The impact of Basel I capital regulation on bank deposits and loans: Empirical evidence for Europe

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Abstract

The Basel Committee on Banking and Supervision established minimum capital requirements for banks in their 1988 Capital Accord. This capital regulation was adopted for European Union banks at the beginning of 1993. After the implementation, a widespread concern emerged about the possible negative impact that higher capital requirements could exert on the level of economic activity, especially on bank lending. This paper investigates the impact of the Basel Accord on bank deposits and loans for eight European countries. We follow the approach taken by Peek and Rosengren (1995a) and test for the regulatory effect in a panel structure with about 2500 individual bank balance sheets for the years 1993-1995. We find that changes in deposits are positively correlated with changes in capital. Lower-capitalized banks show a stronger response to a change in capital than their higher-capitalized competitors. This evidence is consistent with the hypothesis that the implementation of minimum capital requirements had a negative effect on the supply of bank loans.

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1. Introduction

Banking sector stability is a central requirement for stable economic development. Moreover, banks play an important role in the global economy, and are the first category of institutions to be subject to internationally coordinated capital regulation. The Basel Accord of 1988 intended to strengthen the soundness and stability of the international banking system and to reduce competitive inequalities between banks. The potential macroeconomic effects of these regulations have received renewed interest after the decision to introduce an enhanced regulatory framework, laid down in Basel II, which has been agreed on in June 2004.

The Basel Accord of 1988 prescribes common minimum capital requirements for banks operating internationally in the G-10 countries and became effective at the end of 1992. More precisely, it fixes the minimum ratio of capital to risk-weighted assets to 8 percent.[1] Thereby the regulators intended to lower total bank risk by lowering the risk taking of individual banks. Around 100 countries world-wide apply now this new capital regulation.[2] In European Union (EU) countries, the Basel Accord was implemented at the beginning of 1993 not only for banks operating internationally but for the banking sector as a whole.

A potential negative side effect of the introduction of the Basel Accord may have been a reduction in total bank lending as banks adjusted their risk structure. This effect may have been of special relevance for economies heavily depending on bank-intermediated credit, such as those of Europe. This contention is the main focus of the empirical analysis conducted in this paper.

To make sure that the new Accord was more than mere regulatory window-dressing, we have to verify that the implementation of the minimum capital requirements of the Basel Accord actually resulted in an increase in national capital requirements. Germany[3], for example, had strict capital regulation long before the introduction of

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1 Bank assets are allocated into four different categories associated with risk weights between 0-100 percent, according to their perceived default risk. Assets with zero default risk, e.g., government securities, receive 0% risk weight, assets with low default risk, e.g., interbank deposits, get 20 % risk weight, residential mortgage loans are considered to be medium-risk assets and have 50% weight, while all other loans to the private sector are classified in the highest risk category, which requires a 100 % weight. See for further details BIS (1988), Annexes 2 and 3.

2 BIS (1999).

3 We checked these issues mainly for the German case, since the German banking market is the most important credit market in Europe and German banks dominate our sample.

the Basel Accord. A priori, it was not even clear to the national supervisory institution whether the Basel Accord would strengthen the capital regulation in Germany or not, because two countervailing effects had to be considered. The Basel Accord increased the required capital-to-assets ratio, but also expanded the range of allowable capital components.[4] We can infer from reports on the banking sector by the Bundesbank[5] that the average capital-to-assets ratio, calculated on the basis of Basel rules, was approaching 7% at the end of 1991. Thus, German banks still had to increase their risk-weighted capital ratios by at least one percentage point in the year before the Basel Accord came into effect. Gambacorta and Mistrulli (2004) find that Italian banks strongly increased their capital ratios before the implementation of the Basel Accord. These two specific country observations support our assessment that the new capital requirements in 1993 induced banks to improve their capital ratios.

Due to problems of asymmetric information in financial markets, banks may find it difficult to raise new capital by issuing new shares at a price deemed reasonable by shareholders and managers.[6] This is true especially in times when profits are low, and retained earnings are not available as an alternative source of increasing bank capital. To raise its capital-to-assets ratio, a bank can then either shrink its asset side or substitute assets with high risk weights under the Basel Accord for assets with low risk weights. Since loans to the private sector have high risk weights under the Basel Accord, both adjustments are likely to entail contraction in the supply of loans. If all banks in the economy try to achieve an increase in the capital ratio at the same time, this mechanism potentially leads to macroeconomic consequences. Bank lending to the private sector falls, financing restrictions for firms become tighter, and aggregate demand falls as a result. If the incipient cyclical downturn leads to a worsening of the performance of existing loans in the economy, this process may be amplified, as loan losses in the banking sector reduce bank equity and low earnings prevent a new internal build-up of equity capital.

This potential negative impact of higher capital requirements on bank lending has been investigated extensively for the US[7]. In contrast, a comprehensive study for Europe is still missing. This paper aims at filling this gap. Sine the data situation

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4 See Bundesbank (1988).
5 See Bundesbank (1993), p.56.
6 See Myers and Majluf (1984).
7 See Berger and Udell (1994), Brinkmann and Horwitz (1995), Hancock et al. (1995), Hancock and Wilcox (1998), Peek and Rosengren (1995a) and Peek and Rosengren (1995b).

does not allow us to identify directly the regulatory effect, we try to measure this effect indirectly. We do this by investigating the impact of the 1988 Basle Accord on bank deposits and loans for eight European countries. The goal of our empirical analysis is to assess whether the introduction of Basel I was accompanied by a loan contraction in Europe. This loan supply effect can then – in line with the literature – be interpreted as a result of new binding regulation.

We follow the empirical approach taken by Peek and Rosengren (1995a) and run parallel regressions for bank deposits and loans providing a rich perspective of the evolution of bank behavior around the period of the regulatory change. We use an unbalanced panel of 4400 individual bank balance sheets for the years from 1993 to 1995. We find that changes in deposits and loans were positively correlated with changes in capital. This suggests that loan supply was determined by the availability of capital. Lower-capitalized banks show a stronger response to a change in capital than their higher-capitalized competitors. This evidence is consistent with the hypothesis that the implementation of minimum capital requirements had a negative effect on the supply of bank loans. Further robustness checks show that our results are neither affected by the sample structure nor by differences in average capitalization across countries. In addition, we can present comparative regressions for the periods 1989-1992 and 1996-2002 indicating that the loan supply effects were particularly strong in the three years after the implementation of the Basel Accord. In sum, there is reason to believe that the introduction of Basel I had negative macroeconomic consequences in Europe.

The paper is structured as follows: The next section reviews the theoretical and empirical background. In section 3 the data are introduced and discussed, while section 4 presents our estimation strategy and results. The last section concludes.

2. Theoretical and Empirical background

Berger et al. (1995) argue that a bank's capital-to-assets ratio is determined by market and regulatory requirements.[8] Berger et al. (1995, p.395) define *"a bank's market capital requirement as the capital ratio that maximizes the value of the bank in the absence of regulatory capital requirements, but in the presence of the rest of*

[8] The line of reasoning in this section is mainly based on Berger et al. (1995).

the regulatory structure that protects the safety and soundness of banks." They distinguish between five potential determinants of the market capital requirement: taxes and costs of financial distress, transaction costs and asymmetric information, and the regulatory safety net.

If the tax system favors debt over equity financing, owners have an incentive to fund a firm almost completely with debt. Simultaneously, any increase in the leverage brings about a rise in the probability of an insolvency crisis. Any insolvency crisis implies substantial costs of financial distress e.g. cost of bankruptcy procedures and conflicts of interest between different stakeholders of a firm. These two countervailing effects have to be taken into account by the firm when it chooses its optimal capital ratio.

Furthermore, transactions costs of raising funds form external sources, particularly the costs of issuing equity, may be substantial and lead to a preference for debt financing.

Asymmetric information problems shape also the optimal capital structure of the bank. Banks acquire information in the loan screening and contracting process, and then expand this information over time by monitoring the borrower's loan repayments and deposit activity. Consequently, banks produce substantial amounts of private information about their loan customers. This creates a range of asymmetric information problems between incumbent shareholders and potential, new shareholders, depositors and other creditors, and between shareholders and manages.

The capital-to-assets ratio can be used as a signaling device. A high capital ratio can indicate favorable private information, but if it is less costly for a "good" bank to signal good performance through increased leverage than for a "bad" bank, then banks could also show a lower capital ratio when they expect better performance in the future. Asymmetric information may also lead to agency conflicts between shareholders and creditors. This conflict will be more pronounced in times of financial distress, when shareholders prefer actions maximizing the value of their own claims but not necessarily the value of all claims on the bank e.g. shifting wealth from creditors to shareholders through the implementation of a riskier investment strategy. Since creditors anticipate such expropriation behavior, they will demand compensation in the form of higher interest rates on debt. As a reaction, banks may optimally increase their capital ratios to assure creditors that interests of shareholders

and creditors are closely aligned. Asymmetric information is also the foundation for conflicts of interest between shareholders and managers, e.g. when shareholders cannot effectively monitor manager's actions. Higher debt can in this case solve the principal agent problem and implements better incentives for the managers. In summary, the net effect of asymmetric information problems on the optimal capital ratio is unclear, because shareholders have to trade off the benefits of higher capital ratios in solving the conflict of interest between shareholders and creditors with the negative impact of higher capital ratios on the principal agent conflict between shareholders and managers.

Berger et al. (1995) suggest that the existence of a regulatory safety net for the banking sector has a strong effect on the capital requirements requested by the market. The safety net consists of all government actions designed to enhance safety and soundness of the banking system other than the regulation and enforcement of capital requirements. Deposit insurance and the lender of last resort function of the central bank are examples for such government actions. The safety net reduces market capital requirements and the incentives to bank creditors to monitor risk profiles. This reasoning explains why banks which are covered by a more extensive safety net than most other industries generally have lower capital ratios than firms in any other industry. Berger et al. (1995) find confirming evidence for this argument by examining historical data on capital ratios for the last 150 years in the U.S. The introduction of new components of the regulatory safety net has always led to further decreases in bank capital ratios.[9]

Let us now turn to regulatory requirements. Banking regulation enforces capital requirements for two reasons. First, if deposit insurance is at least partially run by government agencies, or the central bank acts as a lender of last resort, the government is effectively one of the largest uninsured creditors of the banking sector. This exposes the government to the same costs of financial distress and expropriation of value as other creditors. Governments impose capital requirements to protect themselves against this risk. Moreover, regulators may also be concerned with systemic risk. The failure of a sufficiently large number of banks could set off a chain reaction that might damage financial stability. Regulators impose capital requirements on banks to strengthen the soundness and stability of the banking system to avoid systemic crisis.

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[9] See Bundesbank (1976) and Holtfrerich (1981) for similar historical observations for Germany.

Although we have already argued above, that the introduction of the Basel minimum capital requirements caused an increase in regulatory requirements, this assertion does not necessarily imply that regulatory capital requirements affected bank behavior. Regulatory capital requirements only matter to the extent that they effectively constrain a significant portion of the banking sector causing an increase in capital ratios or otherwise affecting the behavior of these banks beyond market capital requirements. Berger et al. (1995, p. 418) define, "*that a regulatory capital requirement is binding if the capital ratio that maximizes the bank's value in the presence of regulatory capital requirements is greater than the bank's market capital requirement.*"

Theoretically, the regulatory constraint could be binding for a number of reasons. Examples for these are among various others: Deposit insurance, which renders deposits to be the cheapest source of finance (Repullo and Suarez (2004)), markets do not include the benefits of banking sector stability into their optimization problem (Estrella (2004)), or capital which cannot be used as signaling device (Hakenes and Schnabel (2005)).

Empirically it is difficult to assess whether the regulatory constraint is binding because banks have strong incentives to hold a capital buffer beyond the regulatory capital minimum. A capital buffer allows the bank to exploit unexpected profitable investment opportunities and to cushion the effects of unexpected negative shocks. The higher the regulatory penalty for falling below the minimum requirement and the higher the transaction costs of raising equity quickly, the higher is the capital buffer held by banks. This means, that even if we observe that all banks in an economy have substantial excess capital, bank behavior can still be constrained by the regulatory requirement. A majority of empirical papers, which analyze bank behavior in response to changes in capital regulation, simply assume that the regulatory capital ratios are binding.[10] One exception is the paper by Wall and Peterson (1995) who test whether large bank holding companies in the US were affected by the regulatory changes of the early 1990s. Their results suggest that the regulatory regime was binding in most cases. For Europe, there exists one comparable study for Spain by Barrios and Blanco (2003) who implement the same estimation strategy as Wall and Peterson (1995). They find for Spanish banks that a substantial number of banks

[10] Among others: Barajas et al. (2004), Brinkmann and Horwitz (1995), Chiuri et al. (2002), Ediz et al. (1998), Gambacorta and Mistrulli (2004), Hancock and Wilcox (1998), Peek and Rosengren (1995a), Peek and Rosengren (1995b), Rime (2001), Van Roy (2003).

belong to the "regulatory" model and that the probability of belonging to the "regulatory model" increases with lower observed capital ratios.

As mentioned above, there is evidence for Germany and Italy that banks increased substantially their capital ratios before the implementation of the Basel Accord. We do not have evidence that market capital requirements have risen substantially in the year 1992, so given the evidence of these three countries, we assume that the regulation was indeed binding.

3. Data

3.1 Data sources

We use individual bank data stemming from BankScope. It contains yearly balance sheets and profit and loss data for individual banks in a large number of countries. We retrieved data for the years 1987 to 2003 for banks operating in Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain and the United Kingdom.[11] Our sample is restricted to financial institutions providing credit to the private sector, such as commercial banks, savings banks, cooperative banks, mortgage banks and medium and long term credit banks. Investment banks and alike were excluded. Table 1 gives the number of banks available by country in the BankScope database.

Country	Number of banks
Belgium	121
Denmark	219
France	522
Germany	2674
Italy	993
Netherlands	80
Spain	271
UK	292
All countries	5172

Table 1: Number of financial institutions which potentially provide credit to the private sector in the BankScope sample

[11] The BankScope is a commercially distributed database, which is maintained by the companies Bureau van Dijk and Fitch IBCA. Each issue covers up to ten years of data, therefore we use the January 1997 and the March 2004 issue to cover the period 1987-2003.

BankScope extends its coverage of the banking population every year; as a result our panel is unbalanced with the number of observations varying across banks.[12] The database offers a choice between consolidated and unconsolidated balance sheets. Since the Basel Accord is applied to banks on a consolidated basis[13], we use consolidated balance sheets whenever available, and unconsolidated balance sheets otherwise.

The database presents balance sheet data in a "global format" with more general balance sheet categories, which assures comparability across countries. Total assets are subdivided in four categories: Loans, other earning assets, fixed assets and non-earning assets. The first two positions sum up to total earning assets. Other earning assets include bond and security holdings. Total liabilities and equity include as the most important component customer and short-term funding, which comprises data for demand, savings, and time deposits. Other funding includes long-term borrowing, subordinated debt, and hybrid capital. Furthermore, liabilities encompass other non-interest bearing funding, loan loss reserves, and other reserves. Finally, equity is reported. For some banks also the total capital ratio[14], the so called Basel ratio, can be obtained. The profit and loss statements provide us with data on net interest revenue and other operating income.

Bank mergers could potentially bias our results. Although we do not perform an explicit merger treatment, we check whether our results change when we drop observations which show "extreme" total asset growth rates, since these most likely result from mergers.[15] We find that leaving out such observations does not change our results.

Before the data is used for estimation we clean the data set. We delete observations, which show negative values for balance sheet positions, e.g., negative loans and deposits. Furthermore we consider observations for variables used for estimation below the 5^{th} percentile and above the 95^{th} percentile to be an outlier and drop them. After the cleaning procedure the variables were approximately normally distributed.

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12 BankScope claims to cover at least 90 percent of total banking assets in each country. For more information on the coverage of the estimation sample see section on data description.

13 Consolidation refers to including subsidiaries' balance sheets into the parent company. See Basle Committee on Banking Supervision (1988), p.3.

14 The total capital ratio equals the sum of tier1 and tier2 capital over risk-weighted assets.

15 We define a growth rate of total assets to be "extreme" when the observation is above the 99^{th} percentile of the distribution of growth rates in the sample used for estimation.

In the empirical analysis we also control for general economic factors as suggested also by Chiuri et al. (2002). We include annual, country-specific macroeconomic data for interest rates, GDP and exchange rates. As interest rates we use deposit, lending, and money market rates. As an exchange rate we employ the exchange rate of the respective country's currency vis-à-vis the US dollar. All macroeconomic data are taken from the IMF International Financial Statistics or the OECD Economic Outlook.

3.2 Data description

Table 2 contains information on the composition of the effective sample by country and year.[16]

Country/Year	1993	1994	1995
Belgium	16	32	32
Denmark	37	36	53
France	124	159	157
Germany	433	1145	1236
Italy	149	152	170
Netherlands	16	16	19
Spain	51	80	87
United Kingdom	57	77	72
Total number of banks	883	1697	1826

Table 2: Number of banks by year and country in the effective sample

The largest group of banks in the sample is German banks with much over 1000 banks; the smallest banking populations included are those of the Netherlands and Belgium with only about 20-30 banks. The total number of banks considered in the analysis almost doubles between 1993 and 1994, which reflects that the compilation of the database was still ongoing in 1993. Thereafter the number of banks only increases slightly.

The specific cross-country composition of our sample might affect the empirical results, although we control for this problem as accurately as possible in the regression analysis by using country specific macroeconomic data series and by correcting for bank specific fixed effects and time effects.

[16] We mean by effective sample, all observations which are effectively used for the estimation of the basic regression results.

Table 3 gives an overview of how representative the effective sample is for the countries considered and for the sample overall. We add up all individual bank balance sheet totals by country and year which are in our effective sample and compare this sum to the aggregate end-year balance sheet total of "all banks"[17] published by the OECD (2002) report on bank profitability.

Country/Year	1993	1994	1995
Belgium	2.84	5.71	5.37
Denmark	4.88	12.39	19.58
France	9.56	13.86	13.64
Germany	20.81	34.12	33.40
Italy	15.38	17.84	21.75
Netherlands	5.31	6.72	7.17
Spain	22.19	31.29	35.62
United Kingdom	20.75	24.66	22.40
All countries	15.50	23.03	23.92

Table 3: Coverage of effective sample in percent[18]

Source: Own calculations and OECD (2002)

To gain further insight whether the introduction of the Basel I capital requirements potentially resulted in a retrenchment of credit provision by banks we first show the percentage of banks in our sample that experienced an asset contraction in the sample period. Second, we give an overview on the development of relevant banking variables by country and year. Table 4 shows the percentage of banks whose balance sheet total has shrunk in comparison to the previous year by country and year. In the whole sample, about one eighth of banks face such an asset contraction in 1993, about 10 % of banks in 1994, the percentage falls to about 8% in 1995. In Germany, only a small percentage of banks have a negative total assets growth in the sample period. The banks in Belgium, France and the Netherlands are also relatively mildly affected by asset contraction with percentages always below 25%. The highest percentage of banks with asset contraction can be found in Spain for the year 1993, when 67% of banks show negative growth of total assets. Banks in Spain appear to

[17] The precise classification of "all banks" by the OECD remains unclear, but we think that the group of banks considered should be roughly comparable to the banks we retrieved from the BankScope database.

[18] Coverage is defined as cumulated total assets by country and year to end-year balance sheet total of all banks in the respective country.

be most affected by asset contraction in the first year of the sample; Italian banks in 1994. Great Britain is the country with the highest percentage of banks with asset reduction at the end of the sample period. While in 1993 a lower percentage of banks appear to be affected by asset contraction (with the exception of Spain) with respect to the two following years, in 1994 the percentage of banks losing assets is increasing in most countries.

Country/Year	**1993**	**1994**	**1995**
Belgium	6.25	21.88	25.00
Denmark	5.41	36.11	18.87
France	11.29	14.47	9.55
Germany	3.00	2.18	1.78
Italy	28.86	55.92	28.82
Netherlands	6.25	12.50	10.53
Spain	66.67	11.25	4.60
UK	5.26	24.68	45.83
All countries	12.57	10.78	7.83

Table 4: Percentage of banks with asset contraction by country and year

Table 5 provides an overview of the dynamics of relevant banking variables around the period of regulatory change. We report by country the percentage changes in total assets, loans, deposits, and equity occurring in 1992 to 1995. We show additionally the inflation rate and real GDP growth to ensure comparability and to detect real macroeconomic effects. The table also shows the evolution of capitalization, which is defined as equity over total assets. The growth rates in the table were computed for the sample used for estimation in Section 4.4 and are unweighted averages. At a first glance, in seven out of eight countries the capitalization of banks appears to remain on the level of 1993 (France, Germany, Italy) or has risen only slightly by 0.5 percentage points (Denmark, the Netherlands, Spain, United Kingdom) following the change in regulation. One exception is Belgium, where the banks increased their capital-to-assets ratio by almost two percentage points. So the first impression is that the implementation of the 1988 Basel Accord did not lead to an increase in average capital-to-assets ratios. In most countries, total assets and deposits had decreasing growth rates in the years following the introduction of the new capital requirements. For loan growth the picture is less clear, but one explanation could be that banks tried to shelter their loans from external effects. When the banks show lower growth

rates in total assets but almost stable growth rates in loans, these banks had to accept lower growth rates in other asset categories, e.g. bond and security holdings.

Country /Year	1993	1994	1995
Belgium			
capitalization	5.90	7.10	7.83
total asset growth	10.47	6.25	7.08
loan growth	7.49	6.66	7.01
deposit growth	10.72	2.74	7.52
equity growth	4.68	8.19	8.69
inflation	2.77	2.39	1.42
real GDP growth	-0.95	3.20	2.40
Denmark			
capitalization	11.71	11.86	12.11
total asset growth	11.80	0.97	7.04
loan growth	1.39	5.65	8.06
deposit growth	11.36	0.77	5.29
equity growth	13.63	6.97	15.73
inflation	1.27	1.98	2.15
real GDP growth	0.02	5.28	2.75
France			
capitalization	6.42	6.39	6.32
total asset growth	6.56	3.59	8.64
loan growth	3.20	3.94	5.47
deposit growth	7.80	4.55	7.72
equity growth	10.36	7.18	9.33
inflation	2.01	1.76	1.73
real GDP growth	-0.90	1.80	1.85
Germany			
capitalization	4.55	4.42	4.62
total asset growth	12.57	8.59	7.74
loan growth	10.23	11.70	8.87
deposit growth	11.04	5.81	5.32
equity growth	12.80	10.25	9.27
inflation	4.48	2.72	1.73
real GDP growth	-1.11	2.32	1.70
Italy			
capitalization	10.16	10.15	10.22
total asset growth	2.11	-0.96	3.63
loan growth	4.56	4.18	8.41
deposit growth	10.23	-0.95	2.70
equity growth	7.41	3.91	3.61
inflation	4.46	4.05	5.26
real GDP growth	-0.91	2.18	2.87

Country /Year	1993	1994	1995
Netherlands			
capitalization	6.13	6.46	6.81
total asset growth	11.84	4.89	10.56
loan growth	8.47	8.26	12.62
deposit growth	11.83	2.72	10.83
equity growth	9.82	6.11	8.90
inflation	2.58	2.83	1.94
real GDP growth	0.57	3.13	2.33
Spain			
capitalization	7.11	7.02	7.54
total asset growth	-3.65	8.14	11.96
loan growth	-3.15	8.38	11.74
deposit growth	-3.97	9.38	11.76
equity growth	1.46	6.52	12.20
inflation	4.59	4.71	4.71
real GDP growth	-1.22	2.23	2.69
UK			
capitalization	6.92	7.39	7.40
total asset growth	10.68	4.25	1.44
loan growth	9.21	4.02	8.89
deposit growth	10.52	5.07	0.74
equity growth	14.68	7.91	3.58
inflation	1.61	2.44	3.41
real GDP growth	2.50	4.55	2.87

Table 5: Unweighted average capitalization, total asset growth, loan growth, and deposit and equity growth by country and year for banks in the effective sample; CPI-inflation and real GDP growth by country and year

Spanish banks faced even negative nominal growth rates in 1993, banks in the United Kingdom are affected more strongly at the end of the sample period. Italian banks experienced even negative real growth rates for all categories in more than half of the sample period. It is apparent from the averages that in most countries the growth rates of total assets decreased in the years after the introduction of the new capital regulation, but the patterns differ by country. The application of a panel analysis, which allows for different fixed effects for each bank, and the inclusion of macroeconomic control variables, which relate to each country[19], should properly control for the different sources of heterogeneity and detect the existence of significant regularities.

[19] We assume that banks were affected by the macroeconomic conditions in their country of origin.

Country /Year	1993		1994		1995	
Belgium	5%	0.0290	5%	0.0356	5%	0.0380
	25%	0.0368	25%	0.0494	25%	0.0486
	50%	0.0523	50%	0.0597	50%	0.0646
	75%	0.0628	75%	0.0929	75%	0.0957
	95%	0.1182	95%	0.1406	95%	0.1742
Denmark	5%	0.0617	5%	0.0593	5%	0.0665
	25%	0.1011	25%	0.0987	25%	0.0922
	50%	0.1088	50%	0.1147	50%	0.1199
	75%	0.1366	75%	0.1371	75%	0.1476
	95%	0.1735	95%	0.1822	95%	0.1802
France	5%	0.0324	5%	0.0328	5%	0.0315
	25%	0.0449	25%	0.0435	25%	0.0445
	50%	0.0552	50%	0.0547	50%	0.0554
	75%	0.0706	75%	0.0683	75%	0.0693
	95%	0.1276	95%	0.1188	95%	0.1157
Germany	5%	0.0327	5%	0.0318	5%	0.0334
	25%	0.0376	25%	0.0376	25%	0.0391
	50%	0.0428	50%	0.0423	50%	0.0438
	75%	0.0482	75%	0.0480	75%	0.0493
	95%	0.0705	95%	0.0610	95%	0.0638
Italy	5%	0.0551	5%	0.0556	5%	0.0582
	25%	0.0731	25%	0.0778	25%	0.0736
	50%	0.0912	50%	0.0997	50%	0.0987
	75%	0.1151	75%	0.1226	75%	0.1252
	95%	0.1426	95%	0.1567	95%	0.1603
Netherlands	5%	0.0304	5%	0.0300	5%	0.0295
	25%	0.0412	25%	0.0333	25%	0.0505
	50%	0.0602	50%	0.0612	50%	0.0615
	75%	0.0754	75%	0.0716	75%	0.0789
	95%	0.1377	95%	0.0955	95%	0.1413
Spain	5%	0.0381	5%	0.0410	5%	0.0457
	25%	0.0530	25%	0.0529	25%	0.0546
	50%	0.0636	50%	0.0660	50%	0.0645
	75%	0.0878	75%	0.0860	75%	0.0870
	95%	0.1102	95%	0.1190	95%	0.1293
United Kingdom	5%	0.0387	5%	0.0406	5%	0.0426
	25%	0.0558	25%	0.0578	25%	0.0552
	50%	0.0637	50%	0.0670	50%	0.0665
	75%	0.0721	75%	0.0806	75%	0.0804
	95%	0.1234	95%	0.1214	95%	0.1414

Table 6: Percentiles of the distribution of capitalization in the effective sample

From Table 5 we conclude that the average capitalization of banks in each country does not change very much in the sample period. Besides the average, the distribution of capital across banks plays an important role, since a high variation in capitalization levels across banks facilitates the detection of heterogeneous effects of regulation. In Table 6 we present the percentiles of the distribution of capitalization by year and country. We show the respective values for the 5^{th}, 25^{th}, 50^{th}, 75^{th} and 95^{th} percentiles.

The differences in capital-to-assets ratios across banks is quite substantial for most of the countries and the dispersion, the difference between the values of 95^{th} and the 5^{th} percentiles, ranges from 6.5 to 13.5 percentage points across countries. The German banks in the sample show a much smaller variation in capitalization levels. The dispersion increases in the sample period for banks in Belgium, Italy, Spain and the United Kingdom, decreases for banks in France. The dispersion remains almost stable for banks in Denmark and Germany and shows a strong variation for Dutch banks. The relatively large dispersion on capitalization levels at the banks in our estimation panel let us suspect that the implementation of the Basel Accord could have had substantial heterogeneous effects on banks depending on the level of capitalization.

4. Empirical results

4.1 Estimation strategy

To analyze how the increase in capital requirements by the 1988 Basel Accord might have affected the behavior of European banks, we base our empirical analysis on an extension of the framework by Peek and Rosengren (1995a).[20] Peek and Rosengren (1995a) derive their estimation strategy from a simple bank balance sheet model in which banks operate on less than perfectly competitive markets for loans and deposits. Banks take in deposits and extend loans to maximize their profits, taking into account a required capital-to-assets ratio set by capital regulation. The model shows that the effects of changes in capital on deposits and loans differ between constrained and unconstrained banks. Furthermore it allows to separate loan demand from loan supply effects. For the unconstrained bank, a reduction in capital will be

[20] The framework has also been used by Chiuri et al. (2002) to analyze the macroeconomic impact of bank capital requirements in emerging economies.

offset by an increase in its deposits, and a shrinkage of loans, since the bank increases its deposits to replace at least partially the capital loss, in order to not forgo too many profitable loans. The behavior of constrained banks is very different, as their reaction possibilities are more limited due to the binding capital constraint. A reduction in capital will reduce deposits to meet the binding constraint. So in the case of a loan supply shock, we will expect deposits and loans to react in the same direction as capital. The model also illustrates that the effects of a loan demand shock differ across constrained versus unconstrained banks. In the unconstrained case, a decrease in loan demand causes both deposits and loans to decrease. In the constrained case, neither loans nor deposits decrease. Hence the relative effects on constrained and unconstrained banks of an adverse shock to loan demand are just the opposite of those for an adverse shock to capital.

In particular, capital constraints at the banks included in our sample may have resulted from the introduction of higher required capital-to-assets ratios by the 1988 Basel Accord. Following Gambacorta and Mistrulli (2004), an increase in the regulatory capital ratio itself can be seen as a negative capital shock, because banks find themselves in a position with less capital than desired and will have to restructure their balance sheets. If this hypothesis is correct, the introduction of higher capital requirements will cause the contraction of liabilities and assets to be greater, the lower the capitalization of the bank. If, however, decreases in assets and liabilities of banks during the years after the introduction of the regulatory framework are solely due to decreased loan demand, the degree of contraction should be greatest for banks not constrained by capital regulation. As long as banks cannot fully shelter their loan supply from decreases in deposits by adjusting their security holdings, decreases in deposits will feed into decreases in loan supply. The first goal of the estimation is thus to assess whether there was a loan supply effect present in Europe. The supply effect can then – in line with the literature – be interpreted to result from binding regulation.

While the model provides predictions for the effects of a change in capital on both sides of the balance sheet, Peek and Rosengren (1995a) argue that a focus on estimating equations for the change in deposits rather than the change in loans reduces the data problems associated with the change in loans. These are difficult to control for, since the change in a bank’s outstanding loans reflects more than just the bank’s lending activity. Particularly the treatment of loan write-offs can reduce the

growth in the quantity of loans outstanding without a corresponding reduction in new lending.

We believe that both for loans and deposits, it is quite difficult to separate demand from supply effects. We try to control for loan demand and deposit supply by including variables which represent general economic conditions of the country of origin, since we could not obtain bank specific loan demand or deposit supply proxies.

We will run parallel regressions for bank deposits and loans to improve on the robustness of the results but also to provide a richer perspective on the evolution of bank behavior around the period of regulatory change.

In general there are different options how to measure the effect of a newly introduced capital regulation. The announcement date and then the implementation date of the new regulation are important for the measurement of any regulatory effect. Barajas et al. (2004) analyze banking data before and after the announcement of the adoption of the Basel Accord and cannot find announcement effects on capital ratios and lending behavior in the different regions of the world. We follow them and use the implementation year 1993 as the relevant point in time for our analysis on European banks.[21] Further, we suppose that the effect of the introduction will be only transitory. After a reasonable period of time the banking sector will have adjusted the capital ratios to the new higher levels. But on the other side, we believe that we cannot capture the introduction impact in the same year, since the adjustment of the capital ratio is costly, so that the effects will be spread also over the following years. Therefore, we use as estimation period the years from 1993-1995.

But also the ‘intensity’ of the new capital regulation will matter. Ideally one could use a direct measure of the regulatory pressure as in Peek and Rosengren (1995b), Aggarwal and Jacques (1998) or Gambacorta and Mistrulli (2004). They have explicit data on each individual bank whether and for how long regulatory enforcement actions took place at each institution at their disposal. But for most countries there is no explicit enforcement scheme and data on internal measures of supervisory institutions are not available. Since in our case no direct measure is at hand, we have to rely on an indirect measurement of the regulatory effect. The literature discusses several aspects how to measure the so-called regulatory pressure,

[21] See also for the discussion of adoption and implementation date Barajas et al. (2004), p. 36.

either the level of capitalization or excess capital-to assets-ratio matter, while also the exact definitions of the numerator (capital) and the denominator (assets) of the capitalization measures play a role.

Bank behavior is constrained by regulatory pressure once the bank falls close to the minimum capital requirement. Peek and Rosengren (1995a) suggest using the level of bank's capitalization itself as a proxy for the constraint resulting from regulatory pressure. Estrella et al. (2000) also find that the simple capital-to-assets ratio predicts bank failure as well as more complex risk-weighted ratios over one- or two-period horizons.

Other authors such as Rime (2001) and Gambacorta and Mistrulli (2004) argue that the excess capital-to-assets ratio can better control for the riskiness of banks' portfolios. The excess capital is thereby defined as the capital which is held above the required capital by regulation. Unfortunately, in our sample only 41 banks publish the quantity of regulatory capital held, so we cannot perform our estimations with this measure.

Regarding the capitalization measure, another potential problem is the definition of capital, the numerator of the ratio. Peek and Rosengren (1995a) and particularly the BIS (1988) come to the conclusion that using only equity is advantageous because "*it is the key element of capital and the only common to all banking systems. Furthermore, it is wholly visible in the published accounts and is the basis on which most market judgment of capital adequacy are made, and it has crucial bearing on profit margins and a bank's ability to compete*"[22]. However, capital according to the Basel Accord of 1988 includes equity and supplementary capital like subordinated debt, hybrid capital and general loan loss reserves, so it is useful also to use an extended capital measure in our estimations.

With respect to the denominator of the capital-to-assets ratio one can choose between total assets or risk-weighted assets. Ideally one should use the risk-weighted regulatory capital ratio as the correct measure for capitalization for estimation, because the Basel minimum capital requirement is based on this total regulatory capital ratio. Unfortunately, only a small fraction of banks publish these Basel ratios, so that BankScope provides this variable for about 260 banks out of 2246 banks in our effective sample.

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[22] See BIS (1988), p.3-4.

We estimate the following regressions proposed in Peek and Rosengren (1995a) and Chiuri et al. (2002), in which we include the capitalization measures (CM):

$$dD_{ijt}/TA_{ijt-1} = a_1\, CM_{ijt-1} + a_2\, dK_{ijt}/TA_{ijt-1} + a_3\, CM_{ijt-1}*(dK_{ijt}/TA_{ijt-1}) + a_4\, log\ TA_{ijt-1} + a_5\, liquidity_{ijt-1} + a_6\, fee\ income_{ijt} + a_7\, \Delta\ log\ GDP_{jt} + a_8\, \Delta\ interest\ rate_{jt} + a_9\, \Delta\ exchange\ rate_{jt} + t_t + \mu_i + \varepsilon_{ijt} \quad (1)$$

$$dL_{ijt}/TA_{ijt-1} = a_1\, CM_{ijt-1} + a_2\, dK_{ijt}/TA_{ijt-1} + a_3\, CM_{ijt-1}*(dK_{ijt}/TA_{ijt-1}) + a_4\, log\ TA_{ijt-1} + a_5\, liquidity_{ijt-1} + a_6\, fee\ income_{ijt} + a_7\, \Delta\ log\ GDP_{jt} + a_8\, \Delta\ interest\ rate_{jt} + a_9\, \Delta\ exchange\ rate_{jt} + t_t + \mu_i + \varepsilon_{ijt} \quad (2)$$

Where i={1,…, N} is the index for the N banks, t={1,…, T} refers to the respective year, and j={1,…, J} denotes the country where the bank is situated. We include time dummies t_t and estimate a fixed effect model, where μ_i is the bank specific effect. In order to choose between a random or fixed effect specification the Hausman test is used. The Hausman test rejects in each case the random effects specification. We therefore estimate the fixed effect model.[23]

The dependent variable is the annual change in deposits *D* of bank i normalized by beginning of period total assets *TA* of bank i.[24] CM_{ijt-1} is the bank's beginning of period capitalization measure. *CM* is chosen to capture the degree to which a bank faces regulatory pressure, a high *CM* stands for a high-capitalized bank. Since banks with low capitalization are under pressure to improve their capital ratio, we expect that poorly capitalized institutions show slower growth in liabilities than well-capitalized institutions, other things equal. We expect a positive sign for a_1.

Following the discussion above, we define three different capitalization measures (*CM*). The first measure is the simple equity to total assets ratio, which is also used

[23] We are not particularly interested in country specific effects; therefore we do not include a set of country dummies. Nevertheless from an econometric point of view any country-specific effect will be perfectly controlled for by including bank individual effects in the estimation.

[24] The normalization by the beginning of period total assets should reduce potential heteroscedasticity problems in the error term. See also Peek and Rosengren (1995a).

by Peek and Rosengren (1995a). The second capitalization measure, the extended capitalization, is measured by the ratio of equity plus other capital components to total assets. We add subordinated debt and hybrid capital to core equity whenever the data is available. If data on the supplementary components is missing, the extended capitalization equals the equity-to-total assets ratio. The Basel Accord also allows general loan loss reserves[25] to be used as other capital components, but BankScope does not specify whether the data on loan loss reserves refer to the Basel definition or not, therefore we have not considered them when calculating the extended capitalization. The third and last measure represents the "Basel ratio", which equals to the total regulatory capital over risk-weighted assets. All three ratios are significantly and highly correlated.[26]

Equity capital can change because of retained earnings or losses and by issuing new equity. The change in equity capital dK_{ijt}/ TA_{ijt-1} is normalized by the beginning of period total assets. We expect that increases in capital will result in increases of deposits and loans, a_2 is positive. To assess whether higher capitalized banks react differently from lower capitalized banks, the sign of the coefficient a_3 is decisive. The model implies that higher-capitalized institutions that face a positive change will increase their deposits and loans by less than the lower-capitalized institutions experiencing the same change. A negative coefficient supports the hypothesis, that supply factors play a role in lending.

We control for possible differences in demand factors and macroeconomic effects by introducing the following additional variables. The log of total assets ($log\ TA_{ijt-1}$) should control for the impact of the bank's size on the collection of deposits and the extension of loans. This control variable has been found to have a significant impact by the empirical literature e.g. Peek and Rosengren (1995a), Ehrmann et al. (2003), Gambacorta and Mistrulli (2004).

We add further a proxy for the liquidity position of the bank, since the balance sheet structure with respect to security holdings could influence the lending behavior of banks as found in Ehrmann et al. (2003) and Gambacorta and Mistrulli (2004). Since

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[25] Banks have to establish specific loan loss reserves for expected loan defaults. In contrast, general loan loss reserves are accumulated for unknown contingencies. Only the latter are admitted by the Basel accord to be counted as tier 2 capital.

[26] A pair wise correlation test gives a correlation of 0.65 between the equity-to-total assets ratio to the Basel ratio, a correlation of 0.60 between the extended equity-to-total assets ratio and the Basel ratio. The equity-to-total assets ratio and the extended equity-to-total assets ratio have a correlation coefficient of 0.92. Each of the corresponding p-values is 0.000.

more capitalized banks are typically more liquid, it is necessary to prove that any distributional results found are not driven by the liquidity position instead of capitalization. *Liquidity* in this context is defined as the ratio of other earning assets (bonds and securities) to total assets.

Banks with large off-balance sheet activities may be better insulated from changes in demand than banks that focus on lending. To control for this possibility, we include the variable *fee income*$_{ijt}$, which is given by the ratio of other operating income to the sum of net interest revenue and other operating income.

If demand conditions vary by size of depositor and borrower, we may see very different deposit and loan growth rates by size of institutions. We include the growth rate of real GDP ($\Delta \log GDP_{jt}$) to control for potential effects of the business cycle on deposit supply and loan demand. Positive growth should lead to an increase in deposit supply and loan demand. As an indicator of monetary policy, we include the first difference of a local interest rate (Δ *interest rate*$_t$). A positive change in the interest rate should be followed by a reduction in deposit supply and loan demand. As a final macroeconomic variable we included the first difference in the *exchange rate* vis-à-vis the US Dollar.

Table 7 gives some basic information on what balance sheets look like in the sample. The extended capitalization is on average one percentage point higher than the capitalization given by equity-to-assets ratio. The banks in our sample accumulate only less than 20 % of their capital in tier 2 capital components. Comparing the data on capital of banks which provide the Basle ratio with the banks which only provide equity capital, shows that the group of banks which also publishes Basel ratios is very distinct from the average bank in the sample. Banks which publish its Basel ratio have 40% more equity capital on their balance sheets than the average bank in the sample. Further, they hold on average 7 percentage points excess capital on their balance sheets, since the Basel Accord requires banks to hold 8% capital with respect to risk-weighted assets. The deposit ratio is higher; they have fewer loans and more liquid assets than the average bank. Last but not least, they earn a higher proportion of their income with fees than their competitors.

Variables/Banks	All banks	Bank with Basel ratio	Bank without Basel ratio
Capitalization	0.058 *-0.029*	0.082 *-0.035*	0.055 *-0.027*
Extended Capitalization	0.068 *-0.029*	0.092 *-0.033*	0.064 *-0.026*
Basel ratio		0.155 *0.054*	
Mean Total Assets	1283 *2057*	2852 *3288*	1062 *1709*
Deposit ratio	0.78 *0.15*	0.84 *0.09*	0.77 *0.16*
Loan ratio	0.57 *0.15*	0.54 *0.16*	0.58 *0.15*
Liquidity	0.37 *0.15*	0.40 *0.15*	0.37 *0.15*
Fee income	0.20 *0.09*	0.25 *0.10*	0.19 *0.09*

Table 7: Descriptive statistics for the effective sample
Standard deviations are reported below the means.

4.2 Main results

We have estimated the baseline regressions for each capitalization measure we have introduced in section 4.1. The results are presented in Table 8. First, we test the simple capital-to-assets ratio, second, we use the extended capital-to-assets ratio and last we employ the Basel ratio as capitalization measure. We find for the first two sets of regressions that the coefficient on the change of capital is positive and significantly different from zero. Furthermore, the interaction term has a negative and significant coefficient which shows that higher capitalized banks show a weaker reaction to changes in capital than their lower capitalized counterparts. These specifications thus provide substantial support for the hypothesis that the supply of loans is affected by different degrees of capitalization.

Dependent Variable: Change in deposits/total assets or change in loans/total assets						
Capitalization measure (CM)	capitalization		extended capitalization		Basel ratio	
	deposits	loans	deposits	loans	deposits	loans
capitalization measure	**1.74** ***	**1.28** ***	**1.21** ***	**0.26** ***	**0.73** ***	**0.08**
	0.23	*0.18*	*0.19*	*0.12*	*0.29*	*0.17*
dK(t)/TA(t-1)	**4.87** ***	**3.59** ***	**4.47** ***	**2.75** ***	**-1.09**	**0.28**
	0.64	*0.41*	*0.68*	*0.44*	*2.38*	*1.26*
CM* dK(t)/TA(t-1)	**-18.70** ***	**-17.41** ***	**-14.49** ***	**-10.79** ***	**5.89**	**4.04**
	6.87	*4.40*	*6.94*	*4.47*	*13.98*	*7.63*
log TA(t-1)	**-0.28** ***	**-0.15** ***	**-0.33** ***	**-0.21** ***	**-0.45** ***	**-0.19** ***
	0.02	*0.01*	*0.02*	*0.01*	*0.06*	*0.03*
liquidity(t-1)	**-0.29** ***	**0.45** ***	**-0.30** ***	**0.46** ***	**-0.67** ***	**0.31** ***
	0.03	*0.02*	*0.03*	*0.02*	*0.13*	*0.07*
fee income	**0.05** **	**0.01**	**0.06** ***	**0.00**	**0.26** **	**0.16** ***
	0.03	*0.02*	*0.03*	*0.02*	*0.13*	*0.07*
real GDP growth	**0.0100** ***	**0.0153** ***	**0.0089** ***	**0.0147** ***	**0.0107** **	**0.0120** ***
	0.0023	*0.0015*	*0.0023*	*0.0015*	*0.0063*	*0.0036*
interest rate change	**-0.0079** ***	**-0.0039** ***	**-0.0073** ***	**-0.0037** ***	**-0.0053**	**-0.0041** **
	0.0010	*0.0006*	*0.0099*	*0.0006*	*0.0039*	*0.0023*
exchange rate change	**-0.0006**	**0.0007**	**-0.0007** *	**0.0007** ***	**-0.0015**	**-0.0001**
	0.0004	*0.0026*	*0.0004*	*0.0003*	*0.0017*	*0.0009*
constant	**1.80** ***	**0.75** ***	**2.09** ***	**1.15** ***	**3.39** ***	**1.23** ***
	0.14	*0.09*	*0.12*	*0.08*	*0.46*	*0.24*
R^2 (within)	0.36	0.35	0.36	0.34	0.44	0.37
Obs	4436	4406	4334	4310	451	458

Table 8: Results for the baseline regression for all three capitalization measures

Note: Standard errors are reported below the estimated coefficients.

****, **, * indicate significance at 1%, 5%, 10% level respectively.*

A full set of time dummies is included in each regression.

However, the model predicts that banks are not constrained by capital requirements, if they pass a certain degree of capitalization. Our point estimates indicate, that the reaction of deposits to changes in capital becomes negative, if the capitalization of the bank is greater than 21% percent, the confidence interval for this estimate is however quite large. This means that the majority of banks in the EU countries appear to behave as being capital-constrained. Our regression results are comparable not only qualitatively but also with respect to the size of coefficients to the estimates of Peek and Rosengren (1995a). Depending on the exact specification they find that all banks below a capitalization level of 16-21% are constrained and do show loan supply reactions after the implementation of the new capital requirements. Chiuri et al. (2002) also present regression results that are in accordance with our findings. They discover for their panel of emerging economies that the implementation of the

Basel Accord in these countries had significantly affected loan supply, particularly at less-well capitalized banks.

The estimation results differ when the Basel ratio is used as capitalization measure. Neither the coefficient on the change in capital nor the coefficient of the interaction term is significantly different from zero. This allows two interpretations. If we presume that the Basel ratio is the more appropriate variable to measure the regulatory pressure for banks, we have to conclude that deposits and loans are not affected by capital changes and the capitalization of the bank does not play a role for the behavior of the bank. But as shown above, banks which publish the Basel ratio differ from the rest of the sample. These banks are almost three times bigger and have about 40% higher equity-to-assets ratio than the rest of the banks in the sample. Keeping these facts in mind, we can also deduce from the results that this selected group of banks uses the publication of the Basel ratio as a signaling device to inform the public about its superior capitalization. In that case, the Basel ratio is of no use to measure regulatory pressure at the bank level and these regression results are seriously biased because of sample selection.

With regard to the control variables the following results emerge. The coefficient on the capitalization measure itself is positive and in five out of six cases significant, which means that well-capitalized institutions show faster growth in deposits and loans than the average bank. The coefficient a_4 is negative and significant in all regressions of Table 4.8. This shows that both deposits and loans grow at a slower pace for larger banks, this results is also confirmed by the analysis of Peek and Rosengren (1995a). Banks holding higher proportions of assets in securities and bonds are considered to be more liquid and show a lower growth in deposits and a higher growth in loans. This is in accordance with the idea that deposits and liquid assets can both serve for funding of new loans. A bank with higher liquidity is not as dependent on deposits in order to extend credit. Loans and liquid assets instead compete against each other in a portfolio strategy of the bank. The bank manager can either invest in securities or extend a new loan. The coefficient on the ratio of fee income to fee and interest income is positive in all regressions and significant for the deposits regression. A higher proportion of earnings out of off-balance sheet activities has a positive influence on deposit growth. Banks with more diversified sources of income are better shielded from negative influences on their income e.g. loan losses. Real GDP growth and the change in the interest rate are important

determinants of changes in deposits and loans. Higher overall activity reflected by positive real GDP growth has a positive effect on changes in deposits and loans. An increase in the interest rate has a negative effect on changes in deposits and loans. The change in the exchange rate does not appear to influence the dependent variable.

4.3 Robustness checks

We test the robustness of these results in several ways. The first test uses capitalization measures from which the respective country average is subtracted. The reason for this test is the potential presence of country effects in the capital-to-assets ratios because of different historical development or institutional features of the banking sectors in each country. The capitalization measure CM1country is in that case defined as:

$$\text{Capitalization}_{it} = \frac{C_{ijt}}{A_{ijt}} - \frac{1}{T}\sum_{t}\left(\frac{1}{N_{jt}}\sum_{ij}\frac{C_{ijt}}{A_{ijt}}\right) \qquad (3)$$

Capitalization is given by the ratio of equity C_{ijt} over total assets A_{ijt} minus the average capitalization in country j. The other two capitalization measures are defined accordingly.

However, when the test is performed nothing changes qualitatively. The regression results of this first robustness test are presented in the first four columns in Table 9.

The second robustness check produces regression results with a balanced panel. We only use balance sheets of banks, which have contiguous observations in all three years of the 1993-1995 sample period. This procedure leaves us with about 1000 banks. This test is run to ensure that the changing composition of our original sample does not bias the regression results. The respective regression results can be found in Table 9, columns 5-6. Again, the estimated coefficients do not vary much between the two samples, which assures us that the unbalanced sample structure does not affect our results.

Dependent Variable: Change in deposits/total assets or change in loans/total assets						
Robustness test	**country effects**				**continuous sample**	
Capitalization measure (CM)	capitalization		extended capitalization		capitalization	
	deposits	loans	deposits	loans	deposits	loans
capitalization measure	**1.63** ***	**1.19** ***	**1.15** ***	**0.24** **	**1.63** ***	**1.18** ***
	0.26	*0.18*	*0.19*	*0.12*	*0.30*	*0.20*
dK(t)/TA(t-1)	**3.28** ***	**2.10** ***	**3.14** ***	**1.74** ***	**4.84** ***	**3.72** ***
	0.27	*0.17*	*0.26*	*0.17*	*0.77*	*0.48*
CM* dK(t)/TA(t-1)	**-12.47**	**-15.16** ***	**-7.13**	**-10.31** *	**-18.08** **	**-17.64** ***
	8.40	*5.28*	*8.61*	*5.50*	*8.25*	*5.04*
log TA(t-1)	**-0.29** ***	**-0.16** ***	**-0.33** ***	**-0.21** ***	**-0.26** ***	**-0.13** ***
	0.02	*0.01*	*0.02*	*0.01*	*0.02*	*0.01*
liquidity(t-1)	**-0.29** ***	**0.45** ***	**-0.30** ***	**0.46** ***	**-0.28** ***	**0.40** ***
	0.03	*0.22*	*0.03*	*0.02*	*0.04*	*0.03*
fee income	**0.05** **	**-0.01**	**0.06** **	**-0.0032**	**0.06** *	**-0.0026**
	0.03	*0.02*	*0.03*	*0.0176*	*0.03*	*0.0203*
real GDP growth	**0.0110** ***	**0.0162** ***	**0.0097** ***	**0.0154** ***	**0.0098** ***	**0.0156** ***
	0.0023	*0.0015*	*0.0023*	*0.0015*	*0.0028*	*0.0017*
interest rate change	**-0.0080** ***	**-0.0040** ***	**-0.0074** ***	**-0.0038** ***	**-0.0086** ***	**-0.0039** ***
	0.0010	*0.0006*	*0.0010*	*0.0006*	*0.0012*	*0.0007*
exchange rate change	**-0.0007** *	**0.0006** **	**-0.0008** *	**0.0006** **	**-0.0009** *	**0.0006** *
	0.0004	*0.0003*	*0.0004*	*0.0003*	*0.0005*	*0.0003*
constant	**1.94** ***	**0.85** ***	**2.19** ***	**1.17** ***	**1.72** ***	**0.64** ***
	0.13	*0.08*	*0.11*	*0.07*	*0.17*	*0.11*
R^2 (within)	0.36	0.35	0.36	0.34	0.37	0.34
obs	4436	4406	4334	4310	2551	2523

Table 9: Regression results for the first and second robustness test

Note: Standard errors are reported below the estimated coefficients.
****, **, * indicate significance at 1%, 5%, 10% level respectively.*
A full set of time dummies is included in each regression.

The third robustness check tries to shed some light on the issue whether we can find an announcement effect of the Basel Accord. As mentioned in the introduction, the Basel Accord was agreed on in 1988 but only implemented four years later. We so far followed Barajas et al. (2004) who argue that the actual implementation year and not the announcement date matters for changes in bank behavior. Still, we expect that the banking sectors started preparing for the regulation change as soon as they had reliable information on the exact regulation outcome. Gambacorta and Mistrulli (2004) show that for Italian banks the capital ratios already increased in the period that preceded the implementation of the Basel Accord. We run parallel regressions for the period 1989-1992 and 1993-1995 with a sample with contiguous observations from 1989-1995 to check whether banks' behavior changed with the implementation date.

Dependent Variable: Change in deposits/total assets or change in loans/total assets				
Robustness test	**announcement effect**			
Capitalization measure (CM)	capitalization 1989-1992		capitalization 1993-1995	
	deposits	loans	deposits	loans
capitalization measure	**1.30** ***	**0.54** **	**1.22** **	**1.12** ***
	0.40	*0.24*	*0.15*	*0.34*
dK(t)/TA(t-1)	**3.80** ***	**2.94** ***	**3.81** **	**3.37** ***
	1.06	*0.63*	*1.56*	*0.88*
CM* dK(t)/TA(t-1)	**-26.40** *	**-29.92** ***	**-8.74**	**-22.13** **
	14.76	*8.61*	*17.19*	*9.62*
log TA(t-1)	**-0.19** ***	**-0.16** ***	**-0.23** ***	**-0.12** ***
	0.03	*0.02*	*0.04*	*0.03*
liquidity(t-1)	**-0.17** **	**0.35** ***	**-0.36** ***	**0.34** ***
	0.07	*0.04*	*0.07*	*0.05*
fee income	**0.10** *	**0.00**	**0.10**	**0.03**
	0.05	*0.03*	*0.07*	*0.04*
real GDP growth	**0.0005**	**-0.0009**	**0.0126** **	**0.0163** ***
	0.0012	*0.0007*	*0.0053*	*0.0030*
interest rate change	**-0.0073** **	**-0.0046** **	**-0.0143** ***	**-0.0073** ***
	0.0030	*0.0019*	*0.0020*	*0.0012*
exchange rate change	**-0.0067** ***	**-0.0022** ***	**-0.0039** ***	**-0.0009** *
	0.0013	*0.0008*	*0.0009*	*0.0005*
constant	**1.40** ***	**1.04** ***	**1.73** ***	**0.64** ***
	0.20	*0.13*	*0.33*	*0.21*
R^2 (within)	0.25	0.30	0.36	0.36
obs	1134	1144	865	844

Table 10: Regression results for the third robustness check

Note: Standard errors are reported below the estimated coefficients.
****, **, * indicate significance at 1%, 5%, 10% level respectively.*
A full set of time dummies is included in each regression.

We can use the balance sheet information of about 350 banks which provide continuously their balance sheets from 1989-1995. The respective regression results are presented in Table 10.

We find qualitatively the same results.[27] The coefficients on the interaction term in the regressions for the early period increase substantially. This means, that banks show already in the early period a constrained behavior, but the level of the capital-to-assets ratio beyond which banks do not react positively to capital changes is much lower. Banks with a capital-to-assets ratio above 10% are not constraint by capital regulation, the same banks in the later period shows constrained behavior up to a capital-to-assets ratio of 15%. We therefore conclude that a fraction of banks in the

[27] Since the coefficient on the interaction term for the deposit regressions for the time period 1993-1995 is not longer significant, the reasoning here refers to the loan regressions.

period before the implementation of the Basel Accord were already constrained, possibly preparing for the new regulation, but that the regulatory pressure increased with the actual implementation of the new capital regulation.

The last robustness test tries to verify whether our assumption, that the effects of the introduction of the Basel Accord are only transitory, is correct. If this hypothesis is correct we should find that the banks in a later sample are either not at all constrained or at least a much smaller share of banks should show constrained behavior. This would show up in a much higher coefficient for the interaction term. We run two sets of regressions, one for the 1993-1995 and one for the 1996-2002 period. We use only observations of banks which have contiguous observations for the time period 1993-2002.

Dependent Variable: Change in deposits/total assets or change in loans/total assets				
Robustness test	**transitory effect**			
Capitalization measure (CM)	capitalization 1993-1995		capitalization 1996-2002	
	deposits	loans	deposits	loans
capitalization measure	**2.31** ***	**0.85** ***	**2.86** ***	**1.23** ***
	0.38	*0.25*	*0.22*	*0.13*
dK(t)/TA(t-1)	**5.78** ***	**3.71** ***	**10.51** ***	**7.77** ***
	0.91	*0.58*	*0.63*	*0.37*
CM* dK(t)/TA(t-1)	**-23.99** ***	**-15.43** ***	**-69.75** ***	**-48.20** ***
	9.23	*5.93*	*6.49*	*3.81*
log TA(t-1)	**-0.27** ***	**-0.18** ***	**-0.03** **	**-0.04** ***
	0.03	*0.02*	*0.01*	*0.01*
liquidity(t-1)	**-0.33** ***	**0.47** ***	**-0.34** ***	**0.05** ***
	0.05	*0.03*	*0.03*	*0.02*
fee income	**0.99** ***	**0.42** *	**0.01**	**0.01**
	0.04	*0.03*	*0.03*	*0.02*
real GDP growth	**0.0040**	**0.0141** ***	**-0.0062** *	**-0.0043** *
	0.0029	*0.0019*	*0.0037*	*0.0022*
interest rate change	**-0.0075** ***	**-0.0038** ***	**0.0067** ***	**0.0070** ***
	0.0013	*0.0009*	*0.0026*	*0.0015*
exchange rate change	**0.0006**	**0.0012** ***	**0.0000** ***	**0.0001** *
	0.0006	*0.0004*	*0.0000*	*0.0000*
constant	**1.75** ***	**0.97** ***	**0.21** **	**0.26** ***
	0.21	*0.13*	*0.09*	*0.05*
R^2 (within)	0.44	0.37	0.52	0.56
obs	1689	1684	3369	3367

Table 11: Regression results for the fourth robustness check

Note: Standard errors are reported below the estimated coefficients.
****, **, * indicate significance at 1%, 5%, 10% level respectively.*
A full set of time dummies is included in each regression.

We find that the coefficient on the interaction term is indeed much higher for the regressions in period 1996-2002 than for the period 1993-1995. In the three years after the implementation only banks with a capital-to-assets ratio above 24% would react as unconstrained banks, so effectively all banks behaved as constrained banks. In the later period this capitalization level decreases substantially to 15% capitalization. All banks above that capital-to-assets ratio are not constrained in any way. The respective regression results can be found in Table 11.

5. Conclusions

Banking sector stability is a central requirement to economic stability. Bank regulation aims at increasing the stability of banks, and thereby of financial intermediation, since banking crises are associated with high GDP losses. A central piece of the Basel I regulation was to increase the capital-to-assets ratios for individual banks; Basel II intends to improve on this even further. By increasing capital ratios, regulators hope to reduce incentive problems in the banking business. In particular, risk taking of banks can be shown to be too high if equity capital backing is too low. Thus, regulators intend to stiffen the capital regulation to induce banks to improve their capital positions.

The Basel Committee on Banking and Supervision established minimum capital requirements for banks in their 1988 Capital Accord. This capital regulation was adopted for European Union banks at the beginning of 1993. After the implementation, a widespread concern emerged about the possible negative impact that higher capital requirements could exert on the level of economic activity, especially on bank lending.

This paper investigates the impact of the Basel Accord on bank deposits and loans for eight European countries. We follow the approach taken by Peek and Rosengren (1995a) and test for the regulatory effect in a panel structure with about 2500 individual bank balance sheets for the years 1993-1995. We find that changes in deposits are positively correlated with changes in capital. Lower-capitalized banks show a stronger response to an increase in capital than their higher-capitalized competitors. This evidence is consistent with the hypothesis that the implementation

of minimum capital requirements has negatively affected the supply of bank loans. Further robustness checks indicate that our results are neither affected by the unbalanced sample structure nor by different country averages in capitalization. In addition, we can show with comparative regressions for the periods 1989-1992 and 1996-2002, that the loan supply effects have been particularly strong in the three years after the implementation of the Basel Accord. This evidence is consistent with the hypothesis that the implementation of minimum capital requirements could have negatively affected the supply of bank loans. This is also in accordance with the paper by Barajas et al. (2004) which concludes that Europe was the only region where bank lending not only has grown more slowly but has also been shrinking after the implementation of 1988 Basel Accord.

Further research is however needed to assess the impact of regulation on the distribution of banks' capitalization, respectively on the direct behavior of banks. The standard approach in the literature, also employed by us, only enable an indirect identification of the regulatory effect through the identification of loan supply effects, whose magnitude depend on the level of a bank's capitalization.

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