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Rightsizing Bank Capital for Small, Open Economies

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Abstract

In a macroeconomic cost versus benefit framework, we determine the appropriate Tier 1 capital ratio for the banking system of advanced economies. Of particular interest is the appropriate bank capital range for countries sharing similar macro-financial structural characteristics, during times of normal prevailing risk conditions. The characteristics considered include the relative size of the economy, trade and financial openness, the degree to which the country is FDI-dependent and various measures of banking system concentration. We find that, when the prevailing systemic risk environment is neither elevated nor subdued and other critical modelling parameters are set to plausible levels, an appropriate level for the Tier 1 capital ratio in advanced economies can lie in the range of 12% to 20%, with our benchmark estimate being 16%. When considering the additional risk inherent with being a small, open, FDI-reliant economy with a concentrated banking system, this range and benchmark can be up to 1.25 percentage points higher.

JEL classification: E5, G01, G17, G28, R39.

Keywords: optimal bank capital, macroprudential policy, macro-financial structure, systemic risk, financial crises, financial regulation

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Non Technical Summary

In this paper we estimate the macroeconomic costs and benefits associated with requiring banks to have increasing amounts of loss-absorbing capital (Tier 1 capital). Higher amounts of capital provides greater resilience to banks should losses arise. However, having to fund a larger proportion of their assets with loss-absorbing capital can mean that the cost of lending may be higher, or the supply of credit lower than it would otherwise be. Prior literature has attempted to balance these competing forces to try to determine the appropriate level of capital in the banking system, where the macroeconomic costs of any additional capital outweighs the benefits. We build on this literature, while also examining the extent to which certain characteristics of the economy and financial system can influence the appropriate capital level.

The macroeconomic benefits of higher bank capital ratios are based on the potential for higher capital to reduce the probability of a damaging banking crisis emerging in the economy. Previous experience in Ireland and in other advanced economies highlights that when such crises emerge there are significant negative outcomes for households, businesses and the wider economy. In our analysis we quantify the additional benefit in terms of reducing crisis probability that can accrue from increasing capital ratios, and find that those additional benefits get smaller the higher the capital ratio is. On the cost side, we use two macroeconomic models incorporating the key relationships within the Irish economy between banks, households and businesses. These models estimate the effect that higher interest rates, related to the cost for banks to fund themselves with increasing levels of capital, have on consumption, investment and wider economic growth. We then combine these costs and the (diminishing) benefits for given levels of the Tier 1 capital level and find that for advanced economies, during normal times, the appropriate Tier 1 capital ratio at which no additional net benefit can be realised is 16%. However, this benchmark estimate relies on certain key assumptions, such as whether the costs of crises are permanent or temporary and the extent to which higher capital ratios automatically pass-through to bank funding costs. We establish a range of estimates between 12% and 20% depending on values chosen for these key assumptions, during periods of normal systemic risk conditions. This range is in line with multiple studies which follow the same costs-versus-benefits framework as the one adopted in this paper.

We also make an important contribution to the literature in that we extend the analysis to cater for macro-financial structure-related characteristics of certain countries. In particular, we examine whether or not the appropriate Tier 1 Capital benchmark and range differs depending on the size of the economy, the degree to which it is trade

or financially open, FDI dependent, or having a banking system concentrated along a number of dimensions. We find that for cohorts of countries that are small, open, have a large share of inward FDI and a more concentrated banking system, a Tier 1 capital ratio up to 1.25 percentage points higher than the average advanced economy may be appropriate. This higher level of capital ensures the net benefits of bank capital are maximised.

The approach adopted by our study, in concordance with the literature, assumes that the prevailing systemic risk background is “neutral”, i.e. neither elevated nor low. As such, specific bank risks or the implications of prevailing cyclical conditions per se are not considered within the analysis. Nor do we directly incorporate estimates for the effect of any enhancements to the resolution framework in each country, or the adoption of the Minimum Requirement for Eligible Liabilities (MREL). However the findings of this paper can inform wider consideration on the specific approach to macroprudential capital buffers at a given point in time.

1 Introduction

Given their importance in the economy, banks face a number of requirements on the quantity and quality of their funding structure. Large losses in the banking system can have considerable spillover consequences for the real economy, which cannot be fully internalised by individual banks when mitigating their own risk profile. In addition, banks benefit from both explicit and implicit deposit insurance. Since capital represents the first line of defence from a loss-absorption point of view, banks are required to hold minimum levels of capital in line with existing regulations, regardless of the contribution of debt to their funding structure. In addition, they must fund themselves via tranches of capital to cater for specifically-targeted balance sheet related risks, as well as systemic risk related to the broader environment or the systemic importance of a particular institution.

In O'Brien & Wosser (2022) we find that economies which are smaller, display more trade and financial openness, have a higher dependency on foreign direct investment (FDI) and a higher degree of market and sectoral exposure concentration in their banking system tend to have relatively higher systemic banking crisis probabilities, suffer larger systemic banking crisis-related costs and exhibit relatively more adverse GDP growth tail risk through the financial cycle. In this paper we examine the implications for appropriate levels of capital in the banking system of countries which display these structural characteristics. Specifically, we examine the influence of macro-financial structural characteristics on the appropriate range of Tier 1 capital during periods when cyclical systemic risks are neither elevated nor subdued, including as necessary any additional bank capital needed to mitigate the effect of such structure-related systemic risks. To-date, this issue doesn't appear to have been addressed in the extant literature.[1]

Several studies have attempted to establish an appropriate capital range for particular banking systems based on the macroeconomic cost versus benefit methodology we follow in this paper (see Table 5). In the post global financial-crisis (GFC) era, the Basel Committee on Banking Supervision (2010) study found the "optimal" Tier 1 capital ratio range as being 10%-15% for advanced economies.[2] However, as the approach has been refined and applied in other settings, the range found in subsequent studies is often somewhat higher.

[1] BCBS (2019)

[2] In an update to their paper, they acknowledge subsequent studies and conclude that optimal capital levels are likely to be higher than originally estimated.

From a methodological perspective, our approach is most similar to that of Brooke et al. (2015), who in turn follow Miles et al. (2013), although we depart from their paper in how we treat some modelling assumptions. Depending on the assumed effectiveness of the resolution regime for banks that are failing or likely to fail, Brooke et al. (2015) establish an optimal capital range of between 10% to 19% for the UK. Abstracting from the potential benefits of the resolution regime, Miles et al. (2013) similarly find much higher levels of capital than the original BCBS study were appropriate for the UK, up to as much as 20%.

Firestone et al (2019) consider the US economy and estimate the optimal Tier 1 capital ratio at 13% to 25%. In their analysis, the Modigliani and Miller offset does not fully hold, which has the effect of raising the optimal capital levels somewhat and goes some way toward explaining their relatively higher upper bound. In one of the few papers to specifically consider a smaller economy, Almenberg et al. (2017) determine the appropriate capital range for Sweden. They estimate the ideal Tier 1 capital range as falling in a slightly lower range (10%-24% range with MM offset set to 0). However, this paper does not consider the specific contribution that the macro-financial structural characteristics of Sweden contribute to their findings.

Barth and Miller (2018) examine the costs and benefits from raising the leverage ratio from 4% to 15%.[3] They find that, in their benchmark specification, the ideal leverage ratio is 19% (equating to a Tier 1 capital ratio of circa 25%). At those levels of capital, banks are able to absorb very high losses and almost completely shield the sovereign from having to recapitalise the banking system following crisis onset.

Of particular interest is the study conducted by Cline (2016) who examines optimal capital across a range of countries, including Ireland. Our benchmark model results compares closely with theirs (17.5%). This suggests that smaller countries may benefit from slightly higher capital levels than larger countries such as the US and UK.

In line with the previous literature, we examine the resulting macroeconomic costs and benefits associated with requiring banks to fund themselves through additional capital. Following a similar methodology to the papers listed above, we find that for advanced economies during periods when systemic risk is neither elevated or subdued the net marginal benefit of higher capital is minimised when the Tier 1 capital ratio is 16%. Below this point, the benefits of higher capital still outweigh the costs, whereas above this point the opposite is the case. The results require a range of assumptions on key modelling parameters, such as whether the Modigliani-Miller offset holds, the duration of crises,

[3] Defined as total capital divided by total exposures (i.e. inclusive of off-balance-sheet items. The leverage ratio can be converted to a Tier 1 capital ratio via the application of a risk-weighted asset scaling factor.

and the discount factor applied to future GDP losses related to systemic banking crises. Arising from this is a range of appropriate capital levels during normal risk environments around 16% (12% to 20%), based on modelling assumptions. It is important to note, however, that our analysis does not address ancillary factors such as changes in the resolution framework or in approaches to risk weighting which may also influence both the steady-state and transition costs or benefits of particular capital levels.

In terms of the main focus of the paper, we find that the net benefit of higher capital is up to 1.25% when taking macro-financial structural characteristics into account. This additional capital holds throughout the range derived from various modelling parameter assumptions, indicating that small, trade and financially open economies with more concentrated banking systems would consistently benefit from additional capital of this magnitude relative to other advanced economies.

The paper is organised as follows. Section 2 outlines the overall approach and methodology, followed by the results focusing first on the macroeconomic benefits associated with higher bank capital, then the costs and finally the combination of the two with specific reference to the role of macro-financial structural characteristics. We briefly consider some robustness tests for our analysis in Section 3. The conclusions reached, along with their associated macroprudential policy implications, are outlined in Section 4 .

2 Estimating the Costs and Benefits of Higher Capital

We adopt and slightly modify the "top-down" optimal capital approach set out in the existing literature. The methodology determines the marginal macroeconomic costs and benefits associated with additional bank capital. Both are measured and presented in GDP terms. In this framework the marginal benefit of higher capital relates to any reduction in the probability of a systemic banking crisis as capital levels increase. The reduced probability of a crisis in turn reduces the potential GDP losses that arise when systemic banking crises emerge. The marginal costs of additional capital relate to the potential for higher bank lending rates, which dampens consumption, investment and wider GDP growth relative to what would otherwise be the case. Combining the marginal benefit and the cost of additional bank capital yields the net marginal benefit, as in the following equation:

$$NetMargBen = (\Delta CrisisProb * CrisisCost) - \Delta CapitalCost \tag{1}$$

which remains positive up until the point at which the costs associated with a given level of capital exceed the benefits. The level of capital achieved at that point is the estimate of the appropriate level of capital for a given banking system.

In order to address our main research question - the role of macro-financial structural characteristics in determining appropriate levels of bank capital - we primarily focus on how these factors can influence the marginal benefit side of 1. Specifically we examine how these characteristics can influence the probability of systemic banking crises through the financial cycle. Our approach for the marginal cost side relies on structural and semi-structural models of the Irish economy, the proto-typical small, open advanced economy. Many of the features captured in our modelling approach may be generalisable to smaller, more trade and financially open economies overall.

Marginal Benefits of Higher Capital

Our first step is to estimate systemic banking crisis probabilities for each country at each quarter through time. We use a pooled logit model following O'Brien and Wosser (2018), which estimates systemic banking crisis probabilities for up to 27 advanced economies including Ireland.[4]. Crisis probabilities are estimated within a forecasting horizon of up to 2 years, conditional on a range of contemporaneous indicators found in the literature to have robust predictive properties, augmented by a Tier 1 bank capital variable. The model estimates the following regression specification using bi-annual data from 1980 to 2021:

$$Log\left(\frac{Pr(Crisis_{it}|Z_{it})}{Pr(NoCrisis_{it}|Z_{it)})}\right) = \alpha + \beta Z_{it} + \epsilon_{it} \tag{2}$$

The dependant variable is a binary variable which is 1 for crisis periods and 0 otherwise. To determine crisis and non-crisis periods in our sample we use data from Lo Duca et al. (2017) for European countries and Laeven and Valencia (2013) for non-European countries. Based on the definitions in Laeven & Valencia (2013) and Lo Duca et al. (2017), systemic banking crises are those which result in the failure of one or more banks, exhibit some extent of bank-to-bank contagion, have some government-backed support programme for the banking sector and some spillovers from the banking system losses to the real economy. In the benchmark O'Brien and Wosser (2018) specification, vector Z_{it} comprises eight leading indicator variables: i) the short-term interest rate, ii) the credit-to-GDP ratio, iii) a house price index and iv) its deviation from its long-run trend, v) losses on equity markets, vi) unemployment rates, vii) a financial conditions index and viii) the

[4]The logit model has become the de-facto standard in the literature. See Demirgüç-Kunt & Detragiache (1997), Davis & Karim (2008), Eichler & Sobański (2012) and Lo Duca & Peltonen (2013)

extent of household leverage relative to GDP. To this specification we add the Tier 1 capital ratio in the banking system for each country in our sample.[5]

Our data are pooled across all countries, with standard errors clustered by country. We do not use a fixed effects model, so that countries which never experienced a banking crisis may be included in the estimation process. Later, we add dummy variables capturing structural characteristics to the model, allowing for any role of macro-financial structural characteristics to be identified.

To estimate the marginal effect of higher capital on crisis probability, we hold the remaining explanatory variables at their sample median levels to reflect time periods when systemic risk levels are neither elevated nor subdued. We then repeatedly estimate crisis probabilities for each value of the Tier 1 capital ratio ranging from 5% to 30% in 1% increments. The fitted crisis probabilities across this range allow the marginal contribution of each additional 1% of Tier 1 capital to be estimated. Fitted systemic banking crisis probabilities are determined according to the following equation:

$$Pr\left(Crisis_{it} = \frac{e^{Z_{it}\beta}}{1+e^{Z_{it}\beta}}\right) \tag{3}$$

An example of the regression output from one of the underlying logit models is presented in Table 9. In this model, Tier 1 capital is negative and statistically significant at the 5% level, indicating that the given level of Tier 1 capital reduces the likelihood of a systemic banking crisis emerging in the subsequent two years when general risk conditions are neither elevated nor subdued. This finding of a negative and statistically significant coefficient is robust to alternative model specifications.[6] However, there are diminishing marginal benefits as Tier 1 capital increases. This is an important result with ramifications for any optimal capital assessment study. Without it no marginal benefit curve would exist and the analysis would break down at this point.

As equation 1 makes clear, there are two dimensions associated with calculating the marginal benefits of capital, involving crisis probability and expected crisis cost. In our analysis we use a common measure of the cost of crises derived from the crises identified in our sample. We estimate costs as the difference between actual GDP in the five years following the onset of a systemic banking crisis and a pre-crisis linear projection of GDP over the same period, and express this difference as as a percentage of the projected

[5] The list of our sample countries is provided in Table 6. Data sources and summary statistics are shown in Table 7.

[6] We confirm the latter by following the same procedure in O'Brien and Wosser (2018), in turn based on the algorithm put forward by Young and Holsteen (2017).

values.[7] The results suggest that, on average, crises reduce GDP by 7.17 per cent relative to pre-crisis trend. This is in line with prior studies as shown in Table 1.

The final elements to consider when estimating the marginal benefit of higher bank capital are: (i) the permanence or transience of the shock to GDP arising from crises, (ii) if the crisis costs are transient how long will they last for, and (iii) the discount rate to be applied to the losses to calculate them on a present value basis.

If the loss in GDP is permanent from a systemic banking crisis, the present value (PV) of the loss can be calculated using the formula for a perpetuity, with the PV of the loss (C = 7.17%) determined via a range of discount factors "r" according to this formula:

$$PV(Crisis_{it}) = \frac{C}{r} \tag{4}$$

In contrast, if the costs of crises are assumed to be transient, then the period of time over which they last "t" as well as the discount factor "r" has to be factored in according to the following formula (again with C= 7.17%):

$$PV(Crisis_{it}) = C\left(\frac{1-(1+r)^{-t}}{r}\right) \tag{5}$$

Overall, our estimate of the marginal benefit of higher bank capital is the reduction in crisis probability at each level of the Tier 1 capital ratio multiplied by the expected crisis cost as calculated above.

Marginal Costs of Higher Capital

Imposing additional capital requirements on the banking sector may raise banks' funding costs and ultimately lead to higher interest rates on lending to firms and households. The macroeconomic cost of higher capital is the lower growth in consumption, investment and GDP as a result of the increase in interest rates relative to the scenario in which capital requirements remain unchanged. We examine the extent of this through the lens of two macroeconomic models used in the analysis of the Irish economy - COSMO and EireMod.

The transmission mechanism of an increase in capital requirements to the real economy is broadly similar in both models. There are several channels through which banks can raise their risk-weighted capital ratios: through retained earnings, via deleveraging, by shifting the risk profile of their lending portfolios, or by issuing new equity. Both COSMO

[7] Calculated using an exponentially weighted moving average of the GDP series up to the quarter where the crisis is deemed to have commenced.

and EireMod assume that banks generate higher capital ratios through raising retained earnings. This assumption is consistent with the "pecking order theory" (Myers and Majluf, 1984) according to which banks prefer to exhaust internal funds first due to having to pay a premium on external finance. It is also consistent with other studies that use macroeconomic models to assess the costs of higher capital requirements (BCBS, 2010) and with the empirical evidence on the behaviour banks' capital ratios since the global financial crisis (Cohen and Scatigna, 2016). Deleveraging does occur endogenously in COSMO and EireMod as households and firms demand less credit in response to higher lending rates.

To quantify the impact of higher capital requirements, we simulate a scenario in both COSMO and EireMod in which banks are required to increase their capital ratios by one percentage point. Following the literature on optimal levels of capital, our analysis focuses on the long-run or "steady-state" impact of higher requirements and abstracts from transition costs.[8]

COSMO

COSMO is a medium-scale estimated semi-structural model of the Irish economy. At its core it comprises three sectors: a traded sector that depends on world demand and Ireland's export prices relative to competitors; a non-traded sector that is primarily driven by domestic economic conditions; and a government sector that grows in line with the rest of the economy in the absence of exogenous policy changes.[9]

The model incorporates a wide range of linkages between the central bank, retail banks, households and firms. A key feature of the model is that it includes several borrower- and lender based macroprudential instruments. The central bank can set limits on loan-to-income (LTI) and loan-to-value (LTV) ratios on household mortgage borrowing. Given the focus of our study, it can also impose additional capital requirements or buffers on banks by raising their target capital ratio. These macroprudential and macro-financial linkages are illustrated in Figure 1, where the transmission path of capital shocks to the economy are represented by the solid arrows and that of other macroprudential and monetary shocks are represented by the dashed arrows.

[8] If banks are required to increase capital ratios relatively quickly, they may choose to adjust loan volumes rather than interest rates. This may generate substantial short-run economic costs (Bridges et al. (2014); Aiyar et al. (2016)).

[9] See Bergin et al. (2017), Conefrey et al. (2018) and McInerney (2020) for details on different aspects of COSMO.

COSMO assumes a monopolistically competitive banking sector in which banks set lending rates as a variable spread over deposit and wholesale funding costs. These lending rates form supply curves for the respective types of credit in the model: mortgages, consumer credit, commercial real estate (CRE) lending, and other (non-CRE) corporate credit. Lending spreads are a function of policy and risk factors and it is through the spread that lender-based macroprudential instruments operate. When the central bank raises capital requirements banks respond by raising lending spreads so as to generate the necessary increase in retained earnings to meet the new target capital ratio.

Higher lending rates increase the user cost of capital for firms and households and reduce the demand for all types of credit. The contraction in credit depresses house prices. This reduces household consumption through the housing wealth effect and residential investment due to the fall in the profitability of housing construction. The combination of higher mortgage rates and lower house prices pushes up the rate of household mortgage arrears. As lending to households is now riskier, banks raise lending spreads on loans to this sector.

Similarly, higher borrowing costs reduce corporate investment while the fall in CRE prices reduces investment in CRE. The fall in CRE prices reduces the value of collateral used for corporate borrowing leading to a fall in both CRE and non-CRE corporate lending. Lower collateral values also affect firms' ability to rollover existing credit lines and obtain working capital. This increases the rate of corporate insolvency, which as a driver of the risk component of the corporate lending rate, further raises firms' user cost of capital. The cumulative fall in investment leads to lower capital stocks and accordingly reduces the productive capacity of each sector in the economy in the long run.

To assess the the macroeconomic cost of higher capital requirements we simulate a one percentage point increase in banks' capital ratios in COSMO. The impact on key variables is reported in Table 2. To generate the retained earnings necessary to meet the new target for the capital ratio, banks raise the weighted-average lending rate by 11 basis points relative to the baseline scenario in which capital requirements do not change.[10] The increase in the cost of borrowing reduces the demand for credit, with the weighted-average stock of credit falling by 0.6 percent.[11]

The increase in lending rates raises the user cost of capital for both firms and households. In response, total investment falls by approximately 0.3 percent. CRE and residential

[10] The weighted-average rise in lending rates comprises an increase of 10, 11, and 19 bps in corporate, mortgage, and consumer lending rates, respectively.

[11] This comprises a fall of 0.5, 0.4, 0.7 and 0.8 percent in the stock of mortgage, (non-CRE) corporate, CRE, and consumer credit, respectively.

investment, which are more interest-sensitive than other types of investment, fall by 0.5 percent and 0.6 percent, respectively. The increase in the user cost of housing capital reduces the demand for housing leading to a fall in house prices relative to baseline of 0.4 percent. Household consumption falls by 0.06 percent due to the negative wealth effect arising from lower house prices.

Overall, the long-run macroeconomic impact of a one percentage point increase in capital requirements in COSMO is to reduce GDP by 0.05 percent and employment by 0.06 percent. However, the impact on the more bank-dependent, domestically- oriented sectors of the economy is larger, with the output of the non-traded sector falling by 0.12 percent relative to baseline.[12]

Eiremod

Eiremod is a DSGE model of the Irish economy. At its core it comprises two sectors: a tradable-good sector, which consists of firms producing consumption and investment goods for the domestic market and a tradable goods sector producing export goods. The tradable goods sector uses intermediate imported goods as input and employ foreign capital as a factor of production. The core structure of the model has been extended by Lozej et al. (2022) to include a realistic financial sector, so that credit is intermediated by banks subject to a minimum capital requirement.

In the model, an implicit government guarantee on deposits creates an incentive for banks to increase leverage. As discussed below, this creates a break with the Modigliani Miller proposition. As banks face a trade-off between increasing their leverage and incurring regulatory penalties if a shock hit their balance-sheet, they optimally set their capital ratio above the regulatory minimum. All else equal, a marginal increase in the capital requirement, forces the bank to deleverage, decreasing bank's profitability. Monopolistically competitive banks respond to the decline in profitability by increasing the lending rate. In the long run, the lending rate will increase enough to keep the return-on-equity unaltered.

The model features a central role of the banking system in credit intermediation, by assuming that at each point in time, a constant share of both productive capital and the housing stock is intermediated through bank loans. An increase in the lending rate, will therefore directly affect investment in productive capital and the demand for housing,

[12]The traded, non-traded and government sectors in COSMO are defined using the CSO's Supply and Use Input-Output tables. The non-traded sector includes those sectors in which less than 50 percent of total final uses is exported and those sectors in which less than 50 percent of total final uses are used as government consumption.

which, in turn, affect investment in the construction sector. In the long run, capital will be lower, limiting production possibilities in the economy. Overall, the long-run macroeconomic impact of a one percentage point increase in capital requirements in EireMod is to increase average lending rates by 10 basis points and to reduce GDP by about 0.04 percent.[13]

The Modigliani-Miller Offset

The Modigliani-Miller theorem (Modigliani & Miller (1958)) comprises two propositions. The first states that in a perfectly competitive and frictionless economy the value of a firm is independent of how it is financed while the second postulates that, given the first proposition holds, the cost of equity for a leveraged firm increases linearly with the debt-to-equity ratio. The implication of the theorem is that the relative returns on debt and equity adjust in response to a change in the capital structure so that the weighted average cost of capital (WACC) remains constant. For example, an increase in capital (reduction in leverage) reduces the volatility of the return on equity and therefore lowers its required return.

However, there are two main distortions that prevent the Modigliani-Miller theorem holding empirically in relation to banks. The first is the tax treatment of debt- banks' interest payments on debt can be used to reduce their tax liabilities. The second relates to the implicit or explicit public guarantees on banks' debt, mainly deposits. This acts as a subsidy to banks that reduces the cost of debt relative to equity, which does not enjoy such guarantees.

Accordingly, the key question from an empirical perspective is whether the required return on equity falls as the volatility of the return falls due to higher capital ratios (or lower leverage). The most common approach to testing the Modigliani-Miller theorem uses the Hamada (1972) framework that combines the theorem with the Capital Asset Pricing Model (CAPM). Essentially, this involves estimating the relationship between a bank's leverage and its equity beta.[14] Assuming that the beta of a bank's debt is zero, this gives a relationship between the beta (or riskiness) of a bank's assets and its leverage (Miles et al. (2013)).[15]

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[13] A more detailed decomposition of these results are available from the authors.

[14] A bank's equity beta measures the covariance between the return on the bank's equity and that of the overall market.

[15] Assuming a debt beta of zero implies that debt has bank-specific default risk but no systematic market risk.

As Table 3 shows, the empirical evidence on the Modigliani-Miller theorem is mixed. The estimated values for the offset from the literature range from zero to a full offset, with a median value of close to 50 percent. There is some evidence that the offset is close to full for large or too-big-to-fail banks but significantly lower for small- and medium-sized banks (Clark et al. (2018)) and some evidence that it is time-varying (Kashyap et al. (2010)).

Given the considerable heterogeneity in estimates of the offset together with the absence of specific estimates for Irish banks, it is not clear which value for the offset should be applied to the increase in lending rates. Moreover, in many studies that examine the macroeconomic impact of higher capital requirements, the rate at which the increase in lending rate is "offset" by a fall in the required return on equity is simply assumed. For simplicity, we assume that the offset is zero. However, as both COSMO and EireMod are linear models, any value for the offset can be applied ex-post by scaling the fall in output due to higher capital requirements by that value.

Comparing Cost Estimates With Other Studies

Table 4 compares the impact of a one percentage point on lending rates and GDP in COSMO and EireMod with estimates for other countries. Similar to our approach, some of these studies such as BCBS (2010) and Mikkelsen and Pedersen (2017) use macro models that include a banking sector to quantify the impact of higher capital requirements on both lending rates and GDP and which allow for feedback from the real economy to the banking sector. The remaining studies broadly adopt a two-step approach. They first use a basic loan pricing model and information on the relative cost of debt and equity to calculate how lending spreads may increase in response to higher capital requirements. They then feed this information into either a simple production function as an increase in the cost of capital (Brooke et al, 2015; Cline, 2016) or as an increase in bond spreads facing non-financial firms in a macro model (FRB Minneapolis, 2016; Almenberg et al, 2017; Firestone et al, 2019).

All of the approaches yield broadly similar results to those from COSMO and EireMod in terms of the long-run increase in lending spreads and fall in output relative to a baseline. The study by the Basel Committee on Banking Supervision (BCBS, 2010) is perhaps the most comprehensive as it covers 13 countries and uses a variety of models. It finds that a one percentage point increase in capital requirements raise lending rates by between 9 and 19 basis points and reduces output relative to baseline between 0.02 and 0.35 percent of GDP. However, our results are closest to those of the Bank of England (Brooke et al, 2015). They find that a similar increase in capital requirements raises lending rates by between 5 and 10 basis points and reduces output relative to baseline by between 0.01 and 0.05 percent, depending on the value of the MM offset applied. As the results from COSMO and EireMod assume the MM offset is zero they closely match the upper bound in Brooke et al (2015).

Although the results from COSMO and EireMod for the impact on GDP of higher capital requirements are consistent with other studies, they are clearly amongst the lowest in the literature. One reason for this may be the dominant role played by multinational corporations (MNCs) in economy activity in Ireland. MNCs tend to use internal channels to raise funding and are therefore not bank-dependent like Irish SMEs (Desai et al, 2004; Lawless et al, 2014). Accordingly, the impact of higher capital requirements on an aggregate measure like GDP is likely to be significantly lower than the impact on the output of the more domestically-oriented sectors of the economy.

Net Marginal Benefit of Higher Capital and the Role of Macro-financial Structural Characteristics

Bringing our estimates together we plot the resulting marginal benefit and marginal cost curves commensurate with given levels of Tier 1 capital in Figures 2a and 2b. The point at which these curves intersect corresponds with the level of capital at which no further net benefit can be achieved by increasing the Tier 1 capital ratio. Permanent crisis effects are represented in Figure 2a with the temporary crisis equivalent shown in Figure 2b (rhs). On this basis, the net marginal benefit of additional capital is fully realised at 16% (where crises induce permanently lower GDP) or at 12% (crisis repercussions are transitory for a period of 5 years).

We designate the model graphed as Fig 2a as our "benchmark" optimal capital model. This represents the benchmark case against which different model calibration scenarios are compared. The benchmark model includes all 8 EWS variables, set to their median values, as well as a variable representing the Tier 1 capital ratio. It assumes crises have permanently harmful effects, cost 7.17% of GDP relative to the pre-crisis trend and are discounted at 3% per annum. There is no Modigliani Miller output cost reduction offset in this specification.

To estimate the appropriate Tier 1 capital range stemming from model calibration choices we allow the key input parameters to vary. For example, setting the Modigliani Miller offset to a value of 50%, as some studies have assumed, results in a 1% increase in the appropriate capital level. Assuming crises have temporarily damaging effects of GDP growth, with a 10 year duration for instance, results in a 14.25% appropriate Tier 1 capital ratio. A summary of alternative model calibrations is presented in the upper panel of Table 10, and shows that the range related to plausible assumptions for key input parameters spans 12% to 20% Tier 1 capital ratio, with our benchmark calibration being 16%.

Having established our benchmark estimate for an appropriate Tier 1 capital ratio for advanced economies, we now focus on the role macro-financial structural characteristics may play in influencing that ratio. Our choice of structural characteristics is informed by O'Brien & Wosser (2022), who find that economic size, degree of trade and financial openness, degree of dependency on inward foreign direct investment (FDI), and the degree of market and sectoral exposure concentration in their banking system are important structural factors influencing systemic risk.[16]

We introduce binary dummy variables identifying countries in the upper or lower half of the distribution for a given structural characteristic into our crisis probability logit estimates. For example, a dummy variable representing economic size is added based upon the country's average contribution to world GDP over the time period examined, with those countries in the lower median of the distribution being given a value of 1.

Re-estimating the marginal benefit curve for the cohort of small countries we find the net marginal benefit is fully realised at the point of intersection with the marginal cost curves shown in Figures 3a and 3b. Consistent with the findings in O'Brien & Wosser (2022), smaller countries, given their risk profile, typically derive more benefit from higher capital levels in comparison to typical advanced economies. The difference from our benchmark estimate of the appropriate level of capital due to economic size is circa. +1%.

We examine each of the structural characteristics in this manner and present the results in the lower panel of Table 10. The largest difference between our advanced economy benchmark estimate and the additional capital appropriate to mitigate the additional risk related to particular macro-financial characteristics appears to be related to economies that are both small and more open to trade, as well as to those that are jointly small and FDI dependent. In each case, our results would suggest that up to an additional 1.25 percentage points for the Tier 1 capital ratio is appropriate. All of the structural characteristics are suggestive of higher optimal Tier 1 capital levels relative to the benchmark specification, regardless of whether they are considered in isolation or jointly in various combinations. Figures graphically depicting these results are presented below for completeness.

Overall, the results in Table 10 show that estimates of appropriate levels of the Tier 1 capital ratio in the banking system of advanced economies when cyclical systemic risk is neither elevated or subdued can range from 12% to 20%, depending on modelling assumptions, with our benchmark estimate being 16%. However, when various

[16] Data sources, definitions and summary statistics are shown in Table 7.

structural macro-financial characteristics are considered, that range and benchmark could be up to 1.25 percentage points higher.

3 Robustness Checks

We adopt a number of strategies to assess the robustness of our results. We remove crisis countries on a per-country basis from the panel logistic regressions to ensure that our results are not driven by a single crisis episode and can confirm that this is not the case. We also estimate results over a variety of sampling time-frames without materially altering our primary findings.

More fundamentally we also adjust the classification scheme for assigning dummy variables relating to macro-financial structural characteristics. By choosing top or bottom tertiles, or quartiles, we repeat the analysis and find some sensitivity of the results to the classification scheme adopted. This is especially true in the case of two of our bank concentration measures, whose signs reverse when dummy variables are categorised on the basis of tertiles of the distribution. However as shown in O'Brien & Wosser (2022), when these macro-financial structural characteristics enter the estimation in continuous form instead of via dummy variables they are shown as positively correlated with increased crisis likelihood, so we retain confidence in our core findings. Also, when the classification scheme becomes more restrictive (top quartile or quintile) a blurring between country cohorts sharing multiple characteristics appears, and the underlying structural characteristic becomes more difficult to isolate.

4 Conclusions

The analysis in this paper suggests that when the prevailing systemic risk environment is neither elevated nor subdued, the most appropriate Tier 1 capital range for the banking systems of advanced economies can plausibly lie in the 12% to 20% range with our benchmark specification suggestive of a circa 16% optimum value.

Additionally, we find that a country's macro-financial structural characteristics can materially influence that appropriate level of capital by as much as +1.25 percentage points. This is particularly true for countries that are relatively small, open, FDI dependent and whose banking systems are concentrated.

The range we identify is relatively broad but is in keeping with prior literature, especially those studies which involved the use of panel data similar to our own. To narrow this range further, additional analysis may be warranted. On a country by country basis, a bottom-up approach towards "rightsizing" banking system capital is also advisable, as prior research has shown that the results achieved in top-down studies, such as we have adopted, sometimes yields results indicating a lower capital range than suggested from a bottom-up approach. However, our results do point to the relevant additional capital that macro-prudential policy-makers could consider when framing an approach to capital buffers in small, open advanced economies. While our findings for bank capital to cater for structure-related factors remains, it should be noted that these recommendations relate to the "long run" perspective and cater specifically to normal or median systemic risk levels. When making specific policy decisions, prevailing economic and systemic risk conditions and any related transition costs to the steady-state (or normal times) appropriate level of capital, would have to be evaluated.

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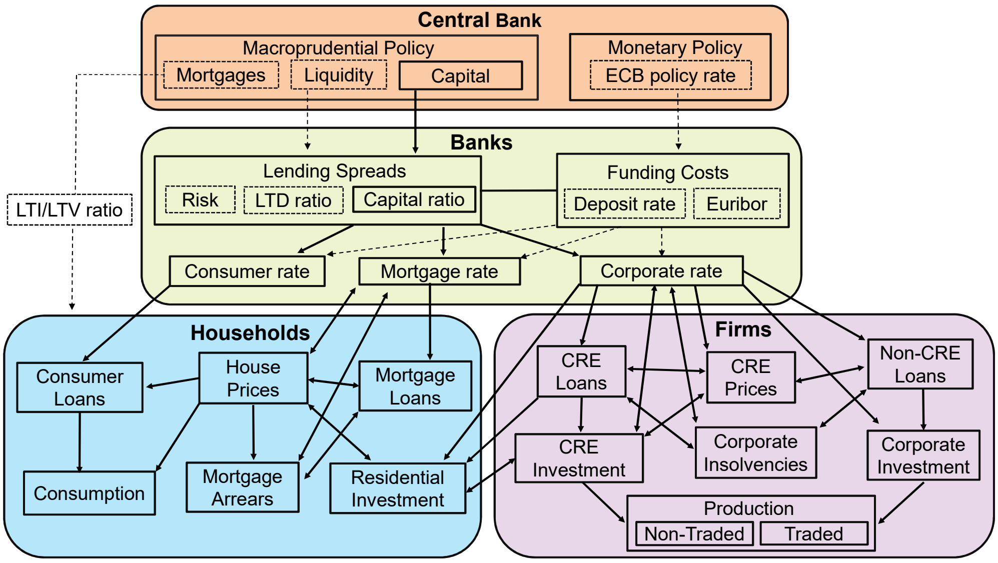
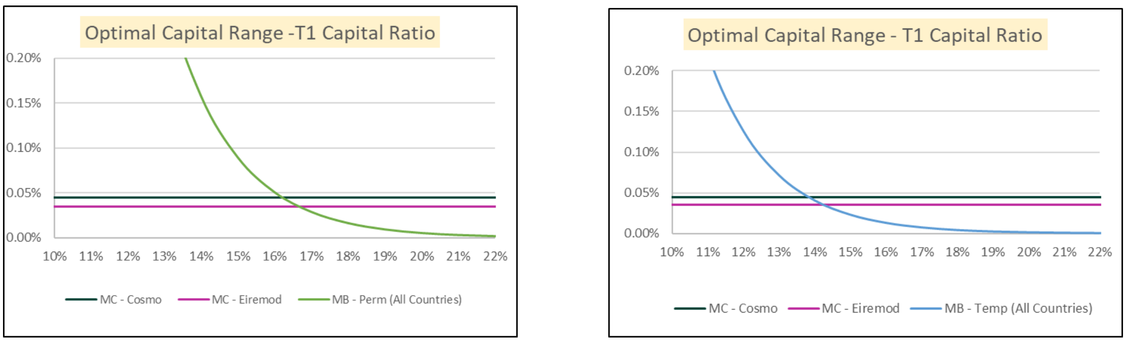
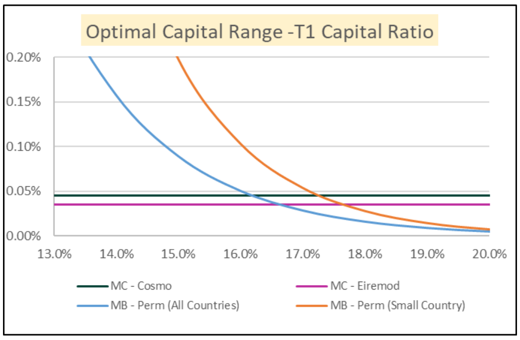
Figure 1. Macroprudential- and Macro-Financial Linkages in COSMO



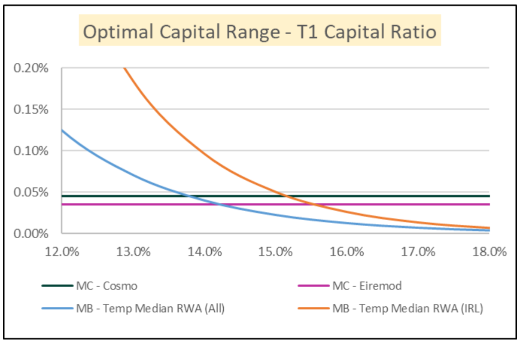


(a) Permanent Crisis Effects (b) Temporary Crisis Effects

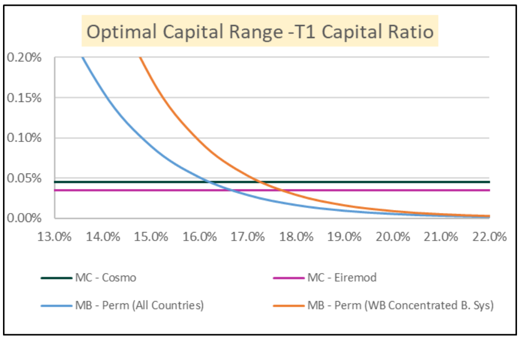
Figure 2. Rightsized Capital - Benchmark and Risk Env.



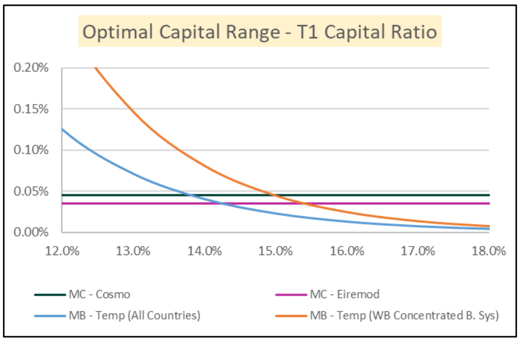
(a) Small Country Effect (Permanent)



(b) Small Country Effect (Temporary)

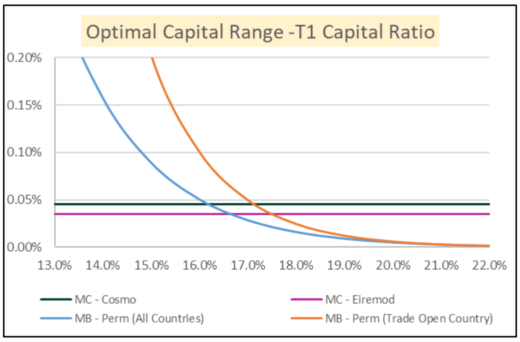


(c) Concentrated Banking Sys. (Permanent)

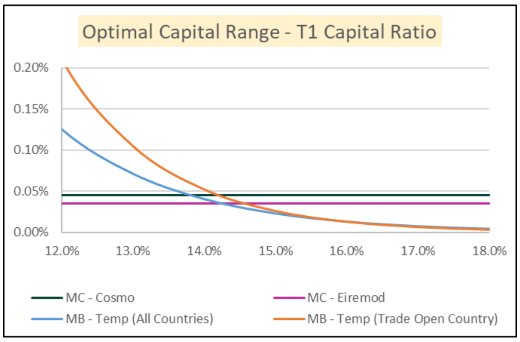


(d) Concentrated Banking Sys. (Temporary)

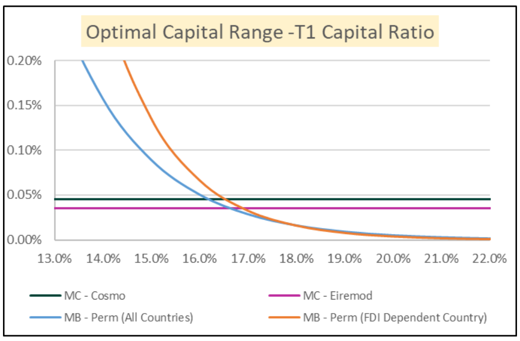
Figure 3. Rightsized Capital with Structural Variable



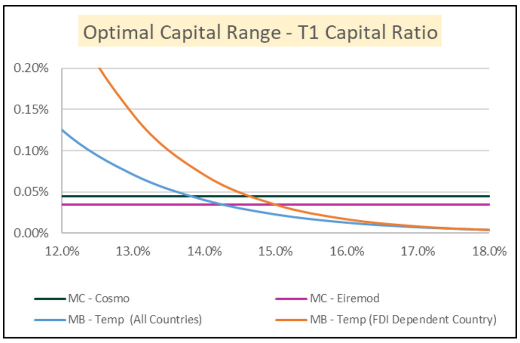
(a) Trade Openness - (Permanent)



(b) Trade Openness - (Temporary)

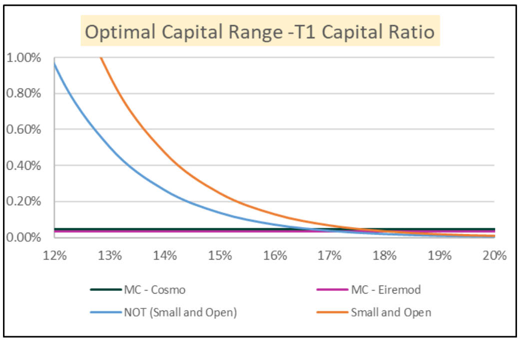


(c) FDI Dependency - (Permanent)

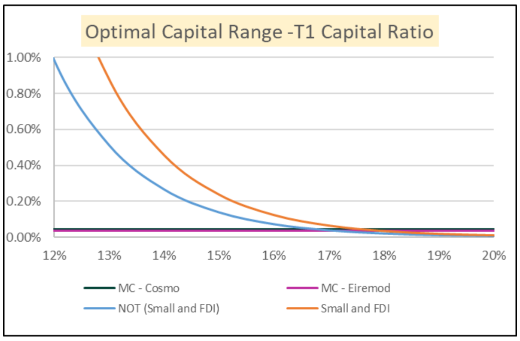


(d) FDI Dependency - (Temporary)

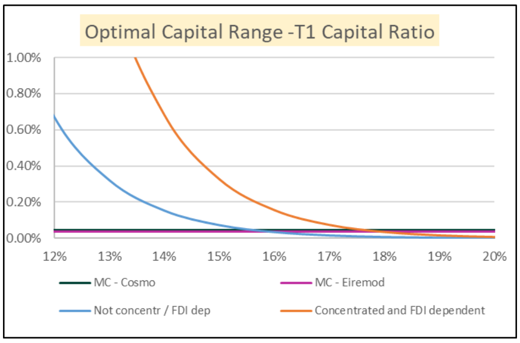
Figure 4. Trade Openness and FDI Dependency Effect



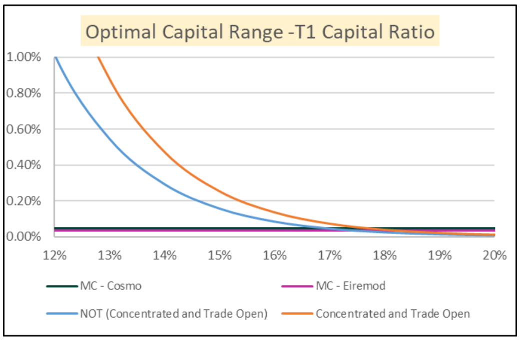
(a) Small, Trade Open - (Permanent)



(b) Small, FDI Dependent - (Permanent)

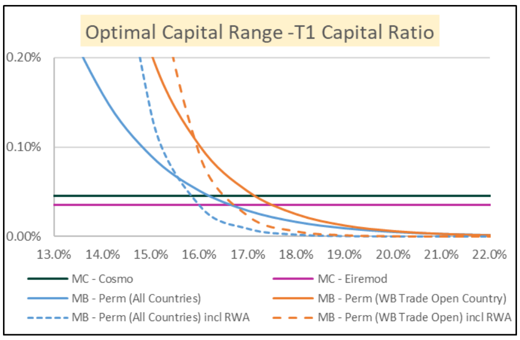


(c) Bank Conc. and FDI Dep. (Perm)

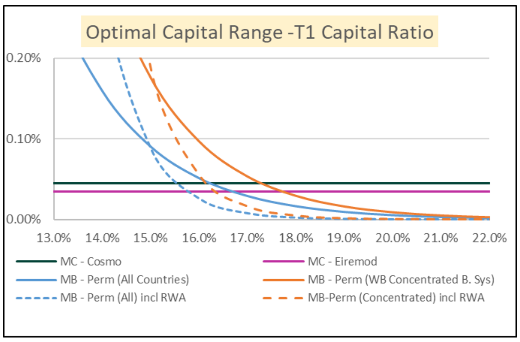


(d) Bank Conc. and Trade Open (Perm)

Figure 5. Structural Variables Combinations



(a) RWA and Trade Openness (Permanent)



(b) RWA and Bank Conc. (Permanent)

Figure 6. Risk Weighted Assets Impact on Structural Capital Delta

Table 1. Prior Studies of Crises and Output Loss

Study	Peak Loss (% GDP)	Long Run Impact (% GDP)
Barrell et al (2010)	6	3
Cecchetti et al (2009)	9	N/A
Cerra and Saxena (2008)	8	7
IMF (2009)	10	10
BCBS (2010)	9	6
Romer and Romer (2015)	4	3
Brooke et al (2015)	5	4

Table 2. Impact of a 1pp Increase in Banks' Capital Ratio in COSMO

Variable	Long-Run Impact (%)
Lending Rates (bps)	+11
Credit	-0.61
Total Investment	-0.28
Residential Investment	-0.64
CRE Investment	-0.51
House Prices	-0.42
Consumption	-0.06
GDP	-0.05
'Non-Traded' Output	-0.12
Total Employment	-0.06

Note: Estimates are percent deviations from baseline except for lending rates,which are basis point deviations.

Table 3. Estimates of the Modigliani-Miller Offset

Study	Sample	Offset (%)
Toader (2015)	European banks	42
ECB (2011)	International banks	41-73
Yang and Tsatsaronis (2012)	International banks	10
Junge and Kugler (2013)	Swiss banks	36
Miles et al (2013)	UK banks	45-90
Brooke et al (2015)	UK banks	53
Kashyap et al (2010)	US banks	36-64
Cline (2015)	US banks	45
Clark et al (2018)	US banks	25-100
Barth and Miller (2018)	US banks	0

Table 4. Impact of a 1pp Increase in Banks' Capital Ratio

Study	Country	Lending Rates (bps)	GDP (%)	Offset (%)
COSMO	Ireland	11	-0.05	0
EireMod	Ireland	10	-0.04	0
Mikk. and Pedersen (2017)	Denmark	10	-0.2	0
BCBS (2010)	OECD	9 to 19	-0.02 to -0.35	0
Almenberg et al (2017)	Sweden	16	-0.09	0
Brooke et al (2015)	UK	5 to 10	-0.01 to -0.05	50 to 0
Cline (2016)	US	6	-0.08	50
FRB Minneapolis (2017)	US	5.7	-0.06	50
Firestone et al (2019)	US	3.4 to 6.9	-0.04 to -0.08	50 to 0

Table 5. Optimal Capital Per Previous Studies

Study	Country	Modigliani and Miller Offset	Optimal Bank Capital
Admati et al. (2013)	-	Holds	20-30% Tier 1 Capital Ratio
Barth and Miller (2018)	US	Does not fully hold	Leverage ratio of 19%. Equates to a Tier 1 Capital Ratio of 25%
BCBS (2010)	OECD	Holds	10%-15% Tier 1 Capital Ratio
Brooke et al. (2015)	UK	Does not fully hold	10%-14% Tier 1 Capital Ratio, 15%-19% if resolution is ineffective
Clerc et al. (2015)	Euro Area	No reference (does not hold)	Circa 10.5% Tier 1 Capital Ratio
Cline (2016)	Industrial Countries	Does not fully hold	12%-14% CET1 to Risk Weighted Assets
Collard et al. (2017)	US	Does not hold	10%-14% Tier 1 Capital Ratio
Dagher et al. (2016) (IMF)	Industrial Countries	0% - 75%	15%-23% Tier 1 Capital Ratio
Firestone et al. (2019)	US	Does not fully hold	13%-26% Tier 1 Capital Ratio
Junge and Kugler (2013)	Switzerland	Does not fully hold	13%-17% Tier 1 Capital Ratio for GSIBs
Miles et al. (2013)	UK	Does not fully hold (45% offset used)	16%-20% CET1 to Risk Weighted Assets
Moyen and Schroth	None	No reference	12.75%-15.75% Tier 1 Capital Ratio
Kragh-Sørensen (2012)	Norway	Does not fully hold	13%-23% CET1 to Risk Weighted Assets
Sveriges Riksbank (2017)	Sweden	Holds	10%-17% CET1 to Risk Weighted Assets

Table 6. Countries and Systemic Banking Crises

	Crisis Years		Source
	Start	End	
Argentina	1980Q1	1980Q4	Laeven and Valencia (2012)
	1989Q1	1989Q4	Laeven and Valencia (2012)
Australia	-	-	Laeven and Valencia (2012)
Austria	2007Q4	2014Q1	ECB MPG/AWG Systemic Crisis Database (2016)
Belgium	2007Q4	Ongoing	ECB MPG/AWG Systemic Crisis Database (2016)
Brazil	1990Q1	1990Q4	Laeven and Valencia
	1994Q1	1994Q4	(2012)
Canada	-	-	Laeven and Valencia (2012)
China	1998Q1	1998Q4	Laeven and Valencia (2012)
Denmark	1987Q1	1995Q1	ECB MPG/AWG Systemic
	2008Q1	2013Q4	Crisis Database (2016)
Finland	1991Q3	1996Q4	ECB MPG/AWG Systemic Crisis Database (2016)
France	1991Q2	1995Q1	ECB MPG/AWG Systemic
	2008Q2	2009Q4	Crisis Database (2016)
Germany	2001Q1	2003Q4	ECB MPG/AWG Systemic
	2007Q3	2013Q2	Crisis Database (2016)
Greece	2010Q2	Ongoing	ECB MPG/AWG Systemic Crisis Database (2016)
Hungary	1991Q1	1995Q4	ECB MPG/AWG Systemic
	2008Q3	2010Q3	Crisis Database (2016)
Ireland	2008Q3	2013Q4	ECB MPG/AWG Systemic Crisis Database (2016)
Italy	1991Q3	1997Q4	ECB MPG/AWG Systemic
	2011Q3	2013Q4	Crisis Database (2016)
Japan	1997Q3	1997Q4	Laeven and Valencia (2012)
Luxembourg	2008Q1	2010Q4	ECB MPG/AWG Systemic Crisis Database (2016)
Netherlands	2008Q1	2013Q2	ECB MPG/AWG Systemic Crisis Database (2016)
New Zealand	-	-	Laeven and Valencia (2012)
Norway	1991Q1	1991Q4	Laeven and Valencia (2012)
Poland	1981Q1	1994Q4	ECB MPG/AWG Systemic Crisis Database (2016)
Portugal	1983Q1	1985Q1	ECB MPG/AWG Systemic
	2008Q4	Ongoing	Crisis Database (2016)
Spain	1980Q1	1985Q3	ECB MPG/AWG Systemic
	2009Q1	2013Q4	Crisis Database (2016)
Sweden	1991Q1	1997Q2	ECB MPG/AWG Systemic
	2008Q3	2010Q4	Crisis Database (2016)
Switzerland	2008Q1	2008Q4	Laeven and Valencia (2012)
United Kingdom	1991Q3	1994Q1	ECB MPG/AWG Systemic
	2007Q3	2010Q1	Crisis Database (2016)
United States	1988Q1	1988Q4	Laeven and Valencia
	2007Q4	2011Q4	(2012)

This table presents information identifying the name and number of countries in the panel. Crisis start and end dates are also presented based upon the ECB's macro-prudential policy assessment group's systemic banking crisis database (covering primarily European countries) and supplemented where necessary by Laeven and Valencia's (2012) database. Data for Brazil comes from FRED database.

Table 7. Variable Description and Summary Statistics

Variable Name	Summary Statistics				Description	Obs.	Countries	Coverage	Source
	Mean	S.D.	Min	Max					
Real short-term interest rates	0.053	0.058	-0.01	0.53	Real 3m money mkt rate	3560	27	1980Q1-201Q2	OECD
Losses only S&P 500 Index	-0.014	0.04	-0.26	0.00	S&P losses only in a quarter	4676	27	1980Q1-2021Q2	Yahoo Finance Historical Data
% Deviation of House Price Index from trend	-.091	0.11	-0.48	2.38	Trend fitted using Hamilton (4,8) filter	3550	17	1981Q4-2021Q2	BIS - Long Property Series
% Deviation of household credit growth from trend	0.036	5.63	-100.45	30.22	Trend fitted using Hamilton (4,8) filter	2780	27	1981Q2-2021Q2	BIS - Total Credit Statistics
% Deviation of unemployment rate from trend	-.06	1.4	-10.00	6.73	Trend fitted using Hamilton (4,8) filter	3228	25	1980Q4-2021Q2	OECD
Credit to GDP ratio	135.48	64.63	9.4	455.3	Total credit extended to GDP	4249	27	1980Q1-2018Q3	BIS - Total Credit Statistics
Financial Stability Index	0.12	0.10	0.00	0.84	Country level index of financial stress (CLIFS)	2750	17	2000Q1-2021Q2	ECB - Statistical Data Warehouse
House Price Index	155.75	101.52	21.29	564.96	House Price Index (1995 =100)	3727	17	1980Q1-2021Q2	BIS - Long Property Series
GDP World Share	2.40	4.07	0.42	22.27	Contribution to world GDP share	4202	27	1980Q1-2021Q2	IMF IFS database
Trade Openness	75.14	54.35	11.54	423.99	Ratio of exports plus imports as a percentage of GDP	3816	27	1980H1-2021H1	IMF - IFS database
Financial Openness	10.65	47.17	0.01	466.33	External claims inwards and outwards as a percentage of GDP	2348	27	1980H1-2021H1	IMF - IFS database
FDI Dependency	49.58	62.27	0.58	391.11	Stock of FDI to GDP ratio	1225	27	1980H1-2021H1	IMF - IFS database
Tier 1 Capital Ratio	0.11	.04	.01	.25	Tier 1 Capital as a proportion of Risk Weighted Assets	1450	15	2000H1-2020H2	Bloomberg
Bank Concentration I	66.47	20.02	20.19	100.00	Share of total banking assets held by 3 largest banks	2252	26	2000H1-2020H2	World Bank
Bank Concentration II	2318.01	520.43	1365.41	3588.03	HHI Index of concentration	682	11	2000H1-2020H2	BIS
Bank Concentration III	53.39	11.28	21.87	74.27	Share of R/E exposures of banking sys.	744	11	2000H1-2020H2	Bloomberg

This table presents information on the variables in the panel. The EWS panel is held at quarterly frequency whereas bank balance sheet data is only available. EWS data is collapsed according to the frequency available for analysis. The bank crisis data is driven by the ECB's MPG/AWG crisis database for EU countries and by Laeven & Valencia (2012) for non-EU countries.

Table 8. Robustness Test - Tier 1 Capital Ratio Rates

Robustness Analysis Type:	**Logit Regression**		
Variable of interest:	**Tier 1 Capital Ratio**		
Outcome Variable:	**Crisis**	No. of Observations	386
Possible control terms:	**8**	Mean R-squared	0.28
Number of models:	256	Multicollinearity	0.48
Model Robustness Statistics:		Significance Testing:	
Mean(b)	-0.7188	Sign Stability	100%
Sampling SE	0.3402	Significance rate	56%
Modeling SE	0.1437		
Total SE	0.3693	Positive	0%
		Positive and Sig	0%
Robustness Ratio:	-1.9461	Negative	100%
		Negative and Sig	56%
Model Influence:			
Marginal effect of variable inclusion:	from Mean(b)	Percent Change	
House Price Index	-0.1929	26.8%	
Real Short-term Interest Rates	0.1584	-22.0%	
Financial Stability Index	0.0588	-8.2%	
% Deviation House Price Index from Trend	0.0433	-6.0%	
Credit-to-GDP Ratio	-0.0231	3.2%	
% Deviation Household Credit from Trend	-0.0223	3.1%	
Losses only S&P 500 Index	0.0139	-1.9%	
% Deviation Unemployment Rate from Trend	-0.0112	1.6%	
Constant	-0.7313		
R-Squared	0.8385		

Table 9. Crisis Probability / EWS Variables and Tier 1 Capital

Dependent Variable - Crisis Dummy Variable

Logistic Regression		Observations:	386
		Wald chi2(9) =	111.44
Log pseudolikelihood = -33.26		Prob > chi2 =	0.000
		Pseudo R2 =	0.283
	(Std. Err. adjusted for 14 clusters in Country ID)		

	Coefficient	S.E.	z	P|>z|	95% Conf. Interval	
Tier 1 Capital Ratio	-.941	0.387	-2.43	0.015	-1.7	-0.182
Change Real S.T. Int. Rates	113.81	86.62	1.31	0.189	-55.96	283.58
Losses Only S&P 500 Index	-21.12	9.97	-2.12	0.034	-40.66	-1.59
% Devn. House Price Index - Trend	7.71	3.77	2.05	0.041	0.331	15.1
% Devn. Household Credit - Trend	-0.011	.009	-1.16	0.246	-0.029	.008
% Devn. Unemp. Rate - Trend	2.56	3.42	0.75	0.454	-4.14	9.27
Credit To GDP Ratio	.0004	.007	0.06	0.949	-0.013	0.013
Financial Stability Index	-7.98	3.42	-2.33	0.02	14.69	-1.27
House Price Index	0.015	0.007	2.06	0.039	0.001	0.030
Constant	1.664	2.54	0.65	0.513	-3.32	6.64

This table shows one of the possible model combinations whereby a Tier 1 Capital Ratio has been added to the Early Warning System. In this case the model includes ALL EWS variables. The dependent variable is the based upon the Laeven and Valencia (2013) and ECB crisis datasets. It is set to “1” only in the quarter where a systemic banking crisis was first registered, i.e. subsequent quarters for that crisis are reset to “0”. This is in keeping with the treatment of the dependent variable by Brooke et al. (2015),whose methodology and approach we follow.

Table 10. Model Calibration and Economic Structure Effect on Optimal Capital

Parameter Settings / Impact	MM Offset %	Discount Factor	Permanent Crisis Effects	Temporary Crisis Effects	Duration (Years)	Appropriate Tier 1 Capital %
Benchmark Scenario (EWS variables set at median)	0	3	Y	N	N/A	16
Scenario 1	0	3	N	Y	5	12
Scenario 2	0	3	N	Y	10	13.5
Scenario 3	50	3	Y	N	N/A	17
Scenario 4	50	3	N	Y	5	13
Scenario 5	50	3	N	Y	10	14.25
Scenario 6	50	5	Y	N	N/A	16.2
Scenario 7	50	5	N	Y	5	13
Scenario 8	50	5	N	Y	10	14.25
Scenario 9	50	1	Y	N	N/A	20
Scenario 10	50	1	N	Y	5	13
Scenario 11	50	1	N	Y	10	14.75

Structural Effects on Benchmark Scenario of 16%

Small Economy	Based on contribution of smallest group of countries in sample to World GDP (IMF rankings)	+ 1.0
Trade Openness	Proportion of exports plus imports relative to GDP	+ 0.5
Financial Openness	Proportion of banking system external claims imports relative to GDP	+ 0.33
FDI Dependent	Based on country average rankings of FDI to GDP ratio	+ 0.33
Conc. Banking Sys. I	Proportion of total banking system assets that are held by three largest retail banks.	+ 0.5
Conc. Banking Sys. II	Concentraed market sector exposures by HHI index	+ 1.0
Conc. Banking Sys. III	Concentraed real estate market exposures	+ 0.75
Small and Trade Open	Based on cohort of countries that are both small and trade open according to above definition	+ 1.25
Small and Financial Open	Based on cohort of countries that are both small and financially open	+ 0.5
Small and FDI Dependent	Based on cohort of countries that are both small and FDI dependent	+ 1.25
FDI dependent and Conc. Banking Sys. I	FDI dependent countries who also have a concentrated banking system (Type I)	+ 1.0
FDI Dependent and Conc. Banking Sys. II	FDI dependent countries who also have a concentrated banking system (Type II)	+ 0.75
FDI Dependent and Conc. Banking Sys. III	FDI dependent countries who also have a concentrated banking system (Type III)	+ 0.75

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