The effect of the Basel Accord on bank portfolios in Japan

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This study investigates the hypothesis that stricter capital adequacy requirements introduced under the Basel Accord caused Japanese banks to alter their portfolios away from heavily weighted risk assets such as loans and corporate bonds and into unweighted assets such as government bonds.

Using a panel of Japanese bank balance sheets for fiscal years 1982–1999, this study finds that neither international nor domestic bank asset portfolios are strongly affected by the total regulatory capital ratio.

However, there is clear evidence that international bank asset portfolios are highly sensitive to the core tier I capital requirement. International banks with relatively low core capital ratios tend to reduce heavily risk weighted assets such as loans and substitute into unweighted low-risk assets such as government bonds. International banks with relatively low core capital ratios also tend to issue more subordinated debt, which counts toward tier II capital.

This sensitivity of international bank portfolios to capitalization is only observed in the post-Basel period since 1988, indicating that the regulatory changes implemented under the Accord significantly affected the behavior of international banks. There is no evidence that the portfolios of domestic banks were affected by the Accord. *J. Japanese Int. Economies* **19** (1) (2005) 24–36. The Asian Development Bank Institute, 3-2-5 Kasumigaseki, Chiyoda-ku, Tokyo 100-6008, Japan.
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1. The Basel Accord of 1988

The Basel Accord, which was signed in 1988, requires internationally active banks to maintain a capital to risk-weighted asset ratio of at least 8%. Japanese regulators allowed banks with purely domestic business the option of maintaining a ratio of capital to assets of at least 4%,[1] and all banks in Japan were given 5 years to adjust to the new standards before the Accord became binding in fiscal year 1992. Despite these allowances, many Japanese banks struggled to meet the new requirements during the transition period and fears of a "capital crunch"—a reduction in bank lending in response to stricter regulations on bank capital—brought on by the Basel Accord capital adequacy standards began to surface in Japan in the early 1990s. Sluggish growth in bank credit and other macroeconomic aggregates throughout Japan's "lost decade" has revived interest in the relationship between regulatory capital and lending in Japan.

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. Tier II capital includes general loan loss reserves, subordinated debt and preferred stock. In Japan, tier II capital also includes up to 45% of unrealized capital gains or land revaluation.[2] 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.[3] Secured loans fall in-between with a 50% weighting.

A bank needing to raise its capital ratio faces the following options. The capital adequacy ratio can be boosted through capital, the numerator, by issuing new equities, subordinated debt, preferred stock or by increasing loan loss reserves.[4] 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 study investigates the effect of these incentives on bank portfolios.

2. Effect of the Basel Accord on bank behavior

The question of how risk-based capital ratios effect bank portfolio decisions, especially lending, attracted the interest of researchers of the US banking industry in the early 1990s

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[1] Capital for domestic banks is calculated slightly differently than for international banks and does not include neither short-term subordinated debt nor latent capital gains. Assets for domestic banks are not risk-weighted as for international banks.

[2] 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 their 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. Land revaluations have only been included in tier II capital since fiscal year 1998.

[3] The current Accord classifies all loans equally at 100%. Government bonds from OECD countries are considered riskless, with a 0% weighting, while government bonds in non-OECD countries are fully weighted at 100%. Both regulations are likely to be revised under Basel II.

[4] The effect of increasing loan loss reserves is limited since loan loss reserves count toward tier II capital only up to a limit of 1.25% of risk-weighted assets.

and several studies confirm the capital crunch hypothesis that pressure to meet the new capital standards forced banks to cut back on loans.[5] Ito and Sasaki (2002) summarize the evidence in Japan, which also points to the conclusion that Japanese banks with lower risk-based capital ratios tended to grow loans relatively slower.[6] For example, Peek and Rosengren (1997) find evidence that capital constraints brought on by the decline in the Japanese stock market were associated with a decrease in lending by Japanese banks in the United States. Ito and Sasaki (2002) themselves contribute to the literature in their study, which shows that banks with lower capital ratios tended to issue more subordinated debts and to reduce lending. A study by Horiuchi and Shimizu (1998), looking at the top 20 Japanese banks[7] for the period 1990–1995, finds a negative statistical relationship between capitalization and loan growth. However, the authors conclude that the recapitalization via subordinated debt issues, which is also documented in Ito and Sasaki (2002), produced a conservative lending attitude by banks. Honda (2002) is the only study thus far to take the approach of this paper in looking at the differential effects of the Basel Accord on domestic and international banks. Due to limited data availability, Honda (2002) was not able to investigate the relationship between actual capital ratios and loan growth, but his finding suggests that the regulatory change that came with the Basel Accord reduced the ratio of credit to total assets, and that the effect was bigger in international banks than on domestic banks.

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 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 introduction of the Basel Accord in 1988.

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

[6] In addition to discussing the result of Peek and Rosengren (1997), Ito and Sasaki (2002) review the studies of Ueda (1993), Yoshikawa and Ike (1994) and Baba (1995), which are written in Japanese.

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

In addition, this study examines the effect of capitalization on various assets, not just loans. Examining the effects of capitalization on total assets as well as various subsets of assets with different risk weights allows us to clarify whether banks chose to adjust to the new capital requirements by shrinking overall assets or by shifting their portfolio of assets toward lower risk-weighted assets.

Finally, the selection of banks included in the empirical analysis here is more comprehensive than in previous studies. As discussed in Section 1, domestic and international banks in Japan face different capital constraints and different incentives to meet those constraints. The traditional categories of Japanese banks as city banks, long-term credit banks, trust banks, and regional I and II banks are not instructive in this instance as not all of the top 20 largest banks are international banks pursuing an 8% capital adequacy ratio, and there are several banks, officially classified as regional, that actually have overseas offices, are engaged in international lending and pursue the 8% requirement. This study includes both international and domestic banks, separating the samples to explore the question of whether international banks and domestic banks reacted differently to the introduction of the Basel Accord.

With this improved data set 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.

3. Empirical methodology and data

To empirically test the hypothesis that capital ratio regulation influences bank portfolios, a panel of data from 72 Japanese banks' balance sheets and income statements for fiscal years 1982–1999 is used to estimate the empirical relationship between growth of various classes of the bank's assets and the bank's capital ratio, both before and after the Basel Accord of 1988.

As explained in Section 1, international and domestic banks in Japan are held to different standards. To minimize heterogeneity, the sample is divided into 47 domestic banks and 25 international banks that have been aiming for a 4 or 8% capital adequacy ratio continuously throughout the post-Basel Accord period. Mergers are accounted for by treating the merged bank as one entity for the entire sample period. 21 banks are excluded from the analysis due to nationalization, failure, or because they were established mid-sample. In addition, 59 banks that originally aimed for the 8% ratio but switched sometime in the post-Basel Accord period to reporting a domestic 4% ratio are excluded from the analysis.[8]

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[8] 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.

Since the empirical analysis aims to isolate loan supply, two empirical specifications are estimated to account for omitted variables such as macroeconomic events or loan demand conditions, that may affect loan growth in each time period. In one specification (Eq. (1)), the lagged differential between loan and deposit interest rates and lagged GDP growth[9] are included to account for macroeconomic conditions. However, since it is impossible to include an exhaustive list of 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 4.[10]

$$\Delta \log(A_{i,t+1}) = \beta_1 \Delta \log(A_{i,t}) + \beta_2(r_t^L - r_t^D) + \beta_3 \Delta \log(GDP_t) + \beta_{4,\theta}$$
$$+ \beta_{5,\theta} \log\left(\frac{K_{i,t}}{A_{i,t}}\right) + \varepsilon_{i,t+1}. \tag{1}$$

In Eq. (1), i stands for an individual bank and t represents the time period. The growth rate of various classes of the bank's assets, A, is regressed upon lagged asset growth, the differential between the interest rates on loans, r^L, and deposits, r^D, growth in GDP, and the bank's individual capital to asset ratio, $K_{i,t}/L_{i,t}$. Note that the constant term, $\beta_{4,\theta}$, and the coefficient on capitalization, $\beta_{5,\theta}$, may change depending upon the regulatory environment, θ, which represents the pre- or post- Basel period before or after 1988. $\varepsilon_{i,t+1}$ 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 $E[\varepsilon_{i,t+1} \mid I_t] = 0$, so that period-$t$ instruments are valid.

This study looks at the effect of capitalization on growth rates of three types of assets—total assets, loans, and government bonds—as well as subordinated debt, which counts toward tier II capital. Loans are the sum of domestic loans to all industries plus international loans as reported in the annual unconsolidated[11] *yukashoken hokokusho* reports. For trust banks, trust account loans are subtracted from total loans.

Several different measures of capitalization are examined. For the post-Basel period since 1988, it is possible to use the actual regulatory capital ratios. Thus, for estimations including only the post-Basel period, for domestic banks, the domestic capital to unweighted asset ratio is used as the measure of capitalization. For international banks, which are subject to the international capital to risk-weighted asset requirement of 8%, two measures of capital are used in the empirical analysis: the total capital to risk-weighted assets ratio and the core tier I ratio. The core capital requirement that at least half of total capital (4% of risk-weighted assets) must be in the form of tier I capital is more binding than the overall 8% capital requirement for Japanese banks. One reason is that tier II capital

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[9] Interest rates and GDP, aggregated to annual averages, are from the research and statistics department of the Bank of Japan.

[10] A third specification incorporating individual fixed effects was also estimated, but the individual effects proved statistically insignificant and did not alter the coefficient estimates on other variables in a significant way, perhaps because the banks in the sample are already separated into homogeneous groups of international banks and domestic banks and size effects are discounted by using growth rates rather than levels.

[11] Although banks are now required to report on a consolidated basis, unconsolidated data is used in order to construct a continuous time-series.

includes much capital that was received as a government capital injection in 1997 and 1998. Even without these substantial capital injections, tier II capital includes many types of capital that can be manipulated by the banks themselves. For example, latent capital gains, revalued real estate assets, and subordinated debt, which has often been purchased by the Japanese government in order to boost the capital positions of troubled banks, all count toward tier II capital. 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 only the standard measure of total (tier I and tier II) regulatory capital in their empirical analysis.

For the entire sample period spanning back to 1982, it is not possible to use the actual capital adequacy ratio in the empirical analysis because it has only been reported since the Basel Accord was signed in fiscal year 1988. Although the response of asset growth to actual regulatory capital ratios is of interest, this study also aims 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, a constructed capital ratio of shareholders equity to assets, which is available for the pre-Basel Accord period as well, is used for the panel regressions that span back to 1982. This capital ratio approximates the banks core tier I capital ratio, which is primarily shareholders equity, and thus avoids the potential problems of including tier II capital explained above.

4. Empirical results

The empirical results presented in this section are divided into two sub-sections. The first set of results examine the sensitivity of various assets to actual regulatory capital ratios for both international and domestic banks in the post-Basel period since 1988. The second set of results uses the whole sample period, including the pre-Basel period before 1988, to look for changes in bank behavior as a result of the Accord.

4.1. The post-Basel period: 1988–1999

Tables 1–4 report the estimated sensitivity of four different asset classes—total assets, loans, corporate bonds, and government bonds—to regulatory capital ratios in the post-Basel period of 1988–1999. Since these regressions cover only the post-Basel period since 1988, it is possible to use the actual regulatory capital ratio as the measure of bank capitalization. These results are reported in Tables 1 and 2. In addition, for the international banks, Tables 3 and 4 report the estimated sensitivity of the four assets classes as well as subordinated debt to the core tier I capital ratio.

Table 1 reports the results of estimation of Eq. (1), including the interest rate spread and GDP growth to account for macroeconomic conditions. When significant, coefficient estimates on lagged asset growth, the interest rate spread, and GDP growth are generally positive, as would be expected for a loan supply equation.[12] Coefficient estimates on regulatory capital, however, are not statistically significant in most cases.

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[12] One exception is that growth in government bonds is negatively related to the interest rate spread, perhaps because it is the spread between deposits and loans.

Table 1
Sensitivity to total capital ratio (BIS or MOF), 1988–1999

Asset $\Delta A_{i,t+1}/A_{i,t}$	Total assets		Loans		Corporate bonds		Government bonds	
Sample	Int.	Domestic	Int.	Domestic	Int.	Domestic	Int.	Domestic
# Obs.	299	563	299	563	299	563	299	563
Constant	−16.208**	−5.880*	−3.951	−4.931	−41.857	−8.511	37.320	28.472
	(7.936)	(3.180)	(3.598)	(3.193)	(23.460)	(16.270)	(26.966)	(22.043)
$\Delta A_{i,t}/A_{i,t-1}$	−0.052	0.125***	0.142***	0.080*	0.008	0.184***	−0.084	−0.023
	(0.061)	(0.043)	(0.053)	(0.045)	(0.062)	(0.054)	(0.073)	(0.051)
$r^L_{t-1} - r^D_{t-1}$	−1.885	1.826*	0.826	2.392**	−0.903	5.108	−13.246*	−12.484
	(2.634)	(1.138)	(1.066)	(1.128)	(6.435)	(5.753)	(7.734)	(7.895)
$\Delta GDP_t/GDP_{t-1}$	1.205***	0.516***	0.299*	0.389**	2.702***	−0.134	−0.014	0.482
	(0.432)	(0.175)	(0.179)	(0.172)	(0.993)	(0.887)	(1.189)	(1.203)
Capital ratio	1.994***	0.377	0.189	0.045	3.605**	−0.369	0.634	2.431
	(0.474)	(0.229)	(0.241)	(0.236)	(1.400)	(0.214)	(1.569)	(1.589)

  * Significant at 10% level.
  ** Idem., at 5%.
  *** Idem., at 1%.

Table 2
Sensitivity to total capital ratio (BIS or MOF), 1988–1999: Time fixed effects model

Asset $\Delta A_{i,t+1}/A_{i,t}$	Total assets		Loans		Corporate bonds		Government bonds	
Sample	Int.	Domestic	Int.	Domestic	Int.	Domestic	Int.	Domestic
# Obs.	299	563	299	563	299	563	299	563
$\Delta A_{i,t}/A_{i,t-1}$	−0.270***	0.045	0.172***	0.061	−0.005	0.185***	−0.086	−0.126**
	(0.063)	(0.043)	(0.050)	(0.046)	(0.063)	(0.054)	(0.074)	(0.052)
Capital ratio	0.335	0.448*	0.569**	0.482*	3.017*	−1.888	−1.841	−3.519**
	(0.448)	(0.247)	(0.240)	(0.268)	(1.594)	(1.439)	(1.702)	(1.770)

  * Significant at 10% level.
  ** Idem., at 5%.
  *** Idem., at 1%.

Most of the coefficient estimates on regulatory capital become marginally statistically significant, at least at the 10% level, when time fixed effects are included to more fully account for macroeconomic conditions.[13] These results are reported in Table 2. For domestic banks' government bond holdings, the parameter estimate on the capital ratio is statistically significantly negative, indicating that relatively poorly capitalized domestic banks tend to shift their portfolio to be more heavily weighted in government bonds. The parameter estimates on the capital ratio for domestic banks' growth in total assets and loans are also positive, indicating that relatively poorly capitalized banks also tend to cut back on

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[13] The coefficient estimate on international banks capital for total assets becomes insignificant when time fixed effects are included, suggesting the result in Table 1 may have been due to macroeconomic factors rather than capital regulation.

total assets and in particular loans, but the estimates are only marginally significant at the 10% level. For international banks, the coefficient estimate on the capital ratio is positive and statistically significant for loan growth at the 5% level and for corporate bond holdings at the 10% level, indicating that relatively poorly capitalized international banks tend to cut back on these relatively heavily risk-weighted assets in the post-Basel period.

For the international banks, two other specifications are estimated for the post-Basel period 1988–1999. These regressions use the core tier I capital to risk-weighted asset ratio as the measure of capitalization rather than the total capital ratio as above. In addition to the assets classes examined above—total assets, loans, corporate bonds, and government bonds—the sensitivity of subordinated debt, which counts toward tier II capital in the overall capital ratio for international banks, is also examined. The results are reported in Tables 3 and 4.

Table 3
International banks' sensitivity to core capital, 1988–1999

Asset $\Delta A_{i,t+1}/A_{i,t}$	Total assets	Loans	Corporate bonds	Government bonds	Subordinated debt
Sample	International	International	International	International	International
# Obs.	299	299	299	299	299
Constant	−0.025	−7.566***	−14.521	61.869***	0.634
	(6.041)	(2.817)	(17.251)	(20.438)	(17.326)
$\Delta A_{i,t}/A_{i,t-1}$	−0.204**	0.119**	0.007	−0.091	0.272***
	(0.055)	(0.052)	(0.063)	(0.073)	(0.086)
$r^L_{t-1} - r^D_{t-1}$	−2.376	1.319	−2.914	−15.919**	9.066
	(2.257)	(1.044)	(6.322)	(7.589)	(6.142)
$\Delta GDP_t/GDP_{t-1}$	0.587	0.347**	2.586***	−0.114	1.221
	(0.372)	(0.174)	(0.995)	(1.182)	(1.367)
"Core" (tier I)	0.839**	0.683***	2.251**	−1.769	−2.802**
Capital ratio	(0.392)	(0.181)	(1.033)	(1.196)	(1.224)

** Significant at 5%.
*** Idem., at 1%.

Table 4
International banks' sensitivity to core capital, 1988–1999. Time fixed effects model

Asset $\Delta A_{i,t+1}/A_{i,t}$	Total assets	Loans	Corporate bonds	Government bonds	Subordinated debt
Sample	International	International	International	International	International
# Obs.	299	299	299	299	299
$\Delta A_{i,t}/A_{i,t-1}$	−0.297***	0.109*	−0.014	−0.094	0.277***
	(0.065)	(0.062)	(0.064)	(0.074)	(0.086)
"Core" (tier I)	1.022***	0.782***	1.933*	−2.494**	−2.774**
Capital ratio	(0.387)	(0.166)	(1.050)	(1.171)	(1.231)

* Significant at 10% level.
** Idem., at 5%.
*** Idem., at 1%.

In both empirical specifications, the OLS regression including the interest rate spread and GDP growth as well as the time fixed effects model, the coefficient estimates on the core tier I capital ratio are of the expected sign and in most cases highly statistically significant. Focusing on the time fixed effects model, both total assets and loans have highly statistically significant positive coefficient estimates, indicating that relatively poorly capitalized international banks tend to grow overall assets, and loans in particular, relatively slower. The coefficient estimate on capital for corporate bonds, which like loans fall into the riskiest asset category under the Basel classification system, is also positive. Government bonds, a zero-weighted "riskless" asset under the Basel Accord, have a statistically significant negative coefficient estimate, indicating that relatively poorly capitalized international banks tend to grow their holdings of government bonds relatively quickly. Subordinated debt issues, which count toward tier II capital, also have a statistically significant negative coefficient estimate, indicating that relatively poorly capitalized banks tend to grow their subordinated debt holdings relatively quickly.

These empirical results demonstrate that international banks with relatively low core tier I capital tend to shrink their overall assets and to shift their asset portfolio out of heavily risk-weighted assets such as loans and corporate bonds and into unweighted assets such as government bonds. In addition, these banks tend to issue more subordinated debt, to compensating for their low tier I capital by increasing tier II capital.

4.2. The pre-Basel period since 1982

The results presented so far can inform us of bank behavior in the post-Basel period since the Accord was signed in 1988, but do not address the question of whether the observed statistical relationships are actually a response to the change in regulatory standards. To address the question of whether introduction of the Basel Accord actually *changed* bank behavior, or whether international bank portfolios have always been sensitive to capital ratios, Tables 5–6 report the results of an estimation over the entire sample period of 1982–1999. This sample period includes observations from both the pre- and post-Basel period, allowing us to look for changes in bank behavior in response to the Accord.

Table 5 reports the estimation results of a specification including the interest rate spread and GDP growth to account for macroeconomic conditions. The post-Basel dummy variable, "Basel," is statistically significant and negative for international banks holdings of total assets, loans and corporate bonds, indicating that the growth of these assets was significantly slower in the post-Basel period. The capital to asset ratio is not significant in the pre-Basel period for most assets, but becomes statistically significantly positive for loans and corporate bonds and statistically significantly negative for government bonds in the post-Basel period. This suggests that the slower growth of risky assets in the post-Basel period was due to regulatory changes that came about with the Basel Accord. As above, when significant, coefficient estimates on lagged asset growth, the interest rate spread and GDP growth are generally positive, as would be expected for a loan supply equation.

Table 6 reports the results of a specification which more fully accounts for macroeconomic conditions with time fixed effects. In this specification, the coefficient estimate on capital for the domestic banks remains statistically insignificantly different from zero in

Table 5
Sensitivity to capital ratio, 1982–1999

Asset $\Delta A_{i,t+1}/A_{i,t}$	Total assets		Loans		Corporate bonds		Government bonds	
Sample	Int.	Domestic	Int.	Domestic	Int.	Domestic	Int.	Domestic
# Obs.	449	845	449	845	449	845	449	845
Constant	−3.560	4.934***	−3.440	1.773	−5.833	5.359	25.491*	32.165***
	(5.456)	(1.708)	(2.945)	(1.720)	(12.858)	(7.773)	(14.245)	(11.093)
$\Delta A_{i,t}/A_{i,t-1}$	0.041	0.216***	0.426***	0.229***	0.057	0.125***	−0.003	0.033
	(0.055)	(0.037)	(0.050)	(0.038)	(0.051)	(0.042)	(0.061)	(0.041)
$r^L_{t-1} - r^D_{t-1}$	4.986***	−1.810***	3.553***	−0.322	4.124	2.639	−1.764	−3.604
	(1.723)	(0.573)	(0.956)	(0.578)	(4.230)	(6.633)	(4.692)	(3.719)
$\Delta GDP_t/GDP_{t-1}$	0.047	1.000***	0.008	0.820***	1.737**	0.095	−1.918**	−1.199
	(0.296)	(0.138)	(0.162)	(0.139)	(0.709)	(0.613)	(0.798)	(0.868)
$K_{i,t-1}/A_{i,t-1}$	−0.840	−0.113	−0.606	−0.281	−3.096*	−4.035	0.102	−0.448
	(0.926)	(0.545)	(0.505)	(0.549)	(1.659)	(2.490)	(1.902)	(3.538)
$K_{i,t-1} \cdot$ Basel $/A_{i,t-1}$	0.797	−0.177	1.190*	−0.062	6.458***	3.182	−4.713**	−7.464*
	(1.141)	(0.616)	(0.618)	(0.621)	(2.043)	(2.814)	(2.283)	(4.008)
Basel	−7.653**	−0.363	−7.115***	0.751	−23.941***	−5.774	11.731	14.332
	(3.703)	(1.677)	(2.021)	(1.689)	(7.362)	(7.668)	(8.229)	(10.915)

* Significant at 10% level.
** Idem., at 5%.
*** Idem., at 1%.

Table 6
Sensitivity to capital ratio 1982–1999. Time fixed effects model

Asset $\Delta A_{i,t+1}/A_{i,t}$	Total assets		Loans		Corporate bonds		Government bonds	
Sample	Int.	Domestic	Int.	Domestic	Int.	Domestic	Int.	Domestic
# Obs.	449	845	449	845	449	845	449	845
$\Delta A_{i,t}/A_{i,t-1}$	−0.199***	0.101***	0.366***	0.150***	0.044	0.123***	−0.062	−0.070*
	(0.053)	(0.037)	(0.045)	(0.037)	(0.051)	(0.042)	(0.061)	(0.042)
$K_{i,t-1}/A_{i,t-1}$	−1.275*	−0.216	−0.834**	−0.332	−2.612	−3.771	−0.254	−1.408
	(0.076)	(0.499)	(0.373)	(0.483)	(1.808)	(2.482)	(1.921)	(3.372)
$K_{i,t-1} \cdot$ Basel $/A_{i,t-1}$	2.868***	0.583	2.089***	0.665	6.639***	2.859	−4.465*	−5.271
	(0.904)	(0.568)	(0.473)	(0.549)	(2.333)	(2.821)	(2.452)	(3.841)

* Significant at 10% level.
** Idem., at 5%.
*** Idem., at 1%.

both the pre-Basel and post-Basel period for all assets. But for the international banks the findings are quite different. The coefficient estimates on capital in the post-Basel period for total assets, loans and corporate bonds is positive and highly statistically significant for the international banks. The coefficient estimate on capital for government bond growth is negative and significant at the 10% level. Furthermore, the post-Basel parameter estimates are quantitatively much larger than the pre-Basel coefficients.

The empirical estimation results over the entire sample period indicate that the Basel Accord of 1988 did change banks' behavior, at least for the international banks. Although the behavior of domestic banks does not appear to have been affected, international bank portfolios did become more sensitive to capitalization in the post-Basel period since 1988. In the post-Basel period relatively less well-capitalized international banks grew total assets, loans and corporate bonds relatively slower while growing government bonds relatively faster.

The observed differences in the behavior of international and domestic banks can be explained by the fact that the regulatory changes implemented in Japan under the Basel Accord were much less stringent for domestic banks than for international banks. Firstly, the change from the pre-Basel requirement that all banks maintain capital of at least 4% of total deposits to the post-Basel requirement for international banks of an 8% capital to risk-weighted asset ratio was much more dramatic than the shift for domestic banks to a 4% capital to asset ratio. Secondly, the regulations were more strictly enforced for the international banks than for the domestic banks, so domestic banks had less incentive than international banks to alter their portfolios in order to meet the new standards. Although regulation of domestic banks has become more strict in recent years, several domestic banks have allowed their regulatory capital ratio to fall below 4%, even in the post-Basel period, but faced no serious penalties from regulatory authorities.

Enforcement of the Accord was stricter for international banks, but there was still some leniency. Short of issuing new equities, relatively rare for Japanese banks, there is little that the banks can do themselves to influence their core capital. But the Japanese government stepped in at times to provide near capital to those banks in danger of not meeting the overall 8% requirement. This usually came in the form of either direct purchases by the government of preferred stock or subordinated debt issues or more indirect measures such as pressure on affiliated companies to purchase these instruments from banks with low capital ratios. This practice helps to explain the finding presented in this study that international bank portfolios are much more sensitive to fluctuations in core tier I capital than to fluctuations in their overall regulatory capital ratio.

5. Conclusions

This is the first study to explore the sensitivity of various risk weight categories of assets to both total regulatory capital and core regulatory capital and to examine differences in the sensitivity of asset growth to regulatory capital for domestic and international banks in Japan. The results demonstrate that capital adequacy requirements introduced under the Basel Accord of 1988 affect the behavior of international and domestic banks in Japan very differently.

Although international bank portfolios have been only marginally sensitive to total regulatory capital in the post-Basel period since 1988, the portfolio allocation of international banks is highly sensitive to the core tier I capital ratio. There is clear evidence that in the post-Basel period international banks with relatively low core capital ratios tended to shrink their overall assets and to shift their asset portfolio out of heavily-weighted risky assets such as loans and corporate bonds and into zero-weighted riskless assets such

as government bonds. In addition, these banks tended to issue more subordinated debt, to compensating for their low tier I capital by increasing tier II capital.

The sensitivity of international bank portfolio allocation to capitalization is solely a post-Basel phenomenon, suggesting that the Accord brought about a significant change in the behavior of international banks.

The portfolio allocation of domestic banks, on the contrary, does not appear to have been affected by the Accord. Domestic bank portfolios may be marginally sensitive to total regulatory capital but the relationship is not strong and there is no evidence that this is a new phenomenon resulting from the implementation of the Basel Accord of 1988.

The results of this study bring new urgency to current efforts to revise the Basel Accord. For example, as shown here, the Accord gives capital constrained banks the incentive to cut back on loans. Since the current rules weight all loans equally, the current Accord may also inadvertently give capital-constrained banks the incentive to allocate the loans that they do make to relatively high-risk borrowers offering higher potential returns. Findings by other researchers that poorly capitalized banks in Japan tend to misallocate credit to troubled borrowers (Peek and Rosengren, 2003) and that capital regulation may actually increase the probability of bank failure (Tsuji, 1999), suggest that this is occurring. Evidence that capital regulation affects bank behavior is reassuring, but also highlights the need to refine the existing regulations.

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