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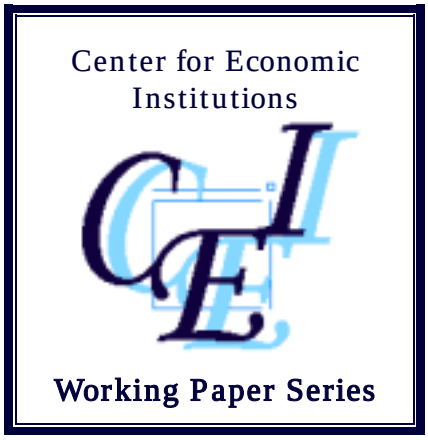

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The Effect of the Basel Accord on Bank Lending in Japan

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Abstract

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This study investigates the hypothesis that stricter capital adequacy requirements introduced under the 1988 Basel Accord caused Japanese banks to restrict loan growth.

Using a panel of Japanese bank balance sheets for fiscal years 1982–1999, this study finds that the 1988 Basel Accord regulation requiring international banks to hold a BIS (Bank for International Settlements) capital to risk-weighted asset ratio of at least 8% increased the sensitivity of total loan growth to capitalization for international banks in Japan.

A similar, but quantitatively smaller, finding is reported for a group of "switcher" banks that initially pursued the 8% BIS capital adequacy requirement following the signing of the Basel Accord in 1988, but then later switched to pursue a domestic 4% MOF (Ministry of Finance) capital adequacy requirement.

Domestic banks, which were subject to the 4% MOF capital adequacy requirement for the entire post-Basel period, show no evidence of increased sensitivity of lending to capitalization in the post-Basel period.

Journal of Economic Literature Classification Codes: G21, G28, C23, E51
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1 Introduction

The capital positions of Japanese banks have been under pressure from several factors throughout the 1990s and pressure on banks to raise capital to asset ratios has been cited as a cause of the reduction in aggregate lending in the 1990s. Many observers point specifically to the Basel Accord on risk-based capital which mandated that by March 1993 international banks hold capital of at least 8% of risk-weighted assets[1].

Fears of a "capital crunch" - a reduction in bank lending in response to stricter regulations on bank capital - brought on by the BIS (Bank of International Settlements) capital adequacy standards first began to surface in Japan in the early 1990s. Bank of Japan officials responded to criticism of slow monetary growth rates by pointing to restrictive bank lending policies and faulted pressure to meet capital-adequacy ratios rather than BOJ policy for sluggish growth.[2] The following April, Nissho Iwai Corporation Chairman and future Bank of Japan Governor Masaru Hayami, citing fears of a credit crunch, called for a suspension of BIS capital adequacy requirements.[3] Recent sluggish growth in bank credit and other macroeconomic aggregates has revived interest in the relationship between regulatory capital and lending in Japan.

This study investigates the effect of the 1988 Basel Accord on Japanese bank portfolios. The paper is organized as follows. Section 2 briefly explains the Basel Accord requirements and how this regulatory shift might influence bank managers portfolio decisions. Section 3 reviews the existing literature on the effects of risk-based capital-asset ratios on lending and highlights how this study contributes to the debate. Section 4 provides a theoretical framework showing that a change in regulatory regime toward stricter enforcement of capital adequacy requirements will affect bank loan growth. Section 5 outlines a strategy for empirically testing the implications of the model and section 6 presents the empirical results. Section 7 summarizes the findings and concludes.

2 The Basel Accord of 1988

The Basel Committee on Banking Supervision, originally comprised of representatives of the central banks and supervisory authorities of the G-10 countries (Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, United Kingdom, United States) and Luxembourg, was formed to secure international convergence of supervisory regulations on capital adequacy[4]. The Basel Committee is under the aegis of the Bank for International Settlements, but has no formal authority. The agreement is carried out on a voluntary basis by signatory countries, which now number over 100.

Calls to standardize capital adequacy regulations were prompted in large part by the aggressive expansion of Japanese banks in the 1980s. Prior to the Basel Accord, a comparatively lenient regu-

[1] See, for example The Economist (1992a), The Economist (1992b).
[2] Brauchli (1991)
[3] Chandler (1992)
[4] Wagster (1996)

lation requiring all banks to maintain capital of at least 4% of deposits had been enforced in Japan by the Ministry of Finance. There were complaints from the international banking community that this regulatory leniency gave Japanese banks an unfair advantage in gaining market share.

Although the Basel Accord was agreed upon in principle in 1988, banks in Japan were given a 5 year transition period in which to adjust to the new standards before the Accord was written into domestic law and became binding in fiscal year 1992. The agreement requires internationally active banks to maintain a BIS (Bank for International Settlements) ratio of capital to risk weighted assets of at least 8%. Japanese regulators allowed Japanese banks with purely domestic business the option of maintaining a MOF (Ministry of Finance) ratio of capital to assets of at least 4%[5].

Under the Basel Accord, capital is defined as Tier I or "core" capital and Tier II capital, which is limited to the value of core capital. Core capital consists primarily of shareholders' equity and disclosed reserves, with some adjustments made for consolidated subsidiaries, dividends and bonus payments. Tier II capital includes "near capital", the definition of which is to some extent left up to the domestic regulatory agency. Banks are allowed to count general loan loss reserves (limited to 1.25% of risk-weighted assets), dated subordinated debt[6] and dated preferred stock toward Tier II capital. In Japan, banks are also allowed to count up to 45% of unrealized capital gains[7], the difference between the market value and book value of security holdings, and up to 45% of any land revaluation[8] toward Tier II capital.

On the asset side, there are currently four categories of risk for classifying assets. Risky assets such as loans receive a 100% weighting while safe assets such as government bonds receive a 0% weighting. Secured loans fall in between with a 50% weighting.

Table 1 Here

Table 1[9] identifies the number of banks subject to the 4% MOF and 8% BIS capital adequacy ratio, as well as the number of banks that succeeded in meeting each standard in the years following the signing of the Basel Accord. Domestic banks in Japan are required to maintain at least a 4% MOF capital adequacy ratio, but domestic banks may choose to pursue the 8% BIS capital adequacy ratio. Several banks seem to have struggled to meet the 8% or 4% standard in the years between

[5]Capital for the MOF ratio is calculated slightly differently than in the BIS ratio. The MOF ratio does not include short term subordinated debt as Tier 3 capital and latent capital gains are not included in Tier 2 capital.

[6]Subordinated debt dated at more that 5 years counts toward Tier II capital. Recently, a third category of capital including short-term subordinated debt (between 2-5 years) has been added.

[7]Until the introduction of mark-to-market accounting for investment account securities in fiscal year 2001, banks in Japan have been able to choose between the book value or fair value (the lower of book or market) method for recording the value of investment account equity holdings on thier balance sheets. Banks that chose the fair value method were able to count 45% of the unrealized gains on these equities toward Tier II capital. Prior to the Basel Accord, Japanese banks had been allowed to count up to 70% of these latent capital gains as capital under domestic law.

[8]Land revaluations have only been included in Tier II captial since fiscal year 1998.

[9]Table 1 does not include failed or nationalized banks, so the total number of banks falls in years in which there was a bank failure. See appendix A for a list of bank failures.

1988, when the Basel Accord was reached, and 1992, when the requirement became effective. After 1992, with the exception of one bank which was nationalized[10], all "international" banks met the 8% requirement. Note however, that many banks switched from pursuing the 8% standard to the 4% standard. The number of banks aiming for 8% remained constant at around 85 for the first half of the sample, but by 1997 the number had fallen to 44, and in the most recent fiscal year only 25 banks were still pursing the 8% BIS standard. Appendix A provides a list of the banks that switched from pursuing the 8% BIS ratio to the 4% MOF ratio in each year.

A bank needing to raise its capital ratio in order to meet the 8% requirement faces the following options. The BIS ratio can be boosted through capital, the numerator, by issuing subordinated debt, preferred stock or (only slightly) by increasing loan loss reserves. Alternatively, the denominator, risk-weighted assets, can be reduced by reducing heavily-weighted assets such as loans or equity holdings and substituting with unweighted, riskless assets such as government bonds. This paper investigates whether this incentive to shift away from heavily risk weighted assets in order to reduce risk weighted assets and boost capital to asset ratios may have resulted in a "capital crunch", reducing the supply of bank loans.

3 Literature Review

The question of how risk-based capital ratios effect bank portfolio decisions, especially lending, attracted the interest of researchers of the U.S. banking industry in the early 1990s and several studies confirm the capital crunch hypothesis that a reduction in loans was brought on by the BIS capital standards[11].

Evidence on the existence of a credit crunch in Japan has been mixed. Peek and Rosengren (1997) find evidence that capital constraints brought on by the decline in the Japanese stock market was associated with a decrease in lending by Japanese banks in the United States. However, other studies looking at domestic lending in Japan have actually uncovered evidence of the reverse behavior: that relatively poorly capitalized banks tend to lend relatively more. For example, a study by Horiuchi and Shimizu (1998) looking at the "top 20" Japanese banks[12] for the period 1990–1995 finds a negative statistical relationship between capitalization and loan growth. The authors conclude that the recapitalization via subordinated debt issues produced a conservative lending attitude by banks. Work by Woo (1999) also finds evidence of a perverse statistical relationship between capitalization and loan growth for Japanese banks. Using aggregate loan quantities for 79 banks, Woo finds evidence of a credit crunch in 1997, but no evidence throughout most of the 1990s. In fact he finds evidence that until recently banks with weak capital positions tended to

[10]Nippon Credit, which had never had overseas branches but had voluntarily aimed to meet the 8% capital adequacy standard, failed to meet the 8% standard in fiscal year 1996. In fiscal year 1997 Nippon Credit switched to the 4% benchmark. The bank was later nationalized in January of 1999.

[11]See Peek and Rosengren (1995a), Peek and Rosengren (1995b), Brinkmann and Horvitz (1995), Hall (1993) and Haubrich and Wachtel (1993).

[12]At that time there were actually 21 top banks: 11 city banks, 7 trust banks and 3 long-term credit banks.

extend loans at a *faster* rate than banks with strong capital positions. Ito and Sasaki (1998) find evidence of a capital crunch, but only for 14 of the 87 banks in their sample. In addition, the authors find it necessary to exclude lending to the real estate, construction and financial industries in their measure of loan growth in order to avoid finding the reverse statistical relationship[13].

This study improves upon previous research on this topic in several ways. First, a longer time-series of data allows us to address the question of whether the observed statistical relationships are actually a response to the change in regulatory standards. A study of only the post-Basel period cannot really address the question of what effect the Accord had on bank lending. Even when evidence that capital adequacy ratios are significantly related to loan growth is uncovered, the question of whether or not this behavior is specific to the post-Basel period remains. It is plausible that banks which are growing loans faster might consistently maintain a larger capital cushion and that the observed statistical relationship is not attributable to the Basel Accord constraints. Rather than simply estimating the statistical relationship between capitalization and loan growth for a sub-sample of years after the new capital requirements were agreed upon, this study analyzes at a long time span of data beginning before the Basel Accord was reached and looks for changes in bank behavior in response to the regulatory change.

Another advantage of the richer data set is that it allows for panel data analysis incorporating time fixed effects. Many of the studies mentioned above rely upon cross-sectional analysis, which fails to account for macroeconomic or loan demand shocks in any given year. In this study, time fixed effects are included in the econometric specification in order to account fully for macroeconomic shocks in any given period that may affect loan growth for reasons other than the supply factors included in the model

The time series element of the data set is also exploited to use 2-stage least squares estimation with lagged instrumental variables, which ensures that the error term in the estimating equation is orthogonal to the dependent right-hand side variables.

Use of a longer time series of data means that is it not possible to use the actual BIS capital adequacy ratio in the empirical analysis. The BIS ratio has only been reported since the Basel Accord was signed in fiscal year 1988. As stated above, the intention of this study is to examine changes in bank behavior after introduction of the new capital adequacy standards, requiring a sample of data from the pre-Basel Accord regime. Thus, this study uses a constructed capital ratio of shareholders equity to loans, which is available for the pre-Basel Accord period as well. This capital ratio approximates the banks "core" or tier I capital ratio, which is primarily shareholders equity. Use of this constructed capital ratio has several advantages. Tier II capital for Japanese banks includes subordinated debt, which has often been purchased by the Japanese government in order to boost the capital positions of troubled banks. Thus, prudent behavior on the part of troubled banks, cutting back on highly risk weighted assets such as loans, could actually yield the opposite statistical relationship between loan growth and capitalization if researchers use the standard measure of total (Tier I and Tier II) capital in their empirical analysis. This point is

[13]Ito and Sasaki (1998) page 27.

discussed in more detail in section 5, which describes some of the other advantages of this measure of capital as well.

Another improvement in this study is the selection of banks to be included in the empirical analysis. As will be discussed further in section 5, domestic and international banks in Japan face different capital constraints and different incentives to meet those constraints. Not all of the "Top 20" largest banks are international banks pursuing an 8% BIS capital adequacy ratio, and there are several "regional" banks with overseas offices, engaged in international lending, that are constrained by the 8% BIS requirement. Since domestic banks are subject to lower capital adequacy requirements and more lenient regulation in meeting those standards, failure to carefully account for these differences could easily lead to the incorrect conclusion that the behavior of all Japanese banks is unaffected by capital ratios.

With this improved data set, including the constructed capital ratios, and having carefully classified the banks included in the sample being estimated, this study reveals that the relationship between capital ratios and bank credit in the post-Basel Accord period since 1988 is very different for international and domestic banks.

4 Model of Representative Bank Behavior

This section presents a rational expectations model of bank behavior in which a representative bank maximizes the present discounted value of future profits. In this simplified model, the bank earns revenue on loans net of the costs of obtaining funds in the form of deposits. It is assumed that the bank views itself as a price taker, so interest rates earned on loans or paid on deposits are exogenously given at the prevailing market rate. The bank also earns a benefit for maintaining a high ratio of capital to assets relative to some target level. This benefit may depend upon the regulatory state. The banks' capital stock at time t is assumed to be exogenously given in each time period, so banks wishing to adjust their capital to asset ratio do so through loans. However, banks face adjustment costs on any changes to the rate of loan growth.

A Taylor series approximation of the capitalization term yields an intercept term and a slope term, implying that banks react to a regulatory change by adjusting the level of the target capital ratio and/or the sensitivity of loan growth to capitalization. Other operating costs are assumed proportional to total loans and are absorbed in the loan adjustment costs term.

Taking these revenues and costs into account, a representative bank chooses loans so as to maximize the expected present discounted value of its future stream of profits. This dynamic maximization yields an Euler equation for loan growth in terms of lagged loan growth, interest rates, capitalization and the regulatory state, which will later be empirically estimated.

4.1 Revenues

Let a simplified bank balance sheet in which loans are the only asset and deposits the only liability[14], be represented by the following:

ASSETS	LIABILITIES
L	D
	K

where L = Loans, D = Deposits, and K = Capital (Shareholders' Equity), and shareholders' equity is calculated according to the accounting identity $L - D = K$. Capital, K, and the interest rates on loans, r^L, and deposits, r^D, are assumed to be exogenously given in each time period t.[15] The revenue of an individual bank at any given point in time is determined by the gross return on loans minus the amount paid for deposits.

$$R_t = r_t^L L_t - r_t^D D_t \tag{1}$$

or, substituting in the short run capital constraint:

$$R_t = (r_t^L - r_t^D) L_t + r_t^D K_t \tag{2}$$

4.2 Costs

There is some benefit, B_t, to high capitalization (a high capital to loan ratio), which depends upon the (discrete) regulatory state θ.

$$\theta = \begin{cases} 0 \\ 1 \end{cases} .$$

This benefit may come in the form of decreased regulatory scrutiny, reputational benefits for existing equity holders, or simply the benefit of being able to make decisions on loan supply independent of capital constraints once the required capital ratio is cleared.

$$B_t = K_t h_\theta \left(\frac{K_t}{L_t} \right) \tag{3}$$

[14]This simplification incorporates the major elements of the aggregate bank balance sheet: loans, deposits and shareholders' equity.

[15]The assumption that capital is exogenous is a short run simplifying assumption. Given the accounting identity, the assumption that capital is exogenously given in each time period amounts to an assumption that banks decide upon loans and then are able to obtain the necessary deposits to fund those loans at the prevailing market interest rate. Although there were fears of a flight to postal savings from bank deposits in response to the failure of several small credit cooperatives in the early 1990s, in 1995 the government announced a complete deposit guarantee through March 2001. Regarding exogenous interest rates: although banks' may in fact hold market power, it is assumed that they view themselves as price takers, and offer loans and deposits at prevailing market rates.

Although bank capital is assumed to be exogenously determined, banks can adjust the capital ratio, and therefore the costs or benefits associated with it, by adjusting loan growth However, there are some adjustment costs A_t associated with any change in loans[16]:

$$A_t = L_{t-1} f\left(\frac{L_t - L_{t-1}}{L_{t-1}}\right) \tag{4}$$

The source of these costs when banks are increasing the rate of loan growth may seem fairly intuitive: the costs of hiring new staff or seeking out new borrowers. However, there may also be significant costs to cutting back on loans, the phenomenon that was observed in response to the Basel Accord capital adequacy standards. These are costs associated with altering the time structure of the banks' portfolio, the increased risk of default when loans are called in early, or the costs of damage to a long-term business relationship when existing lines of credit are closed (loans are not rolled over).

As presented here, $h_\theta(\cdot)$ and $f(\cdot)$ are general, non-specified concave and convex functions, respectively.

As stated above, the bank views the stock of capital, K_t, and interest rates, r_t^L and r_t^D as exogenously given. Banks select loans at time t in order to maximize expected present discounted value π_t:

$$\max_{L_t} \pi_t = E_t \sum_{j=0}^{\infty} b^j \Bigg[\left(r_{t+j}^L - r_{t+j}^D\right) L_{t+j} + r_{t+j}^D K_{t+j} - L_{t+j-1} f\left(\frac{L_{t+j} - L_{t+j-1}}{L_{t+j-1}}\right) + K_{t+j} h_\theta\left(\frac{K_{t+j}}{L_{t+j}}\right) \Bigg] \tag{5}$$

where $0 < b < 1$ is the rate of discount.

Maximization with respect to L_t yields the Euler equation:

$$E_t \left[(r_{t+j}^L - r_{t+j}^D) + h_\theta'\left(\frac{K_{t+j}}{L_{t+j}}\right) - L_{t+j-1} f'\left(\frac{L_{t+j} - L_{t+j-1}}{L_{t+j-1}}\right) \right] = E_t \left[-b L_{t+j} f'\left(\frac{L_{t+j+1} - L_{t+j}}{L_{t+j}}\right) - b f\left(\frac{L_{t+j+1} - L_{t+j}}{L_{t+j}}\right) \right] \tag{6}$$

[16] As shown in section 2, many Japanese banks were below the 4% or 8% requirement when the Basel Accord was reached in late 1987. However, banks were able to adjust their balance sheets gradually over the 5 year transition period between 1988 and 1993, and by 1993 almost all were above the required BIS ratio. The fact that the banks adjusted slowly over the transition period rather than suddenly cutting leverage ratios when the accord was implemented in 1993 suggests that there are costs of adjustment associated with changes in loan growth. Empirical support for this observation is given by Hancock and Wilcox (1995), who report that while it takes banks only about a year to adjust securities in response to capital shocks, adjustments of most loan categories require two to three years.

If we let

$$-L_{t+j-1} f' \left(\frac{L_{t+j} - L_{t+j-1}}{L_{t+j-1}} \right) = \Psi(\Delta \log(L_{t+j})) \tag{7}$$

$$-bL_{t+j} f' \left(\frac{L_{t+j+1} - L_{t+j}}{L_{t+j}} \right) - bf \left(\frac{L_{t+j+1} - L_{t+j}}{L_{t+j}} \right) = \Upsilon(\Delta \log(L_{t+j+1})) \tag{8}$$

$$h'_\theta \left(\frac{K_{t+j}}{L_{t+j}} \right) = \Phi_\theta \left(\log \left(\frac{K_{t+j}}{L_{t+j}} \right) \right) \tag{9}$$

the Euler equation can be represented in the following log-linearized form:

$$E_t \left[\Delta \log(L_{t+j+1}) \right] = E_t \left[\beta_1 \Delta \log(L_{t+j}) + \beta_2 (r^L_{t+j} - r^D_{t+j}) + \beta_{3,\theta} + \beta_{4\theta} \log \left(\frac{K_{t+j}}{L_{t+j}} \right) \right] \tag{10}$$

Note that the constant term, $\beta_{3,\theta}$, and the coefficient on capitalization, $\beta_{4,\theta}$, may change depending upon the regulatory environment, θ.

5 Empirical Methodology and Data

The model presented in section 4 provides a framework for testing whether loan growth became more sensitive to capitalization after the Basel Accord of 1988. This section outlines the methodology and data used in empirically testing the implications of the model presented above.

Replacing conditional expectations in the log-linearized Euler equation 10 of section 4 with actual values yields an equation of the form:

$$\Delta \log(L_{i,t+1}) = \beta_1 \Delta \log(L_{i,t}) + \beta_2 (r^L_t - r^D_t) + \beta_{3,\theta} + \beta_{4,\theta} \log \left(\frac{K_{i,t}}{L_{i,t}} \right) + \varepsilon_{i,t+1} \tag{11}$$

$\varepsilon_{i,t+1}$ is a rational expectations error term, which is serially uncorrelated and orthogonal to information available at time t. The expectation conditional on time t information, I_t, is $E[\varepsilon_{i,t+1} \mid I_t] = 0$, suggesting that period t instruments are valid. However, to address concerns that the capital to asset ratio, $\frac{K_{i,t}}{L_{i,t}}$, may be correlated with the error term $\varepsilon_{i,t+1}$, equation 11 is estimated by 2-stage least squares using lagged instrumental variables.

Since the model presented here only incorporates loan supply, there may be omitted variables, such as macroeconomic events or loan demand conditions, that affect loan growth in each time period. Two empirical specifications are estimated to account for these omitted variables. In one specification, lagged GDP growth is included in the empirical specification as a "Z" variable[17] to account for macroeconomic conditions. However, since it is impossible to include an exhaustive

[17]Similar results were obtained when lagged growth in exchange rates or the Nikkei Index were included in the regression analysis.

list of "Z" variables that will adequately account for credit demand and macroeconomic conditions, an empirical specification including time fixed effects is also estimated. The estimation results of both empirical specifications are reported in section 6. In addition, the results of an estimation including individual fixed effects in addition to time fixed effects are reported in appendix B.

A panel of data from 131 Japanese banks' balance sheets and income statements for fiscal years 1982–1999 is used to estimate equation 11. As explained in section 2, international and domestic banks in Japan are held to different standards. Under the Basel Accord, an international bank, defined as any bank with an overseas branch office, is subject to an 8% BIS ratio requirement. In Japan, domestic banks are only required to maintain a 4% MOF ratio requirement, but they may self-select to pursue the 8% BIS ratio requirement. Initially, several purely domestic banks that did not have an overseas office and did not engage in international lending elected to report the BIS capital adequacy ratio and hold themselves to the 8% standard. However, all but two of these banks, Michinoku Bank and Iyo Bank, have since switched to pursuing the domestic 4% MOF ratio target. In addition, since 1988 several internationally active banks chose to close their international offices and switch from pursuing the 8% BIS ratio to the 4% MOF ratio. These regulatory differences likely affected how different types of Japanese banks respond to changes in their regulatory capital ratio.

These potential differences are allowed for in the estimation by separating the sample into three sub-samples: domestic banks, international banks and "switcher" banks. The three sub-samples are comprised of 47 "domestic" banks that have been aiming for a 4% MOF ratio continuously throughout the post-Basel Accord period, 25 "international" banks that have been aiming for an 8% BIS ratio continuously throughout the post-Basel Accord period, and 59 "switcher" banks that originally reported a BIS ratio but switched sometime in the post-Basel Accord period to reporting a domestic MOF ratio. 21 banks are excluded from the analysis due to nationalization, failure, or because they were established mid-sample. Appendix A presents a detailed list of the banks included in each group.

Mergers are accounted for by treating the merged bank as one entity for the entire sample period. For example, Tokyo-Mitsubishi bank is treated as one bank throughout the sample period, with the balance sheets of Tokyo Bank and Mitsubishi Bank being combined even in the years before the merger took place.

Balance sheet data is reported at book value and on a unconsolidated basis. In fiscal year 1997 many large banks began reporting on a consolidated basis and all banks are now required to do so, but unconsolidated data is used in order to construct a continuous time series.

Loans are the sum of domestic loans to all industries plus international loans and trust account loans as reported in the annual *yukashoken hokokusho* reports.

The measure of capital used in the empirical analysis is meant to approximate the Basel definition of Tier I capital. Since an exact measure of Tier I capital is not available prior to fiscal year 1988, the book value of each banks' net worth as reported in the annual *yukashoken hokokusho* is used. Tier I capital as defined in the Basel Accord is adjusted for minority interest in consolidated subsidiaries, but mostly consists of shareholders equity, as would be reported in the *yukashoken*

filing.

There are several advantages to using this measure of capital rather than the actual BIS capital ratio. The first is data availability. Actual BIS ratios and measures of Tier I and Tier II capital are only available from 1988 and it is of interest to know how bank behavior may have changed after the introduction of new regulations stemming from the Basel Accord rather than to simply look at the empirical relationship between loans and capital ratios after the Accord was signed.

Secondly, this measure of capital is advantageous because it does not include subordinated debt issues. In recent years, the Japanese government has made direct purchases of subordinated debt as way in recapitalizing the troubled banking sector. These capital injections, initiated in March of 1998, 1999 and 2000 amounted to over 8 trillion yen, or approximately 80 billion dollars. Even prior to these overt policy actions, the Ministry of Finance often arranged subordinated debt purchases for troubled banks. Non-bank finance companies or insurance companies affiliated with large banks were pressured by the Ministry of Finance to purchase subordinated debt issues in order to help troubled banks meet the 8% BIS ratio required under the Basel Accord. Thus, measures of capital including subordinated debt are likely to be negatively correlated with the banks "core" capital measure. As pointed out indirectly by Horiuchi and Shimizu (1998), the findings of moral hazard behavior in previous studies of the relationship between bank capital and lending in Japan may be due to the fact that the measure of capital used in these studies includes Tier II capital, and therefore subordinated debt issues. Even if capital constrained banks in Japan react by cutting back on loans in order to boost BIS ratios, the fact that the government regularly intervenes by supplying Tier II capital to weak banks at the close of the fiscal year could yield the opposite statistical relationship if the measure of capital used includes subordinated debt issues.

In all the data series, log changes are used to approximate growth rates, as discussed in Section 4. GDP and the average interest rate on loans and deposits are aggregated up to annual averages from the monthly statistics reported by the research and statistics department of the Bank of Japan.

6 Empirical Results

Table 2 Here

Table 2 reports the results of an estimation of equation 11, including lagged GDP growth as a "Z" variable to account for macroeconomic conditions. For all three bank groups - international, domestic and "switcher" - the parameter estimate on lagged loan growth is statistically significantly positive at the 5% level and less than 1 as would be expected. Parameter estimates for GDP loan growth and the interest rate spread are also positive, as would be expected for a loan supply equation, and statistically significant at the 5% level. The parameter estimate on the capital to asset ratio is not statistically significantly different from zero in the pre-Basel period for international banks. For the domestic and switcher banks, the coefficient on the capital to asset ratio in the pre-Basel period is actually *negative*, suggesting that less well capitalized banks may have grown loans relatively faster.

Turning to the post-Basel period, the "Basel" dummy variable is negative and statistically significant at the 5% level for all the bank groups, indicating that banks of all types have reduced loan growth in the post-Basel period since FY 1988. Quantitatively, this coefficient is largest for the international banks, followed by the "switcher" banks and domestic banks.

Finally, the parameters of most interest, the coefficient estimates for capital to asset ratios in the post-Basel period, are positive and statistically significant for all three bank groups. This indicates that the sensitivity of lending to capital to asset ratios changed significantly for all three types of banks in the post-Basel period.

However, closer inspection of the coefficient estimates reveals some important differences in the behavior of the three bank groups. For domestic and "switcher" banks, the positive coefficient estimates on capital ratios in the post-Basel period are not very large relative to the negative coefficient estimates on capital ratios in the pre-Basel period. This means that the net effect of capital ratios on loan growth may be negligible for banks in these groups.

For the "switcher" banks, a dummy term is included for the period after the switch year when each bank switched from pursuing the 8% BIS capital adequacy requirement to pursuing the domestic 4% MOF requirement. This switch year dummy is also interacted with the capital to asset ratio. Neither coefficient estimate is statistically significantly different from zero, suggesting that the switch from pursuing the 8% BIS ratio to pursuing the 4% MOF ratio did not significantly affect the sensitivity of lending to capitalization for these banks. In this empirical specification the switcher banks do not appear to have acted very differently from domestic banks to begin with - as stated above lending by both domestic and switcher banks appears relatively insensitive to capitalization - so this is not surprising.

On the contrary, the coefficient estimate on capital ratios in the post-Basel period for international banks is large, and the coefficient estimate on pre-Basel capital ratios was not significantly different from zero to start with.

Overall, we may conclude that although all bank groups were affected by the regulatory change, the net effect was much larger for international banks in Japan. This result is consistent with the observation that required capital ratios were higher for international banks than domestic banks in the post-Basel period[18]. In addition, capital requirements for international banks were likely more strictly enforced by regulatory authorities and international banks may have had stronger individual incentives to meet the requirement.

Table 3 Here

Table 3 presents the results of a specification including time fixed effects[19]. The results reported in table 3 largely confirm the findings above. Similar to the results reported in table 2, the

[18]Prior to the Basel Accord, domestic banks and international banks in Japan faced the same domestic regulatory constraint of maintaining a 4% capital to deposit ratio.

[19]Since the interest rate spread only varies by time, not across banks, it is not included in this specification. Results of a specification including fixed time and individual effects, which are consistent with those reported here, are reported in table 8 in appendix B.

parameter estimate on lagged loan growth is statistically significantly positive at the 5% level and less than 1 for all three bank groups. Once macroeconomic factors are accounted for using fixed time effects, the coefficient estimates for the capital to asset ratios are not statistically significantly different from zero in the pre-Basel period for any of the bank groups.

For domestic banks, the coefficient estimates on capital to asset ratios in the post-Basel period are also not statistically significantly different from zero, indicating that the change in regulatory regime did not affect the sensitivity of loan growth to capitalization for domestic banks.

Loan growth for the "switcher" banks is sensitive to capitalization, as demonstrated by the positive and statistically significant coefficient estimate on capitalization in the post-Basel period for the "switcher" banks. However, as in the previous specification, the behavior of the "switcher" bank group does not seem to have changed once these banks switched from pursuing the 8% BIS capital adequacy ratio to pursuing the domestic 4% MOF capital adequacy ratio. This is illustrated by the statistically insignificant coefficient estimate on the capitalization - "switch year" interaction term.

For international banks, the coefficient estimate on capital to asset ratios in the post-Basel period are positive and statistically significant at the 5% level. In addition, the coefficient estimate on capitalization is quantitatively larger for the international banks, suggesting that the Basel Accord affected international banks pursuing an 8% BIS requirement more than eventual "switcher" banks pursuing the same goal. As reported above, the Accord appears not to have affected the lending behavior of domestic banks pursuing the 4% MOF ratio much at all.

Overall, the results of both empirical specifications indicate that lending in the post-Basel period is significantly linked to capitalization for international banks, but not for domestic banks. The positive parameter estimates on capital ratios in the post-Basel period for international banks indicate that relatively well capitalized banks tended to grow loans relatively quickly (or that less well capitalized banks tended to grow loans relatively slowly). Although there is evidence of a shift in behavior in the post-Basel period for "switcher" banks that originally opted to pursue the 8% BIS capital requirement as well, the shift seems to have been largest for international banks. The parameter estimate on capitalization in the post-Basel period is larger for the international banks that for the "switcher" banks, indicating that the effects of the regulatory change were bigger for the international banks. However, the coefficient estimate on capitalization in the post-Basel period is still quantitatively as well as statistically significant for both international and "switcher" bank groups. Capital ratios for Japanese banks varied between 2% to 11% over the sample period, so a parameter estimate of around 1 (0.8), as estimated for the international (switcher) bank group, indicates that capitalization has an economically significant effect on loan growth of these banks in the post-Basel period. On the contrary, coefficient estimates on capitalization for the domestic banks are found to be either statistically or quantitatively insignificant in both empirical specifications.

7 Conclusions

This paper provides evidence that the response to stricter capital adequacy ratios introduced under the Basel Accord of 1988 was different for international and domestic banks in Japan.

This study first provides an analytic framework for addressing this question that is consistent with observed behavior of Japanese banks. A rational expectations model of profit maximization incorporating adjustment costs to changes in loan growth provides a theoretical framework for empirically estimating the effect of regulatory changes brought on by the Basel Accord on bank lending. One empirical finding, that international bank lending is sensitive to capitalization, is consistent with previous studies on U.S. banks. These studies generally find that U.S. banks reduced loans in order to boost capital positions after stricter capital adequacy requirements were introduced under the Basel Accord. However the evidence presented on international banks in this study marks a departure from previous research on Japanese banks, which has generally failed to find evidence that loan growth is sensitive to capitalization.

This is the first study to explore the possibility of differential reactions to the regulation by domestic and international banks, and the findings of previous researchers may have been partially driven by the fact that analysis was conducted on a cross-section including both international and domestic banks. Other improvements in the analysis presented here include the long time-series of data under analysis and the measure of capital. Some of the existing studies examine only a sub-sample of data after adjustment to the new regulation had already taken place. The use of a longer time series of data including individual bank data from before and after the Basel Accord allows for a test for a change in the relationship between capitalization and bank credit after the regulatory change. In addition, the use of time series data allows for the estimation of a fixed time effects model, accounting for macroeconomic conditions that may have affected bank lending behavior, and the use of 2-stage least squares estimation using lagged instrumental variables, addressing concerns of endogeneity between capital ratios and shocks to loan growth. Finally, the measure of capitalization used in this study approximates the banks' "core" capital and does not include subordinated debt. Subordinated debt has been used as a means of providing "capital injections" to troubled banks, which may explain the finding in some earlier studies of a negative relationship between loan growth and capitalization for Japanese banks.

With the improvements identified above, convincing evidence is found that internationally active banks in Japan behaved similarly to banks in the United States in responding to the new capital requirements introduced under the Basel Accord of 1988. For international banks in Japan, the sensitivity of loan growth to capitalization has increased in response to stricter capital adequacy requirements introduced under the Basel Accord of 1988. A similar finding is reported for a groups of "switcher" banks that initially pursued the same 8% capital adequacy requirement as international banks, but then later switched to pursuing a domestic 4% MOF ratio. However, for domestic banks, which were consistently pursuing the 4% MOF capital adequacy ratio in the post-Basel period, there is no evidence of a shift in the sensitivity of lending to capitalization. These findings are consistent with the fact that the domestic MOF capital adequacy requirement

is less stringent than the international BIS capital adequacy requirement, therefore requiring less of a behavioral shift on the part of banks. In addition, the requirement for domestic banks is likely less rigorously enforced, as evidenced by differential timing of inspections and application of prompt corrective action legislation.

Tables and Figures

Table 1: Japanese Bank Capital Ratios

Year	No. Banks Aiming for 4% MOF	MOF Ratio <4%	MOF Ratio ≥4%	No. Banks Aiming for 8% BIS	BIS Ratio <8%	BIS Ratio ≥8%
1988	53	21	32	85	10	75
1989	53	16	37	85	18	67
1990	53	18	34	85	2	83
1991	53	11	42	85	4	81
1992	53	9	44	85	0	85
1993	53	9	44	85	0	85
1994	54	6	48	84	0	84
1995	55	6	49	83	0	83
1996	58	7	51	79	0	79
1997	94	0	94	44	0	44
1998	102	2	100	36	0	36
1999	106			25	0	26

Table 2: Instrumental Variables Estimation of Equation 11

Dependent variable: $\triangle L_{i,t+1}/L_{i,t}$			
Sample:	International	Domestic	"Switcher"
Observations:	449	845	1060
$\frac{\triangle L_{i,t}}{L_{i,t-1}}$	0.465*	0.179*	0.348*
	(0.050)	(0.039)	(0.034)
$\frac{\triangle GDP_t}{GDP_{t-1}}$	0.221	0.451*	0.239*
	(0.150)	(0.113)	(0.111)
$r^L_{t-1} - r^D_{t-1}$	2.109*	2.532*	2.366*
	(0.641)	(0.505)	(0.492)
$\frac{K_{i,t-1}}{L_{i,t-1}}$	−0.601	−1.656*	−0.846*
	(0.338)	(0.350)	(0.278)
$Basel$	−7.607*	−4.844*	−5.120*
	(2.063)	(0.512)	(1.838)
$\frac{K_{i,t-1}}{L_{i,t-1}} \cdot Basel$	0.985*	1.653*	0.813*
	(0.420)	(0.411)	(0.371)
$\frac{K_{i,t-1}}{L_{i,t-1}} \cdot SwitchYR$			0.104
			(0.412)
$SwitchYR$			−1.242
			(2.454)
* Indicates significance at 5% level.			

Table 3: Instrumental Variables Estimation with Time Fixed Effects

Dependent variable: $\triangle L_{i,t+1}/L_{i,t}$			
Sample:	International	Domestic	"Switcher"
Observations:	449	845	1061
$\frac{\triangle L_{i,t}}{L_{i,t-1}}$	0.429*	0.147*	0.299*
	(0.044)	(0.037)	(0.033)
$\frac{K_{i,t-1}}{L_{i,t-1}}$	−0.460	−0.464	−0.520
	(0.295)	(0.388)	(0.292)
$\frac{K_{i,t-1}}{L_{i,t-1}} \cdot Basel$	1.260*	0.745	0.826*
	(0.354)	(0.434)	(0.340)
$\frac{K_{i,t-1}}{L_{i,t-1}} \cdot SwitchYR$			0.188
			(0.157)
*Indicates significance at the 5% level.			

Appendices

A Bank Groups

Table 4: International Banks - Total 25

Asahi (8)	Joyo (2)	Shiga (1)
Chiba (3)	Juroku (1)	Shizuoka (3)
Chugoku (2)	Michinoku (0)	Sumitomo (17)
Daiichi Kangyo (17)	Mitsubishi Trust (5)	Sumitomo Trust (5)
Fuji (17)	Nishi-Nippon (2)	Tokai (12)
Gunma (1)	Ogaki Kyoritsu (2)	Tokyo Mitsubishi (44)
Hachijuni (1)	Sakura (16)	Yamaguchi (4)
Industrial Bank of Japan (15)	San-in Godo (1)	
Iyo (0)	Sanwa (17)	

Table 4 provides a list of international banks included in the empirical analysis of section 6. An international banks is defined as a bank that reports the BIS capital adequacy ratio and has held to the 8% BIS capital adequacy ratio for the entire sample period under analysis: FY1982-FY1999. The number in parenthesis in table 4 indicates the number of international branches as of September 2000. International representative offices are not included in this total. Michinoku Bank and Iyo Bank have no branches outside Japan but have elected to report the BIS international capital adequacy ratio and pursue the 8% standard. Most of the "international" group file both consolidated and unconsolidated balance sheets. Exceptions are Iyo Bank, Michinoku Bank and Shiga Bank, which only file unconsolidated balance sheets.

Table 5 provides a list of domestic banks used in the empirical analysis of section 6. Domestic banks are defined as banks that report the MOF capital to asset ratio and are required to maintain a 4% MOF capital adequacy ratio. These banks by definition do not have offices outside of Japan. Most of the domestic banks only file unconsolidated balance sheets. The exception is Ibaraki Bank, which files both an unconsolidated and a consolidated balance sheet.

Table 6 provides a list of "switcher" banks, banks that first reported a BIS capital to asset ratio and were held to the 8% BIS capital adequacy ratio, and then switched sometime during the sample period to report the domestic MOF capital to asset ratio and be held to the MOF 4% capital adequacy ratio. These switcher banks are organized by the year in which they switched

Table 5: Domestic Banks - Total 47

Bank of Kansai	Kagawa	Shokusan
Bank of Kochi	Kanagawa	Shonai
Bank of Nagasaki	Kanto	Taiko
Chikuho	Kumamoto Family	Taisho
Chubu	Kyushu	Tajima
Daito	Minami-Nippon	Tochigi
First Bank of Toyama	Nagano	Tohoku
Fukuho	Nara	Tokushima
Fukuoka Chuo	Okinawa Kaiho	Tomato
Fukushima	Saga Kyoei	Tottori
Gifu	Saikyo	Towa
Higashi-Nippon	Sapporo	Toyama
Hiroshima-Sogo	Sendai	Tsukuba
Howa	Setouchi	Wakayama
Ibaraki	Shimane	Yamagata Shiawase
Ishikawa	Shizuoka Chuo	

Table 6: "Switcher" Banks - Total 59

FY 1995 (2)		
Hokkaido*	Bank of Osaka	
FY 1996 (3)		
Bank of Ikeda	Bank of Kinki	Bank of Senshu
FY 1997 (35)		
Aichi	Daisan	Musashino
Aomori	Ehime	Nanto
Akita	Fukui*	Nippon Trust
Ashikaga*	Higo	North Pacific
Awa	Hokuetsu	Oita
Bank of Iwate	Hokuriku*	Shikoku
Bank of Okinawa	Kagoshima	Shinwa
Bank of the Ryukyus	Keiyo	Shimizu
Bank of Saga	Kita-Nippon	Toho
Biwako	Kiyo*	Yamagata
Chiba Kogyo	Mie	Yamanashi Chuo
Chukyo	Miyazaki	
FY 1998 (10)		
77*	Fukuoka City*	Hyakujushi*
Bank of Kyoto*	Hiroshima*	Suruga
Bank of Nagoya*	Hokkoku*	
Bank of Yokohama*	Hyakugo*	
FY 1999 (8)		
Bank of Fukuoka*	Daiwa*	Tokyo Tomin*
Chuo Trust*	Eighteenth Bank*	Yasuda Trust*
Daishi*	Mitsui Trust*	
FY 2000 (1)		
Toyo Trust*		

Table 7: Excluded Banks - Total 21

Hokkaido Takushoku	Hanshin Bank	Monato Bank
Nippon Credit Bank	Hanwa Bank	Namihaya Bank
Aozora Bank	Hokuto Bank	Niigata-Chuo Bank
LTCB	Kofuku Bank	Sendai Bank
Shinsei Bank	Kokumin Bank	Tokuyo City Bank
Bank of Naniwa	Kyoto Kyoei Bank	Tokuyo Sowa Bank
Fukutoku Bank	Midori Bank	Yachiyo Bank

from pursuing the BIS 8% capital adequacy standard to pursuing the MOF 4% capital adequacy standard. An asterisk marks those banks that had international offices (that were subsequently closed) in the year prior to switching to the domestic MOF standard.

Table 7 lists those banks excluded from the analysis reported in section 6. The following banks are excluded from the analysis because they were closed or nationalized during the sample period between FY1982-FY1999. Hokkaido Takushoku Bank failed on October 17, 1997. The Nippon Credit Bank[20] was nationalized on December 13, 1998 and in January 2001 reopened as Aozora Bank. The Long Term Credit Bank of Japan was nationalized on October 23, 1998 and reopened on June 5, 2000 as Shinsei Bank. Namihaya Bank, which was formed on October 1, 1998 from the merger of Bank of Naniwa and Fukutoku Bank, was closed on August 6, 1999.[21] Hanwa Bank failed in November 1996. Kofuku Bank , which absorbed Kyoto Kyoei Bank on October 26, 1998, closed on May 21, 1999. Kokumin Bank[22] failed on April 11, 1999, and was absorbed by Yachiyo Bank[23] on August 14, 2000. Minato Bank[24] was established toward the end of the sample on September 1, 1999. Niigata-Chuo Bank[25] failed in October 1999. Tokuyo City Bank failed on November 26, 1997, and was absorbed by Sendai Bank[26] on November 24, 1998. Tokyo Sowa Bank, established

[20]Established on April 1, 1957 as Hypotec Bank of Japan, Ltd. In 1970, its name changed to Nippon Fudosan Bank and to Nippon Credit Bank Ltd in 1977.

[21]In February 2001 the failed Namihaya Bank was absorbed by Daiwa Bank and Kinki Osaka Bank.

[22]The bank was established in 1926 as Kofuku Sogo Bank Ltd. In February 1, 1989, upon converting to a regional II bank, its name changed to Kofuku Bank, Ltd. After being closed, Kofuku Bank was purchased by the Asia Recovery Fund and reopened on February 26, 2001 as Kansai Sawayaka Bank, Ltd.

[23]Yachiyo was originally established in 1924 as Credit Union. In 1991, its name changed to Yachiyo Bank.

[24]Minato Bank was formed from the merger of Midori Bank and Hanshin Bank on April 1, 1999.

[25]Niigata Chuo was eventually absorbed by six other regional banks: Higashi-Nippon, Gunma Bank, Towa Bank, Taiko Bank, Daishi Bank and Hyakujushi Bank.

[26]Sendai Bank was originally established on July 5, 1951.

in 1950 as a "sogo" bank[27], was closed on June 11, 1999. In addition, Hokuto Bank is excluded because it was established mid-sample in 1993. The Bank was first established in 1895 as Masuda Bank and changed its name to Hokuto Bank after absorbing Akita Akebono Bank on April 1, 1993.

Other Data Adjustments

Data for Asahi Bank[28], which was formed by the merger of Kyowa Bank and Saitama Bank on April 1, 1991, is backdated by combining data from the two bank balance sheets. The same technique is used to backdate data for Tokyo-Mitsubishi Bank, which was formed by the merger of Bank of Tokyo Bank and Mistubishi Bank on April 1, 1996 and for Sakura Bank, which was established on April 1990 through the merger of Mitsui Bank Ltd. and Taiyo Kobe Bank Ltd. In order to include Sendai Bank in the sample, the last fiscal year of data is not used.

Several other banks in the sample - Dai-Ichi Kangyo Bank, Joyo Bank, Minami-Nippon Bank and Tokai Bank were also formed as the result of mergers, although they occurred before the sample period so no data adjustment was necessary. Dai-Ichi Kangyo was established on October 1, 1971 (pre-sample) through the merger of the Dai-Ichi Bank Ltd. and The Nippon Kangyo Bank Ltd. Joyo Bank Ltd. was established on July 30, 1935 following merger of Tokiwa Bank and Goyu Bank. Tokai Bank was established in 1941 as the result of the merger between Aichi Bank, Nagoya Bank and Ito Bank. Minami-Nippon Bank, a domestic bank, was established in 1943 through the merger of 2 local banking institutes in Kagoshima prefecture.

Recent mergers forming the Mizuho Financial Group (a holding company of Dai-Ichi Kangyo Bank, Fuji Bank and Industrial Bank of Japan), the Sumitomo Mitsui Banking Corporation (formed by the merger of Sumitomo Bank and Sakura Bank in April 2001), Chuo Mitsui Trust Bank (formed by the merger of Chuo Trust and Mitsui Trust in April 2000), and the Mitsubishi Tokyo Financial Group (formed in April 2001 by Tokyo Mitsubishi Bank and Mitsubishi Trust; soon to be joined by Nippon Trust and Toyo Trust) occurred post-sample and thus do not require any data adjustments.

[27]Tokyo Sogo Bank converted to a regional II bank in 1989 and its name changed to Tokyo Sowa Bank.

[28]The merged bank was first named the Kyowa Saitama Bank. The bank name was changed to Asahi Bank on September 21, 1992.

B Empirical Specification Including Individual Fixed Effects

Table 8: Instrumental Variables Estimation with Time and Individual Fixed Effects

Dependent variable: $\triangle L_{i,t+1}/L_{i,t}$			
Sample:	International	Domestic	"Switcher"
Observations:	449	845	1060
$\frac{\triangle L_{i,t}}{L_{i,t-1}}$	0.413*	0.068	0.202*
	(0.047)	(0.039)	(0.035)
$\frac{K_{i,t-1}}{L_{i,t-1}}$	0.194	-0.305	-0.811*
	(0.388)	(0.466)	(0.364)
$\frac{K_{i,t-1}}{L_{i,t-1}} \cdot Basel$	1.548*	0.894	1.191*
	(0.375)	(0.456)	(0.349)
$\frac{K_{i,t-1}}{L_{i,t-1}} \cdot SwitchYR$			0.230
			(0.164)
* Indicates significance at 5% level.			

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