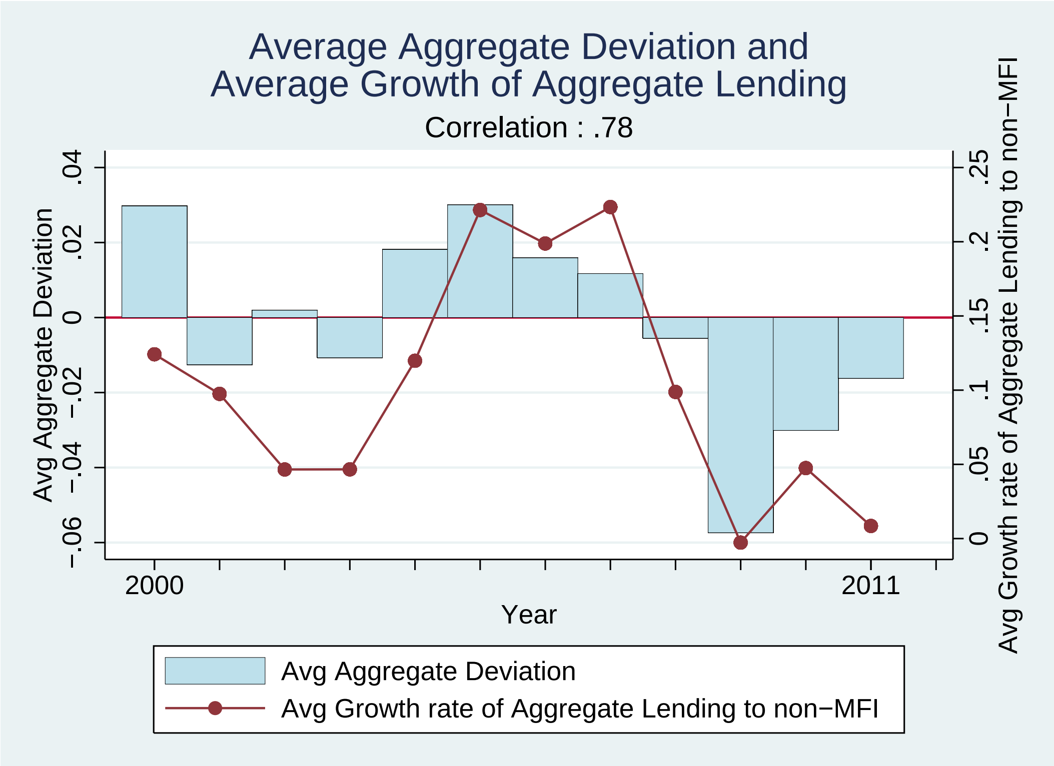
This figure represents the evolution of the average aggregate deviation across time and the evolution of the average growth rate of aggregate lending. A positive number indicates a situation where the banking system if over-capitalised and a negative number indicates a situation where the banking system if under-capitalised. Two distinct axis are used.

Figure 3: Evolution of the capitalisation index and the evolution of the growth rate of aggregate lending averaged across countries



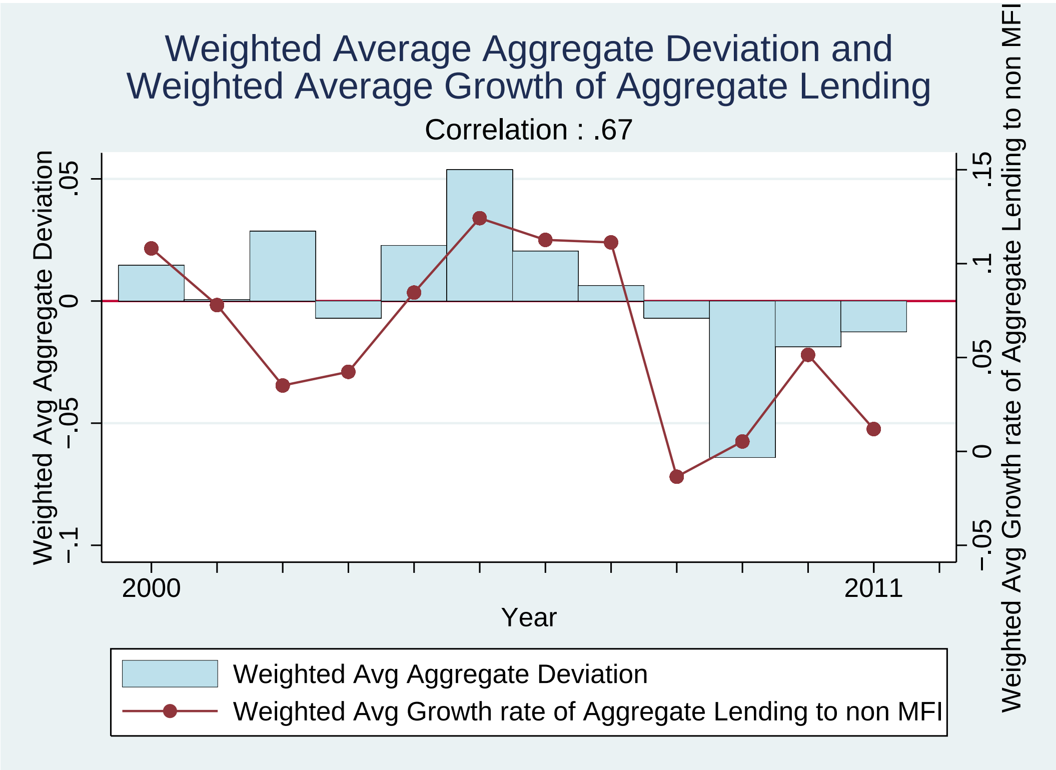
This figure represents the evolution of the average aggregate deviation across time and the evolution of the average growth rate of aggregate lending weighted by banking system's importance. A positive number indicates a situation where the banking system if over-capitalised and a negative number indicates a situation where the banking system if under-capitalised. Two distinct axis are used.

Figure 4: Evolution of the capitalisation index and the evolution of the growth rate of aggregate lending to non MFI averaged across countries



This figure represents the evolution of the average aggregate deviation across time and the evolution of the average growth rate of aggregate lending to non MFI (including central governement). A positive number indicates a situation where the banking system if over-capitalised and a negative number indicates a situation where the banking system if under-capitalised. Two distinct axis are used.

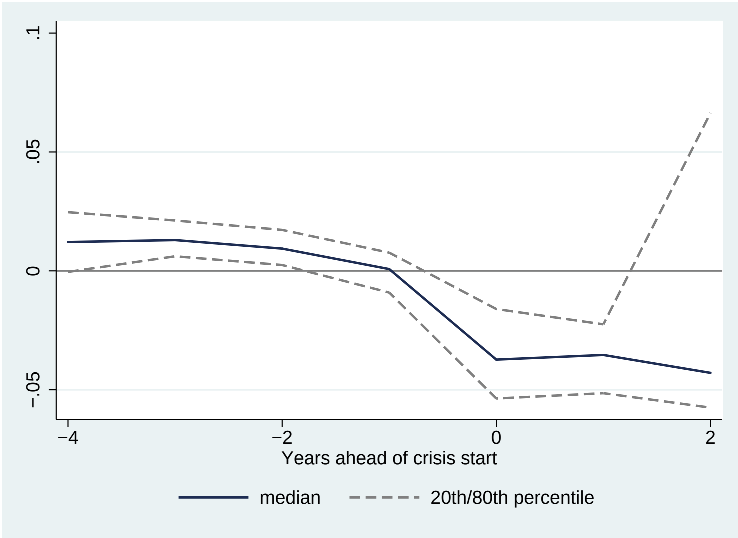
Figure 5: Evolution of the capitalisation index and the evolution of the growth rate of aggregate lending to non MFI averaged across countries



This figure represents the evolution of the average aggregate deviation across time and the evolution of the average growth rate of aggregate lending to non MFI (including central governement) weighted by banking system's importance. A positive number indicates a situation where the banking system if over-capitalised and a negative number indicates a situation where the banking system if under-capitalised. Two distinct axis are used.

7.3 Before/After Crisis Analysis

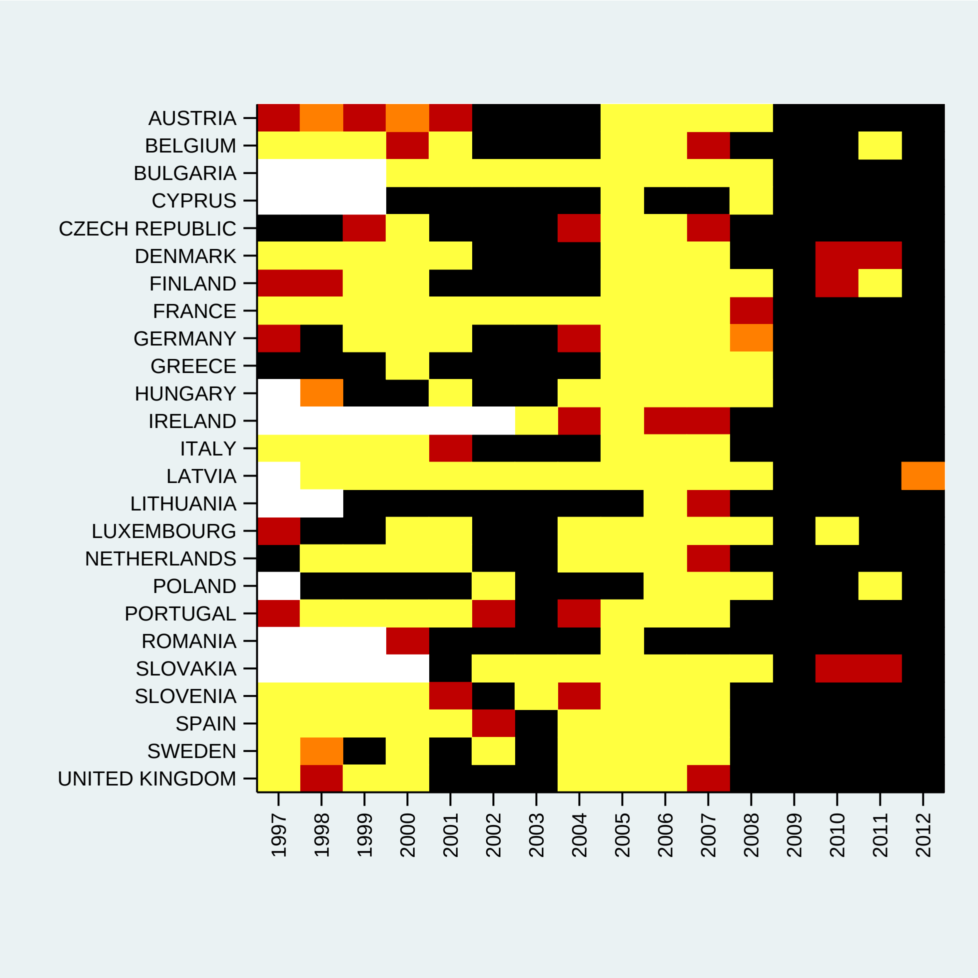
Figure 6: Capitalisation index around crisis episodes



This figure represents the evolution of the average aggregate deviation (calculated using only data available at each date) for year before and after the start of the crisis, defined as the year during which a banking crisis started as recorded at the quarterly frequency in the ECB dataset. Also to be consistent with the timing of the crisis dummy, the deviation at time t is recoded as deviation at time t-1, so that the deviation at time t-1 indeed depends on end of period t-1 observables.

7.4 Heat Map

Figure 7: Heatmap of the capitalisation index of the banking sector classified by share of under-capitalised banks in the system



- White: not enough information.
- Yellow : over-capitalisation on average and less than two thirds of individual banks are under-capitalised.
- Orange : over-capitalisation on average but with lot of heterogeneity in capital position of individual banks (at least two thirds are under-capitalised).
- Red : under-capitalisation on average but lot of heterogeneity in capital position of individual banks.
- Black: under-capitalisation on average and most banks individually under-capitalised (more than two thirds are under-capitalised), i.e. the worst case scenario.

8 Tables

Table 1: Average Representativeness of Bankscope by year

Year	Average
1997	23,35%
1998	24,89%
1999	42,21%
2000	50,00%
2001	54,20%
2002	53,44%
2003	52,24%
2004	56,49%
2005	62,77%
2006	66,29%
2007	68,63%
2008	75,89%
2009	70,35%
2010	72,00%
2011	67,46%

This table shows the yearly average ratio of total banking loans aggregated from Bankscope over aggregate lending reported by the ECB. It indicates the proportion of loans reported to the ECB by Monetary and Financial Institutions that is captured in the data from Bankscope.

Table 2: Descriptive Statistics. Bank Level and Macro Variables

Variable	N	Mean	SD	P5	Median	P95	Source
Log of Assets	5136	9.94	2.02	6.88	9.78	13.51	BankScope
ROAA	5235	0.01	0.01	-0.00	0.01	0.02	BankScope
Liquid Assets over Assets	5136	0.22	0.15	0.04	0.18	0.51	BankScope
Deposits-to-Assets Ratio	5233	0.49	0.20	0.11	0.51	0.78	BankScope
Cost-to-Income Ratio	5136	0.64	0.20	0.42	0.63	0.87	BankScope
Loan Loss Provision (%)	5136	0.01	0.02	-0.00	0.01	0.03	BankScope
Tier 1 Capital ratio < 4%	5423	0.37					BankScope
GDP growth	435	0.03	0.03	-0.03	0.03	0.07	UNSTAT
Inflation rate	435	0.04	0.05	-0.00	0.03	0.12	UNSTAT
VSTOXX Volatility Index	349	26.59	10.60	14.07	24.06	51.21	Bloomberg
Log of the Size of Banking Sector	435	11.97	2.39	7.50	12.28	15.26	Bankscope
Change in Sample Representativeness	254	0.02	0.14	-0.16	0.01	0.23	Bankscope and ECB
Change in Country S&P Rating	427	-0.18	2.86	-4.00	0.00	3.00	S&P

This table present some descriptive statistics for variables used in the micro-level analysis as well as in the aggregate analysis.

Table 3: Estimating the Adjustment Process

	Tier 1 capital ratio					
Lag of Tier 1 ratio	0.791***	0.789***	0.805***	0.768***	0.804***	0.842***
	(0.045)	(0.046)	(0.040)	(0.060)	(0.047)	(0.038)
Log of Assets	0.003	0.004**	0.001	0.006***	0.004**	0.001
	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)
ROAA	-0.169**	-0.176**	-0.120	-0.225**	-0.220***	-0.150*
	(0.074)	(0.075)	(0.088)	(0.106)	(0.074)	(0.089)
Liquid Assets over Assets	-0.002	-0.000	0.001	-0.007	-0.003	-0.001
	(0.017)	(0.014)	(0.006)	(0.016)	(0.011)	(0.006)
Deposit-to-Asset Ratio	0.003	0.004	-0.002	0.011	0.002	0.002
	(0.010)	(0.009)	(0.005)	(0.010)	(0.007)	(0.004)
Cost-to-Income Ratio	0.006*	0.006**	0.004	0.008***	0.008**	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
Loan Loss Provision (%)	-0.016	-0.017	-0.094	-0.010	0.007	-0.112
	(0.063)	(0.057)	(0.071)	(0.061)	(0.040)	(0.075)
Tier 1 Capital ratio $<$ 4%	0.021**	0.023**	0.009	0.020*	0.024**	0.009
	(0.010)	(0.009)	(0.009)	(0.012)	(0.010)	(0.006)
GDP growth	0.010	0.007	-0.047	0.055*	0.001	-0.047*
	(0.033)	(0.033)	(0.029)	(0.030)	(0.033)	(0.026)
Inflation rate	0.038	0.035	0.067**	0.020	0.030	0.068***
	(0.033)	(0.036)	(0.030)	(0.030)	(0.033)	(0.025)
Observations	4,578	4,578	4,578	4,578	4,578	4,578
Number of id	447	447	447	447	447	447
Nber Countries	27	27	27	27	27	27
Year FE	YES	YES	YES	YES	YES	YES
Transform	First Differencing	First Differencing	Orthogonal Dev.	First Differencing	First Differencing	Orthogonal Dev.
Collapse	NO	NO	NO	YES	NO	YES
Windmeijer Correction	YES	YES	YES	YES	YES	YES
Nber instruments	294	294	294	54	154	54
First Order AR Test	0	0	0	0	0	0
Second Order AR Test	.739	.754	.705	.881	.758	.712
Hansen Test	.248	.248	.276	.182	.011	.736
Wald Test	.004	.001	.031	0	.000	.028

*** $p<0.01$, ** $p<0.05$ and * $p<0.1$. Standard Errors clustered at the bank level in parentheses. All regressions includes a constant term. The Wald Test is a test of joint significancy of control variables excluding the lagged dependend variables as well as the year dummies. This table present the result from the estimation of the partial adjustment framework described in equation (3). Each column use a different specification. The first column uses the one-step system-GMM estimator. The second column uses the two-step system-GMM estimator. The third column uses the two-step system-GMM estimator and the forward orthogonal deviations transform rather than the first-differencing. The Fourth column the two-step system-GMM estimator and collapse the instrument set to avoid proliferation of instruments. All the two-step regressions use Windmeijer correction for variance-covariance matrix

Table 4: Estimating the Adjustment Process Excluding Forward Looking Information

	Tier 1 capital ratio						
Lag of Tier 1 ratio	0.749***	0.749***	0.807***	0.809***	0.770***	0.801***	0.786***
	(0.101)	(0.084)	(0.080)	(0.076)	(0.085)	(0.087)	(0.058)
Log of Assets	-0.000	-0.000	0.002	0.002	0.002	0.001	0.000
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)
ROAA	-0.571**	-0.316	-0.318*	-0.261	-0.289*	-0.443**	-0.403**
	(0.280)	(0.201)	(0.189)	(0.174)	(0.152)	(0.213)	(0.185)
Liquid Assets over Assets	-0.022	-0.009	-0.009	-0.006	0.004	0.008	0.006
	(0.017)	(0.014)	(0.015)	(0.014)	(0.021)	(0.019)	(0.015)
Deposit-to-Asset Ratio	-0.008	-0.006	-0.002	-0.004	0.003	0.002	0.003
	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)	(0.011)	(0.011)
Cost-to-Income Ratio	-0.011	0.003	0.007	0.004	0.006	-0.004	-0.004
	(0.012)	(0.007)	(0.009)	(0.007)	(0.008)	(0.010)	(0.009)
Loan Loss Provision (%)	-0.250*	-0.102	-0.029	-0.023	-0.083	-0.106**	-0.071
	(0.151)	(0.095)	(0.070)	(0.072)	(0.055)	(0.051)	(0.079)
Tier 1 Capital ratio $< 4\%$	0.006	0.006	0.021	0.023*	0.023*	0.023*	0.021*
	(0.004)	(0.005)	(0.016)	(0.013)	(0.012)	(0.012)	(0.013)
GDP growth	0.094	0.109**	0.047	0.061	-0.023	-0.043	-0.050
	(0.065)	(0.055)	(0.065)	(0.055)	(0.060)	(0.057)	(0.053)
Inflation rate	-0.124**	-0.101**	-0.031	-0.044	-0.022	-0.003	0.017
	(0.048)	(0.049)	(0.047)	(0.045)	(0.045)	(0.040)	(0.037)
Observations	1,387	1,639	1,897	2,157	2,407	2,674	2,964
Number of id	297	326	347	366	371	383	401
Nber Countries	27	27	27	27	27	27	27
Year FE	YES	YES	YES	YES	YES	YES	YES
Nber instruments	84	96	109	123	138	154	171
First Order AR Test	.000	.000	.000	0	0	.000	0
Second Order AR Test	.970	.971	.773	.865	.728	.834	.815
Hansen Test	.456	.636	.746	.706	.652	.495	.292
Wald Test	.007	.02	.117	.113	.356	.122	.147
Using data until	2000	2001	2002	2003	2004	2005	2006

*** p<0.01, ** p<0.05 and * p<0.1. Standard Errors clustered at the bank level in parentheses. All regressions includes a constant term. The Wald Test is a test of joint significancy of control variables excluding the lagged dependend variables as well as the year dummies. This table present the result from the estimation of the partial adjustment model described in equation (3) excluding forward looking information. We estimate it using two step system-GMM with Windmeijeir correction. Each column corresponds to a different samples where we iteratively include new years. Hence we start in the first column by restricting the sample to all the years up to 2000, i.e. we exclude all years after 2000. Then we add the year 2001 (the second column), the year 2002 (the third column) and so on.

Table 5: Estimating the Adjustment Process Excluding Forward Looking Information

	Tier 1 capital ratio					
Lag of Tier 1 ratio	0.786***	0.790***	0.794***	0.797***	0.790***	0.789***
	(0.057)	(0.055)	(0.053)	(0.048)	(0.046)	(0.046)
Log of Assets	-0.000	-0.001	0.001	0.003*	0.003*	0.004**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
ROAA	-0.461***	-0.392***	-0.248***	-0.247**	-0.206**	-0.176**
	(0.175)	(0.126)	(0.095)	(0.102)	(0.081)	(0.075)
Liquid Assets over Assets	0.007	0.007	-0.003	0.000	0.000	-0.000
	(0.015)	(0.015)	(0.015)	(0.014)	(0.014)	(0.014)
Deposit-to-Asset Ratio	0.004	0.004	0.000	0.002	0.006	0.004
	(0.010)	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)
Cost-to-Income Ratio	-0.006	-0.008	0.003	0.004	0.006	0.006**
	(0.009)	(0.009)	(0.005)	(0.004)	(0.004)	(0.003)
Loan Loss Provision (%)	-0.073	-0.065	-0.034	-0.017	-0.018	-0.017
	(0.070)	(0.069)	(0.069)	(0.061)	(0.060)	(0.057)
Tier 1 Capital ratio $< 4\%$	0.020	0.021*	0.024**	0.023**	0.023**	0.023**
	(0.013)	(0.012)	(0.012)	(0.010)	(0.010)	(0.009)
GDP growth	-0.039	-0.020	0.008	-0.030	0.010	0.007
	(0.052)	(0.051)	(0.051)	(0.035)	(0.033)	(0.033)
Inflation rate	0.015	0.009	0.068*	0.033	0.041	0.035
	(0.036)	(0.036)	(0.040)	(0.034)	(0.036)	(0.036)
Observations	3,278	3,602	3,927	4,221	4,499	4,578
Number of id	423	440	445	447	447	447
Nber Countries	27	27	27	27	27	27
Year FE	YES	YES	YES	YES	YES	YES
Nber instruments	189	208	228	249	271	294
First Order AR Test	0	0	0	0	0	0
Second Order AR Test	.710	.814	.917	.958	.977	.754
Hansen Test	.344	.294	.259	.246	.124	.248
Wald Test	.075	.010	.010	.012	.003	.001
Using data until	2007	2008	2009	2010	2011	2012

*** p<0.01, ** p<0.05 and * p<0.1. Standard Errors clustered at the bank level in parentheses. All regressions includes a constant term. The Wald Test is a test of joint significancy of control variables excluding the lagged dependend variables as well as the year dummies. This table present the result from the estimation of the partial adjustment model described in equation (3) excluding forward looking information. We estimate it using two step system-GMM with Windmeijeir correction. Each column corresponds to a different samples where we iteratively include new years. Hence we start in the first column (in the previous table) by restricting the sample to all the years up to 2000, i.e. we exclude all years after 2007. Then we add the year 2008 (the second column), the year 2009 (the third column) and so on. The last column correspond to the regression using the full sample.

Table 6: Descriptive Statistics of Capital Variables (Bank Level)

Variable	N	Mean	SD	P5	Median	P95
Tier 1 Ratio	5216	0.11	0.06	0.06	0.09	0.20
Total Capital Ratio	5028	0.13	0.05	0.09	0.12	0.22
Targeted Tier 1 Ratio	4759	0.11	0.07	0.04	0.10	0.22
Deviation	4759	-0.00	0.07	-0.08	-0.00	0.06
OverCap	2077	0.03	0.07	0.00	0.02	0.12
UnderCap	2682	-0.04	0.04	-0.10	-0.02	-0.00
OverCap dummy	4759	43.64				

This table presents summary statistics for the actual and the predicted Tier 1 ratio as well as for the deviation computed as the difference between the two (see (4)). It also presents some decompositions according to whether the bank has an actual ratio above its target (OverCap.) or below it target (UnderCap.). It also indicates the share of bank with an actual ratio above its target.

Table 7: Descriptive Statistics of Capital Variables (Country Level)

Variable	N	Mean	SD	P5	Median	P95
Avg Deviation	429	-.006	.056	-.070	-.004	.053
Avg Deviation (Overcap.)	183	.029	.061	.001	.013	.115
Avg Deviation (Undercap.)	246	-.032	.035	-.078	-.022	-.002
Avg Deviation of Overcap. Banks	331	.043	.109	.004	.020	.134
Avg Deviation of Undercap. Banks	382	-.031	.032	-.082	-.020	-.004
Avg Deviation of Large Banks (Top 50%)	396	-.008	.056	-.073	-.007	.041
Avg Deviation of Small Banks (Bottom 50%)	396	.002	.062	-.070	-.003	.103
Avg Deviation of Large Banks (Undercap.)	243	-.030	.028	-.084	-.020	-.001
Avg Deviation of Small Banks (Undercap.)	210	-.032	.030	-.088	-.023	-.003
Avg Deviation of Large Banks (Overcap.)	153	.029	.069	.001	.012	.097
Avg Deviation of Small Banks (Overcap.)	186	.041	.066	.002	.019	.171

This table presents the aggregate capitalisation index computed as the weighted mean of individual deviation in a given country at a given period (see (5)). We also provide decompositions depending on whether this aggregate capitalisation index is positive (OverCap.) or negative (UnderCap.). The next two lines presents the aggregate capitalisation index computed on the undercapitalised (overcapitalised) banks *only* for a given country at a given period. Finally, we present aggregate capitalisation index computed for banks in the top –i.e. with size above than the median– (resp. bottom –i.e. with size below than the median–) of the distribution *within* a country at a given period. We also provide decompositions of these index depending on whether they are positive (OverCap.) or negative (UnderCap.).

Table 8: Correlation between the BLS Survey and the measure of aggregate capitalisation

Country	Obs.	Correlation in level	Correlation in level	Correlation in change
AUSTRIA	15	-.9059**	-.758**	-.8721**
BELGIUM	15	-.5821*	-.5582*	-.638*
FRANCE	15	-.7335**	-.1218	-.1111
GERMANY	15	-.7058**	-.7994**	-.9224**
IRELAND	10	-.3452	-.157	.0339
ITALY	15	-.6138*	-.7778**	-.7727**
LUXEMBOURG	15	-.5149	-.4853	-.8848**
NETHERLANDS	15	-.4776	-.5073	-.0725
PORTUGAL	15	-.9068**	-.7433**	-.7493**
SLOVENIA	7	-.2179	-.2115	-.4089
SPAIN	15	-.5657*	-.4706	-.4919
FULL SAMPLE	152	-.4728**	-.5233**	-.3373**
PERIOD		BLS responses Q1	BLS responses yearly avg	BLS responses Q1

** p<0.05 and * p<0.1. This table shows within country correlation between our aggregate measure of capitalisation and the aggregate response to question relative to the role of capital position in credit tightening from the BLS survey

Table 9: Baseline Aggregate Analysis

	Growth rate of Aggregate Lending					
	Total	non-MFI	MFI	Total	non-MFI	MFI
Avg Deviation	0.812**	0.897**	0.486	0.918***	0.919***	0.676
	(0.311)	(0.341)	(0.536)	(0.314)	(0.280)	(0.812)
Dispersion of Deviation	-0.190	-0.245	0.034	0.034	0.020	0.095
	(0.236)	(0.240)	(0.216)	(0.144)	(0.095)	(0.268)
GDP growth				1.137***	1.254***	0.368
				(0.252)	(0.291)	(0.875)
Inflation rate				1.366**	1.286**	1.181
				(0.568)	(0.475)	(1.061)
VSTOXX Volatility Index				-0.001**	-0.001*	-0.002
				(0.001)	(0.001)	(0.001)
Log of the Size of Banking Sector				-0.036	-0.081**	0.067
				(0.041)	(0.038)	(0.042)
Change in Sample Representativeness				-0.124*	-0.009	-0.354***
				(0.061)	(0.046)	(0.105)
Change in Country S&P Rating				0.003*	-0.000	0.015***
				(0.002)	(0.002)	(0.004)
Observations	257	257	257	233	233	233
Adjusted R-squared	0.472	0.529	0.105	0.608	0.697	0.205
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Cluster	Cntry	Cntry	Cntry	Cntry	Cntry	Cntry
TimeFrame	After 2000	After 2000	After 2000	After 2000	After 2000	After 2000

*** p<0.01, ** p<0.05 and * p<0.1. Robust standard errors in parentheses. All regressions include a constant term.

Table 10: Baseline Aggregate Analysis: Decomposing by Counterparty

	Growth rate of Aggregate Lending			
	non-MFI		MFI	
	Domestic	Non-Domestic	Domestic	Non-Domestic
Avg Deviation	1.037***	-3.003	-0.444	2.942
	(0.278)	(8.363)	(1.244)	(2.567)
Dispersion of Deviation	-0.005	1.600	0.040	0.122
	(0.088)	(2.430)	(0.510)	(0.302)
GDP growth	1.348***	-2.211	2.035*	-4.082*
	(0.335)	(5.092)	(1.057)	(2.090)
Inflation rate	1.328**	14.026	0.639	4.024***
	(0.540)	(9.651)	(1.549)	(1.389)
VSTOXX Volatility Index	-0.001	-0.039	-0.002	-0.005*
	(0.001)	(0.026)	(0.002)	(0.003)
Log of the Size of Banking Sector	-0.064*	-2.325	0.025	0.176**
	(0.034)	(1.572)	(0.085)	(0.084)
Change in Sample Representativeness	-0.046	0.320	-0.547**	-0.097
	(0.049)	(0.594)	(0.217)	(0.231)
Change in Country S&P Rating	-0.000	0.027	0.025***	0.016
	(0.002)	(0.034)	(0.006)	(0.010)
Observations	233	230	233	230
Adjusted R-squared	0.676	0.191	0.074	0.098
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Cluster	Cntry	Cntry	Cntry	Cntry
TimeFrame	After 2000	After 2000	After 2000	After 2000

*** $p<0.01$, ** $p<0.05$ and * $p<0.1$. Robust standard errors in parentheses. All regressions include a constant term.

Table 11: Aggregate Analysis : UnderCap. vs OverCap.

	Growth rate of Aggregate Lending					
	Total	non-MFI	MFI	Total	non-MFI	MFI
Avg Deviation (Undercap.)	1.190***	1.331***	0.945	1.378***	1.392***	1.122
	(0.411)	(0.460)	(0.666)	(0.364)	(0.331)	(0.920)
Avg Deviation (Overcap.)	-0.075	0.366	-1.023	-0.089	0.072	-0.238
	(0.986)	(0.938)	(0.996)	(0.663)	(0.603)	(0.965)
Dispersion of Deviation	-0.218	-0.157	-0.265	-0.067	-0.020	-0.104
	(0.165)	(0.113)	(0.271)	(0.135)	(0.072)	(0.252)
GDP growth				1.202***	1.318***	0.420
				(0.251)	(0.273)	(0.889)
Inflation rate				1.237**	1.169**	1.081
				(0.580)	(0.481)	(1.093)
VSTOXX Volatility Index				-0.006*	-0.010***	0.002
				(0.003)	(0.003)	(0.006)
Log of the Size of Banking Sector				-0.044	-0.086**	0.059
				(0.038)	(0.037)	(0.036)
Change in Sample Representativeness				-0.110*	-0.001	-0.336***
				(0.060)	(0.045)	(0.109)
Change in Country S&P Rating				0.002	-0.000	0.015***
				(0.002)	(0.002)	(0.004)
Observations	257	257	257	233	233	233
Adjusted R-squared	0.472	0.528	0.112	0.616	0.701	0.203
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Cluster	Cntry	Cntry	Cntry	Cntry	Cntry	Cntry
TimeFrame	After 2000	After 2000	After 2000	After 2000	After 2000	After 2000

*** p<0.01, ** p<0.05 and * p<0.1. Robust standard errors in parentheses. All regressions include a constant term.

A A toy model of bank capital adjustment

The program of an individual bank can be expressed in a very simple way as maximizing profits Π under the balance sheet and capital adequacy constraints, where E stands for equity, D for debt and A for total assets. We posit the existence of an adjustment cost function Ψ which depends on leverage with $\Psi' > 0$; that is to say, the marginal cost of adjustment increases with incremental leverage. Equivalently, it is more costly to adjust at the margin when a bank de-leverages, that is to say when the bank increases its share of equity finance either by levying capital or by (fire-)selling assets which did not mature yet. So the maximisation program writes:

$$\begin{aligned} \underset{\{A_{t+i};D_{t+i}\}_{i=0}^{\infty}}{\texttt{Max}} \quad & \sum_{i=0}^{\infty} \beta^i \mathrm{E}_t \left\{ \Pi_{t+i} \right\} = \sum_{i=0}^{\infty} \beta^i \mathrm{E}_t \left\{ \tilde{r}^a_{t+i} A_{t+i} - r^d_{t+i} D_{t+i} - \Psi \left(\frac{A_{t+i}}{E_{t+i}} \right) \cdot E_{t+i} \right\} \quad (8) \\ & \text{s.t.} \\ A_{t+i} &= E_{t+i} + D_{t+i} \\ E_{t+i} &\geq \kappa A_{t+i} \end{aligned}$$

Where $\tilde{r}^a$ stands for the uncertain return on assets, r^d the promised repayment on debt, and κ the regulatory constraint.

But it is more convenient to simplify it further by considering that all that matters to the bank is the choice of leverage, rather than the absolute size of its balance sheet, which could more likely be determined by the demand side. So the bank chooses its leverage $L = \frac{A}{E}$ in order to maximize its return on equity. Assuming a standard quadratic adjustment costs with respect to the initial leverage ratio of the bank $\Psi(L) = \psi \cdot \frac{(L_t - L_{t-1})^2}{2}$ with $\psi > 0$, and after rearranging (8), one obtains:

$$\begin{aligned} \underset{\{L_{t+i}\}_{i=0}^{\infty}}{\texttt{Max}} \quad & \sum_{i=0}^{\infty} \beta^i \mathrm{E}_t \left\{ (\tilde{r}^a_{t+i} - r^d_{t+i}(L_{t+i})) L_{t+i} + r^d_{t+i}(L_{t+i}) - \psi_{t+i} \frac{(L_{t+i} - L_{t+i-1})^2}{2} \right\} \quad (9) \\ & \text{s.t.} \\ \frac{1}{\kappa} &\geq L \end{aligned}$$

The fundamental trade-off the bank faces is a choice between more leverage in order to maximize its gain in terms of interest margin $\tilde{r}^a - r^d$, but more leverage induces a larger probability of default which translates into a higher risk premium when raising unsecured external finance. Henceforth, D in our setting should be understood as representing unsecured debt, like wholesale funding, while insured deposits should not depend on the riskiness of the bank and can be abstracted from. As a consequence, the interest rate $r^d = r^d(L)$ paid on unsecured debt should be an increasing function of leverage $r^{d'} > 0$. This can be readily seen from the arbitrage equation between a riskfree asset with return r and a bank unsecured bond:

$$r^d \left(1 - P \left(\tilde{r}^a A < r^d D \right) \right) = r \quad (10)$$

A total differential with respect to leverage L yields the desired property, that is to say the more the bank leverages, the lower the distance to default and the larger the risk premium the bank must pay to compensate external investors.

Taking a linear approximation for the expression of the outside finance premium, with the default premium being linear in leverage $r^d(L) = r + \mu L$, the first order condition of equation 9 is given by:

$$0 = \mathrm{E}_t \left(\tilde{r}_t^a - 2\mu L_t + \mu - (1 - \beta L^{-1})(\psi_t(L_t - L_{t-1})) \right) \qquad (11)$$

And at the steady state where $\bar{L} = L_t = L_{t-1}$ we have:

$$r^a = 2\bar{L}\mu - \mu \qquad (12)$$

So plugging equation (12) in the FOC given by equation (11), the infinite horizon result [34] is obtained after rearranging:

$$L_t - L_{t-1} = \mathrm{E}_t \sum_{i=0}^{\infty} \beta^i \left(\frac{\psi_{t+i}}{2\mu + \psi_{t+i}} \right)^i \lambda_{t+i}(\bar{L} - L_{t-1+i}) \qquad (13)$$

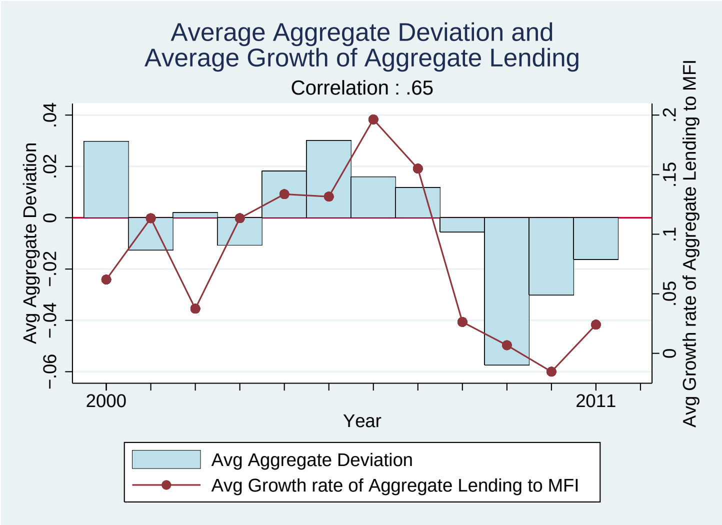
We obtain a forward looking partial adjustment equation. Namely, the adjustment today depends on the discounted expected future deviations from the target and the associated expected cost. Thus the bank will smooth its leverage position to avoid large adjustment costs, but in the meantime larger risk premium on the unsecured debt prevent the bank from completely postponing its leverage adjustment. In the empirical part, we restrict the analysis to the simple version a version of equation 13, with only one lag and use current deviation as a proxy for expected deviations.

34. When the capital constraint is not binding, i.e. the endogenous market forces require more than κ of capital. When the regulatory constraint binds, an additional term depending on the shadow cost of the capital constraint appears in equation 13.

B Additional graphs

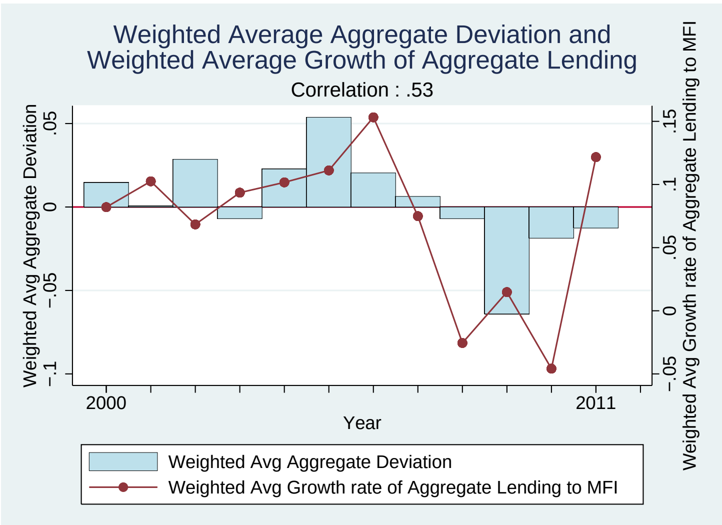
B.1 Evolution of aggregate deviation and growth rate of aggregate lending of MFI

Figure 8: Evolution of the capitalisation index and the evolution of the growth rate of aggregate lending to MFI averaged across countries



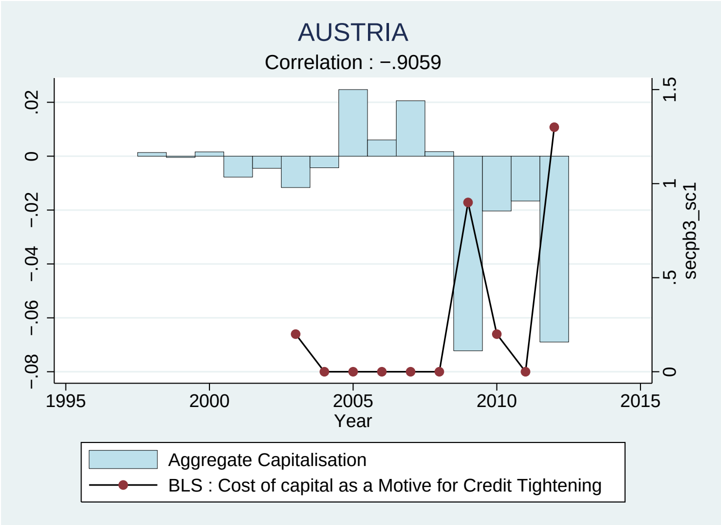
This figure represents the evolution of the average aggregate deviation across time and the evolution of the average growth rate of aggregate lending to MFI. A positive number indicates a situation where the banking system if over-capitalised and a negative number indicates a situation where the banking system if under-capitalised. Two distinct axis are used.

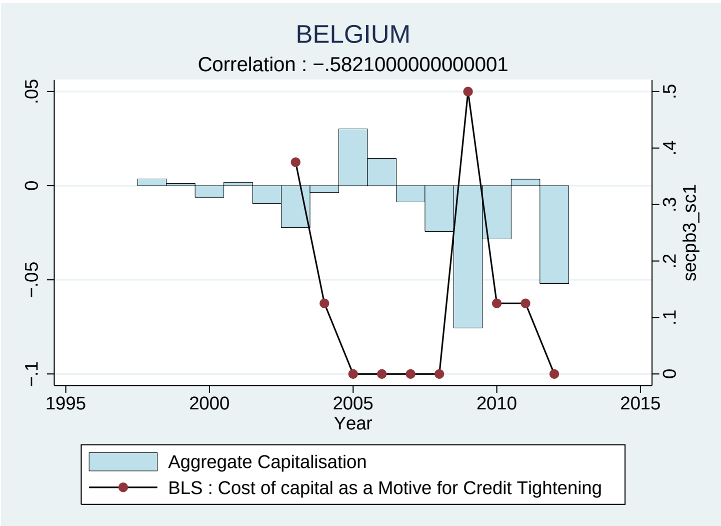
Figure 9: Evolution of the capitalisation index and the evolution of the growth rate of aggregate lending to MFI averaged across countries

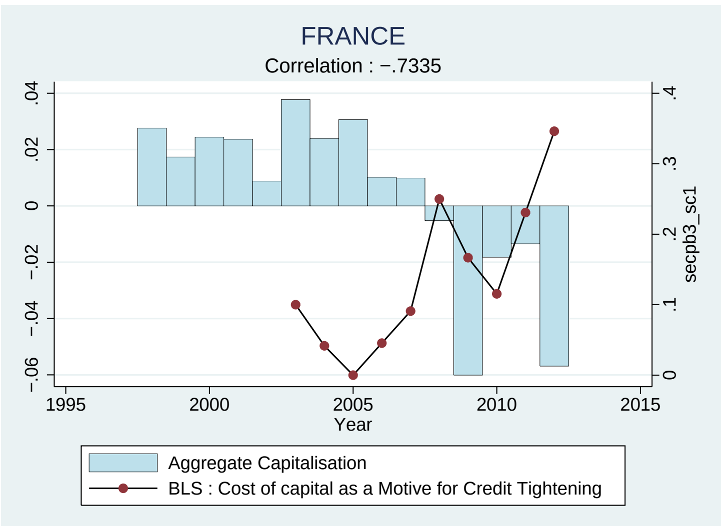


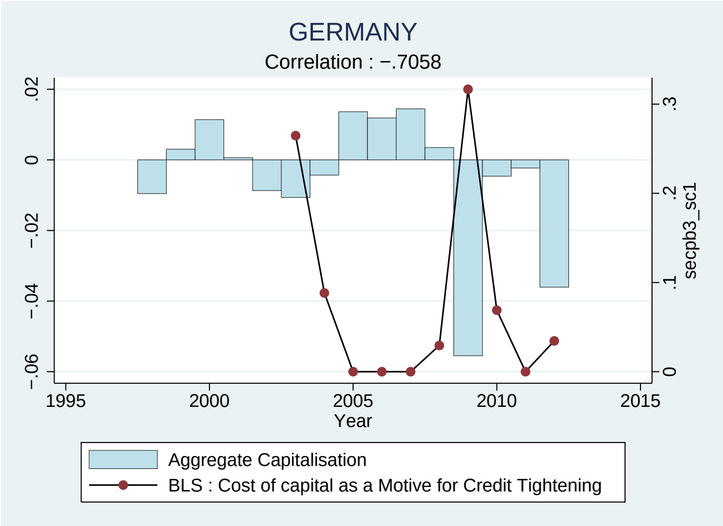
This figure represents the evolution of the average aggregate deviation across time and the evolution of the average growth rate of aggregate lending to MFI weighted by banking system's importance. A positive number indicates a situation where the banking system if over-capitalised and a negative number indicates a situation where the banking system if under-capitalised. Two distinct axis are used.

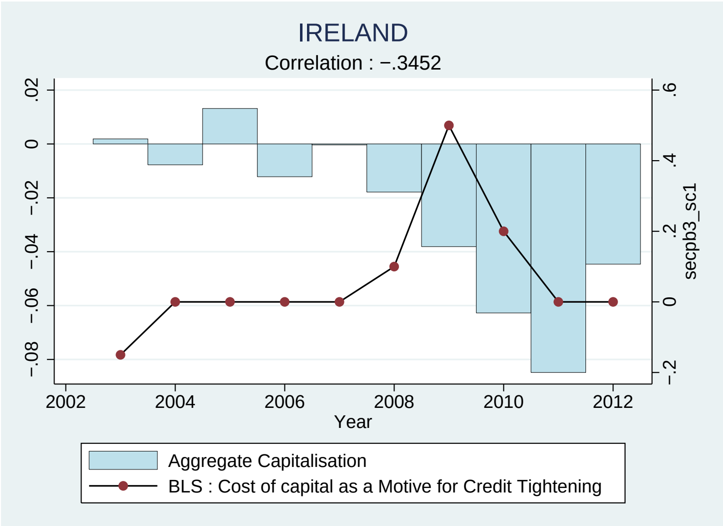
B.2 Comparing Aggregate Deviation Measurement with the Bank Lending Survey

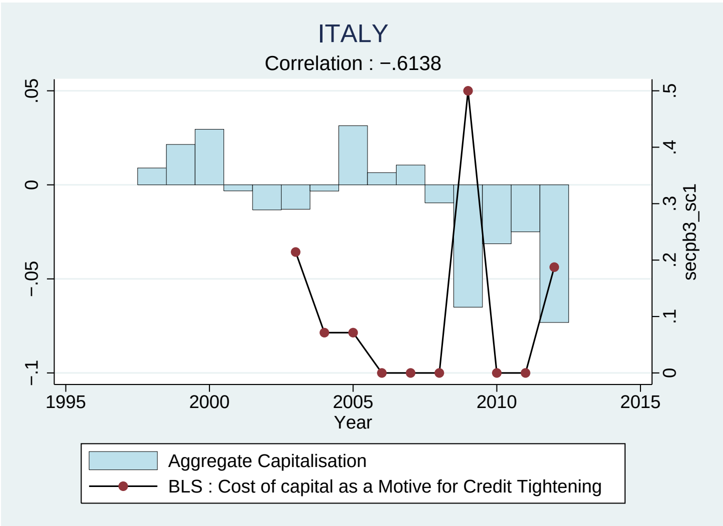


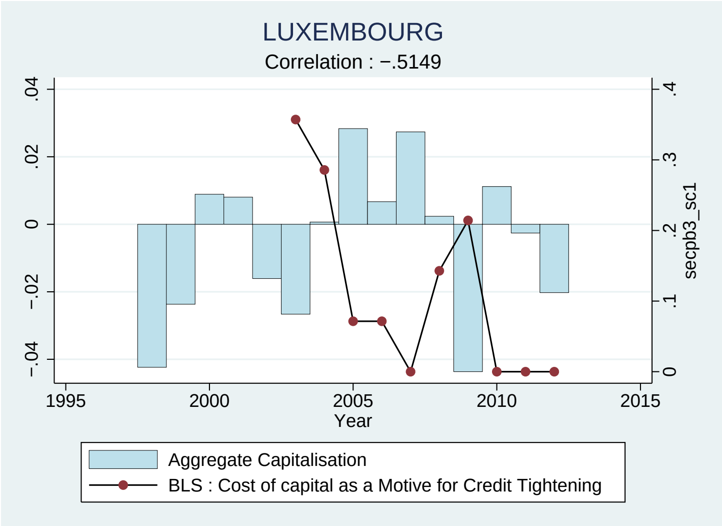


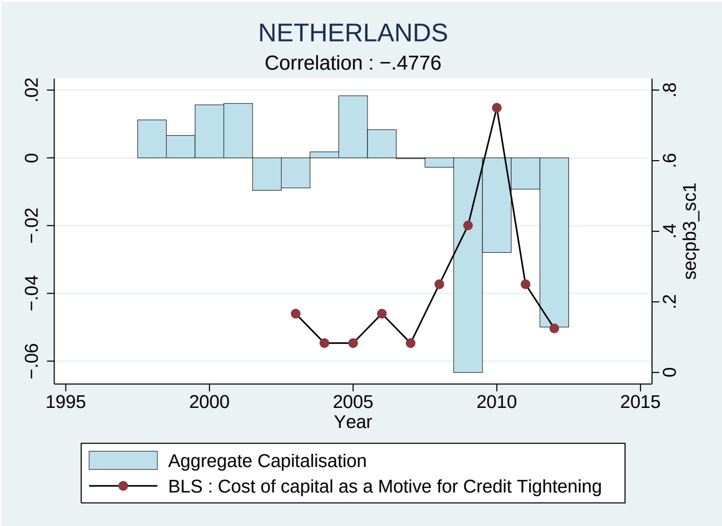


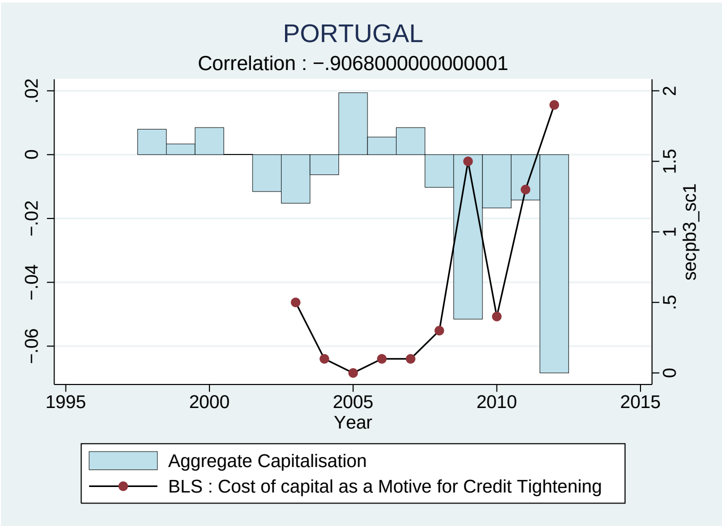

GERMANY
Correlation : −.7058
.02
0
−.02
−.04
−.06
.3
.2
.1
0
secpb3_sc1
1995
2000
2005
2010
2015
Year
Aggregate Capitalisation
BLS : Cost of capital as a Motive for Credit Tightening

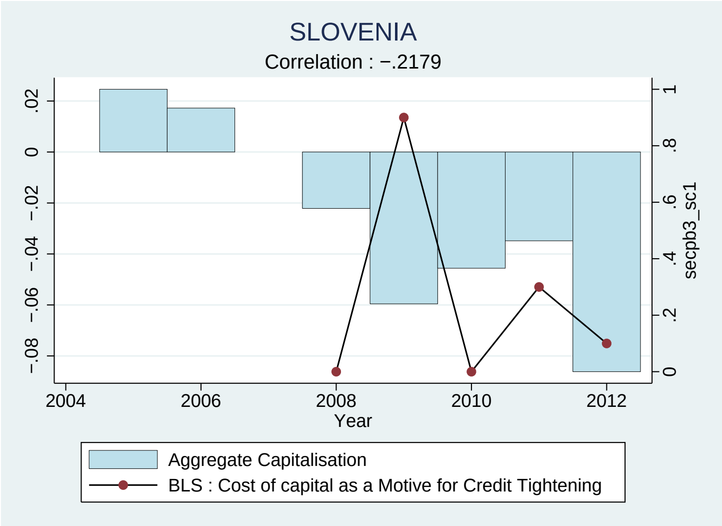

IRELAND
Correlation : −.3452
.02
0
−.02
−.04
−.06
−.08
.6
.4
.2
0
−.2
secpb3_sc1
2002
2004
2006
2008
2010
2012
Year
Aggregate Capitalisation
BLS : Cost of capital as a Motive for Credit Tightening

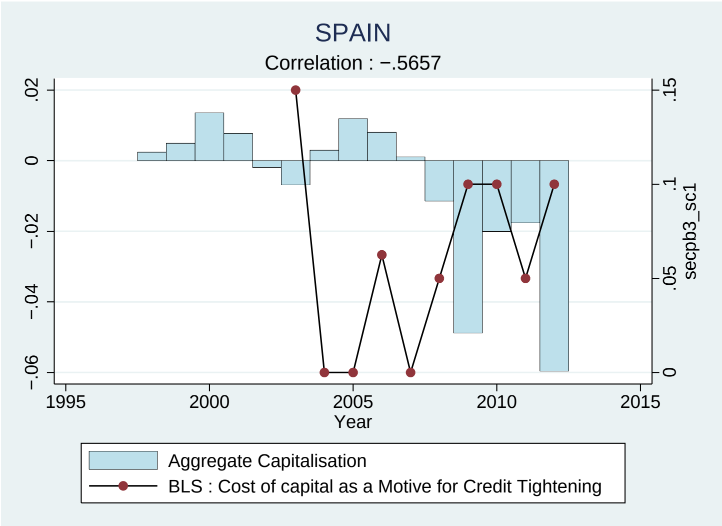

ITALY
Correlation : −.6138
.05
0
−.05
−.1
.5
.4
.3
.2
.1
0
secpb3_sc1
1995
2000
2005
2010
2015
Year
Aggregate Capitalisation
BLS : Cost of capital as a Motive for Credit Tightening


LUXEMBOURG
Correlation : −.5149
Year
secpb3_sc1
Aggregate Capitalisation
BLS : Cost of capital as a Motive for Credit Tightening


NETHERLANDS
Correlation : −.4776
Year
secpb3_sc1
Aggregate Capitalisation
BLS : Cost of capital as a Motive for Credit Tightening

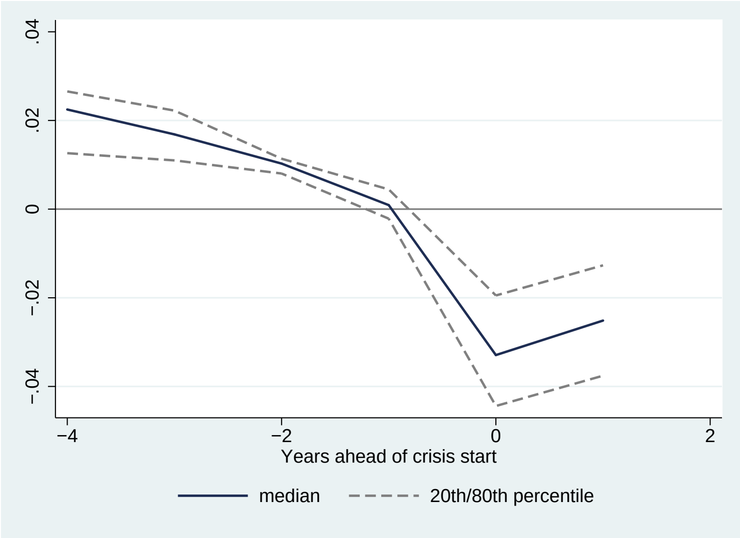

PORTUGAL
Correlation : −.9068000000000001
Year
secpb3_sc1
Aggregate Capitalisation
BLS : Cost of capital as a Motive for Credit Tightening


SLOVENIA
Correlation : −.2179
.02
0
−.02
−.04
−.06
−.08
2004
2006
2008
2010
2012
Year
1
.8
.6
.4
.2
0
secpb3_sc1
Aggregate Capitalisation
BLS : Cost of capital as a Motive for Credit Tightening


SPAIN
Correlation : −.5657
.02
0
−.02
−.04
−.06
1995
2000
2005
2010
2015
Year
.15
.1
.05
0
secpb3_sc1
Aggregate Capitalisation
BLS : Cost of capital as a Motive for Credit Tightening

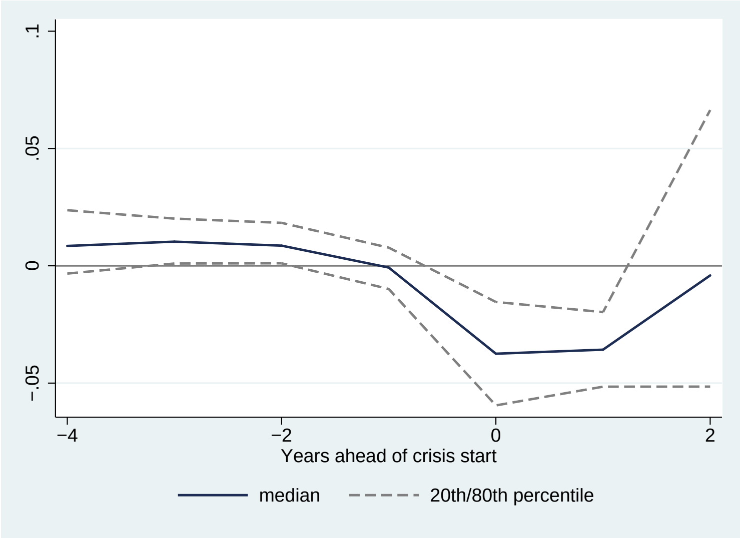
B.3 Before/after analysis around crisis events

Figure 10: Capitalisation index around crisis episodes for Northern Europe



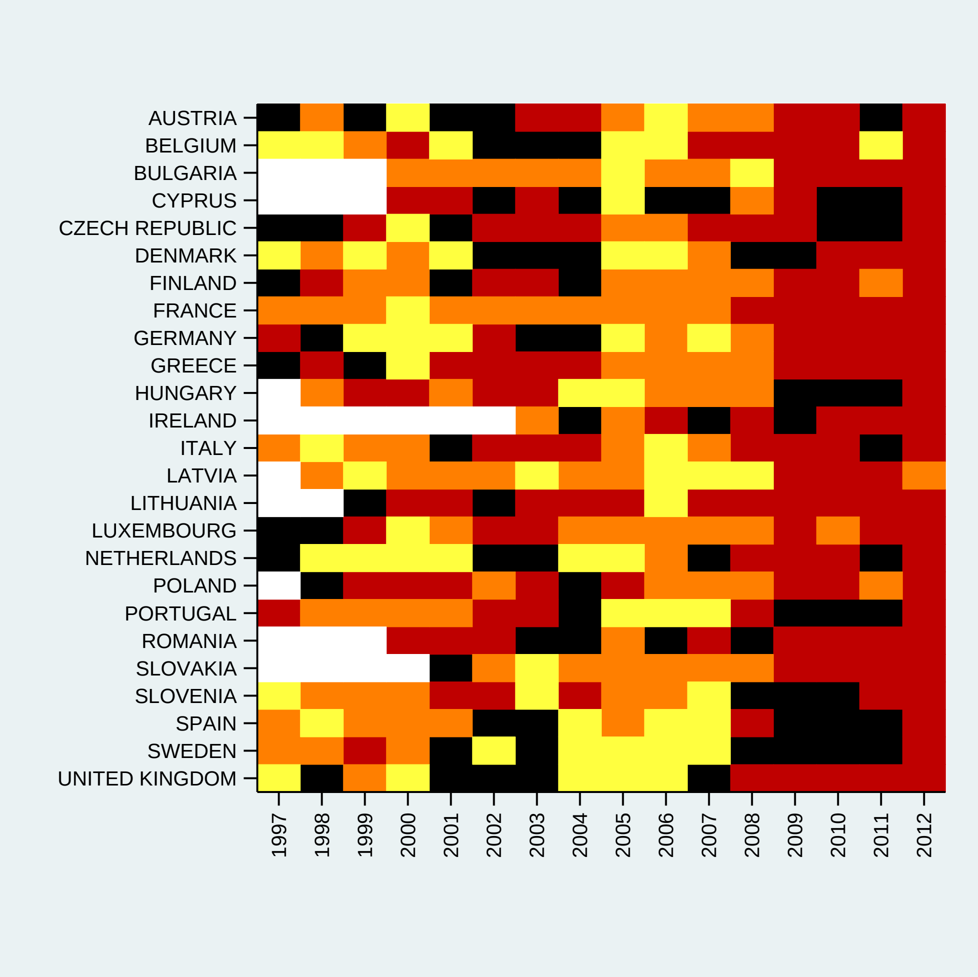
This figure represents the evolution of the average aggregate deviation (calculated using only data available at each date) for year before and after the start of the crisis, defined as the year during which a banking crisis started as recorded at the quarterly frequency in the ECB dataset. Also to be consistent with the timing of the crisis dummy, the deviation at time t is recoded as deviation at time t-1, so that the deviation at time t-1 indeed depends on end of period t-1 observables.

Figure 11: Capitalisation index around crisis episodes for Eastern and Southern Europe



This figure represents the evolution of the average aggregate deviation (calculated using only data available at each date) for year before and after the start of the crisis, defined as the year during which a banking crisis started as recorded at the quarterly frequency in the ECB dataset. Also to be consistent with the timing of the crisis dummy, the deviation at time t is recoded as deviation at time t-1, so that the deviation at time t-1 indeed depends on end of period t-1 observables.

Figure 12: Heatmap of the capitalisation index of the banking sector classified by heterogeneity of the index within each country



- White: not enough information.
- Yellow : over-capitalisation on average and the standard deviation of the index is smaller than the median, i.e. more homogeneity among banks.
- Orange : over-capitalisation on average but the standard deviation of the index is larger than the median, i.e. more heterogeneity which means some bansk possibly undercap.
- Red : under-capitalisation on average but the standard deviation of the index is larger than the median, i.e. more heterogeneity among banks such that some banks can possibly offset a negative capital shock.
- Black: under-capitalisation on average and the standard deviation of the index is smaller than the median, i.e. more homogeneity among banks mostly undercapitalised and only few banks with excess capital, i.e. the worst case scenario.

C Additional Tables

Table 12: Descriptive Statistics. Aggregate Lending

Variable	N	Mean	SD	P5	Median	P95	Source
Share of Lending to MFI	302	0.33	0.15	0.12	0.31	0.69	ECB
Share of Lending to non-MFI	302	0.67	0.15	0.31	0.69	0.88	ECB
Share of Domestic Lending, MFI	302	0.55	0.24	0.16	0.59	0.95	ECB
Share of non Domestic Lending, MFI	302	0.45	0.24	0.05	0.41	0.84	ECB
Share of Domestic Lending, non-MFI	302	0.86	0.19	0.37	0.95	1.00	ECB
Share of non Domestic Lending, non-MFI	302	0.14	0.19	0.00	0.05	0.63	ECB
Growth rate of Aggregate Lending	280	0.07	0.15	-0.13	0.07	0.32	ECB
Growth rate of Aggregate Lending to MFI	280	0.07	0.19	-0.23	0.06	0.37	ECB
Growth rate of Aggregate Lending to Domestic MFI	280	0.08	0.29	-0.34	0.05	0.54	ECB
Growth rate of Aggregate Lending to non Domestic MFI	277	0.10	0.45	-0.44	0.06	0.64	ECB
Growth rate of Aggregate Lending to non-MFI	280	0.08	0.16	-0.11	0.07	0.32	ECB
Growth rate of Aggregate Lending to Domestic non-MFI	280	0.10	0.13	-0.07	0.07	0.33	ECB
Growth rate of Aggregate Lending to non Domestic non-MFI	277	0.31	1.77	-0.53	0.10	1.04	ECB

This table presents descriptive statistics about the aggregate lending in the European Union. Data are disaggregated by type of borrowers as well as their geographical location.

Table 13: Summary statistics of Aggregate Deviation, by Year

Variable	N	Mean	SD	P25	Median	P75
Aggregate Deviation 1995	14	0.01	0.02	-0.00	0.00	0.01
Aggregate Deviation 1996	16	0.00	0.01	-0.01	0.00	0.01
Aggregate Deviation 1997	15	-0.00	0.02	-0.00	-0.00	0.01
Aggregate Deviation 1998	18	-0.00	0.05	-0.01	0.00	0.01
Aggregate Deviation 1999	19	-0.00	0.02	-0.02	0.00	0.01
Aggregate Deviation 2000	22	0.03	0.15	-0.01	0.01	0.02
Aggregate Deviation 2001	23	-0.01	0.10	-0.03	-0.00	0.01
Aggregate Deviation 2002	23	0.00	0.05	-0.02	-0.01	0.00
Aggregate Deviation 2003	23	-0.01	0.05	-0.03	-0.01	0.00
Aggregate Deviation 2004	22	0.02	0.06	-0.01	-0.00	0.00
Aggregate Deviation 2005	23	0.03	0.03	0.01	0.02	0.03
Aggregate Deviation 2006	24	0.02	0.02	0.01	0.01	0.02
Aggregate Deviation 2007	24	0.01	0.02	-0.00	0.01	0.02
Aggregate Deviation 2008	24	-0.01	0.02	-0.01	-0.00	0.01
Aggregate Deviation 2009	24	-0.06	0.01	-0.07	-0.06	-0.05
Aggregate Deviation 2010	24	-0.03	0.03	-0.03	-0.02	-0.02
Aggregate Deviation 2011	24	-0.02	0.02	-0.02	-0.01	-0.00

This table present descriptive statistics about the aggregate capitalisation index (see (5)) disagregated by year. The year 2012 is excluded because there are not sufficient observations for this indicator to be relevant.

Table 14: Summary statistics of the change in Aggregate Deviation, by Year

Variable	N	Mean	SD	P25	Median	P75
Change in Aggregate Deviation 1995	13	0.02	0.04	0.02	0.03	0.03
Change in Aggregate Deviation 1996	14	-0.01	0.02	-0.01	-0.01	0.00
Change in Aggregate Deviation 1997	14	-0.00	0.02	-0.01	-0.00	0.02
Change in Aggregate Deviation 1998	15	-0.01	0.04	-0.01	0.00	0.01
Change in Aggregate Deviation 1999	18	0.00	0.04	-0.01	-0.00	0.01
Change in Aggregate Deviation 2000	19	0.01	0.02	-0.00	0.01	0.02
Change in Aggregate Deviation 2001	22	-0.03	0.09	-0.03	-0.01	-0.00
Change in Aggregate Deviation 2002	23	0.01	0.09	-0.01	-0.01	0.00
Change in Aggregate Deviation 2003	22	-0.01	0.04	-0.02	-0.00	0.00
Change in Aggregate Deviation 2004	22	0.03	0.05	0.00	0.01	0.03
Change in Aggregate Deviation 2005	22	0.01	0.04	0.01	0.02	0.03
Change in Aggregate Deviation 2006	23	-0.01	0.02	-0.02	-0.02	-0.01
Change in Aggregate Deviation 2007	24	-0.00	0.01	-0.02	-0.00	0.01
Change in Aggregate Deviation 2008	24	-0.02	0.02	-0.03	-0.02	-0.01
Change in Aggregate Deviation 2009	24	-0.05	0.02	-0.07	-0.06	-0.04
Change in Aggregate Deviation 2010	24	0.03	0.03	0.02	0.03	0.04
Change in Aggregate Deviation 2011	24	0.01	0.02	0.00	0.01	0.02

This table present descriptive statistics about the *change* in the aggregate capitalisation index (see (5)) disagregated by year. The year 2012 is excluded because there are not sufficient observations for this indicator to be relevant.

Table 15: Estimating the Adjustment Process : Robustness Checks

	Tier 1 capital ratio					
Lag of Tier1 ratio	0.789***	0.789***	0.788***	0.786***	0.788***	0.788***
	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)
Log of Assets	0.004**	0.004**	0.004**	0.004*	0.004**	0.004**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
ROAA	-0.166**	-0.176**	-0.176**	-0.172**	-0.197***	-0.192***
	(0.077)	(0.075)	(0.076)	(0.077)	(0.076)	(0.071)
Liquid Assets over Assets	0.000	-0.000	-0.000	-0.001	-0.001	-0.001
	(0.014)	(0.014)	(0.014)	(0.014)	(0.015)	(0.015)
Deposit-to-Asset Ratio	0.004	0.004	0.004	0.004	0.002	0.002
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)
Cost-to-Income Ratio	0.006**	0.006**	0.006**	0.006*	0.005	0.005
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
Loan Loss Provision (%)	-0.016	-0.017	-0.017	-0.018	-0.044	-0.044
	(0.058)	(0.057)	(0.058)	(0.059)	(0.062)	(0.061)
Tier 1 Capital ratio < 4%	0.023**	0.023**	0.023***	0.023**	0.022**	0.021**
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)
GDP growth		0.007	0.004	0.005	0.001	0.001
		(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
Inflation rate		0.035	0.034	0.035	0.042	0.042
		(0.036)	(0.036)	(0.036)	(0.039)	(0.039)
Loans-to-Deposits Ratio			0.000***	0.000***	0.000***	0.000***
			(0.000)	(0.000)	(0.000)	(0.000)
Taxes over pre-tax Profit				-0.000	-0.000	-0.000
				(0.001)	(0.001)	(0.001)
Cash (%)					-0.025	-0.022
					(0.030)	(0.029)
Overhead over Assets						-0.019
						(0.265)
Observations	4,578	4,578	4,575	4,559	4,510	4,510
Number of id	447	447	447	447	446	446
Nber Countries	27	27	27	27	27	27
Year FE	YES	YES	YES	YES	YES	YES
Nber instruments	292	294	295	296	297	298
First Order AR Test	0	0	0	0	0	0
Second Order AR Test	.728	.754	.775	.737	.925	.917
Hansen Test	.274	.248	.222	.244	.251	.281
Wald Test	.001	.001	.001	.001	.002	.000

*** p<0.01, ** p<0.05 and * p<0.1. Standard Errors clustered at the bank level in parentheses. All regressions includes a constant term. The Wald Test is a test of joint significancy of control variables excluding the lagged dependend variables as well as the year dummies. This table present the result from the estimation of the partial adjustment framework described in equation (3). Each column use a various set of variables. We estimate it using two step system-GMM with Windmeijeir correction.

Table 16: Aggregate Analysis: UnderCap. vs OverCap. and Decomposing by Counterparty

	Growth rate of Aggregate Lending			
	non-MFI		MFI	
	Domestic	Non-Domestic	Domestic	Non-Domestic
Avg Deviation (Undercap.)	1.474***	4.195	-0.588	7.672*
	(0.325)	(4.783)	(1.656)	(4.159)
Avg Deviation (Overcap.)	0.366	-16.298	-0.696	-3.170
	(0.565)	(17.268)	(2.427)	(2.082)
Dispersion of Deviation	-0.038	2.648	-0.237	0.377
	(0.064)	(3.607)	(0.473)	(0.453)
GDP growth	1.403***	-1.213	2.015*	-3.583*
	(0.315)	(4.968)	(1.079)	(2.013)
Inflation rate	1.234**	12.161	0.653	3.255**
	(0.546)	(10.259)	(1.570)	(1.263)
VSTOXX Volatility Index	-0.012***	-0.027	0.016	-0.012
	(0.003)	(0.037)	(0.014)	(0.014)
Log of the Size of Banking Sector	-0.068*	-2.415	0.019	0.138*
	(0.034)	(1.585)	(0.083)	(0.076)
Change in Sample Representativeness	-0.039	0.376	-0.528**	-0.069
	(0.048)	(0.673)	(0.230)	(0.195)
Change in Country S&P Rating	-0.001	0.026	0.025***	0.015
	(0.002)	(0.034)	(0.006)	(0.011)
Observations	233	230	233	230
Adjusted R-squared	0.676	0.193	0.064	0.127
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Cluster	Cntry	Cntry	Cntry	Cntry
TimeFrame	After 2000	After 2000	After 2000	After 2000

*** $p<0.01$, ** $p<0.05$ and * $p<0.1$. Robust standard errors in parentheses. All regressions include a constant term. Average deviation weighted by assets/total assets.

Table 17: Robustness Checks : Including Lagged Control Variables

	Growth rate of Aggregate Lending		
	Total	non-MFI	MFI
Avg Deviation	0.652*	0.641*	0.416
	(0.321)	(0.318)	(0.828)
Dispersion of Deviation	0.065	0.056	0.116
	(0.135)	(0.084)	(0.269)
GDP growth	1.250***	1.407***	0.367
	(0.374)	(0.390)	(0.984)
Lag of GDP growth	0.479	0.450	0.633
	(0.411)	(0.392)	(0.755)
Inflation rate	0.746	0.607	0.667
	(0.724)	(0.580)	(1.257)
Lag of Inflation	0.896**	1.060***	0.493
	(0.373)	(0.309)	(0.817)
VSTOXX Volatility Index	-0.002***	-0.002***	-0.002
	(0.001)	(0.001)	(0.001)
Lag of VSTOXX Volatility Index	-0.001**	-0.002***	-0.000
	(0.001)	(0.001)	(0.001)
Log of the Size of Banking Sector	-0.042	-0.087**	0.064
	(0.037)	(0.035)	(0.043)
Change in Sample Representativeness	-0.116*	0.000	-0.353***
	(0.059)	(0.041)	(0.109)
Change in Country S&P Rating	0.004*	0.001	0.016***
	(0.002)	(0.002)	(0.004)
Observations	233	233	233
Adjusted R-squared	0.632	0.726	0.205
Country FE	YES	YES	YES
Year FE	YES	YES	YES
Cluster	Cntry	Cntry	Cntry
TimeFrame	After 2000	After 2000	After 2000

*** p<0.01, ** p<0.05 and * p<0.1. Robust standard errors in parentheses. All regressions include a constant term. Average deviation weighted by assets/total assets.

Table 18: Robustness Checks : Including Lagged Control Variables

	Growth rate of Aggregate Lending		
	Total	non-MFI	MFI
Avg Deviation (Undercap.)	0.838*	0.790**	0.666
	(0.408)	(0.308)	(0.978)
Avg Deviation (Overcap.)	0.011	0.217	-0.240
	(0.670)	(0.632)	(0.927)
Dispersion of Deviation	-0.044	0.008	-0.091
	(0.134)	(0.070)	(0.253)
GDP growth	1.258***	1.417***	0.371
	(0.370)	(0.380)	(0.985)
Lag of GDP growth	0.474	0.445	0.615
	(0.442)	(0.407)	(0.792)
Inflation rate	0.723	0.589	0.667
	(0.735)	(0.590)	(1.274)
Lag of Inflation	0.785**	0.985***	0.369
	(0.328)	(0.287)	(0.748)
VSTOXX Volatility Index	-0.008*	-0.012**	-0.001
	(0.004)	(0.005)	(0.008)
Lag of VSTOXX Volatility Index	0.001	0.001	0.000
	(0.002)	(0.003)	(0.005)
Log of the Size of Banking Sector	-0.047	-0.091**	0.058
	(0.036)	(0.034)	(0.037)
Change in Sample Representativeness	-0.105*	0.006	-0.337***
	(0.058)	(0.040)	(0.111)
Change in Country S&P Rating	0.003	0.000	0.015***
	(0.002)	(0.002)	(0.004)
Observations	233	233	233
Adjusted R-squared	0.634	0.724	0.201
Country FE	YES	YES	YES
Year FE	YES	YES	YES
Cluster	Cntry	Cntry	Cntry
TimeFrame	After 2000	After 2000	After 2000

*** p<0.01, ** p<0.05 and * p<0.1. Robust standard errors in parentheses. All regressions include a constant term. Average deviation weighted by assets/total assets.

Table 19: Robustness Checks : Including the Lagged Dependent Variable

	Growth rate of Aggregate Lending		
	Total	non-MFI	MFI
Avg Deviation	0.739*	0.867**	0.497
	(0.411)	(0.325)	(1.196)
Lag of Dependent Variable	0.216**	0.178*	-0.052
	(0.084)	(0.095)	(0.079)
Dispersion of Deviation	0.087	0.023	0.060
	(0.125)	(0.091)	(0.283)
GDP growth	0.866***	0.957***	0.346
	(0.198)	(0.269)	(0.861)
Inflation rate	1.136*	1.110**	1.263
	(0.573)	(0.428)	(0.966)
VSTOXX Volatility Index	-0.001**	-0.001**	-0.001
	(0.001)	(0.001)	(0.001)
Log of the Size of Banking Sector	-0.037	-0.086**	0.094*
	(0.042)	(0.035)	(0.054)
Change in Sample Representativeness	-0.138**	-0.023	-0.348***
	(0.055)	(0.039)	(0.112)
Change in Country S&P Rating	0.004**	0.002	0.014***
	(0.001)	(0.002)	(0.004)
Observations	222	222	222
Adjusted R-squared	0.603	0.707	0.193
Country FE	YES	YES	YES
Year FE	YES	YES	YES
Cluster	Cntry	Cntry	Cntry
TimeFrame	After 2000	After 2000	After 2000

*** $p<0.01$, ** $p<0.05$ and * $p<0.1$. Robust standard errors in parentheses. All regressions include a constant term. Average deviation weighted by assets/total assets.

Table 20: Robustness Checks : Including the Lagged Dependent Variable

	Growth rate of Aggregate Lending		
	Total	non-MFI	MFI
Avg Deviation (Undercap.)	1.149***	1.280***	1.416
	(0.402)	(0.245)	(1.125)
Avg Deviation (Overcap.)	-0.375	0.223	-1.534
	(0.775)	(0.837)	(1.494)
Lag of Dependent Variable	0.199**	0.167*	-0.053
	(0.071)	(0.092)	(0.080)
Dispersion of Deviation	-0.022	-0.039	-0.122
	(0.127)	(0.085)	(0.252)
GDP growth	0.898***	0.976***	0.367
	(0.182)	(0.261)	(0.878)
Inflation rate	1.077*	1.081**	1.136
	(0.587)	(0.436)	(1.030)
VSTOXX Volatility Index	-0.006**	-0.011***	0.002
	(0.003)	(0.003)	(0.006)
Log of the Size of Banking Sector	-0.047	-0.092**	0.076
	(0.040)	(0.033)	(0.051)
Change in Sample Representativeness	-0.122**	-0.016	-0.323**
	(0.057)	(0.039)	(0.116)
Change in Country S&P Rating	0.004**	0.002	0.014***
	(0.002)	(0.002)	(0.004)
Observations	222	222	222
Adjusted R-squared	0.611	0.708	0.203
Country FE	YES	YES	YES
Year FE	YES	YES	YES
Cluster	Cntry	Cntry	Cntry
TimeFrame	After 2000	After 2000	After 2000

*** p<0.01, ** p<0.05 and * p<0.1. Robust standard errors in parentheses. All regressions include a constant term. Average deviation weighted by assets/total assets.

Table 21: Robustness Checks : Lagged Aggregate Deviation

	Growth rate of Aggregate Lending					
	Total	non-MFI	MFI	Total	non-MFI	MFI
Avg Deviation				0.662*	0.754**	0.680
				(0.384)	(0.322)	(1.028)
Lagged Avg Deviation	0.837**	0.538	0.869	0.709*	0.393	0.738
	(0.361)	(0.402)	(0.643)	(0.395)	(0.454)	(0.762)
Dispersion of Deviation	0.059	0.036	0.118	0.050	0.026	0.109
	(0.139)	(0.100)	(0.262)	(0.133)	(0.092)	(0.257)
GDP growth	1.069***	1.179***	0.407	1.095***	1.209***	0.434
	(0.293)	(0.325)	(0.903)	(0.270)	(0.304)	(0.896)
Inflation rate	1.435**	1.376***	1.160	1.400**	1.337***	1.124
	(0.520)	(0.445)	(1.023)	(0.541)	(0.473)	(1.046)
VSTOXX Volatility Index	-0.002***	-0.002***	-0.003**	-0.002***	-0.001**	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Log of the Size of Banking Sector	-0.025	-0.077*	0.084*	-0.021	-0.073*	0.087*
	(0.038)	(0.038)	(0.043)	(0.040)	(0.040)	(0.044)
Change in Sample Representativeness	-0.160**	-0.029	-0.386***	-0.161**	-0.031	-0.387***
	(0.064)	(0.047)	(0.121)	(0.065)	(0.049)	(0.121)
Change in Country S&P Rating	0.003**	0.000	0.016***	0.003**	0.000	0.015***
	(0.002)	(0.002)	(0.004)	(0.001)	(0.002)	(0.004)
Observations	230	230	230	230	230	230
Adjusted R-squared	0.612	0.691	0.206	0.617	0.698	0.206
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Cluster	Cntry	Cntry	Cntry	Cntry	Cntry	Cntry
TimeFrame	After 2000	After 2000	After 2000	After 2000	After 2000	After 2000

*** p<0.01, ** p<0.05 and * p<0.1. Robust standard errors in parentheses. All regressions include a constant term. Average deviation weighted by assets/total assets.

Table 22: Robustness Checks : Lagged Aggregate Deviation

	Growth rate of Aggregate Lending					
	Total	non-MFI	MFI	Total	non-MFI	MFI
Avg Deviation (Undercap.)				1.294***	1.338***	1.269
				(0.409)	(0.392)	(0.936)
Avg Deviation (Overcap.)				-0.183	0.311	-0.825
				(0.848)	(0.859)	(1.147)
Lag of Avg Deviation (Undercap.)	1.860**	1.728***	0.780	1.803**	1.709***	0.673
	(0.745)	(0.606)	(2.042)	(0.706)	(0.588)	(1.982)
Lag of Avg Deviation (Overcap.)	0.272	-0.123	0.924*	0.372	-0.179	1.229**
	(0.199)	(0.198)	(0.461)	(0.287)	(0.282)	(0.593)
Dispersion of Deviation	-0.097	-0.058	-0.127	-0.075	-0.036	-0.106
	(0.163)	(0.093)	(0.293)	(0.128)	(0.067)	(0.258)
GDP growth	1.114***	1.236***	0.390	1.206***	1.319***	0.496
	(0.327)	(0.346)	(0.933)	(0.327)	(0.320)	(0.949)
Inflation rate	1.376**	1.304**	1.172	1.226*	1.182**	0.985
	(0.559)	(0.470)	(1.047)	(0.611)	(0.523)	(1.090)
VSTOXX Volatility Index	-0.010***	-0.014***	0.002	-0.012***	-0.016***	0.000
	(0.003)	(0.002)	(0.011)	(0.003)	(0.003)	(0.010)
Log of the Size of Banking Sector	-0.035	-0.087**	0.081*	-0.032	-0.083**	0.080**
	(0.037)	(0.036)	(0.042)	(0.037)	(0.037)	(0.038)
Change in Sample Representativeness	-0.143**	-0.016	-0.371***	-0.136*	-0.013	-0.357**
	(0.062)	(0.045)	(0.121)	(0.067)	(0.049)	(0.128)
Change in Country S&P Rating	0.004**	0.001	0.015***	0.003*	0.000	0.015***
	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)	(0.004)
Observations	230	230	230	230	230	230
Adjusted R-squared	0.631	0.711	0.203	0.643	0.724	0.204
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Cluster	Cntry	Cntry	Cntry	Cntry	Cntry	Cntry
TimeFrame	After 2000	After 2000	After 2000	After 2000	After 2000	After 2000

*** p<0.01, ** p<0.05 and * p<0.1. Robust standard errors in parentheses. All regressions include a constant term. Average deviation weighted by assets/total assets.

Table 23: Robustness Checks : Using Raw Leverage i.e. Capital-to-Assets Ratio

	Growth rate of Aggregate Lending					
	Total	non-MFI	MFI	Total	non-MFI	MFI
Avg Deviation	0.212***	0.175**	0.290**			
	(0.073)	(0.070)	(0.106)			
Avg Deviation (Undercap.)				0.161*	0.028	0.381**
				(0.081)	(0.067)	(0.155)
Avg Deviation (Overcap.)				0.313**	0.353**	0.340
				(0.144)	(0.166)	(0.336)
Dispersion of Deviation	-0.099**	-0.032	-0.190**	-0.003	0.023	-0.070
	(0.037)	(0.033)	(0.078)	(0.040)	(0.044)	(0.068)
GDP growth	1.130***	1.255***	0.344	1.055***	1.172***	0.319
	(0.275)	(0.329)	(0.876)	(0.301)	(0.346)	(0.879)
Inflation rate	1.353**	1.280***	1.130	1.366**	1.299***	1.133
	(0.542)	(0.445)	(1.068)	(0.518)	(0.434)	(1.035)
VSTOXX Volatility Index	-0.002***	-0.002***	-0.003**	-0.005*	-0.009***	0.004
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.007)
Log of the Size of Banking Sector	-0.036	-0.083**	0.072*	-0.033	-0.075*	0.067*
	(0.040)	(0.038)	(0.039)	(0.040)	(0.039)	(0.037)
Change in Sample Representativeness	-0.119*	-0.006	-0.350***	-0.128**	-0.019	-0.347***
	(0.061)	(0.045)	(0.105)	(0.055)	(0.038)	(0.103)
Change in Country S&P Rating	0.003**	0.000	0.016***	0.004***	0.000	0.017***
	(0.001)	(0.002)	(0.004)	(0.001)	(0.002)	(0.004)
Observations	233	233	233	233	233	233
Adjusted R-squared	0.616	0.694	0.228	0.629	0.705	0.229
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Cluster	Cntry	Cntry	Cntry	Cntry	Cntry	Cntry
TimeFrame	After 2000	After 2000	After 2000	After 2000	After 2000	After 2000

*** p<0.01, ** p<0.05 and * p<0.1. Robust standard errors in parentheses. All regressions include a constant term. The weighted Average Deviation in computed using the Capital-to-Assets ratio, i.e. the a non risk-weighted leverage measure.

Documents de Travail

485. M. Bussière, B. Camara, F.-D. Castellani, V. Potier and J. Schmidt, " Shock Transmission Through International Banks - Evidence From France," May 2014

486. A. Monfort, J-P. Renne and G. Roussellet, "A Quadratic Kalman Filter," May 2014

487. P. Benczúr, G. Kátay, Á. Kiss and O. M. Rácz, "Income Taxation, Transfers and Labour Supply at the Extensive Margin," June 2014

488. R. Jimborean and A. Kelber, "Foreign direct investment drivers and growth in Central and Eastern Europe in the aftermath of the 2007 global financial crisis," June 2014

489. F. Pegoraro, A. F. Siegel and L. Tiozzo 'Pezzoli, "International Yield Curves and Principal Components Selection Techniques: An Empirical Assessment," June 2014

490. F. Pegoraro, A. F. Siegel and L. Tiozzo 'Pezzoli, "Specification Analysis of International Treasury Yield Curve Factors," June 2014

491. J-S. Mésonnier and A. Monks, "Did the EBA Capital Exercise Cause a Credit Crunch in the Euro Area?," June 2014

492. F. Alvarez , H. Le Bihan and F. Lippi, "Small and large price changes and the propagation of monetary shocks," June 2014

493. A. Devulder, "Heterogeneity, Unemployment Benefits and Voluntary Labor Force Participation," June 2014

494. C. Bortoli, L. Harreau, C. Pouvelle, "Determinants of OECD countries' sovereign yields: safe havens, purgatory, and the damned," June 2014

495. A. Bernales and M Guidolin, "The Effects of Information Asymmetries on the Ex-Post Success of Stock Option Listings," June 2014

496. J. I. Lopez and V. Olivella Moppett, "Financial Shocks and the Cyclical Behavior of Skilled and Unskilled Unemployment," July 2014

497. L. Arrondel, M. Roger, and F. Savignac, "Wealth and Income in the Euro Area: Heterogeneity in Households' Behaviours? ," July 2014

498. J. Carluccio, D. Fougère and E. Gautier, "Trade, Wages, and Collective Bargaining: Evidence from France," July 2014

499. T. Duprey and M. Lé, "Bank Capital Adjustment Process and Aggregate Lending," July 2014

Pour accéder à la liste complète des Documents de Travail publiés par la Banque de France veuillez consulter le site : www.banque-france.fr

For a complete list of Working Papers published by the Banque de France, please visit the website: www.banque-france.fr

Pour tous commentaires ou demandes sur les Documents de Travail, contacter la bibliothèque de la Direction Générale des Études et des Relations Internationales à l'adresse suivante :

For any comment or enquiries on the Working Papers, contact the library of the Directorate General Economics and International Relations at the following address :

BANQUE DE FRANCE
49- 1404 Labolog
75049 Paris Cedex 01
tél : 0033 (0)1 42 97 77 24 ou 01 42 92 63 40 ou 48 90 ou 69 81
email : 1404-ut@banque-france.fr