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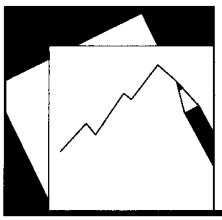

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Bank Behavior in Response to Basel III: A Cross-Country Analysis

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Bank Behavior in Response to Basel III: A Cross-Country Analysis

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Abstract

This paper investigates the impact of the new capital requirements introduced under the Basel III framework on bank lending rates and loan growth. Higher capital requirements, by raising banks' marginal cost of funding, lead to higher lending rates. The data presented in the paper suggest that large banks would on average need to increase their equity-to-asset ratio by 1.3 percentage points under the Basel III framework. GMM estimations indicate that this would lead large banks to increase their lending rates by 16 basis points, causing loan growth to decline by 1.3 percent in the long run. The results also suggest that banks' responses to the new regulations will vary considerably from one advanced economy to another (e.g. a relatively large impact on loan growth in Japan and Denmark and a relatively lower impact in the U.S.) depending on cross-country variations in banks' net cost of raising equity and the elasticity of loan demand with respect to changes in loan rates.

JEL Classification Numbers: E5, G2

Keywords: Commercial banks, capital constraints

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I. INTRODUCTION

The recent financial crises and their profound spillovers to the real sector have prompted the Bank for International Settlements (BIS, 2010c) to develop new regulations, known as Basel III. The aim of the new regulations is to promote the resilience of the banking system and improve its ability to absorb shocks arising from financial and economic stress.[2] The new regulations tighten the definition of bank capital and require that banks hold a larger amount of capital for a given amount of assets, and expand the coverage of bank assets.[3] The purpose of this paper is to estimate to what extent these higher capital requirements will lead to higher loan rates and slower credit growth.

The desirability of the Basel III regulations is hotly debated. One strand of literature argues that there are significant macroeconomic benefits from raising bank equity. Higher capital requirements lower leverage and the risk of bank bankruptcies (see e.g. Admati, DeMarzo, Hellwig, and Pfleiderer, 2010). Another strand of literature points out that there could be significant costs of implementing a regime with higher capital requirements (e.g. BIS, 2010b, and Angelini and others, 2011). Higher capital requirements will increase banks' marginal cost of loans if, contrary to the Modigliani-Miller (1958) Theorem, the marginal cost of capital is greater than the marginal cost of deposits, i.e. if there is a net cost of raising capital. In that case, a higher cost of equity financing relative to debt financing, would lead banks to raise the price of their lending and could slow loan growth and hold back the economic recovery.

Several studies have examined the impact of higher capital requirements on bank lending rates and the volume of lending. Kashyap, Stein, and Hanson (2010) calibrates key parameters of the United States' banking system to identify the impact of an increase in the equity to asset ratio.[4] It finds an upper bound of 6 basis points for the increase in U.S. banks'

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[2] See Otker-Robe, Pazarbasioglu, and others (2010) for a discussion of Basel II and III in relation to the large and complex financial institutions. Acharya, Kulkarni and Richardson (2011) explain how the Dodd-Frank bill calls for the adoption of international bank capital standards in the United States.

[3] Key elements of the new regulations as detailed in BIS (2010a and 2010b) include a minimum common equity tier 1 (CET1) ratio of 4.5 percent, the introduction of a conservation buffer of 2.5 percent to all forms of capital such that a bank must restrict payment of earnings as dividends when the ratio is less than 2.5 percent above the requirement, and a designated national authority must monitor credit conditions and add an additional capital requirement of up to 2.5 percent to the capital ratios during periods of excessive credit growth. The latter regulation implies that a bank holding company can be subject to an equity to risk-weighted asset ratio between 7 and 9.5 percent over the credit cycle, while large complex financial institutions (LCFI) would be subject to more stringent regulations. Most of the new regulations are to be phased in over the 2013-2015 period, with the capital conservation buffer to be phased in by end 2018.

[4] The calibrations in Kashyap, Stein, and Hanson (2010) assume violations of the Modigliani-Miller Theorem are associated with asymmetric information and differences in the tax treatment of payments from debt and equity. Elliott (2009) also undertakes a calibration of the banking industry. In contrast with these papers, this paper estimates to what extent the Modigliani and Miller (1958) conditions do not apply.

lending spreads following an increase in the capital to asset ratio in line with that required under Basel III.[5] BIS (2010b) estimates a significantly higher increase in the lending spread, on the order of between 12.2 and 15.5 basis points, based on simulations with 38 macroeconomic models maintained by the central banks of advanced economies.[6] Angelini and others (2011) reports similar findings. Similarly, using aggregate banking data, Slovik and Cournede (2011) uses accounting relations to find that lending spreads could be expected to increase by about 15 basis points.

This paper aims to broaden and deepen the understanding of the likely impact of the new capital requirements, introduced under the Basel III framework, on bank lending rates and loan growth. Complementing the studies mentioned above, this paper makes three contributions to understanding and testing the impact of the new regulations on the banks. First, the paper derives empirically testable relations from a structural model of the capital channel of monetary policy developed by Chami and Cosimano (2010). In doing so it follows Barajas, Chami, Cosimano, and Hakura's (2010) analysis of large bank holding companies in the United States. In this model, loan demand shocks are transmitted to the credit supply via the regulatory capital constraint. In particular, a bank's decision to hold capital is modeled as a call option on the optimal future loans issued by the bank. This option value of the bank's capital increases, when the expected level of loans and the amount of capital required by the regulator increase.[7] The bank's choice of capital influences its loan rate, since the marginal cost of loans is a weighted average of the marginal cost of deposits and equity. Consequently, the loan rate increases with an increase in required capital, as long as the marginal cost of equity exceeds the marginal cost of deposits. Second, unlike the earlier studies which use aggregate bank data, this paper uses bank-by-bank data for advanced economies for the period 2001-2009 to investigate the impact of the new capital requirements. Third, the paper considers three different groupings of banks: (i) the 100 largest banks worldwide as measured by their total assets in 2006; (ii) commercial banks or bank holding companies (BHCs) in advanced economies that experienced a banking crisis between 2007 and 2009; and (iii) the commercial banks or BHCs in advanced economies that did not experience a banking crisis between 2007 and 2009.

[5] Their estimate is 9 basis points for a 2 percentage points increase in the capital to equity ratio so that 6 basis points would result from a 1.3 percentage points increase in the capital to asset ratio discussed here.

[6] Dib (2010) provides an example of a macroeconomic model in which bank capital requirements impact the lending spread and real GDP. The model has a cost of adjusting deposit rates and a reduced form model of the asymmetric information cost of equity. The model is calibrated using macroeconomic data and does not rely on empirical evidence from individual banks.

[7] Flannery and Rangan (2008), Francis and Osborne (2009), and Berrospide and Edge (2010) use a partial adjustment model to a target level of capital to estimate the capital to asset ratio of banks. Subsequently, the unanticipated change in the capital to asset ratio is used to estimate the change in loans.

The empirical estimation relies on a generalized method of moment (GMM) estimation procedure which captures banks' simultaneous decisions on how much capital to hold, at what level to set the loan rate, and the size of their loan portfolio. In line with Chami and Cosimano (2010), the first stage regression for banks' holdings of capital is specified in terms of previous-period changes in capital, interest expenses and non-interest expenses. The hypothesis is that there is a negative and convex relationship between a bank's capital and each of these factors. In particular, an increase in the future marginal cost of loans means the bank issues less loans, so that the need for equity dissipates.[8] The loan rate is the dependent variable in the second stage regression and is specified in terms of the optimal bank capital predicted by the first stage regression, as well as interest and non-interest expenses and the level of economic activity. A regression of total loans on the predicted loan rate from the second stage GMM regression is then used to determine the interest elasticity of loan demand.

The key findings of the paper are as follows. First, a one percent increase in the equity-to-asset ratio is associated with a 0.12 percent increase in the loan rate for the 100 largest banks. For banks in countries that experienced a banking crisis during 2007-09, it is associated with a 0.09 percent average increase in the loan rate. For banks in countries that did not experience a banking crisis during 2007-09, it is associated with a 0.13 percent average increase. Thus, under normal credit conditions, the projected 1.3 percentage point increase in the equity-to-asset ratio that is required for banks and BHCs under the Basel III framework is estimated to increase the loan rate by 16 basis points for the 100 largest banks. This translates into an upper bound of 0.12 percent higher return on equity relative to the marginal cost of deposits, which is evidence against the Modigliani-Miller Theorem. One possible source of the higher cost of equity relative to the upper bound found by Kashyap, Stein, and Hanson (2010) is the too-big-to-fail policy which lowers the risk to the banks' debt holders and which is not accounted for by the latter study's calibration. Following Admati and others (2010), the higher loan rate may not be a social cost since it mitigates the adverse effects of a too-big-to-fail policy as it reduces excessive lending.[9]

During times when the monetary authorities invoke the "excessive credit growth" regulation—which requires banks and BHCs to increase the equity-to-asset ratio by up to 2.5 percentage points—loan rates would be raised further by up to 31 basis points. Moreover, an additional capital requirement for LCFIs is predicted to raise the loan rate by 0.12 percent times the additional equity-to-asset ratio. Thus, these higher capital requirements would impose an indirect tax on loans and excessive credit growth.

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[8] Gropp and Heider (2010) use financial variables to forecast bank capital but do not provide a structural model.

[9] Acharya, Pedersen, Phillippon, and Richardson (2011) argue that taxation is the most effective way to discourage excessive systematic risk. Capital requirements are an indirect and second best way to achieve this objective.

The findings from the loan rate estimations and the loan demand estimations together imply that the 1.3 percentage point increase in the equity-to-asset ratio required by Basel III is predicted to reduce loans for the 100 largest banks by 1.3 percent in the long run. In addition, a declaration of "excessive credit growth" which requires up to an additional 2.5 percentage points increase in the equity-to-asset ratio is predicted to reduce loans by about 2.5 percent in the long run. Thus, invoking the "excessive credit growth" regulation could have a significant impact on the lending volume of large banks and BHCs in developed countries. Assuming a 1.3 percentage point increase in the equity-to-asset ratio to meet the Basel III regulations, the country-by-country estimations imply a reduction in the volume of loans by on average 4.6 percent in the long run in banks in the countries that experienced a crisis and by 14.8 percent in banks in the countries that did not experience a crisis. The wide variance in the results reflects cross-country differences in the interest elasticity of loan demand and bank's net cost of raising equity. The estimated elasticity of loan demand is about -0.33 for the 100 largest banks and ranges from -0.92 percent for the United States to -6.61 percent for Denmark when the estimations are conducted for banks at the country level. An upper bound on the net cost of raising equity (i.e. the return on equity relative to the marginal cost of deposits) is estimated to range from 0 basis points in Canada to 26 basis points in Japan suggesting that there is wide variation in the evidence against the Modigliani-Miller Theorem. Exactly why the elasticity of demand or cost of capital is higher in these specific countries is beyond the scope of this work. Differences in the cost of capital are likely to be related to differences in the tax treatment of debt and equity. Cross-country differences in deposit guarantee schemes for "too big to fail" banks may also play a role. However, it is important for policy makers to identify exactly why the elasticity of loan demand to loan rates or the cost of equity are so high in specific countries so as to improve the formulation of economic policy.

The paper's findings suggest several implications of the Basel III framework. While the change in the lending rate is not predicted to be substantial, it could create significant incentives for regulatory arbitrage and a shift away from traditional banking activity to the "shadow-banking sector". In particular, a corporation could save $1.6 million on each $1 billion borrowed from a financial institution that has circumvented the additional capital requirement.[10] Under Basel II similar capital requirements gave large financial institutions incentives to move assets off their balance sheets, while keeping the responsibility to fund these assets in an emergency.[11] This led to the development of the shadow banking sector. An important implication of this is that increased regulation of the shadow banking sector could be needed to complement the reforms envisaged for the banking sector and LCFI. Second, additional capital requirements on LCFIs would act as a tax on such firms, since the additional cost of equity would lead to higher loan rates or a smaller return on equity. With a

[10] See Kashyap, Stein, and Hanson (2010) for a discussion of how a small change in the loan rate can lead to incentives for regulation arbitrage.

[11] See Acharya, Schnabl, and Suarez (2010) for details.

higher loan rate the LCFIs would have a competitive disadvantage relative to smaller institutions which are not subject to the extra capital requirements. Consequently, LCFIs would lose business to less systemic firms if they choose to raise loan rates. On the other hand, investors would find smaller less systematic firms with higher returns more attractive investments, so that smaller financial institutions could raise more equity, while shareholders of LCFIs have an incentive to break them up into smaller institutions. Third, the negative effect of a declaration of excess credit growth should be accounted for when considering appropriate countercyclical monetary policy. If the additional capital requirements reduce loan growth by 2.5 percent, then the increase in central banks' policy rates aimed at slowing an expansion would need to be modified to avoid an excessive slowdown in economic activity.

The remainder of the paper is organized as follows. Section II presents some descriptive statistics for the three groupings of banks examined in the paper. Section III describes the structural model for banks' optimal holding of capital and presents the specification of the empirical tests for bank capital, lending rates and loans. Section IV reports the results; and Section V concludes.

II. DATA AND DESCRIPTIVE STATISTICS

Annual data for commercial banks and BHCs for a large number of advanced countries are obtained from the Bankscope database for the 2001-2009 period. Three different groupings of banks are examined. The first grouping takes the largest 100 commercial banks and BHCs in the sample as measured by their total assets in 2006. The second grouping includes the commercial banks or BHCs in advanced economies that experienced a banking crisis between 2007 and 2009. The third grouping includes the commercial banks or BHCs in advanced economies that did not experience a banking crisis between 2007 and 2009.

Banking crises are identified using the index of money market pressure developed by Von Hagen and Ho (2007). This index defines banking crises as periods in which there are excessive increases in the demand for liquidity in the money market.

$$IMP_t = \frac{\Delta\gamma_t}{\sigma_\gamma} + \frac{\Delta r_t}{\sigma_{\Delta r}} \qquad (1)$$

Here $\Delta\gamma$ is the change in total bank reserves relative to non-bank deposits, Δr is the change in the short term real interest rate, and σ refers to the standard deviation of each variable.[12] Table 1 reports the year and quarter in which IMP meets two criteria: (i) it exceeds the 98.5 percentile, 97 percentile, and 95 percentile of the sample distribution of IMP for each

[12] The data for the 1992:Q1-2010:Q2 period is taken from the IMF's *International Financial Statistics* database.

advanced economy in the sample; and (ii) the increase in IMP from the previous period is by at least five percent. Based on this index, Austria, Belgium, Germany, Greece, Netherlands, Sweden, Spain, Italy, the United Kingdom and the United States are identified as having experienced a banking crisis between 2007 and 2009 when the cutoff is the 98.5 percentile. The banking crises, identified using this method, were also cross-checked against the method developed by Laeven and Valencia (2010).[13] The two approaches identify the same banking crisis episodes with the exceptions of 2008 crises in Japan and New Zealand which are only captured by the IMP index and a 2008 crisis in Switzerland which is only captured by the Laeven and Valencia (2010) study because the data to calculate the IMP index was not available for the latter country. Japan and New Zealand are, therefore, not included in the grouping of banks identified as experiencing a crisis and Switzerland is included in this grouping of banks.

Tables 2-4 show that bank profitability, represented by the return on equity (*ROE*), was markedly affected by the 2007-2009 financial crises for each grouping of banks. For the largest 100 banks worldwide the ROE registered a drop of twenty percentage points between 2006 and 2008, from 17 percent in 2006 to -3 percent in 2008 and recovered to only 1.4 percent in 2009. Consequently, the profitability of these banks was still suffering from the aftermath of the financial crisis in 2009. Further insight into the changes in the banks profitability can be obtained from the equation expressing the ROE as the product of the equity multiplier (*A*/*E*) and the return on assets (*ROA*). The ROA can be decomposed as in Koch and MacDonald (2007) as follows:

$$ROE = \frac{A}{E} \cdot ROA = \frac{A}{E}\left[\frac{NIM}{A} + \frac{NII}{A} - \frac{NIE}{A} + \frac{SG}{A} - \frac{PLL}{A} - \frac{TAX}{A}\right] \qquad (2)$$

where *E* is equity; *A* is total assets; *NIM* is the net interest margin, calculated as the difference between interest income (*II*) and interest expense (*IE*); *NII* is non–interest income; *SG* is security gains (losses); *NIE* is non–interest expense, *PLL* is provisions for loan losses, and *TAX* is the taxes paid.

As the decomposition shows for the 100 largest bank holding companies, the decline in ROA can be attributed to a one percent increase in the noninterest expense ratio and a near tripling of the loan loss provision ratio between 2006 and 2008 amplified by an equity multiplier (A/E) of over 19.5. The increase in the noninterest expense ratio between 2006 and 2008 likely results from extraordinary expenses and charges associated with the 45 percent decline in off-balance sheet activity in this period. In addition, there was a 0.6 percent decline in (NII + SG –TAX)/A from 2007 to 2008. This decline is associated with capital losses on security

[13] This study extends the work of Caprio, Klingebiel, Laeven, and Noguera (2005), Laeven and Valencia (2008), and Reinhart and Rogoff (2009).

and a decline in off-balance sheet activity which led to smaller fee income. The NIE recovered by 0.22 percent in 2009, which accounts for most of the increase in ROA from 2008 to 2009. On the other hand, the net interest margin remained fairly stable between 2006 and 2008 and increased by 0.07 percent in 2009. This suggests that banks offset the 0.4 percent increase in the interest expense to total assets ratio between 2006 and 2008 by increasing lending rates given that credit growth was declining in this period. The higher interest expense ratio was reversed in 2009 by 1.15 percent as a result of expansionary monetary policy around the world. Banks also managed to trim their noninterest expense ratios which contributed to higher profits. In summary, large bank profitability had a significant decline from capital losses on securities and a decrease in off-balance activity.

Despite the large declines in the ROE the largest bank holding companies kept the tier 1 equity to risk weighted assets significantly above the 4 percent required by Basel II. The total capital to risk weighted asset ratio was also kept significantly above the 8 percent requirement. Finally, the equity to asset ratio was always above 5 percent. Consequently, it does not appear that Basel II was effective at mitigating the financial crisis at the large BHCs. In particular, the substantial losses from off-balance sheet activity is in line with the analysis of Acharya, Schnabl, and Suarez (2010) that the large bank holding companies took advantage of regulatory rules to circumvent capital requirements. As a consequence, the large bank holding companies were subject to large declines in ROE even though they were adhering to the regulations under Basel II.

Table 3 shows that the profitability of banks, as measured by the ROE in advanced economies that registered a financial crisis between 2007 and 2009, were less affected than the 100 largest BHCs in the world. Also, by contrast with the 100 largest BHCs, these banks registered a negative ROE only in 2009. The decline in these banks profitability is largely attributable to the decline in (NII+SG-TAX)/A stemming from losses on securities[14] and the 0.5 percentage point increase in the loan loss provision ratio that are amplified by the sharp increase in the equity multiplier between 2006 and 2009. The equity multiplier for this group of banks is less than half of the equity multiplier of the 100 largest BHCs in the 2006-2008 period but increases substantially in 2009. Contrary to the finding for the largest 100 BHCs, the noninterest expense ratio declined by one percentage point between 2006 and 2009. Similar results are reported in Table 4 for the banks in countries that did not experience a financial crisis except that the decline in ROE is larger for this group of banks because of their larger equity multiplier.

In summary, the financial crisis had a significant negative impact on bank profitability including banks in countries that did not experience a crisis, though the impact is recorded under different headings for each group of banks. For the 100 largest banks, the declines in

[14] A small percentage of the decline can also be attributed to NII because of the decline in off-balance sheet assets. It is presumed that taxes did not change appreciably over this period.

ROE were mostly associated with increases in noninterest expenses and increases in nonperforming loans. In the case of the other two groups of banks, the declines were mostly directly associated with capital losses on marketable securities.[15] As a consequence, banks experienced a significant deterioration in their equity to asset ratios except in the case of the largest 100 banks for which equity to asset ratios tend to be considerably lower.

III. Specification of the Empirical Tests

A. The Choice of Capital

Following Chami and Cosimano (2001, 2010) the level of capital held by banks depends on the banks' anticipation of their optimal loans in the future. Capital is seen as a call option in which the strike price is the difference between the expected optimal loans and the amount of loans supported by the capital. The capital limits the amount of loans since a fraction of the total loans must be held as capital. If the optimal amount of loans next period exceeds this limit, then the bank would suffer a lost opportunity, which is measured by the shadow price on the capital constraint. In this case total capital has a positive option value, and, the bank will tend to hold more capital than required in order to gain flexibility to increase its supply of loans in the future. If, on the other hand, there is a low demand for loans in the future such that the shock to demand is below the critical level, then total capital serves no purpose so its payoff is zero.

Banks with more capital will have a higher strike price since their loan capacity is greater. As a result, an increase in capital leads to a decrease in the demand for future capital, K'. An increase in the marginal cost of loans leads the bank to forecast a higher marginal cost in the future, since such changes tend to persist into the future. Consequently, a bank anticipates a decrease in their optimal future loans, and will in turn reduce their holding of capital today. Similarly, an increase in marginal revenue related to stronger economic activity will lead to an increase in optimal loans so that the optimal capital goes up.

In view of this and following Barajas and others (2010), the relation for the bank choice of capital is specified as:

$$\frac{K^{'}}{A} = a_0 + \left(a_1 + a_2\frac{K}{A}\right)\times\Delta\frac{K}{A} + \left(a_3 + a_4\frac{K}{A}\right)r^D + \left(a_5 + a_6\frac{K}{A}\right)\left(C_L + C_D\right) + a_7\log\left(A\right) + \varepsilon_3 \qquad (3)$$

[15] Acharya, Schnabl, and Suarez (2009) explain how off-balance sheet items of large bank holding companies in the U.S. led to significant capital losses during the financial crisis.

Call options are generally decreasing and convex in the strike price.[16] As a result, we expect $a_1 + a_2 \frac{K}{A} < 0$ such that $a_2 > 0$, $a_1 < 0$. Similarly, it is expected that $a_3 < 0, a_4 > 0$, $a_5 < 0$ and $a_6 > 0$. So for example, a decrease in capital in the past which lowers the strike price, should lead to a significant increase in total current capital. This impact should be smaller when the bank has more initial capital, consistent with the convex property of call options. In addition, a decrease in interest and non-interest expenses should lead to an increase in bank capital at a decreasing rate. This convex property predicted by the call option view of bank capital distinguishes this model from the partial adjustment model of bank capital estimated by Flannery and Rangan (2008), Berrospide and Edge (2010), Francis and Osborne (2009).

B. The Loan Rate

Banks are assumed to have some monopoly power so that they choose the loan rate, r^L, such that the marginal revenue of loans equals to its marginal cost.[17] The marginal cost consists of the interest rate on deposits, r^D, and the noninterest marginal factor cost of loans and deposits, respectively, C_L and C_D. The marginal cost of loans also depends on the risk adjusted rate of return on capital (RAROC).[18] Thus, total marginal cost, MC, is given by:

$$MC = \frac{D}{A}(r^D + C_D) + C_L + \frac{A - D}{A} r^K \qquad (4)$$

Here, r^K is the return on equity, A is total assets and D is deposits so that bank capital is K' = A-D. As a result, the marginal cost increases with an increase in bank capital only if $r^K > r^D + C_D$. However, this result would violate the Modigliani-Miller (1958) Theorem that the source of financing does not influence a corporation's decisions. In particular, a higher level of equity would reduce the riskiness of the bank equity such that the return on equity declines. The Modigliani-Miller Theorem demonstrates that this effect is strong enough to completely remove the excess marginal cost of equity. Consequently, evidence of bank equity influencing the bank's loan pricing decision can be taken as a violation of the Modigliani-Miller Theorem.

The marginal revenue of loans is dependent on economic activity (M) as it impacts the demand for loans. As a result, the optimal loan rate is given by:

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[16] See Hull (2006) page 389 for proof of convexity of European call option in the strike price.

[17] See Barajas, Chami, Cosimano and Hakura (2010) for a discussion of empirical evidence for monopoly power.

[18] Froot and Stein (1998) discuss the disadvantages of RAROC. They explain that the impact of a specific loan on the cost of capital is dependent on the extent of non-diversifiable and diversifiable risk inherent in the project.

$$r^L = b_0 + b_1 r^D + b_2\left(C_L + C_D\right) + b_3 \frac{K'}{A} + b_4 \log\left(A\right) + b_5 M + \varepsilon_1 \quad (5)$$

An increase in the deposit rate, the noninterest cost of deposits and the provision for loan losses would lead to an increase in the loan rate, since the marginal cost of loans would increase. The marginal cost also increases with an increase in RAROC. This effect is measured by the optimal capital asset ratio K'/A as given in (5) above. An increase in the demand for loans would raise marginal revenue and the loan rate. This effect is captured by the level of economic activity, M as measured by real GDP and the inflation rate. Finally, ε is the estimation error.

C. Bank Loans

With monopoly power, the demand for loans, L, depends on the optimal loan rate of the bank as determined in (5) above and the level of economic activity, M. As a result, the demand for loans, L, can be modeled as:

$$L = c_0 - c_1 r^L + c_2 M + \varepsilon_2 \quad (6)$$

where c_i, i=0,1,2 are parameters to be estimated. It is expected that an increase in the loan rate would reduce the demand for loans, and hence loans issued by the bank. On the other hand, an increase in economic activity is expected to increase the demand for loans. Note that c_1 and c_2 capture the long-run responses of loans to changes in loan rates and the level of economic activity. Given that the variables are non-stationary (I(1)), we test the null hypothesis of no cointegration in the model. We were able to reject the null hypothesis, i.e. cointegration was found.[19]

D. Empirical Strategy

Banks simultaneously choose the optimal amount of capital to hold, the loan rate, and the quantity of loans. Because of this simultaneity, a generalized method of moments (GMM) estimation procedure is used. In the first stage the capital regression (3) is estimated to determine the bank's projected or optimal level of capital. The change in the capital-to-asset ratio, the interest expense ratio, the noninterest expense ratio and the nonperforming loans to total assets ratio as well as the interaction of each of these variables with the previous period capital-to-asset ratio are assumed to be instruments for the optimal capital ratio. The

[19] For each bank grouping, group mean panel ADF cointegration tests are conducted for the banks which have at least 7 years of consecutive observations. The cointegration test could not be conducted for Sweden and Ireland because of insufficient consecutive observations.

predicted demand for capital is then used in the second-stage regression for the bank's loan rate (5). The GMM estimations are conducted using the Bartlett kernel function,[20] thereby yielding heteroskedasticity- and autocorrelation-consistent (HAC) standard errors. Lastly, the regression for the demand for loans (6) is estimated using as an explanatory variable the loan rates predicted by the GMM estimations.

The estimations for the three grouping of banks are conducted using data for the 2001 to 2009 period. For the group of the 100 largest banks worldwide, country and year dummies are included in the regressions. For the second and third groupings—banks in advanced economies that experienced a banking crisis between 2007 and 2009, and banks in advanced economies that did not experience a banking crisis between 2007 and 2009, respectively—the estimations are conducted on a country-by-country basis. The number of banks included in each estimation depends on the degree of concentration of the banking system in each country and the availability of the data in the Bankscope database. The regressions for the latter two bank groupings are estimated including year dummies.

IV. Estimation Results

A. Largest Banks

Tables 5 and 6 provide estimates of the capital choice equation (3) and the loan rate equation (5), respectively. These estimates are obtained using GMM for the largest banks worldwide as measured by their assets in 2006.[21] Tables 7 and 8 report the results of these equations for each advanced economy. Heteroskedasticity- and autocorrelation- consistent standard errors are reported in parentheses. The dependent variable in the first stage capital equation (3) is the equity to asset ratio, the measure of capital for which data is readily available.

Table 5 shows that for the 100 largest banks, the choice of bank capital in a given period was negatively related to the prior change in the equity to asset ratio, $a_1 < 0$, and, contrary to expectations, negatively related to the interaction between this change and the initial level, $a_2 < 0$, but these effects are not significant. The interest expense to asset ratio has the expected negative sign ($a_3 < 0$) and is statistically significant at the one percent level, so that a one percent increase in the interest expense ratio reduces the banks' holding of equity by 0.63 percent. The interaction term with the initial equity-to-asset ratio, $a_4 > 0$, has the correct positive sign, so that banks with a one percent higher equity-to-asset ratio would reduce their optimal holding of equity by only 0.52 percent for a one percent increase in the interest expense ratio.

[20] The bandwidth is set to 2 for the regressions for the largest banks and 4 for the bank regressions at the country level.

[21] The reported estimations do not include all the 100 largest banks that were identified because of the lack of data for all the included variables.

The marginal cost of deposits and loans is measured by the noninterest expense to asset ratio and the nonperforming loan to asset ratio. Both effects are negative $a_5 < 0$ as expected but only the noninterest expense ratio is statistically significant at the 1 percent level. A one percent increase in noninterest expense ratio leads to a 0.78 percent reduction in capital which is reduced to 0.67 percent for a bank with one percent higher equity- to-asset ratio. The interaction term $a_6 > 0$ is also significant at the one percent level for nonperforming loans. The evidence suggests that larger banks tend to have smaller equity-asset ratios, or in other words, banks with one percent more assets hold 0.23 percent less equity relative to assets.[22] With an adjusted R-square of 84 percent the optimal equity equation (3) is strongly supported by the data for the largest banks across the world. In addition, the convex property of the option value of capital is confirmed by the empirical test. Thus, the findings for the large banks confirm the predictions of the Chami and Cosimano (2001, 2010) model that banks treat capital as a call option, where holding more capital allows greater flexibility to issue more loans in the future.

Table 6 reports the second stage regression, equation (5), for the loan rate. Three different specifications of the loan rate equations were estimated. The first specification includes year dummies, and lagged real GDP growth and lagged inflation for the countries in which the bank is located. The second specification excludes the year dummies and the third specification excludes the variables representing economic conditions in the country. All three regressions convey the same information, so only the last specification is reported. A one percent increase in the equity-to-asset ratio yields a statistically significant 12 basis points increase in the interest income ratio or loan rate, so that the net cost of raising equity is about 12 basis points for the 100 largest banks.[23] Given that this is the long-run relation, the estimated effect cannot be associated with temporary asymmetric information effects as in Admati and others (2010). This result confirms that the Modigliani-Miller assumptions do not apply for the 100 largest banks.

A one percent increase in the interest expense ratio leads to an increase in the interest income to asset ratio of 0.95 percent. This effect is significant at the one percent level. A one percent increase in the noninterest expense ratio also has a significant positive effect on the interest

[22] The results do not change substantially if the logarithm of assets is replaced by the difference in the logarithm of assets in this regression.

[23] The marginal cost of loans coming from equity is the spread between the marginal cost of equity and deposits weighted by the equity to asset ratio, $(r^K - r^D - C_D)\frac{K\prime}{A}$. Following Cosimano and McDonald (1998) the marginal cost is equal to the loan rate in a perfectly competitive industry, so that $(r^K - r^D - C_D)\Delta\frac{K\prime}{A} = \Delta r^L$. As a result, $(r^K - r^D - C_D) = \Delta r^L/(\Delta\frac{K\prime}{A})$. In the case of an imperfectly competitive market, Cosimano and McDonald show the change in the loan rate would be smaller so this spread would be smaller relative to a competitive market. Column (2) in Table 10 records this effect for the various countries and the largest banks.

income ratio but it changes the interest income ratio by only 0.18 percent. The nonperforming loans to assets ratio has a positive albeit insignificant effect.

Table 9, column (1) reports the results of estimating the long-run loan demand equation (6) for the 100 largest banks. The equation is estimated using the predicted loan rate from equation (5). The loan rate has the expected negative impact on the loans issued by the bank.[24] The coefficient (-0.24) can be used to estimate the elasticity of loan demand -0.33 (-0.24*(4.02/2.52)).[25] This elasticity of loan demand means that the largest banks are operating at loan levels associated with negative marginal revenue, since the absolute value of the elasticity is less than one. In addition, the bank's loan customers have few substitutes for bank loans, which suggest the largest banks' customers on average lack access to the capital markets. Consequently, a one percent increase in the predicted loan rate leads to a reduction in loans by the largest banks in the world by about 1.3 percent.

In the bottom panel of Table 10 the impact of Basel III is estimated using only the data through 2007. The impact on loan demand of 1.55 percent is higher than for the entire sample period because the interest elasticity of loan demand is estimated to be larger. This result suggests that the largest banks' customers had fewer opportunities to substitute away from bank borrowing during the financial crisis.

B. Country-by-country estimations

Table 7 reports the results of estimating equation (3) as the first stage in the GMM procedure on a country by country basis for the second two groupings of banks. Because of the availability of data, for the countries that experienced a financial crisis between 2007 and 2009, results are reported for the United States, Germany, the United Kingdom, Greece, Sweden, and Switzerland. France, Netherlands and Austria were excluded because of insufficient data. For the third grouping of banks in countries which did not experience a crisis, results are reported for Canada, Czech Republic, Denmark, Ireland, Japan and Korea. The change in the equity-to-asset ratio has the predicted sign $a_1 < 0$ for the U. S., U. K., Greece, Switzerland, Canada, Denmark and Ireland but is statistically significant for only four countries (the U.K., Switzerland, Denmark and Canada). The estimated coefficients on this variable for the other countries have the wrong sign and are statistically insignificant except for Sweden. The interaction term, $a_2 > 0$, has the correct sign for the U.S., the U.K., Greece, Switzerland, Canada, Denmark, Ireland, and Korea, however only the U.K.,

[24] Given there is long run cointegration, the parameter estimates are asymptotically unbiased and robust to endogeneity. Formally, the standard errors need to be adjusted for the long run correlation between the errors and the innovations of the explanatory variables before we can do formal hypothesis testing. However, the time dimension (a maximum of 9 observations per bank) is too small to make the required adjust. In any case, given the large size of the standard t-statistics in Table 9 we do not expect the results to change drastically.

[25] Here, the mean predicted loan rate and loans for the l00 largest banks are used to estimate the elasticity.

Switzerland, Canada, Denmark, and Ireland are statistically significant. The other countries have the wrong sign with Germany, and Sweden being statistically significant. The results for the interest expense to asset ratio are more consistent with the theory. All the countries that experienced a crisis have the correct signs, $a_3 < 0$ and $a_4 > 0$, which are all statistically significant except Greece. Among the counties that did not experience a crisis, Canada, Denmark, the Czech Republic, and Ireland had correctly signed and significant coefficients. The magnitude of these coefficients for the crisis and non-crisis countries is generally larger relative to the 100 largest banks. The noninterest expense ratio has statistically significant and correct signs $a_5 < 0$ and $a_6 > 0$ for the U.S., the U.K., Greece, Sweden, Switzerland, Denmark, and Korea. Nonperforming loans only has significant and correct signs for Switzerland and Japan. The logarithm of total assets is only significant at the one percent level for the U.K. and Canada. The coefficient on the logarithm of assets is negative for most of the countries implying that larger banks have smaller equity-to-asset ratios. This is consistent with the evidence from the estimations for the 100 largest banks. Overall, the results are consistent with (3) except for some countries with a small number of observations.

The estimates for equation (5) for the two country groupings are provided in Table 8. Equity and interest expense ratios have the predicted signs and are statistically significant at the five percent level, except the equity ratio in the case of Canada and Korea. Thus, there is significant deviation from the Modigliani-Miller conditions for banks across these countries. The noninterest expense to asset ratio has the correct positive effect on the loan income of the banks for all countries. They are statistically significant except for Switzerland, Denmark, Ireland and Japan. The results for nonperforming loans to assets are insignificant for most of the countries. The interest expense ratio has a larger impact on the interest income ratio for the U.S., Germany, and the U.K. relative to the grouping of the largest banks. The equity-to-asset ratio generally has the same impact as the large banks in the U.S., Germany, and the Czech Republic, while the impact of equity-to-asset ratio on the interest income ratio is larger for Denmark, Ireland andJapan. The remaining countries tended to have a lower impact of equity on the interest income ratio of the banks with Switzerland having a low but significant effect, and Canada and Koreas having insignificant effects. On net these variables explain between 96 percent and 67 percent of the changes in the interest income ratio of the banks for the group of banks in countries that experienced a crisis between 2007 and 2009, and between 45 percent and 85 percent for the countries that did not experience a crisis.

Table 9 reports the results of estimating the long run loan demand equation (6) for the country-by-country estimations. For most of the countries the loan rate has the expected negative impact on the loans issued by the bank.[26] Given the mean predicted loan rate and loans for the banks in each respective country, the elasticity of loan demand with respect to the predicted loan rate in Table 10a is estimated to range from 0.92 percent in the United

[26] See footnote 23.

States to 6.61 percent in Denmark. Consequently, the banks across most of these countries operate at loan levels associated with positive marginal revenue. In addition, the banks' customers in these countries can choose from more alternatives for bank financing relative to the 100 largest banks.

Table 10b summarizes the results when the estimations are conducted excluding the crisis period from the data. The average impact of the equity-to-asset ratio on the loan rate is slightly smaller when the crisis period is excluded for all countries. This implies that deviations from the Modigliani-Miller Theorem are larger during financial crisis. The elasticity of loan demand is on average lower in crisis countries and higher for non-crisis countries when the crisis period is excluded. This result implies that the banks' customers in (noncrisis) crisis countries had a bigger (smaller) change in their demand for loans during the financial crisis.

C. Impact of Basel III

The BIS (2010d) and the Committee of European Banking Supervisors (CEBS, 2010) have conducted quantitative impact studies which report the additional capital needs for banks under Basel III given their financial position on December 31, 2009. The BIS study is for banks in 23 jurisdictions across the world, while the CEBS report is for 19 European countries. Both studies report information for Group 1 banks that have over 3 Billion Euros of Tier 1 capital which is consistent with our largest banks.

Although we do not know the exact banks that were included in these studies, we think it is safe to assume that our sample of the worldwide largest banks would on average be subject to the same constraints on bank equity under Basel III. In particular, the 2009 Tier 1 ratio for Group 1 banks in the BIS (CEBS) study is 10.5 percent (10.3 percent), while our sample of the largest banks has a Tier 1 ratio of 10.3 percent (Table 11). Also, the total capital ratio is 14 percent in both the BIS and CEBS studies which is comparable to the 13.7 percent for the group of largest banks analyzed in this paper. It is interesting to note that our 5.7 percent equity-to-actual asset ratio is identical to the net equity to risk-weighted asset (CET1) ratio for their Group 1 banks, while it is 11.1 percent before the changes in regulation (i.e. for the gross common equity tier 1 ratio) in the BIS study. This result suggests that the new equity to risk-weighted asset ratio is close to a pure equity-to-asset ratio.[27]

The BIS (CEBS) estimates that under Basel III the equity to risk-weighted asset (CET1) ratio would fall to 5.7 percent (4.9 percent) from 11.1 percent (10.7 percent) for the gross CET1 ratio (pre-Basel III ratio) for Group 1 banks. Most of this decline is associated with tighter standards on bank equity with the removal of goodwill being the most important one. The rest of the decline arises from stricter rules on risk-weighted assets. The biggest contributors

[27] This correspondence is not as strong for the equity to asset ratio for the banks in crisis countries.

to this increase are adjustment for counterparty risk and the application of the capital definition.

On the assumption that the equity-to-asset ratio used in the estimations reported in this paper is a good proxy for the new equity to risk-weighted ratio under Basel III, the results in this paper can be used to infer the impact of an increase in capital regulations on the loan rate charged by the largest banks. Under the Basel III regulations, the largest banks would need to increase their equity-to-asset ratio from 5.7 percent to 7 percent. The results reported in Table 5 imply that a 1.3 percentage point increase in the equity-to-asset ratio would tend to increase the loan rate by 0.159 percent (0.122*1.3 percent).

The results from Tables 5 and 6 can be used to estimate the impact of an increase in the equity ratio by 1.3 percent under Basel III on loans in the long run. This increase in capital would lead to a 3.9 percent (0.159/4.02) increase in the loan rate when the equity-to-asset ratio is used to proxy for the new regulation. Given a long run elasticity of loan demand with respect to the loan rate of -0.33 percent, this would imply an overall reduction of loans by 1.3 percent.

The change in loans is relatively small for the largest banks because of the small elasticity of demand for loans.[28] Table 10a reports similar calculations assuming the same capital shortfall of 1.3 percentage points under Basel III for the cross-country results. For the crisis countries, a 1.3 percentage point increase in equity-asset ratio is estimated to have a more substantial impact on loans (4.6%), since the elasticity of demand for loans is estimated to be about eight times larger than in the case of the 100 largest banks. It is also the case that the deviation from the Modigliani-Miller Theorem is smallest in the countries with the highest elasticity of demand, the U.K. and Sweden. The impact of Basel III is largest in the non-crisis countries of Denmark and Japan. In the case of Japan, the impact is large because it has the highest net cost of raising equity. In the case of Denmark, the impact of Basel III is large because it is estimated to have both a relatively high elasticity of loan demand with respect to changes in the loan rate and a high net cost of raising equity.

If the crisis period is excluded from the estimation period in Table 10b, then the impact of Basel III in the crisis countries is slightly smaller following the lower elasticity of demand across these countries.[29] On the other hand, the average elasticity of loan demand is larger for the non-crisis countries, which dominates the decline in the cost of equity under the shorter time period. This result arises from unusual behavior of Denmark. Finally, the impact of

[28] The relatively low elasticity of loan demand for the largest banks reflects that the largest banks loans constitute the lion's share of loans of advanced economies and hence the limited scope for borrowers to borrow from alternative sources.

[29] Part of this decline in average elasticity arises from the exclusion of Sweden in the shorter period since it does not have a sufficient number of observations to conduct a reliable estimation.

Basel III on the largest banks is larger, since the elasticity of loan demand is higher when the crisis period is excluded from the sample.[30]

The results for the loan rates reported in column 1 in Table 10a are broadly consistent with the findings from BIS (2010d) and CEBS (2010) for the loan rate which found that the mean, weighted by GDP, lending rate would increase across 53 models by 16.7 basis points over eight years and 15 basis points respectively. However, the magnitude is significantly above the upper bound of 6 basis points calibrated in Kashyap, Stein, and Hanson (2010). While the source of this discrepancy cannot be identified, one possible reason is the lower cost of debt arising from the too big to fail policy for LCFIs which is not explored in the latter study.

The impact on loan volume for the largest banks is 30 percent lower than the BIS estimate of -1.89 percent (GDP weighted mean over 48 quarters), while the predicted impact is significantly higher for the individual countries. This difference can be attributed to the higher elasticity of demand for loans for the individual countries relative to the largest banks.

V. CONCLUSIONS

The 2007-2009 financial crisis which began in the United States and spread to other developed countries exposed substantial weakness in the Basel II rules for regulating commercial banks. In particular, large bank holding companies suffered large declines in their return on equity from losses on off-balance sheet activities despite maintaining the capital ratios required under Basel II. As a result, the BIS (2010a) developed a new set of regulations, Basel III, designed to alleviate the shortcomings of the previous regulations. There has been much speculation concerning the increase in the cost to banks and borrowers due to these more stringent regulations.[31] This study examines the behavior of banks across developed countries from 2001-2009 to determine to what extent the increase in capital requirements will lead to higher loan rates and slower loan growth.[32]

Using a structural model of bank behavior from Chami and Cosimano (2010) and Barajas and others (2010) this study identifies the optimal holding of equity by banks. On this basis it is estimated that the largest banks in the world would raise their lending rates by on average 16 basis points in order to increase their equity-to-asset ratio by the 1.3 percentage points needed to achieve the new Basel regulation of a 7 percent equity to new risk-weighted asset ratio. This estimate suggests the cost of equity is about 16 basis points above the bank's alternative source of financing and, hence, that the Modigliani-Miller (1958) assumptions do

[30] The lower elasticity of loan demand for the largest banks when the crisis period is included may be a reflection of the decline in shadow banking activity during the crisis and too-big-to-fail guarantee schemes.

[31] See Rose (2010) and KPMG (2011).

[32] BIS (2010d) estimates that 87 of the largest banks across the world would have to raise 577 Billion € to meet all the Basel III requirements.

not apply for the largest banks in the world. Given an estimated elasticity of loan demand with respect to the loan rate of 0.33 percent for the group of largest banks, the increase in lending rates is estimated to cause loan growth to decline by 1.3 percent in the long run.

The paper's results also suggest that banks' responses will vary considerably from one advanced economy to another reflecting cross-country variations in the tightness of capital constraints, banks' net cost of raising equity, and elasticities of loan demand with respect to changes in loan rates. The country-by-country estimations which include both large and small banks for which data is available in each country suggest that the net cost of raising equity by 1.3 percentage points ranges from 0 basis points in Canada to 26 basis points in Japan. Similarly, the estimated elasticities of loan demand range from 0.92 percent in the United States to 6.6 percent in Denmark. As a result, the average impact of a 1.3 percentage point increase in the equity-asset ratio on loan growth for the crisis countries is 4.9 percent. This impact is significantly higher in the non-crisis countries such as Japan and Denmark. The potential for a substantial impact of capital requirements makes it even more important for policy makers in these countries to identify exactly why the elasticity of loan demand or cost of equity is so high in these economies.

An additional feature of Basel III is a countercyclical capital requirement which can lead to an additional 2.5 percent increase in the capital ratios under a declaration of "excessive credit growth." The estimations in this paper imply that such a declaration is predicted to reduce the largest banks loans by 2.5 percent. As a result, a declaration of "excessive credit growth" could have a significant countercyclical impact on the developed countries' economies. This result suggests that such a declaration should be closely coordinated with monetary policy decision-making. The simultaneous declaration of "excessive credit growth" alongside a contractionary monetary policy could conspire to an excessive policy-tightening. The converse of this is that this additional capital requirement should be considered part of the monetary authority's tool kit.

Table 1: Banking Crises in Advanced Economies Identified Using the Von Hagen and Ho (2007) Index of Money Market Pressure

Time	Thresholds		
Country	98.5%	97%	95%
Austria	2008q4	1994q4,2008q4	1994q4,1995q4,1999q3,2008q4
Belgium	2006q4,2008q3	2005q4,2006q4,2008q3	1997q4,2005q4,2006q4,2008q3
Canada	1994q2	1994q2,1997q3	1994q2,1997q3,2000q4,2003q2
Czech Republic	1997q2,1997q4	1997q2,1997q4,2008q4	1994q1,1997q2,1997q4,2008q4
Denmark	1993q1,1993q3	1993q1,1993q3,2000q3	1993q1,1993q3,2000q3,2008q3
Finland	1992q3,1999q4	1992q3,1999q4,2008q3	1992q3,1999q4,2000q3,2008q3
France	1992q3,1993q3	1992q3,1993q3	1992q3,1993q3,2008q3
Germany	2008q3	1997q4,2008q3	1997q4,2000q4,2008q3
Greece	2008q4,2010q1	1993q1,2008q4,2010q1	1993q1,1998q3,2008q4,2010q1
Ireland	1992q3	1992q3	1992q3,2008q3,2009q1
Israel	1993q1,1999q1	1993q1,1999q1,2002q3	1993q1,1994q3,1999q1,2002q3
Italy	1992q3,2008q4	1992q3,2000q2,2008q4	1992q3,1999q4,2000q2,2008q4
Japan	1999q4,2008q4	1997q3,1999q4,2008q4	1997q3,1998q3,1999q4,2008q4
Korea, Republic of	1992q3,1997q4	1992q3,1993q3,1997q4	1992q3,1993q3,1996q3,1997q4
Netherlands	2008q3	2003q3,2008q3	2001q3,2003q3,2008q3,2009q3
New Zealand	2008q4	2008q4	2002q3,2008q4
Portugal	1992q3,1994q2	1992q3,1994q2,2008q3	1992q3,1994q2,2007q3,2008q3
Spain	1992q4,2008q3	1992q4,2007q3,2008q3	1992q4,1995q2,2007q3,2008q3
Sweden	2008q4	2008q4	2008q4,2009q3
United Kingdom	2008q3,2009q2	1993q3,2008q3,2009q2	1993q3,2007q3,2008q3,2009q2
United States	2008q3,2008q4	2007q3,2008q3,2008q4	2006q4,2007q3,2008q3,2008q4

Source: International Financial Statistics

Note: Each column reports the year and the quarter in which the Von Hagen and Ho (2007) index of money market pressure (IMP) meets two criteria: (i) it exceeds the 98.5 percentile, 97 percentile, and 95 percentile of the sample distribution of IMP for each advanced economy in the sample; and (ii) the increase in IMP from the previous period is by at least five percent (see text for explanation).

Table 2: Selected Banking Indicators for the Largest 100 Banks Based on Total Assets in 2006

	2006	2007	2008	2009
Equity-asset ratio				
Mean	5.3	5.5	5.1	5.7
Median	5.2	5.1	4.4	5.3
Std. Dev.	2.9	3.8	3.8	3.0
No. of Obs.	93	90	100	94
Total capital ratio				
Mean	11.8	11.4	12.1	13.7
Median	11.6	11.2	11.6	13.5
Std. Dev.	1.9	1.9	2.3	2.9
No. of Obs.	77	82	84	77
Tier 1 ratio				
Mean	8.7	8.3	8.8	10.3
Median	8.5	7.8	8.5	10.4
Std. Dev.	1.9	1.8	2.2	3.3
No. of Obs.	77	76	85	84
Return on average equity				
Mean	17.1	14.3	-2.9	1.4
Median	17.9	14.7	5.4	5.1
Std. Dev.	6.3	7.8	35.7	27.6
No. of Obs.	92	90	99	94
Decomposition of bank profitability				
Equity multiplier[1]	18.7	18.2	19.6	17.6
Net interest margin (NIM/A)	1.62	1.54	1.61	1.68
Interest expense to total assets	2.72	3.18	3.09	1.94
Noninterest expenses (NIE/A)	1.80	2.69	2.81	2.59
Loan loss provisions (PLL)	0.17	0.20	0.48	0.83
Noninterest income plus securities gains, net of taxes ($NII + SG - TAX$)/A[2]	1.3	2.1	1.5	1.8
Offbalance sheet items to total assets				
Mean	48.1	21.2	20.6	26.6
Median	19.3	20.2	18.9	19.9
Std. Dev.	226.5	15.0	18.0	27.5
No. of Obs.	60	72	76	60

Source: Bankscope

[1] Defined as the inverse of the equity-asset ratio.

[2] Calculated as a residual from the definition of return on equity:

$$ROE = \frac{A}{E}\left[\frac{NIM}{A} - \frac{NIE}{A} + \frac{NII}{A} + \frac{SG}{A} - \frac{TAX}{A} - \frac{PLL}{A}\right]$$

Table 3: Selected Banking Indicators for Advanced Economies That Had a Banking Crisis in 2007-09

	2006	2007	2008	2009
Equity-asset ratio				
Mean	15.3	14.3	13.7	11.5
Median	8.6	8.5	8.1	8.4
Std. Dev.	18.9	17.4	17.3	13.1
No. of Obs.	835	919	936	501
Total capital ratio				
Mean	20.9	18.3	15.2	15.0
Median	12.2	12.0	12.6	13.5
Std. Dev.	40.6	30.2	10.1	8.1
No. of Obs.	291	374	467	105
Tier 1 ratio				
Mean	18.4	15.8	12.7	12.7
Median	9.4	9.8	10.3	11.2
Std. Dev.	42.0	31.1	9.7	7.3
No. of Obs.	271	352	430	321
Return on average equity				
Mean	10.9	10.1	3.7	-0.4
Median	8.9	8.4	4.9	4.0
Std. Dev.	15.8	17.8	29.0	24.8
No. of Obs.	831	916	931	501
Decomposition of bank profitability				
Equity multiplier[1]	6.5	7.0	7.3	8.7
Net interest margin (NIM/A)	2.8	3.0	2.7	3.0
Interest expense to total assets	2.4	3.7	2.8	1.9
Noninterest expenses (NIE/A)	5.2	5.0	5.0	4.2
Loan loss provisions (PLL)	0.4	0.5	0.7	0.9
Noninterest income plus securities gains, net of taxes ($NII + SG - TAX$)/A[2]	4.5	4.0	3.5	2.1
Offbalance sheet items to total assets				
Mean	21.9	21.7	18.5	19.7
Median	6.8	6.9	5.3	8.9
Std. Dev.	65.5	61.8	55.8	37.4
No. of Obs.	640	710	759	435

Source: Bankscope

Note: Banks in the following countries are included in the calculations: Austria, Belgium, Germany, Greece, Italy, Netherlands, Spain, Sweden, United Kingdom, and the United States.

[1] Defined as the inverse of the equity-asset ratio.

[2] Calculated as a residual from the definition of return on equity:

$$ROE = \frac{A}{E}\left[\frac{NIM}{A} - \frac{NIE}{A} + \frac{NII}{A} + \frac{SG}{A} - \frac{TAX}{A} - \frac{PLL}{A}\right]$$

Table 4: Selected Banking Indicators for Advanced Economies That Did Not Have a Banking Crisis in 2007-09

	2006	2007	2008	2009
Equity-asset ratio				
Mean	8.8	8.8	7.9	7.2
Median	6.5	6.6	5.9	5.4
Std. Dev.	8.9	9.0	8.4	9.2
No. of Obs.	353	354	354	235
Total capital ratio				
Mean	13.6	14.0	13.7	14.1
Median	11.2	11.5	11.4	11.9
Std. Dev.	16.3	19.0	17.1	17.3
No. of Obs.	237	238	239	257
Tier 1 ratio				
Mean	11.2	11.3	11.2	11.8
Median	8.9	8.8	9.0	9.6
Std. Dev.	16.9	19.0	17.5	17.7
No. of Obs.	219	226	231	212
Return on average equity				
Mean	10.3	9.0	2.9	-5.7
Median	8.8	8.7	4.9	1.6
Std. Dev.	13.6	18.8	30.8	41.0
No. of Obs.	352	354	354	234.0
Decomposition of bank profitability				
Equity multiplier[1]	11.3	11.4	12.7	13.8
Net interest margin (NIM/A)	2.2	2.1	2.1	2.0
Interest expense to total assets	1.7	2.2	2.4	1.2
Noninterest expenses (NIE/A)	2.4	2.6	2.6	2.8
Loan loss provisions (PLL)	0.2	0.2	0.4	0.8
Noninterest income plus securities gains, net of taxes ($NII + SG - TAX$)/A[2]	1.4	1.5	1.2	1.2
Offbalance sheet items to total assets				
Mean	22.1	20.6	18.0	13.6
Median	9.2	8.4	6.5	2.2
Std. Dev.	40.0	38.2	32.9	31.8
No. of Obs.	353	354	354	235

Source: Bankscope

Note: Banks in the following countries are included in the calculations: Zew Zealand, Japan, Denmark, Canada, Czech Republic, Ireland, France, Finland, Korea, and Portugal.

[1] Defined as the inverse of the equity-asset ratio.

[2] Calculated as a residual from the definition of return on equity:

$$ROE = \frac{A}{E}\left[\frac{NIM}{A} - \frac{NIE}{A} + \frac{NII}{A} + \frac{SG}{A} - \frac{TAX}{A} - \frac{PLL}{A}\right]$$

Table 5: GMM First-Stage Regressions for the Capital Choice: 100 Largest Banks

	Dependent variable: equity-asset ratio
Change in equity-to-asset ratio (lagged)	-0.049
	(0.16)
Change in equity-to-asset ratio (lagged)*initial equity-to-asset ratio	-0.004
	(0.02)
Interest expense ratio	-0.63***
	(0.15)
Interest expense ratio*initial equity-to-asset ratio	0.113***
	(0.04)
Noninterest expense ratio	-0.78***
	(0.16)
Noninterest expense ratio*initial equity-to-asset ratio	0.107***
	(0.02)
Ratio of nonperforming loans to assets	-0.000679
	(0.00095)
Nonperforming loans ratio*initial equity-to-asset ratio	0.0009***
	(0.0002)
Logarithm of assets	-0.227**
	(0.00095)
Constant	7.05***
	(1.87)
Observations	388
R-squared	0.851
Adjusted R-squared	0.8363

The table shows the first stage GMM regression for the equity-asset ratio. In addition to the variables listed above, country and year dummies are included. Heteroskedasticity-and autocorrelation-consistent standard errors are shown in parentheses, and significances of 1 (***), 5 (**), and 10 (*) percent are indicated.

Table 6: GMM Second-Stage Regressions for the Loan Rate: 100 Largest Banks

	Dependent variable: interest income ratio
Equity-asset ratio	0.122***
	(0.0249)
Interest expense ratio	0.947***
	(0.0240)
Noninterest expense ratio	0.184***
	(0.0325)
Ratio of nonperforming loans to assets	0.000173
	(0.000304)
Logarithm of assets	-0.0434
	(0.0410)
Constant	1.417**
	(0.644)
Observations	388
R-squared	0.933
Adjusted R-squared	0.9274

The table shows the second stage GMM regression for the interest income-asset ratio. In addition to the variables listed above, country and year dummies are included, Heteroskedasticity- and autocorrelation- consistent standard errors are shown in parentheses, and signficances of 1 (***), 5 (**), and (*) percent are indicated.

Table 7: GMM First-Stage Regressions for the Capital Choice for Advanced Economies

	Dependent Variable: Equity to Asset Ratio											
	Countries which experienced a banking crisis in 2007-09						Other countries					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	U.S.	Germany	U.K.	Greece	Sweden	Switzerland	Canada	Czech Republic	Denmark	Ireland	Japan	Korea
Change in equity-to-asset ratio (lagged)	-0.393	0.863*	-0.766***	-0.0973	1.085**	-0.698***	-0.388***	0.0251	-1.228***	-0.922	0.230*	0.0893
	(0.252)	(0.487)	(0.244)	(0.181)	(0.466)	(0.186)	(0.071)	(0.321)	(0.432)	(0.891)	(0.122)	(0.429)
Change in equity-to-asset ratio (lagged)*initial equity-to-asset ratio	0.0279	-0.197***	0.0279*	0.00741	-0.101***	0.0236***	0.0293***	-0.0321	0.0928**	0.150	-0.00975	0.0252
	(0.025)	(0.061)	(0.015)	(0.008)	(0.025)	(0.008)	(0.004)	(0.034)	(0.036)	(0.096)	(0.008)	(0.055)
Interest expense ratio	-2.658***	-1.032***	-1.625***	-0.845	-0.537	-3.141***	-1.608***	-2.327***	-2.312***	-1.031*	-0.671	0.989
	(0.472)	(0.305)	(0.234)	(0.548)	(0.432)	(0.599)	(0.426)	(0.536)	(0.434)	(0.568)	(3.197)	(0.597)
Interest expense ratio*initial equity-to-asset ratio	0.235***	0.214***	0.192***	0.142	0.0910*	0.234***	0.271***	0.296***	0.242***	0.271***	0.0983	-0.114
	(0.043)	(0.047)	(0.015)	(0.085)	(0.047)	(0.053)	(0.027)	(0.045)	(0.053)	(0.056)	(0.607)	(0.104)
Noninterest expense ratio	-0.669***	-0.373	-1.056**	-2.144*	-2.107***	-0.625**	-0.0943	-0.187	-1.378***	0.163	-0.226	-2.321**
	(0.172)	(0.601)	(0.41)	(1.12)	(0.493)	(0.303)	(0.176)	(0.519)	(0.158)	(0.484)	(0.216)	(0.995)
Noninterest expense ratio*initial equity-to-asset ratio	0.0488***	0.0956	0.0809**	0.152	0.324***	0.0576***	0.0184**	0.0173	0.113***	-0.0399	0.0526	0.465**
	(0.012)	(0.129)	(0.032)	(0.092)	(0.062)	(0.012)	(0.007)	(0.04)	(0.021)	(0.073)	(0.069)	(0.181)
Ratio of nonperforming loans to assets	0.00190	0.000535	-0.000608	0.00301	0.00148	-0.00464***	-0.00169	-0.00184	-0.000301	-0.000583	-0.00546***	-0.00742
	(0.002)	(0.001)	(0.001)	(0.002)	(0.005)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.006)
Nonperforming loans ratio*initial equity-to-asset ratio	-0.000161	-0.0000932	0.000116	-0.000177	0.000422	0.000373***	0.000654*	0.000747***	-0.000000957	0.00161	0.000444	-0.0000864
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Logarithm of assets	0.0608	-0.0721	-0.560***	0.00818	-0.171	-0.122	-0.394***	0.0835	-0.240**	-0.0619	-0.159*	0.187**
	(0.051)	(0.162)	(0.121)	(0.415)	(0.23)	(0.125)	(0.074)	(0.152)	(0.113)	(0.327)	(0.092)	(0.09)
Dummy for large banks	-0.0418											
	(0.324)											
Constant	10.33***	5.668*	14.70***	9.287	8.014*	12.34***	9.138***	7.683***	11.51***	3.642	7.993***	2.367
	(0.701)	(2.808)	(2.228)	(5.882)	(3.9)	(1.806)	(1.271)	(2.057)	(1.468)	(4.708)	(1.206)	(1.322)
Observations	631	43	185	35	28	382	208	58	92	25	797	70
R-squared	0.617	0.908	0.828	0.790	0.983	0.824	0.903	0.955	0.943	0.878	0.599	0.707
Adjusted R-squared	0.6069	0.8565	0.8133	0.6754	0.9691	0.8172	0.8957	0.9396	0.9315	0.7551	0.5908	0.6262

The table shows the first stage GMM regression for the equity-asset ratio. In addition to the variables listed above, year dummies are included. Heteroskedasticiy- and autocorrelation- consistent standard errors are shown in parentheses, and significances of 1 (***), 5(**), and 10 (*) percent are indicated.

Table 8: GMM Second-Stage Regressions for the Loan Rate for Advanced Economies

	Dependent Variable: Interest Income to Assets Ratio											
	Countries which experienced a banking crisis in 2007-09						Other countries					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	U.S.	Germany	U.K.	Greece	Sweden	Switzerland	Canada	Czech Republic	Denmark	Ireland	Japan	Korea
Equity-asset ratio	0.131***	0.116***	0.0637***	0.0805**	0.0201***	0.00970**	0.00320	0.105***	0.191***	0.216***	0.261***	0.0550
	(0.0322)	(0.0122)	(0.0144)	(0.0394)	(0.00777)	(0.00399)	(0.0259)	(0.0322)	(0.0552)	(0.0443)	(0.0740)	(0.0397)
Interest expense ratio	1.213***	1.278***	1.210***	0.895***	0.828***	0.954***	0.999***	0.800***	0.527***	0.944***	0.833***	0.906***
	(0.105)	(0.0465)	(0.122)	(0.0734)	(0.0384)	(0.0551)	(0.145)	(0.128)	(0.140)	(0.138)	(0.248)	(0.0981)
Noninterest expense ratio	0.439***	0.525***	0.350***	0.243*	0.181***	0.00449	0.142***	0.592***	0.0457	0.0480	0.131	0.757***
	(0.0267)	(0.0872)	(0.0944)	(0.142)	(0.0563)	(0.0158)	(0.0291)	(0.181)	(0.153)	(0.0331)	(0.108)	(0.0809)
Ratio of nonperforming loans to assets	-0.000567	0.000262	-0.0000872	0.000144	0.000935	0.000316**	-0.000885	0.000190	0.00135**	0.000381	0.00190***	-0.00302
	(0.000624)	(0.000226)	(0.0000732)	(0.000441)	(0.000791)	(0.000142)	(0.000618)	(0.000728)	(0.000673)	(0.000343)	(0.000603)	(0.00199)
Logarithm of assets	-0.172***	0.0188	0.0308	0.342***	-0.194***	-0.0454	-0.0538	0.220*	-0.0504	0.169**	-0.0587	-0.0581
	(0.0231)	(0.0248)	(0.0395)	(0.0713)	(0.0196)	(0.0294)	(0.0395)	(0.118)	(0.0785)	(0.0856)	(0.0452)	(0.0383)
year1	-0.434*	-0.0307	-0.0131	0.676***	0.329***	0.150	0.0281	-0.0614	-0.481**	0.665**	0.145	0.433
	(0.223)	(0.0949)	(0.492)	(0.231)	(0.0756)	(0.171)	(0.241)	(0.195)	(0.224)	(0.285)	(0.0906)	(0.266)
year2	-0.539**	-0.0956	-0.136	0.506***	0.375***	0.246	0.0873	0.163	-0.170	0.835*	0.0643	0.403
	(0.230)	(0.0954)	(0.556)	(0.0965)	(0.0732)	(0.167)	(0.255)	(0.199)	(0.200)	(0.430)	(0.109)	(0.286)
year3	-0.768***	0.0205	-0.282	0.425***	0.675***	0.169	0.0906	0.352	0.227	1.122**	0.311**	0.322
	(0.191)	(0.0815)	(0.554)	(0.158)	(0.105)	(0.156)	(0.240)	(0.239)	(0.303)	(0.515)	(0.149)	(0.271)
year4	-0.879***	0.139	0.0751			0.0433	0.120	0.0961	-0.591**		0.507***	-0.0537
	(0.239)	(0.0906)	(0.405)			(0.155)	(0.318)	(0.335)	(0.260)		(0.188)	(0.259)
year5	-0.0723	0.162*	0.0175			0.0800	-0.0573	-0.262	-0.439*		0.157**	0.521**
	(0.110)	(0.0968)	(0.404)			(0.167)	(0.204)	(0.179)	(0.242)		(0.0733)	(0.264)
year6	0.0398	0.0423	-0.0315			0.146	-0.00544	-0.0847	-0.285**		0.0653	0.371
	(0.0938)	(0.0890)	(0.294)			(0.186)	(0.175)	(0.153)	(0.140)		(0.0577)	(0.237)
Constant	1.733***	-1.243**	-0.248	-2.318**	3.030***	1.611***	1.884***	-1.480	2.431	-2.431**	-0.159	1.379**
	(0.446)	(0.494)	(0.547)	(0.932)	(0.378)	(0.346)	(0.669)	(1.144)	(1.482)	(1.105)	(0.831)	(0.665)
Observations	631	43	185	35	28	382	208	58	92	25	797	70
R-squared	0.807	0.970	0.794	0.898	0.971	0.675	0.623	0.766	0.569	0.906	0.456	0.762
Adjusted R-squared	0.8038	0.9599	0.7813	0.8671	0.9581	0.6657	0.6015	0.7101	0.5092	0.8584	0.4480	0.7173

The table shows the first stage GMM regression for the equity-asset ratio. Heteroskedasticity- and autocorrelation-consistent standard errors are shown in parentheses, and significances of 1 (***), 5(**), and 10 (*) percent are indicated.

Table 9: Loan Demand Equations

	Dependent Variable: Loans												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Largest banks	Countries which experienced a banking crisis in 2007-09						Other countries					
		U.S.	Germany	U.K.	Greece	Sweden	Switzerland	Canada	Czech Republic	Denmark	Ireland	Japan	Korea
Real GDP	-1.41E-06	0.000702**	0.00143	0.0107**	-0.0322	0.00848***	-0.00612	0.0000754	-0.0000700	0.000413	0.0194	0.000000270	0.000000657
	(0.00000273)	(0.000340)	(0.00527)	(0.00490)	(0.0212)	(0.00262)	(0.00531)	(0.00273)	(0.000122)	(0.00257)	(0.0183)	(0.00000256)	(0.00000386)
CPI	0.0576457***	-0.0000645	-0.0700	0.00739	0.0276	0.0432	0.0593	0.0290	0.00541	0.0250	0.115	-0.00144	0.00795
	(0.0204355)	(0.0149)	(0.0892)	(0.0395)	(0.0198)	(0.0457)	(0.0624)	(0.0356)	(0.00555)	(0.0245)	(0.133)	(0.0855)	(0.0417)
Predicted loan rate	-0.2447607**	-0.0868**	-0.604**	-0.412***	0.162***	-0.737***	0.0910*	-0.130***	0.00972	-0.363***	-0.198*	-0.197***	-0.0107
	(0.1005815)	(0.0343)	(0.278)	(0.104)	(0.0308)	(0.215)	(0.0482)	(0.0239)	(0.00974)	(0.115)	(0.113)	(0.0621)	(0.143)
Constant	-0.3905656	-7.818***	7.767	-12.10***	1.729	-28.29**	-3.312	-2.377**	-0.347	-1.288	-14.00	0.713	-0.812
	(2.161236)	(1.852)	(7.472)	(3.387)	(2.180)	(10.94)	(4.006)	(1.124)	(0.258)	(1.715)	(12.87)	(7.727)	(1.608)
Observations	388	631	43	185	35	28	382	208	58	92	25	797	70
R-squared	0.3345	0.077	0.181	0.156	0.287	0.506	0.021	0.084	0.096	0.239	0.127	0.024	0.029

Country dummies are included in the column (1) regression for the largest banks. Robust standard errors are shown in parentheses, and significances of 1 (***), 5 (**), and 10 (*) percent are indicated.

Table 10a: Impact of a 1.3 Percentage Point Increase in the Equity-Asset Ratio on Loans Based on Regressions for 2001–09

	Impact on loan rate [1/]	Net Cost of Raising Equity [2/]	Elasticity of Loan Demand [3/]	Percentage change in loans [4/]
Crisis countries				
Germany	0.15	0.12	-1.83	-7.16
Sweden	0.03	0.02	-5.90	-3.72
U.K.	0.08	0.06	-2.57	-4.35
U.S.	0.17	0.13	-0.92	-2.97
Average	0.11	0.08	-2.80	-4.55
Other countries				
Canada	0.00	0.00	-1.67	-0.16
Denmark	0.25	0.19	-6.61	-32.61
Ireland	0.28	0.22	-1.00	-6.46
Japan	0.34	0.26	-1.11	-19.81
Average	0.22	0.17	-2.60	-14.76
Largest banks	0.16	0.12	-0.33	-1.28

Source: Authors' calculations.

1/ Based on estimates reported in Tables 6 and 8.
2/ Impact on loan rate times the change in asset to equity ratio.
3/ The elasticity of loan demand for each country/largest banks is calculated by multiplying the estimated coeficient for the loan rate reported in Table 9 by the average loan rate divided by average level of loans in the sample.
4/ This is calculated as the product of the percentage increase in the loan rate times the elasticity of loan demand with respect to changes in the loan rate.

Table 10b: Impact of a 1.3 Percentage Point Increase in the Equity-Asset Ratio on Loans Based on Regressions for 2001–07

	Impact on loan rate	Net Cost of Raising Equity [1/]	Elasticity of Loan Demand [2/]	Percentage change in loans [3/]
Crisis countries				
Germany	0.14	0.11	-2.13	-7.73
U.K.	0.06	0.05	-2.22	-2.75
U.S.	0.20	0.15	-0.67	-2.48
Average	0.13	0.10	-1.67	-4.32
Other countries				
Denmark	0.21	0.16	-9.73	-40.49
Canada	0.03	0.02	-1.44	-0.98
Japan	0.21	0.16	-1.11	-12.42
Average	0.15	0.12	-4.09	-17.96
Largest banks	0.15	0.11	-0.42	-1.55

Source: Authors' calculations.

1/ Impact on loan rate times the change in asset to equity ratio.

2/ The elasticity of loan demand for each country/largest banks is calculated by multiplying the estimated coeficient for the impact of the predicted loan rate from the second-stage GMM regression on loan demand by the average loan rate divided by average level of loans in the sample.

3/ This is calculated as the product of the percentage increase in the loan rate times the elasticity of loan demand with respect to changes in the loan rate.

Table 11: Comparison of Capital Adequacy Ratios Across Selected Studies

	Number of banks	CET1 Basel III	Tier 1 Old	Total Old
Group 1 BIS (2010d)	74	5.7	10.5	14
Group 1 CEBS (2010)	33	4.9	10.3	15
Largest banks [1/]	94	5.7	10.3	13.7

Group 1 banks are those that have Tier 1 capital in excess of 3 billion euros, are well diversified, and are internationally active.
CET1-Common Equity Tier 1: net CET (with deductions) relative to new risk-weighted assets

1/Equity to total assets reported for CET1.

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