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BANK CAPITAL COMPOSITION, REGULATION AND RISK TAKING

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Abstract: This paper explores the link from capital adequacy and capital composition to risk taking behaviour of banks, using data on 713 OECD banks over 1993-2007. Our results suggest that an increase in the overall capital adequacy ratio reduces the risk appetite of banks in both ex-ante and ex-post terms, in line with theory and regulatory practice. We also show that increasing the proportion of Tier 2 (mainly subordinated debt) within a given capital adequacy structure induces increased ex-ante and ex-post risk measures for banks. Given the regulatory community is undertaking radical changes to current regulation, it is a paradox that virtually no empirical work has looked at the actual effects of Tier 2 on bank performance. This paper seeks to fill this gap and our results tend to justify the downgrade to Tier 2 introduced under the Basel III proposals.

Keywords: Basel agreement, Tier 2 capital, panel estimation, bank performance

JEL Classification: G12, G21

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1. Introduction

This paper explores the macroeconomic and bank-specific factors affecting risk taking behaviour of individual banks in OECD countries, as shown by provisions (ex ante risk) and charge-offs (ex post risks). Our sample comprises balance sheet data for a panel of 713 OECD banks over 1993-2007, and related macroeconomic data. Bank-level factors which are assessed include the level of capital and its distribution between Tier 1 (mainly equity) and Tier 2 (principally subordinated debt). Our key aim is to establish whether increases in the level and quality of overall capital reduce risk taking, taking into account other determinants of bank risks. This is of central relevance in the light of the current consensus among financial regulators that Tier 2 capital is inferior to Tier 1, both in terms of incentives for an ongoing bank and regarding the protection it offers in the case of failure.

Our results suggest that increasing the proportion of Tier 2 within a given capital adequacy structure increases both ex-ante and ex-post risk measures for banks. As banks issue more subordinated debt, they incur more realised losses and their future expected losses increase. We also show that an increase in the overall capital adequacy ratio reduces the risk appetite of banks in both ex-ante and ex-post terms. On the other hand, loan growth per se does not affect bank risk. The macro-economic (or systemic) dynamics of GDP cycles as well as property prices and interest rates appear also to be drivers of bank risk.

We contend that the results for capital adequacy and composition have a crucial bearing on banking, credit intermediation and financial stability, and in the first instance should inform regulation. To our knowledge, the direct impact of Tier 2 holdings on banks' riskiness has not been empirically quantified before, although views of Tier 2 have been central to discussions leading to the recent Basel III agreement on bank regulation (Basel Committee 2010). Our results underpin their decision to reduce the proportion of capital that can be in the form of Tier 2, although we would argue that Tier 2 should have been eliminated entirely from regulatory capital. The results also suggest that the rise in Tier 1 decided on in Basel is likely to curb risk taking by banks, but the level might remain inadequate.

The paper proceeds as follows: section 2 summarises the empirical and theoretical literature surrounding bank capital and risk taking and presents a simple theoretical model of bank risk, regulation and profits; section 3 discusses our data and methodology; section 4 presents our results and in section 5 we assess the impact of Basel III on bank risk taking. The last section concludes.

2. Bank behaviour, capital and risk

To mitigate the risks of bank failure and the externalities associated with it, regulators require banks to hold capital in excess of that which they may themselves choose, which can be used to absorb losses when banks' net worth declines. Internationally, benchmark standards for this regulatory capital are set by the Basel Committee meeting at the Bank for International Settlements (BIS)[6]. The standards allow banks

[6] Individual sovereigns are free to augment the international standards to reduce their systemic bank risk at their discretion.

to hold two types of capital according to certain rules: Tier 1 (high quality capital, mainly equity) and Tier 2 (lower quality capital, mainly subordinated debt). There have been three generations of Basel Agreements on capital adequacy, Basel I dating from 1988, Basel II of 2006 and the current Basel III proposals (Basel Committee 2010). Our regression sample features Basel I and II, but we also focus on the implications of Basel III. The key constraints are that under Basel I and II, total capital must be at least 8% of risk weighted assets, and no more than half of this can be Tier 2,. Under Basel III, no more than 2% can be Tier 2, and Tier 1 must in normal times be 8.5% (it can be reduced to 6% in a crisis as the "capital conservation buffer" is decumulated).

During the development of the capital standards, regulators' justification for allowing banks to count subordinated debt as Tier 2 capital was that it provides an additional benefit of market discipline as compared to deposits, because it is junior to them in a winding up. Accordingly, the subordinated debt holder should monitor the riskiness of the bank and set the yield accordingly. The incentives of the bond holder and the regulator are presumed to be aligned and supposedly bank failure risk is reduced. The disciplining role of the market has been considered important enough by regulators to include Tier II as a pillar of Basel II and Basel III (Basel Committee 2010). Moreover, subordinated debt is attractive to banks for being cheaper to issue than equity (Miles et al, 2011) and does not dilute ownership control.

However, the sub-prime episode has illustrated the fact that in a systemic crisis, subordinated debt holders were generally not required to absorb the losses of large banks[7] because of taxpayer bailouts. In effect, deposit insurance generally expanded to cover subordinated debt, while liquidity support and credit guarantees limited the losses of shareholders (D'Souza et al, 2010). It is also quite likely that in the light of past systemic crises with similar outcomes (Hoelscher and Quintyn 2003), subordinated debt holders anticipated even ahead of sub-prime that this would be the case.

In the light of the experience of the subprime crisis, Turner (2009) of the UK FSA expressed concerns among regulators that Tier 2 might be only useful to protect creditors in failure (gone concern) but does not give the right incentives to banks' ongoing operations (going concern). In particular, the loss incurred by the owners of the bank in case of failure is reduced markedly by holding more Tier 2 within a given overall Basel ratio. Turner concluded that "the FSA therefore believes that required capital ratios for such banks should be expressed entirely in terms of high quality capital – broadly speaking the current Core Tier 1 and Tier 1 definitions – and should not count dated subordinated debt as providing relevant support". As noted above, Basel III has reduced but not eliminated the Tier 2 concession and our empirical work below casts further light on this debate.

The view of regulators that Tier 2 has a justification in terms of market discipline links to a related debate in the academic literature. For example, the US Shadow Financial Regulatory Committee (2001) suggested that mandatory issuance of subordinated debt[8] would expose risky banks to market discipline of two types: It

[7] Currently this issue is termed as "bail-ins" and is being discussed by regulators internationally.
[8] by 2% of assets

promotes direct market discipline because as their risk increases, banks face higher yields when they refinance. Indirect discipline occurs when regulators use information carried in higher yields to take prompt corrective action against banks. This information may be superior to what they could obtain themselves on the basis of bank examinations, since the market is considered to be better equipped to evaluate complex banks than regulators and the market prices risk on a continuous basis instead of discretely like regulators (Bliss, 2001).

An alternative view to this is Levonian (2001) who models the pecking order of payoffs to shareholders, depositors and debt holders in the presence of subsidies. Where deposit insurance eliminates the need for depositors to monitor efficiently, subordinated debt holders will also reduce their monitoring efforts since the government guarantee on deposits now makes it more likely they will be repaid in full. Hence, higher Tier 2 may accompany higher risk taking.

Further conflicting considerations arise from relative incentives of shareholders and bondholders to monitor banks. First, the standard corporate governance literature suggests equity is a better disciplining device than debt because in the event of bankruptcy, shareholders' claims rank lower than those of subordinated debt holders, and therefore shareholders have the stronger incentive to monitor bank risk. Second, the emergence of index tracking funds as major players in stock markets has probably led to a reduction in shareholder monitoring as it raises costs for the tracker, and on this basis it can be argued that subordinated debt holders may have more incentive than a tracker to monitor bank behaviour. Equity incentives to monitor may also be low because equity always has an option value even when the firm is close to bankruptcy (the equity holders can "gamble for resurrection") while the same is not true of bond holders. Third, if owing to the "safety net", bondholders perceived that they would not take many losses, their intensity of monitoring might drop below that of shareholders, even if the latter are index trackers who seek to minimise costs of corporate governance interventions.

We can conclude from these papers and related considerations that there is no consensus on the effect of Tier 2 capital on risk taking, and arguments can be made for it either decreasing or increasing risk taking. Furthermore, the wider theoretical literature on bank capital has typically not distinguished between total and equity capital adequacy, let alone between Tiers 1 and 2 (see Van den Heuvel (2002) and its references). This implies that conclusions need to be drawn using empirical evidence. Most of the existing literature, summarised below, looks at the impact of subordinated debt only and not capital composition.. For example, Evanoff and Wall (2000) and Sironi (2003) highlight how distress signals for subordinated debt are indicated by credit spreads between banks' risky debt and risk free debt[9]. Their results favour the market discipline hypothesis. However, if subordinated debt holders anticipate their losses will be limited in the event of bankruptcy, perhaps owing to extension of deposit insurance in a systemic crisis, subordinated debt yields are unlikely to be closely tied to bank risk. This effect has been confirmed by studies such as Krishnan et al (2005) who focus on the first issuance of subordinated debt by US banks and

[9] Evanoff and Wall (2000) focus on the US and Sironi (2003) on Europe.

assess whether term credit spreads[10] respond to changes in risk around this time. This question is aligned with our study in the sense that we implicitly examine whether issuance of subordinated debt increases the riskiness of banks or not. The authors find that following an initial subordinated debt issue, bank-specific risk characteristics do not change. In other words, Tier 2 capital does not act as a significant disciplining device on banks' risk appetites. This is confirmed by Morgan and Stiroh (2005) who show that yield spreads do not act strongly to discipline banks when the market considers them "too big to fail". Experiences in the subprime crisis since 2007 bear out this expectation.

Several empirical studies give reasons for the poor bank-risk content of subordinated debt spreads and thus why disciplining may be imperfect. Jagtiani et al (2000) note differences between the regulators' and debt holders' perspectives; regulators care about bankruptcy per se whereas subordinated debt holders care more about their losses in the event of bankruptcy. Since these losses are mitigated by expectations of government forbearance, subordinated debt holders will price this into the yield which thus diverges away from the regulatory measure of interest. Ashcraft (2008) finds that subordinated debt market monitoring increases after government subsidies are removed.

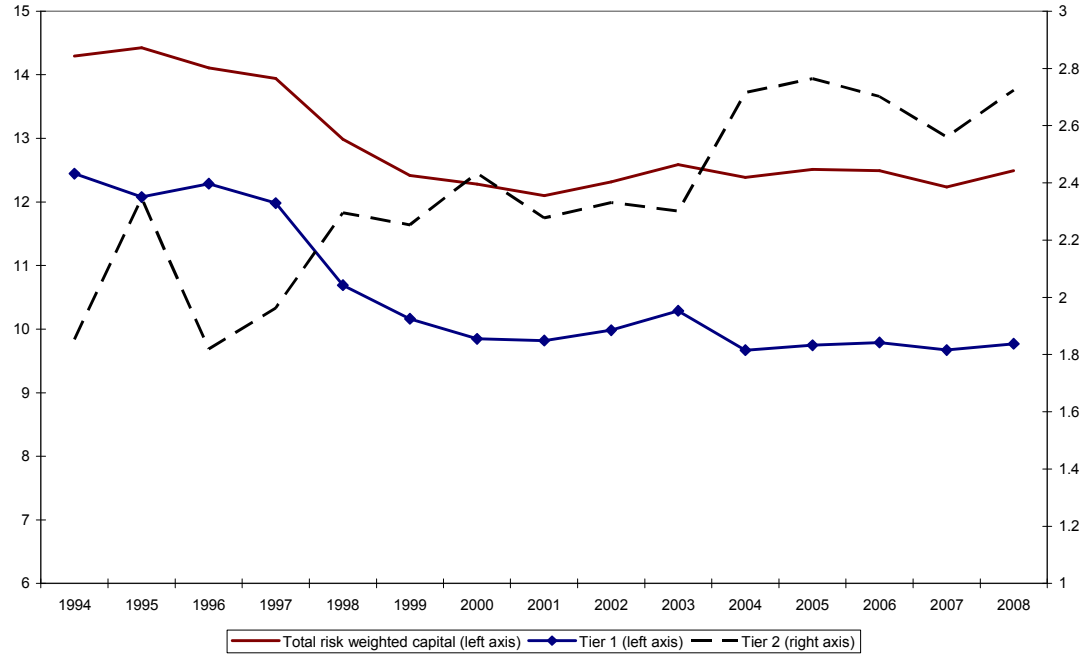
There are also structural reasons as to why subordinated debt markets may be poor sources of bank discipline. Bliss (2001) notes that subordinated debt yields contain noise; information apart from bank risk includes liquidity and term structure. In addition, opacity of bank risk may be problematic; the very existence of banks hinges on their superior ability (economies of scale and scope) to obtain and process information on illiquid risky projects compared to markets. Consequently, as Morgan (1997) indicates, subordinated debt markets may be unable to circumvent banks' informational advantage and yields will be mispriced.

Given that subordinated debt yields may under-price risk and the fact the subordinated debt is a cheaper source of capital (and financing) than equity, it is plausible that bank shareholders can optimise returns by issuing subordinated debt, increasing their balance sheet risks and increasing their upside gains in the presence of limited downside losses. Indeed, Figure 1 that banks already issue Tier 1 in excess of the regulatory minimum and so their use of Tier 2 allows them to maintain additional buffers and lower their financing costs.

On the other hand, as Admati et al. (2010) and Miles et al (2011) point out, if banks are required to raise their overall capital ratios they are likely to take less risk, and vice versa if regulators allow capital adequacy to fall. The falling level of overall capital and of Tier 1 in Figure 1 may hence have been part of the cause of the build up of risk prior to the subprime crisis. They also suggest that it might be the case (if the Modigliani Miller theorem holds) that the structure of capital does not affect risk taking. These are the empirical issues we go on to test in the rest of the paper. Prior to that, we describe a simple theoretical model without any restrictive assumptions, which reveals the overall nature of bank risk and how Tier 2 capital relates to it.

[10] This is basically the term structure of credit spreads for a bank. The authors extract this measure because its change akin to the second difference of yields with respect to maturity whereas the yield itself is a measure of risk in level form.

Figure 1: The composition of risk-adjusted capital adequacy ratios (averaged across banks in the sample)



Note: the number of observations (banks) changes over time

3. Modelling banks' balance sheets, risk and incentives

Abstracting initially from regulation, banks act as intermediaries which allocate surplus funds on behalf of their creditors and they generate income from the spread between loan rates and deposit rates (Goodhart 2010). All their potential loans[11] attract some risk, and they have to hold enough capital to absorb this risk. As a result, the value of claims issued by the bank outweighs the value of its liabilities. Failures happen when banks lose the ability to pay their creditors and face bankruptcy. Insolvency may happen because of depositor bank runs, as discussed in Diamond and Dyvbig (1983), or because sufficient borrowers default for the bank to become insolvent. These are separate problems, reflecting the two sides of a bank's balance sheet. A simplified model of banks balance sheets helps us understand the dynamics of bank risk taking and the rationale for regulation, including the role of Tier 1 and Tier 2 capital, charge-offs and provisions which are central to this paper.

Banks take in deposits (D) in some form, on which they pay interest at a rate $r_{d,}$ and make loans (L) or enter into other credit provision arrangements on which they charge interest r_l. Depositors may randomly withdraw and hence low-risk liquid assets (LA with a rate of return r_{ra}) have to be held. The appropriate (on-book) liquid asset ratios will depend on the variance of deposits (var(D)), the maturity composition of assets and liabilities, and on the availability and maturity of off-book, or wholesale market, liquidity. We may write the asset side of the bank's balance sheet (AS) as

$$AS = L + LA \text{ where } LA/D = f(\text{var}(D), \text{maturity}, \text{wholesale}) \qquad (1)$$

[11] We abstract from lending via non liquid securities without loss of generality.

When banks make loans they take risks, and the loan book will face a default rate that will vary over time with economic conditions. The expected default rate (b) is included in the spread between borrowing and lending rates, which will also include administrative costs (ad) and a payment for risk taking (rp):

$$r_l = r_d + b + ad + rp \quad (2)$$

Given that banks may make larger-than-anticipated losses on their loan portfolio in some periods, they have to carry both contingency reserves (provisions) and finance some of their loan book with capital[12]. In the absence of regulation, the amount of capital held by a bank will depend on the variance of loan losses (var(BL)) and on the cost of generating capital. The larger the quantity of capital (K) relative to loans (K/L), the lower the probability of bankruptcy for a given var(BL) and hence the lower the cost of capital to the bank.

The classic form of capital is equity. Additional loss-absorbing capacity can be provided by subordinated debt, although since it is an obligation it does not protect against bankruptcy in the way that equity does. If the composition of the capital base between pure equity (EQ with return r_{eq}) and subordinated debt (SD with return r_{sd}) does not change the behaviour of the bank, then the Modigliani-Miller theorem suggests that the providers of bank equity will be indifferent between debt and equity finance. However, as Levonian (2001) suggests, increasing subordinated debt raises risk in banks, and hence the cost of capital will change with the mix of equity and subordinated debt in the capital base (we discuss this point further below). The liabilities of the bank may be written as

$$LS = EQ + SD + D \quad (3)$$

The gross profits (Π_g) of the bank after allowing for current charge-offs (BL) may be written as

$$\Pi_g = r_l L + r_{ra} LA - r_{sd} SD - r_d D - BL - ad L \quad (4)$$

If bad loan provisions (bL) exceed charge-offs (BL), then the bank can build its provisions P with (bL – BL) or pay out some proportion (β) of the gain (or claw back a loss) in current profit. Profits (Π) may then be written as

$$\Pi = \Pi_g + \beta (bL - BL) - (bL - BL) \quad (5)$$

The pure capital of the bank (K), all else equal, is its capital base plus its provisions, and abstracting from new issues of equity or subordinated debt, capital evolves in relation to profit retentions ($\gamma\Pi$) and excess provisioning (1- β) (bL – BL), with (-1) indicating previous period values.

$$K = EQ + SD + P = EQ(-1) + \gamma\Pi + SD(-1) + P(-1) + (1- \beta) (bL - BL) \quad (6)$$

[12] Loss absorbing equity is not the same as the equity value of a bank on the market, as the latter may include goodwill and other intangibles that cannot be used to offset losses on the loan book. In its simplest form, the loss absorbing equity in a bank is the difference between its current assets and its other liabilities (loans and liquid assets less deposits)

In this context, a failure might emerge either because a bank does not have enough on-book liquidity to meet the needs of depositors, and cannot access the wholesale market, or because loan losses have built up to the point where capital is expected to be exhausted. This would require a series of periods where provisions (1- β)bL had been less than subsequent charge-offs (BL). The higher is LA/D for a given var(D) the less likely is a liquidity crisis, and the higher K/L or (EQ+SD)/L for a given var(BL), the less likely a solvency crisis will emerge.

In the absence of government guarantees, deposit risk arises because the bank transfers credit, liquidity, market and interest rate risks to depositors such that depositors' claims on a bank may drop below face value if risks cause substantial bank losses that exhaust the loss absorbing equity base. Banks' risk appetites may incur negative externalities for society since bank failures harm depositors directly, and, by impairing the payments system and subsequent credit allocation, harm the economy as a whole. Moreover if these externalities are systemically large, taxpayers may be forced to bail out imprudent banks. As bank failure may involve external social costs, regulators may require banks to hold more capital to absorb losses than the banks themselves may choose.

Appendix 2 shows the impact of Tier 2 on bank behaviour from the perspective of a profit function. It illustrates that an increase in Tier 1 dilutes any rise in profits whereas increasing Tier 2 boosts profits further, underlining the incentive to maximise issuance of Tier 2. However, there may be limits if markets perceive changes in behaviour, thus raising the cost of equity as more Tier 2 is issued. And indeed, we saw in Figure 1 above that average Tier 2 holdings are below the Basel limits.

Going beyond the model, banks, perhaps to a greater extent than other companies, face principal-agent problems between managers and providers of finance. The managers have asymmetric incentives, with a large positive stimulus to raise profitability and take risks owing to the use of bonuses, while the downside effect of losses is a low risk of losing employment. There is an interaction between managers and funders which determines the level of risk taking, and this is policed by monitoring by providers of finance. It is reasonable to assume the degree of monitoring from a given source of finance depends on the volume of finance provided and on the funding provider's perceptions of potential losses. The larger the potential losses the more intensive will be the level of the monitoring. More Tier 2 capital implies more bondholder monitoring and more Tier 1, more shareholder monitoring for a given distribution of perceptions of losses. However, we noted in Section 2 above that both forms of monitoring may be subject to distortions in terms of incentives. Hence, it is an empirical question which form of monitoring is more effective, which will be shown by the effect of the proportion of Tier 2 on risk taking in the estimates below, to which we now turn.

4. An empirical evaluation of bank risk taking

Our discussion above suggests we should look at the factor affecting loan-loss provisions and net charge-offs, and we do this by investigating structural relationships describing individual bank behaviour. These must include both the total level of capital and its structure. Because balance sheet variables refer to year-end data we use the lagged values of these variables to determine the flow of charge-offs and loan-loss

provisions in the subsequent year. Total capital is measured by the risk-adjusted Basel II capital ratio as reported by the banks in our sample. If the structure of capital does not affect behaviour we should find that the ratio of Tier 2 capital (denoted SD above) to total regulatory capital is not significant when included along with total capital. Charge-offs and provisions potentially depend upon other factors, some of which are specific to the bank in question, and some of which reflect the environment within which it operates. Most of these latter variables will be macro-economic in nature in our advanced economy sample, reflecting cyclical and structural factors in the economy.

In modelling charge-offs and provisions using micro data, we build on an existing literature, which has however to date not focused on capital composition. Salas and Saurina (2002) modelled the problem loans of Spanish banks, controlling for macro factors such as the growth of GDP, the level of indebtedness in the non-financial sector and numerous bank-specific variables, as is feasible in a study of a national market as opposed to an international study where only standardised variables can be used. Individual bank level variables also have a high explanatory power for credit risk, with loan losses rising following aggressive growth policies, as shown by credit expansion and market penetration. In one of the few international studies of bad loans, Davis and Zhu (2009) found both macro variables, including property prices and interest rates, and bank specific variables, including loan growth and the interest margin, were significant in determining non performing loans ratios.

In terms of provisioning, bank-level studies on global samples such as Cavallo and Majnoni (2002), Laeven and Majnoni (2003) and Bikker and Metzemakers (2005) find provisioning decisions are associated with economic growth, banks' lending behaviour and banks' capital strength. Banks with higher loan-to-asset ratios tend to be involved in higher credit risk and therefore their loan-loss provisions are higher (see Cavallo and Majnoni, 2002). Davis and Zhu (2009), in their international study, found that provisioning is linked to GDP, interest rates and property price growth, but also micro variables such as loan growth and the loan/assets ratio. We focus on GDP growth, property prices and interest rates as our key macro variables. We include only current values of our macro variables in the loan-loss provisions equation, as this is a current or forward looking activity, whilst we include current and lagged values in the charge-offs equation, as this will be influenced more by events in the past that are loan-loss provisions. We envisage no endogeneity problems for these macro variables in our individual bank behaviour equations (individual banks do not themselves have an impact on variables at a macro level).

Besides total capital ratios and the Tier 2 proportion, our bank-specific variables include the loan-to-asset ratio and real loan growth rate, in line with the literature cited above. These may proxy the evolution of the credit risk taken on when creating bank assets. We also include the net interest margin as an indicator of the profitability of assets. In all three cases we presume that current charge-offs and loan-loss provisions are driven by previous behaviour, and we include only lagged values of these variables, and hence we do not have to deal with endogeneity problems. In both relationships we investigate, we include a lagged dependent variable and if this is significant it will mean that effects build up or die out (slowly) over time[13].

[13] If the lagged dependent variable is not significantly different from one our results may be spurious.

Our empirical work covers banks from 14 OECD countries, namely Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Spain, Sweden, UK and US[14]. Appendix 1 details data sources for inflation, GDP growth, interest rates and house prices. Bank-specific data are derived from the Bankscope database over 1993-2007. We utilise the balance sheet variables total assets and loans, loan-loss provisions, net charge-offs, and the total capital ratio (risk adjusted) and Tier 1 ratio (risk adjusted) to derive a Tier 2 ratio. The density of coverage increases over time, as reporting standards changed with a move toward consolidated accounts[15]. As banks began to face problems in 2008, our data set for provisions and charge-offs becomes clearly non-stationary. Including that year would have made our inferences spurious, and hence we use data from 1993 to 2007.

As a preliminary to our main results, we note that it is possible that banks facing more risk might take on more Tier 2 capital to deal with it, and hence a regression relationship between risk and the proportion of Tier 2 may give a false signal of the direction of causality. We first estimated equations to test for Granger causality between Tier 2 capital and our risk measures in order to investigate this. As all three variables are stationary over our 1993 to 2007 sample period, we can test for the impact of changes in Tier 2 on changes in charge-offs and in loan-loss provisions and vice versa. Table 1 shows that Tier 2 does Granger-cause loan-loss provisions and charge-offs but reverse causality does not hold, suggesting that banks first issue subordinated debt and then increase balance sheet risk, and not the reverse. We would not expect any other bank-based variables to be Granger-caused by charge-offs and loan-loss provisions, nor would we expect current or lagged macro variables to be influenced by them, although variables in the future may be affected.

Table 1: Granger Causality Between the Proportion of Tier 2 Capital, Net Charge-offs and Loan-loss provisions

3 Lags, F statistic **(probability)** Null Hypothesis: No Granger Causality			
DOES TIER 2 GRANGER-CAUSE LOAN-LOSS PROVISIONS?:	6.62 **(0.0002)**	DOES TIER 2 GRANGER-CAUSE NET CHARGE-OFFS?	3.14 **(0.0245)**
DO LOAN-LOSS PROVISIONS GRANGER-CAUSE TIER 2?	2.38 **(0.0924)**	DO NET CHARGE-OFFS GRANGER-CAUSE TIER 2?	2.37 **(0.0687)**

Given the absence of endogeneity problems and the clear causality structure between Tier 2 and risk taking, we may justifiably estimate our structural equations by Least Squares. We start with an encompassing relationship and test down from more general equations, where insignificant variables were deleted, with the least significant being eliminated first and the equation then re-estimated[16].

[14] This is the same country group as that used in Barrell et al (2010a) for banking crisis prediction.
[15] The changing nature of the data over the time domain means that we cannot easily test for structural change
[16] As the density of the sample increases over time, the exclusion of a lag in a bank specific variable may lead to the inclusion of additional bank year observations as we test down. We allow this to happen as the change in sample size is small.

As we can see from Table 2, lending risk indicators based on the loans to asset ratio and real loan growth drop out of the loan-loss provisions equation at an early stage, as does the net interest margin (although it is more significant). Bank-specific information apart from the level of capital and its structure do not add to our understanding of loan-loss provisions, and these seem to depend largely on indicators external to the bank itself. Real house price growth is eliminated, but real interest rates and the growth of real GDP both remain significant as in Davis and Zhu (2009). When GDP growth is currently strong there are fewer loan-loss provisions and when real interest rates are low there are also fewer provisions. Both might indicate the views of the banks on the quality of loans they are making, rather than the (lack) of stress felt by borrowers. The lagged dependent variable is significantly different from both one and zero, and suggests that there is a degree of inertia in loan loss provisioning.

Table 2: General to Specific Estimation: Loan-loss Provisions

	1	2	3	4	**5**
C	0.431 (0.117)	0.389 (3.968)	0.374 (4.278)	0.428 (6.445)	**0.44** **(6.424)**
Lagged dependent	0.494 (9.781)	0.495 (9.814)	0.464 (10.668)	0.47 (10.711)	**0.473** **(10.964)**
Real GDP Growth	-0.072 (-8.319)	-0.072 (-8.325)	-0.057 (-6.84)	-0.054 (-6.308)	**-0.059** **(-7.068)**
Real Short Term Interest Rate	0.026 (5.229)	0.027 (5.257)	0.022 (4.728)	0.028 (5.847)	**0.031** **(7.998)**
Total Capital Ratio (-1)	-0.009 (-2.056)	-0.008 (-2.06)	-0.009 (-2.736)	-0.009 (-2.587)	**-0.01** **(-2.867)**
TIER2 proportion (-1)	0.326 (1.913)	0.321 (1.9)	0.34 (2.148)	0.279 (2.128)	**0.289** **(2.196)**
Real House Price Growth	-0.006 (-2.177)	-0.006 (-2.137)	-0.007 (-2.645)	-0.004 (-1.765)	
Net Interest Margin (-1)	2.853 (1.577)	2.577 (1.518)	2.662 (1.693)		
Real Loan Growth (-1)	-0.001 (-0.82)	-0.001 (-0.877)			
Loans to Assets Ratio (-1)	-0.001 (-0.617)				
Observations	3438	3438	3975	3975	3975
R^2 adj	0.32	0.32	0.30	0.30	0.30
DW	2.10	2.10	2.09	2.09	2.10

It is clear that the more capital a bank holds, the fewer loan-loss provisions it makes: a one percentage point increase in its total risk weighted capital is associated with a two per cent reduction in loan-loss provisions. The structure of capital also affects behaviour, with banks that hold a higher Tier 2 proportion making more loan-loss provisions as a consequence. This suggests that markets should not treat the structure of bank capital as "irrelevant".

The estimation of the relationship for net charge-offs is set out in Table 3. We include both levels and lags of macro variables, and we would expect a different set of

variables to affect charge-offs as they cover the whole portfolio of bank assets, unlike loan-loss provisions. The net interest margin dropped out after loan growth, and lagged real interest rates are also eliminated. The resulting equation displays more inertia than does loan-loss provisions as it has a lagged dependent variable coefficient of 0.8, and two lags in real GDP growth remain significant. Stronger GDP growth and stronger lagged house price growth are associated with fewer charge-offs, and the lower the real interest rate the lower the charge-off rate. The long run effect of overall capital on charge-offs is twice as large as it is on provisions, although the initial impact is marginally smaller. The larger the proportion of capital held in Tier 2 assets, the higher the charge-off rate, suggesting that banks with more Tier 2 capital have taken more risk. As we have tested for the direction of causality we can be reasonably sure that the Tier 2 ratio drives risk taking, and is not a protection against it.

Table 3: General to Specific Estimation: Net charge-off rates

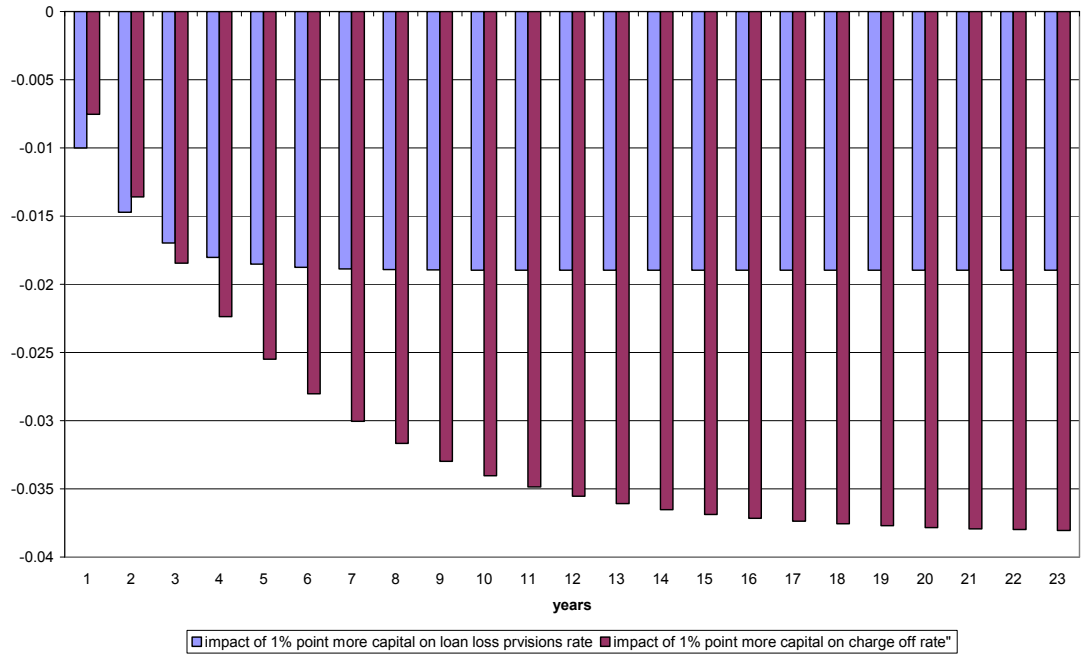
	1	2	3	4	**5**
C	0.206 (3.876)	0.206 (3.947)	0.201 (3.915)	0.198 (3.855)	**0.195** **(3.855)**
Lagged dependent	0.813 (34.277)	0.813 (34.26)	0.802 (32.567)	0.803 (32.574)	**0.803** **(32.692)**
Real GDP Growth	-0.041 (-5.218)	-0.041 (-5.371)	-0.035 (-4.919)	-0.034 (-4.654)	**-0.033** **(-4.816)**
Real GDP Growth (-1)	-0.024 (-2.601)	-0.024 (-2.833)	-0.023 (-3.07)	-0.022 (-3.041)	**-0.023** **(-3.095)**
Real Short Term Interest Rate	0.03 (3.596)	0.03 (4.347)	0.026 (4.511)	0.026 (4.466)	**0.022** **(5.366)**
Total Capital Ratio (-1)	-0.008 (-2.937)	-0.008 (-2.937)	-0.008 (-3.283)	-0.007 (-3.218)	**-0.008** **(-3.28)**
TIER2 proportion (-1)	0.163 (3.408)	0.163 (3.401)	0.156 (3.351)	0.14 (3.309)	**0.142** **(3.297)**
Loan to Asset Ratio (-1)	0.001 (1.841)	0.001 (1.818)	0.001 (2.265)	0.001 (2.882)	**0.001** **(2.909)**
Real House Price Growth (-1)	-0.006 (-2.258)	-0.006 (-2.92)	-0.005 (-2.886)	-0.005 (-2.479)	**-0.004** **(-2.46)**
Real Short Term Interest Rate (-1)	-0.006 (-1.15)	-0.006 (-1.173)	-0.006 (-1.346)	-0.004 (-0.949)	
Net Interest Margin (-1)	1.496 (2.226)	1.507 (2.298)	0.846 (1.284)		
Real Loan Growth (-1)	0.0002 (0.35)	0.0002 (0.354)			
Real House Price Growth	0.0003 (0.092)				
Observations	3122	3122	3538	3538	3538
R^2 adj	0.79	0.79	0.77	0.77	0.77
DW	1.71	1.71	1.97	1.97	1.97

Summarising the results, in terms of macro variables, GDP growth reduces provisions and charge-offs due to lower default probabilities, similar to Bikker and Metzemakers (2005) and Davis and Zhu (2009). There is a lagged effect of GDP growth on net charge-offs indicating a certain amount of inertia which may be attributed to the business cycle. Higher real interest rates tend to raise net charge-offs and provisions, given their impact on the economy and borrower financial positions. lagged house

price growth raises the value of collateral, reducing the need for net charge-offs. The overall capital ratio is negatively related to both charge-offs and provisions, consistent with Salas and Saurina (2002) and Bikker and Metzemakers (2005) respectively.

It is possible to evaluate the impacts of an increase of 1 percentage point in overall capital on both loan-loss provisions and net charge-offs, and we plot the two paths in Figure 2. As would be expected from the lagged dependent variable, the loan-loss provisions effect settles down quickly, and if provisioning was at the 2007 rate of 0.46 percentage points then they would have fallen to 0.44 percentage points if capital had been one percentage point higher for some years. Net charge-offs, which cover a wider spectrum of assets, would have fallen from their 2007 level of 0.31 percent to 0.27 percent of the asset book. However, we should note charge-offs were exceptionally low in that year, having peaked at 0.55 per cent in 2001.

Figure 2 Impact of a one percentage point increase in risk weighted capital



It is also possible to look at the effects of changing the structure of capital, either by increasing Tier 2 capital at the expense of Tier 1 capital, or by an expansion of the same size that augments the total level of capital. Our previous thought-experiment kept the structure of capital constant. If we were to keep the level of capital constant but convert one percentage point of it from Tier 1 to Tier 2, then as we can see from Figure 3 loan-loss provisions would rise by 0.045 percent, which would have taken them to 0.50 percent in 2007 if the change had taken place some time before. Net charge-offs would have also risen by 0.05 percentage points or more, as we can see from Figure 4, increasing to 0.36 percent in 2007. The effects on loan-loss provisions and charge-offs of a one percentage point increase in capital entirely financed by issuing Tier 2 are also presented in Figures 3 and 4. Loan-loss provisions might expand by around 0.025 percentage points taking them to 0.48 percent of the loan book, whilst charge-offs, which represent actual losses, would increase by 0.02 percentage points to 0.33 per cent.

Figure 3 Impact of a one percentage point increase in Tier 2 capital on loan-loss provisions

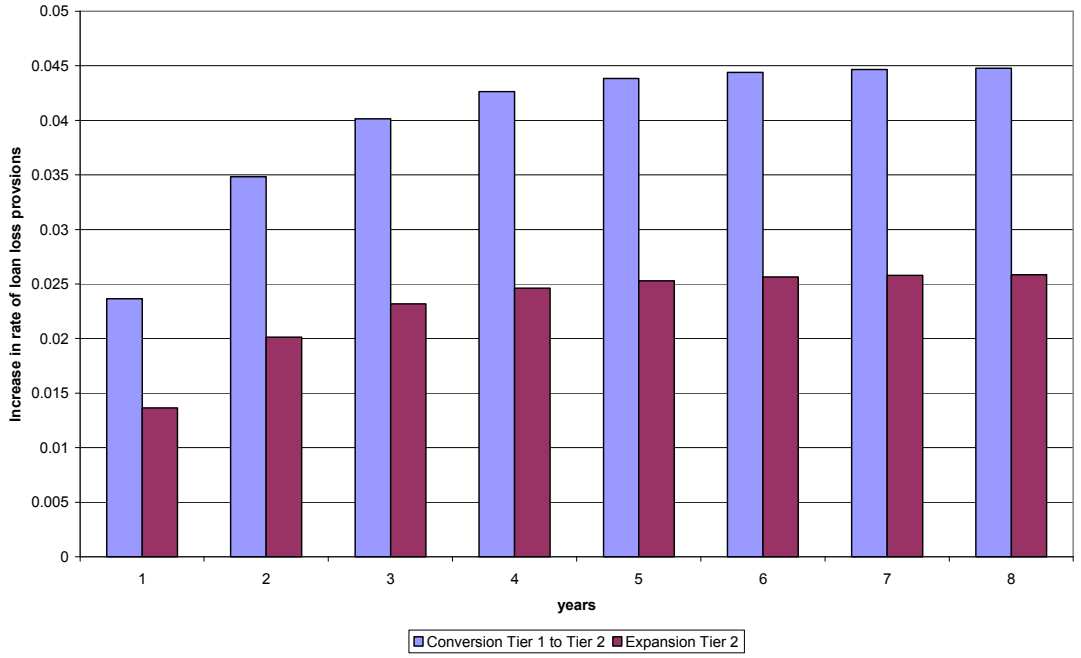
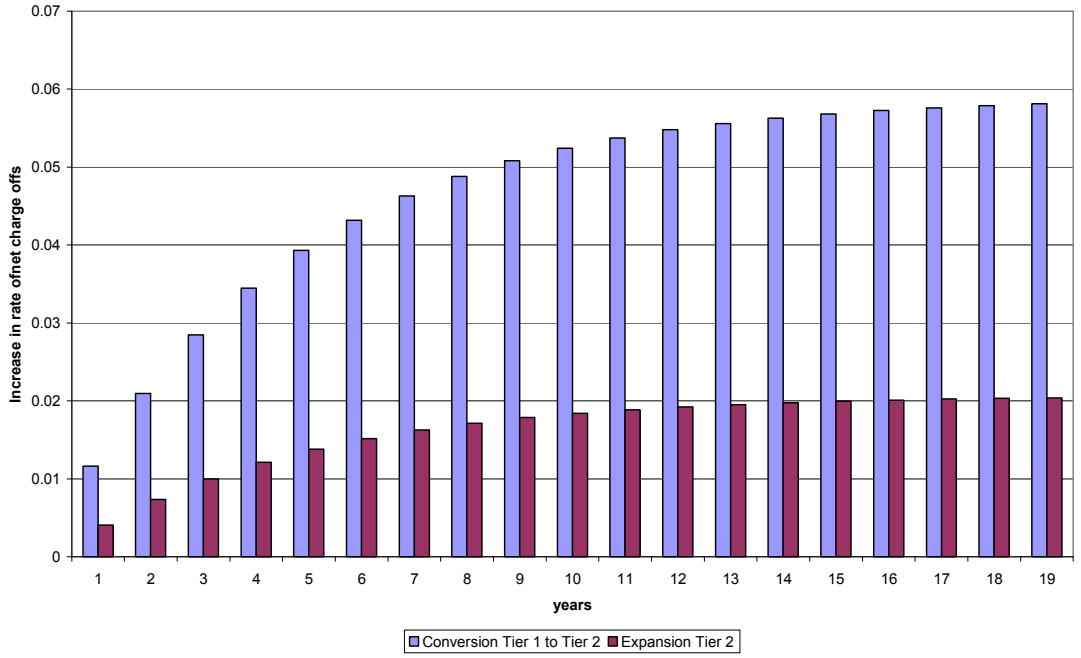


Figure 4 Impact of a one percentage point increase in Tier 2 capital on net charge off rates



If capital were to be increased solely by increasing Tier 1, and hence reducing the proportion of Tier 2, then with 2007 levels of Tier 1 and Tier 2 across our sample loan-loss provisions would fall by 0.028 percentage points rather than 0.019 percentage points with a fixed ratio, and net charge-offs would fall by 0.049 percentage points rather than 0.038 percentage points if the ratio were constant. Given that Tier 2 was around 2.6 percent of assets in 2007, if it had been swapped for Tier 1 some years before then mean loan-loss provisions would have been around 0.12 percentage points lower at 0.35, and net charge-offs would have been around 0.14

percentage points lower at 0.27, around the rate experienced in our sample between 1994 and 1998 when Tier 2 was below 2 per cent, as we can see from Figure 1.

Concerning an increase in the proportion of Tier 2 at the cost of Tier 1, the theoretical predictions shown in Appendix 2 suggest profits should increase as Tier 1 is replaced by Tier 2 since Tier 2 is less costly. Going beyond the model, profits may also be boosted if subordinated debt holders exert less monitoring on banks than shareholders, where the option nature of bank lending means banks can increase returns on the upside but can be bailed out on the downside. These factors in combination suggest banks have incentives to engage in morally hazardous behaviour following issuance of Tier 2, thereby expanding their loan books with risky projects. This should manifest itself as raised levels of net charge-offs (as credit risk materialises) and loan-loss provisions (necessitated by banks' internal credit risk models).

We have indeed found that the Tier 2 proportion has a positive effect on charge-offs and provisions – the more Tier 2, the higher the losses. Overall these results imply that banks with a high share of Tier 2 are subject to relatively poor risk management, leading to adverse outturns during recessions. The results are not consistent with the idea that market discipline is enhanced by Tier 2, or is effective in reducing bank risk taking. Rather, they imply that there is scope for more moral hazard by banks that limit their exposure to monitoring by shareholders. Our results appear to suggest that there are differences in the quality of capital as defined by Tier 1 and 2 because they drive banks to behave in different risk-generating ways. Higher Tier 2 capital seems to give scope for more moral hazard by banks that have less exposure to monitoring by shareholders.

5. Policy implications

The Basel Committee (2010) has introduced a new set of rules oriented at enhancing the stability of the banking system after recognising the risks which result from the inadequate capital (and liquidity) framework of Basel II. We investigate how the new rules of Basel III concerning the structure of the minimum capital requirement, as well as additional capital cushions in the form of conservation buffers will affect risk taking by banks in the light of our results.

Table 4: Basel III capital requirements

Calibration of the Capital Framework **Capital requirements and buffers (all numbers in per cent)**			
	Common equity (after deductions)	Tier 1 capital	Total capital
Minimum	4.5	6.0	8.0
Conservation buffer	2.5		
Minimum + conservation buffer	7.0	8.5	10.5
Countercyclical buffer range	0-2.5		

Source: BIS

Basel III increases the required minimum level of Tier 1 capital to 6 per cent of risk weighted total assets, maintaining the minimum requirement for total capital at 8 per cent. At the same time a common equity capital conservation buffer of 2.5 per cent to be held by all banks will increase the required level of equity capital to 7 per cent,

Tier 1 capital to 8.5 per cent and the ratio of total capital to assets to 10.5 per cent. On top of that banks are required to hold a countercyclical capital buffer of 0 to 2.5 per cent monitored nationally with the aim of cushioning exuberance of risk taking should it materialise during boom periods of the business cycle or early phases of a build up of a house price bubble. We might expect banks to on average hold around 1.5 percentage points extra capital over the cycle as a result of this additional buffer[17]..

Basel II raises total capital requirements on average over the cycle by around 4 percentage points (2.5 base and 1.5 cycle), and requires a reduction in Tier 2 capital to below 2 percent or risk weighted assets. We can see this as an increase in Tier 1 of 5 per cent and a reduction in Tier 2 of one per cent, and this will have a significant impact on average risk taking. Overall we might expect loan-loss provisions to fall in the long run by 0.14 percentage points, which is about a quarter of their sample average of 0.59 percent, whilst net charge-offs would fall by around 0.23 percentage points as compared to their sample average of 0.38 percent. Around half of this change would be due to the conservation buffer, whilst the rest is the result of the underlying increase in capital and the conversion of some Tier 2 into Tier 1 capital. Naturally, effects in individual banks would differ from this summary measure.

6. Conclusions

Our overall aim has been to show that bank behaviour differs when they have larger proportions of Tier 2 capital, even with a similar level of total capital. We have found that the banks in our sample in OECD countries with higher proportions of Tier 2 have higher charge-offs and higher provisions. This underlines the poor qualities of Tier 2 in terms of possible adverse incentives it may generate (for example, moral hazard leading to risk taking on behalf of managers/shareholders at the expense of subordinated debt holders), as well as being a weaker protection against banking distress. Meanwhile, total capital appears to have a positive impact on bank performance, underlining the benefits of raising the level of regulatory capital.

This exercise complements previous work using micro level data, since it gives a unique view of individual bank risk and how it is aggravated by Tier 2. Since the models are linear, they generate precise estimates of the impact of Tier 2 ratios on risk and risk taking that has simply not been done anywhere else. Overall, we contend that our work can make an important contribution to policy decisions on capital adequacy to be taken by international agreement and within national jurisdictions. It provides support for regulatory arguments in favour of a sole focus on Tier 1 in such discussions.

[17] Banks normally hold a buffer of operational capital above the regulatory floor, and this will vary with market conditions. However, as Frances and Osborne (2009) discuss, changes in the regulatory minimum are likely to have a minimal impact of the scale of the buffer, and we would expect it to remain around the 4.5 percentage points observed between 1998 and 2007

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Appendix 1: Data

As noted in the text, our data source for individual banks' balance sheets and profit and loss is Bankscope using consolidated data only. Filtering the raw data, first, we exclude the central bank, government and multilateral institutions but include all other types of bank and bank-like financial institutions. We use the definition "large banks" as set out by Bankscope, as well as the consolidated balance sheet data only. This gives a greater role of banks in the US and Japan (which have long used consolidated data) compared with European countries, although since 2000 more and more European banks have also provided consolidated accounts. We also excluded banks with less than four years' continuous observations.

In order to avoid outliers we trimmed the data according to the following rules: loan growth not exceeding 50% in absolute terms, asset growth not exceeding 50% in absolute terms, a ratio of bank loans to bank assets larger than 10% and smaller than 90%. The resultant dataset has 713 banks and the country distribution is shown in Table A1 in the Appendix, with around half of banks being from the US and Japan, the rest distributed across EU countries and Canada. Table A2 shows the distribution of variables. We note that the correlation between TOTCAP and TIER2R is -0.29 suggesting that weaker banks in terms of overall capitalisation tend to issue Tier 2.

Table A1: Country distribution of banks

Country	Banks	Percent of sample	Country	Banks	Percent of sample
Belgium	4	0.6	**Japan**	132	18.5
Canada	27	3.8	**Netherlands**	20	2.8
Denmark	12	1.7	**Norway**	9	1.3
Finland	6	0.8	**Spain**	48	6.7
France	53	7.4	**Sweden**	5	0.7
Germany	36	5	**UK**	51	7.2
Italy	35	4.9	**US**	275	38.6
Japan	132	18.5	**Total**	**713**	

Table A2: Variables used (in percent)

Variable	Mean	Median	Standard deviation	Minimum	Maximum
DRLOAN	8.0	7.1	13.6	-48.2	47.8
NCO	0.38	0.14	0.69	0.0	6.0
LLP	0.59	0.34	0.95	-8.01	9.72
GDP	2.36	2.49	1.53	-2.15	6.34
RSR	1.94	1.80	1.66	-1.49	9.73
DRHP	2.30	1.70	4.90	-7.97	19.65
LASSR	64.09	66.88	14.55	11.32	89.98
NIM	2.55	2.41	12.37	-3.82	9.75
TOTCAPR	12.44	11.80	3.39	-1.50	28.90
TIER2R	0.177	0.126	0.139	-2.65	1.0

Table A3: Data sources

Variable	Source	Notes	Coverage
Net Charge-offs	Bankscope*	Extracted from banks' annual statements	1993 - 2008
Total Assets	Bankscope*	Extracted from banks' annual statements	1993 - 2008
Real Loan Growth	Bankscope*	Calculated from loan levels which are extracted from banks' annual statements	1993 - 2008
Capital Adequacy	Bankscope*	Extracted from banks' annual statements	1993 - 2008
Tier 2 Proportion	Calculated based on Bankscope data for Tier 1and Capital Adequacy	Tier 1 data extracted from banks' annual statements	1993 - 2008
GDP growth	National Accounts	Extracted from the NIESR NiGEM database	1993 - 2008
Interest rates	National Accounts	Extracted from the NIESR NiGEM database	1993 - 2008
Residential Property Price Growth	European Central Bank and Bank for International Settlements	Extracted from the NIESR NiGEM database	1993 - 2008

* Bankscope is the proprietary database of Bureau van Dijk Electronic Publishing

Appendix 2: Modelling the Impact of Tier 2 on Bank Profits

As set out in Section 2, there are typically three constraints on bank capital. Let RL be risk adjusted assets, while EQ as before is equity (Tier 1 capital) and SD is subordinated debt (Tier 2). The regulatory constraints require that a certain proportion of assets (γ_1)[18] must be backed by EQ, that the proportion of total capital on the balance sheet must be equal to or above a required level (γ_2)[19] and that SD cannot exceed EQ, giving us $\gamma_1 AS \leq EQ$; $\gamma_2 AS \leq K=EQ+SD$ and $0 < SD \leq EQ$ respectively[20].

Within the capital constraints, banks seek to generate profits (Π) arising from the returns on their net assets subject to losses from defaults. Simplifying (4) above, Bank profits (Π)[21] can be expressed as:

$$\Pi = r_{sa} SA - r_D D - r_{sd} SD - BL \qquad \text{(A1)}$$

where Π is profit as above; r_{sa} is the return on assets, SA; which is made up of the return on loans and the return on liquid assets, r_D is the return on deposits (D) and ($r_D < r_{sa}$); r_{sd} is the cost of (Tier 2) subordinated debt, SD and $B < 1$ is the proportion of loans that default.

The cost of debt finance can be expressed as a proportion (θ) of the equity financing cost (r_e), and this could be as high as unity.

Since a proportion (γ_2) of loans must be covered by capital, SA= K/ γ_2 and so

$$SA = \frac{EQ + SD}{\gamma_2} \qquad \text{(A2)}$$

Loans must be financed either by deposits or capital and therefore

$$D = (1 - \gamma_2) SA \qquad \text{(A3)}$$

Hence, equation (7) can be rewritten as

$$\Pi = \left(\frac{EQ + SD}{\gamma_2} \right) \left[r_L - r_d (1 - \gamma_2) - \theta r_e (\gamma_2 - \gamma_1) - B \right] \qquad \text{(A4)}$$

Using the constraints and (A3) we can take the derivative [22] of profits with respect to total capital and with respect to changes in capital composition[23],:

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[18] Where γ_1 is 4% under Basel I and II and 8.5% in normal times under Basel III (including the capital conservation buffer of 2.5%).

[19] Where γ_2 is 8% under Basel II and 10.5% in normal times under Basel III (including the capital conservation buffer of 2.5%).

[20] As a corollary, note that Basel II also specifically required that the ratio of Tier 1 to Tier 2 is such that: $2 * \gamma_1 \geq \gamma_2$ _ under Basel III the ratio is 8.5/2 in normal times (including the capital conservation buffer of 2.5%).

[21] We elide the issue of the return on liquid assets and the issue of loan-loss provisions discussed above since these make no difference to our analysis at this point

$$\frac{\delta \Pi}{\delta \gamma_2} = -\left(\frac{EQ+SD}{\gamma_2^2}\right)\left[r_L - r_d(1-\gamma_2) - \theta r_e(\gamma_2 - \gamma_1) - B\right] + (r_d - \theta r_e)\left(\frac{EQ+SD}{\gamma_2}\right) \quad \text{(A5)}$$

since $r_d < \theta r_e$, $\frac{\delta \Pi}{\delta \gamma_2} < 0$ and so an increase in the regulatory capital ratio reduces profits;

$$\frac{\delta \Pi}{\delta EQ} = \theta r_e \quad \text{(A6)}$$

Equation (A6) shows that when Tier 1 increases by one unit, profits only increase by θr_e. Since Tier 1 (equity capital) normally earns a return of r_e, increasing the proportion of Tier 1 in the capital base dilutes profits. Conversely, increasing Tier 2 by one unit will increase profits by $(1-\theta)r_e$. The greater the differential between the cost of debt and equity the more the bank will have an incentive to load up with Tier 2. It could of course be the case that the market may perceive increases in Tier 2 capital as associated with a change in behaviour, and hence the cost of equity finance could rise as more Tier 2 is issued. This would put an upper limit on the amount of Tier 2 that is held that would be below the regulatory maximum. Indeed, as we can see from Figure 1 above, Tier 2 holdings are below the maximum permitted, at least in the sample of banks we study. Hence we can presume that the markets are aware that Tier 1 and Tier 2 are not perfect substitutes, and the Modigliani Miller theorem perhaps should not be used blindly when commenting on bank behaviour.

[22] On the assumption that the constraints become binding, that is that banks lend up to the limit allowed by their capital buffers.

[23] For this we assume that a unit of equity is replaced by a unit of subordinated debt to keep the overall ratio (γ_2) fixed. Therefore we assume dT1/dT2 = -1.