How sensitive are bank market values to regulatory adjustments of capital?

MARTIEN LUBBERINK[a1] and ROGER WILLETT[1]

[1]Victoria University of Wellington

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[a]*Corresponding Author*: School of Accounting and Commercial Law, Victoria University of Wellington, PO Box 600, Wellington 6140, New Zealand. W: +64 4 463 5968; M: +64 21 134 7500; F: +64 4 463 5076. Email: martien.lubberink@vuw.ac.nz.

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ABSTRACT

We measure the sensitivity of bank market values to capital and to regulatory adjustments applied to bank capital. Results for U.S. banks over the years 2001-2020 show that the sensitivity of banks' market values to measures of bank capital e.g. book equity, Tier 1, and Total Capital, converges to a one-to-one relationship when market uncertainty is low and when banks' Tier 1 ratios reach 12 percent of RWAs. Market values are more sensitive to changes in capital of highly geared banks when market uncertainty is high; with shareholders responding positively in particular to increases in Tier 1 and Total Capital. Share prices are less sensitive to deductions from capital. The methods we adopt thus show, with some precision, which adjustments proposed by regulators have positive and which adjustments have negative effects on market valuations of banks.

JEL classification: G21, G32, M41

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1. Introduction

The global financial crisis prompted renewed attention to bank capital. In the wake of the crisis, rules on regulatory capital changed. New capital rules (Basel III) entered into force (BCBS, 2010a). In anticipation of these rules, banks increased the level of regulatory capital significantly (BCBS, 2020; EBA, 2020b).

Attention to bank capital is focused predominantly on levels of capital, and views as to the benefits and costs of bank capital vary. Where Admati, DeMarzo, Hellwig & Pfleiderer (2016), Mehran & Thakor (2011), Berger & Bouwman (2013), and Gambacorta & Shin (2018) highlight the benefits of increased levels of bank capital, others express a more moderate position (e.g., Diamond & Rajan, 2001; Kashyap, Rajan & Stein, 2008; DeAngelo & Stulz, 2013; Jordà, Richter, Schularick & Taylor, 2017).

Little has been written about the detailed structure of bank capital, regulatory adjustments or about the interaction between the structure and the level of capital. This is surprising for four reasons.

First, bank regulators consider the structure of regulatory capital to be important. For example, Basel III aims to raise both the *quantity* and the *quality* of regulatory capital (BCBS, 2010a, paragraphs 8 and 9). Basel rules accomplish this by way of setting capital requirements and applying adjustments to book equity to calculate regulatory capital, where book equity is the starting point of the calculation of solvency ratios (Federal Reserve, 2005; BCBS, 2010a; FDIC, 2012; OCC, 2012). As a result, regulatory capital differs from "accounting capital" or book equity. Non-common equity components can increase (decrease) Tier 1 capital up to 26.1 percent (97.1 percent) of risk-weighted assets. Tier 2 capital can increase regulatory capital by up to 24.4 percent of risk-weighted assets, see Table 2. These differences are significant. However, investors' responses to these differences are underresearched by academics.

Second, banks and investors do focus on capital ratios that are based on adjusted book equity. For example, JPMorgan Chase's 2020Q3 earnings announcement features the CET1 capital ratio at the top of the first page. Jamie Dimon's comments on the announcement discuss Common Equity Tier 1 jointly with the bank's profitability and revenues (JPMorgan Chase, 2020).

Research then appears to favour simple, accounting-based measures of capitalization over adjusted ratios. Demirgüç-Kunt, Detragiache & Merrouche (2013), for example, find that higher quality forms of capital, such as tangible common equity, are more relevant than other forms of capital. Martynova & Perotti (2018) argue that non-equity capital is inferior to pure equity. Haldane (2012) asserts that simpler measures of accounting capital based on equity outperform broader, more complex, measures.

Third, the regulatory adjustments spark controversy. Additions to regulatory capital have been criticized for lack of an ability to absorb losses (Ball, 2008; Collins, 2010). The alleged dysfunctional additions to regulatory capital were an important reason for the Basel Committee to amend the definition of capital after the onset of the global financial crisis. On the other hand, the comments from the banking sector on the initial Basel III proposal show that banks resist the introduction of deductions. A case in point is the controversy around mortgage-servicing rights (MSRs, Harper (2010)). Under Basel III rules, these are now deducted from capital. Banks resisted this deduction, as shown by the response of Wells Fargo to the Basel III proposal, which:

> "...would require that all intangibles be deducted from Common Equity. Although we believe there is sufficient uncertainty as to the realizable value of certain intangible assets to warrant their deduction, we do not believe that is the case for all intangible assets. Mortgage-servicing assets, nonmortgage-servicing assets and purchased credit-card relationships have shown themselves to have demonstrable realizable value over sustained periods." (BCBS, 2010b).

Last, recent research examines the effectiveness of capital requirements once banks achieve a certain level of capitalization (BCBS, 2018, 2019; Arnould, Pancaro & Żochowski, 2020). BCBS (2018), for example, shows that once banks are well-capitalized, the mitigating effects on the probability of default of various measures of bank solvency (Tier 1 ratio, leverage ratio) converge. BCBS (2019) demonstrates that increasing Tier 1 capital ratios beyond 12 percent of risk-weighted assets has limited benefits.

The reasons above prompt the question: what do we know about the effect on bank market values of the adjustments made by banks to their book value of equity to produce the regulatory capital that enters into their capital adequacy ratios? To answer that question, this paper examines the sensitivity of market values to bank capital and to regulatory adjustments applied to bank capital. However, unlike conventional studies, we rely on elasticities that measure the proportionate effect of changes in bank capital components on market values. The elasticities are derived from log-linear models which mitigate important shortcomings of conventional research designs, including coefficient estimates that are hard to interpret, exhibit great volatility, and change from study to study.

Using data of U.S. bank holding companies covering 78 quarters from 2001 to 2020Q2, we empirically examine the elasticities of book equity, Tier 1, Tier 2, Total Capital, and regulatory adjustments with respect to market values. Our results show that the book equity elasticity of market values stays close to a value of one, with an average of 1.04 over the sample period, including the global financial crisis. This result dovetails with a proportionate form of a *dollar-for-dollar* relation between market and book values (Miller & Modigliani, 1961).[1]

The Tier 1 and Total Capital elasticities of market values are also generally close to one. However, we document significant excess elasticities beyond the elasticity of book equity when levels of market uncertainty are high and when banks are poorly capitalized. The Total Capital elasticity during the global financial crisis reaches a value of 2, while the Tier 1 capital elasticity reaches a value of 1.3: a one percent change in

[1]The proportionate *dollar-for-dollar* relationship we refer to is consistent with a one percent change in book equity being associated with a one percent change in market value. This result gives substance to the theoretical position of Penman (1996) lessening the need to consider questions of scale, which are measured separately in the market-to-book ratio in the model we use for estimation, see Appendix A.

Total Capital (Tier 1) is associated with a two (1.3) percent change in market value. We attribute the excess sensitivities to regulatory adjustments that increase regulatory capital.

As bank capitalizations improve in the aftermath of the global financial crisis, the coefficients on Tier 1 and Total Capital converge to each other, to the elasticity of book value, i.e. to the value of one. These uniform coefficients correspond with a Tier 1 ratio of approximately 12-13 percent, reflecting results reported by Firestone, Lorenc & Ranish (2017); BCBS (2019), who document optimal bank capital levels of close to this percentage.

From these results we infer that shareholders benefit from increases in Tier 1 and Total Capital when banks are highly leveraged, during times of market uncertainty, when bank capital matters most.

Five particular regulatory adjustments, or prudential filters, are examined in detail: *i*) the deduction of Goodwill and Intangibles, *ii*) the deduction of Deferred Tax Assets (DTAs), *iii*) the deduction of Mortgage-Servicing Rights (MSRs), *iv*) the prudential filter on unrealized gains and losses on available for sale (AFS) securities, and *v*) the inclusion of minority interests. These are the most significant adjustments and were the subject of intensive discussion among regulators before the finalization of Basel III (BCBS, 2009; Haig, 2010; Enrich & Paletta, 2010).

The market sensitivity to each of the five adjustments individually varies, and is generally low. The elasticities of the hotly debated MSRs and the prudential filter on unrealized gains and losses on AFS securities are less than 0.05, for instance, which is interesting given existing papers on this subject; e.g. Chircop & Novotny-Farkas (2016) assert that the regulation on the recognition of unrealized gains and losses affects risk taking by banks.

The Tier 2 capital elasticity of market values is generally insignificant until the global financial crisis, when it becomes temporarily significantly negative.[2] Contemporaneously with the downward movement of the Tier 2 capital elasticity, we see a significant increase in the elasticity of Total Capital. From this we infer that shareholders perceive increases in the regulatory Total Capital of poorly capitalized banks during times of heightened systemic risk to be beneficial.

The results we report are consistent with the models we use being well-specified. Components such as the book value of equity and Tier 1 explain 90–95 percent of the variation in bank market values. Moreover, the elasticities associated with these variables are noticeably more stable and easier to interpret than results of conventional research designs.[3]

This paper contributes to the literature by documenting with some precision the effects of regulatory adjustments on market valuations of banks. The aggregate adjustments are composed of a number of individual adjustments, some of which have either a small or negligible effect on market valuation, e.g. unrealized gains and losses, while others, such as Tier 2 capital have a more significant impact. Market values of banks are particularly sensitive to regulatory capital of highly geared banks, during times of elevated market volatility. However, in more sanguine economic conditions, the effect of regulatory adjustments, both individually and in aggregate, becomes quite unimportant. The market's sensitivity to measures of bank capital converges after the global financial crisis, coinciding with a Tier 1 ratio of about 12 percent. This last result contributes to studies that demonstrate the limited effectiveness of capital requirements once capital ratios reach a certain level.

From a policy perspective, our paper shows that shareholders perceive benefits from regulatory adjustments that increase capital when banks are highly levered and when market uncertainty is high: increases in

[2]This is predominantly the result of increases in banks' loan loss reserves, which predict future losses (Ng & Roychowdhury, 2014).

[3]A replication of a published study that demonstrates this feature of elasticities, by comparing the volatility and relative ease of interpretation of coefficient estimates derived from additive-linear and log-linear models, is contained in Appendix B.

Tier 1 and Total Capital are more strongly associated with increased market values than increases in book equity. This result supports theories of risk shifting by shareholders (Koziol & Lawrenz, 2012; Chan & Van Wijnbergen, 2014). However, it does not support the superiority of capital components that are deemed "pure" or "simple", especially when banks are well-capitalized. Regarding regulatory adjustments, regulators continue to tweak them. For example, in 2020, the EU introduced a prudential filter that requires banks to include intangible software assets in capital, which is a departure from Basel III (EBA, 2020a). Our research, specifically the results on the prudential filter for Goodwill and Intangibles, shows such tweaks have limited relevance.

2. Literature and hypotheses

2.1. Literature

To the best of our knowledge, no empirical studies thus far have comprehensively or collectively examined the relevance of the different adjustments to regulatory capital for common equity investors. Many papers focus only on single items, in particular loan-losses (Moyer, 1990; Bushman & Williams, 2012), goodwill (Begley, Chamberlain & Li, 2006), deferred tax assets of Japanese banks Skinner (2008), the allowance for loan and lease losses includible in Tier 2 capital (Kim & Kross, 1998; Ramesh & Revsine, 2000), prudential filters (Barth, Gómez-Biscarri, Kasznik & López-Espinosa, 2017; Dong & Zhang, 2017; Kim, Kim & Ryan, 2019). These papers predominantly examine levels of capital and the management thereof. For example, in a study of commercial banks, Beatty, Chamberlain & Magliolo (1995) examine factors that banks may use to manage tax, regulatory capital, and earnings. Similarly, Kim et al. (2019) show that banks mitigate regulatory capital volatility by way of classifying an increased proportion of investment securities as held to maturity.

Studies on the quality of capital generally favour common equity over non-equity capital. Analytical papers by Koziol & Lawrenz (2012) and Chan & Van Wijnbergen (2014) argue that non-equity capital distort risk taking incentives that destabilize financial stability while benefiting equity holders. Demirgüç-Kunt et al. (2013); Conlon, Cotter & Molyneux (2020) support these studies empirically.

Regarding the quantity of capital, the literature on regulatory capital acknowledges that bank capital is expensive (Plosser & Santos, 2018). The higher cost of capital is attributed to subsidized debt, tax deductibility of debt, and benefits forgone by less-intense creditor monitoring (Diamond & Rajan, 2001). In the presence of a regulatory safety net that mitigates the effects of bank failure on the financial system, banks may increase leverage beyond levels observed in corporate firms (Berger, Herring & Szegö, 1995).

Admati et al. (2016), however argue against high leverage. Empirical papers supporting Admati et al. include Mehran & Thakor (2011), who show that bank value increases with capital. Berger & Bouwman (2013) show that banks' odds of surviving a crisis increase with capital. Firestone et al. (2017) conclude that the economic benefits of higher capital ratios outweigh the economic cost, with the net GDP benefit reaching a maximum when capital ratios are between 13 percent and 25 percent, depending on the assumptions made about the costs and benefits of financial crises.

But the jury is still out: Jordà et al. (2017) show empirical evidence contradicting studies that merit high capital ratios. Using data from 17 countries over the years 1870 to 2013, they demonstrate that the capital ratio is a poor indicator of systemic financial crises. BCBS (2019) replicate Jordà et al. and confirm their findings. Moreover, the literature review in BCBS (2019) shows that the marginal benefits of higher capital diminish once risk-weighted capital ratios reach a level of 12 percent. Arnould et al. (2020), studying the relationship between bank funding costs and solvency for European banks find that this relationship is convex for senior bond yields and term deposit rates. For senior bonds, the inflexion point occurs at a 12 percent CET1 ratio, beyond which funding costs increase.

Regarding Tier 2 capital, Ng & Roychowdhury (2014) document a positive association between the allowance for loan and lease losses includible in Tier 2 capital, an "add-back" to capital, and the risk of bank failure. Their study confirms the results of Laeven & Majnoni (2003), who show that banks tend to postpone provisioning.

2.2. Conventional research designs

Studies on bank capital ratios generally employ research designs that use ratios to adjust variables by a measure of scale. Demirgüç-Kunt et al. (2013), for example, study the link between different solvency ratio definitions and stock market performance. Their explanatory variables are all deflated by a scale factor. Similar papers are Vallascas & Hagendorff (2013); Conlon et al. (2020). The problems of statistical specification introduced by deflated variables are well-known, which we avoid in our research design.

There is a rich literature in accounting that uses variations of the following model to estimate the relevance of accounting for capital markets, see for example Ali & Zarowin (1992); Barth (1994); Dhaliwal, Subramanyam & Trezevant (1999); Holthausen & Watts (2001); Barth & Clinch (2009); Aledo Martínez, García Lara, González Pérez & Grambovas (2020):

$$M_{i,t} = \beta_0 + \sum_n \beta_n \cdot A_{n,i,t} + \varepsilon_{i,t} \quad (1)$$

where $M_{i,t}$ is the market value and $A_{n,i,t}$ a list of n accounting variables for the i^{th} firm all at, or in the year (or quarter) to, time t. The intercept term, β_0, and the slope coefficients, β_n, are assumed constant in the cross-section models, interpreted as averages across firms in each time period, with the error term, $\varepsilon_{i,t}$.

Easton (1998) shows that the coefficients of these models suffer from problems related to scale. Lubberink & Willett (2020) argue that the correct mathematical form of relationships between the type of variables entering into expression (1) take the form of a multiplicative power law and that distributions of the magnitudes of those variables are close to being jointly log-normal. This makes log-linear models, transforming all the variables to logs, rather than the additive-linear models in (1), a natural choice for estimating coefficients showing the effect of changes in the independent on the dependent variables in the models.

The coefficients in log-linear models are scale-free elasticities measuring the proportional change in the dependent variable associated with a proportional change in the independent variables. Note, Appendix A provides a brief explanation of the application of log-linear models.

2.3. Hypotheses

Based on and the (proportionate) dollar-for-dollar relation between market and book values and theoretical arguments derived from Miller & Modigliani (1961), Penman (1996), and Lubberink & Willett (2020) we expect the elasticity of the accounting book value of equity with respect to market values to be positive and close to 1. As Tier 1 and Total Capital are derived from book equity, and given BCBS (2018), we expect their elasticities to be positive and close to 1 too. For now, we do not rule out elasticities that exceed a value of one (1), but this warrants further examination. Formally, therefore our main hypothesis is:

Hypothesis 1 *The elasticities of measures of bank capital, i.e. book equity, Tier 1 capital, Total Capital with respect to market values are positive and close to 1.*

From Appendix A we know that elasticities on individual variables sum to the elasticity on the sum of the variables. If we use book equity as a reference point, we should expect the elasticities on components that in aggregate sum up to book equity to be close to one. To illustrate, the value of book equity equals the sum of Tier 1 capital minus the negative value of Goodwill and Intangibles. The elasticities on both variables should sum up to one (that is, in a hypothetical case where Goodwill and Intangibles are the only regulatory adjustments). Referring to our first hypothesis, we expect the elasticities on book equity, Tier 1 capital and Total Capital to be close to one. The elasticities on the remaining adjustments then should be close to zero. The second hypothesis, therefore, is:

Hypothesis 2 *The elasticities of regulatory adjustments with respect to market values are close to zero.*

3. Research design

3.1. The regression model

Our choice of the research design follows Lubberink & Willett (2020) who demonstrate that the functional form for estimating the relationship between market values and the type of values used in this paper is a multiplicative power law of the following type:

$$M_{i,t} = \nu \prod_n |A_n|_{i,t}^{\beta_n} \tag{2}$$

where M_i is the market value of a bank i at time t. $A_n, n = 0, 1, \ldots$ are lognormally distributed accounting and bank capital variables. ν is a constant scale factor relating $M_{i,t}$ to the weighted product of the magnitudes of the latter variables. β_n is component's A_n elasticity with respect to market values.

To estimate the models, we convert (2) to a linear model where the lowercase variables are the logs of the absolute values of M and A:

$$m_{i,t} = \beta_0 + \sum_n \beta_n \cdot |a|_{n,i,t} + \varepsilon_{i,t} \tag{3}$$

Here m is the log of market value two months after the end of quarter. For the main regression models, $a_{n,i,t}$ comprises the following, end of quarter variables: i) *BV*. This is the book value of equity excluding perpetual preferred stock [3210]–[3283]; ii) *Tier 1*. This is Tier 1 capital [8274]. iii) *Tier 2*. This is Supplementary Capital [5311]; iv) *Net Adjustments*. These are net prudential adjustments, defined as Tier 1 minus BV, both as previously defined; v) *Pos Adjustments*. These are adjustments that increase Tier 1 relative to equity; and vi) *Neg Adjustments*. These are adjustments that decrease Tier 1 relative to equity.

3.2. Choice of market value as the dependent variable

We measure the market's sensitivity to measures of bank capital using a log-linear model, where the coefficient estimates are the components' elasticities with respect to market values. Market values are primarily relevant for shareholders. However, as Laux (2016) notices, what is relevant for shareholders may not necessarily be relevant for prudential regulators, financial stability, taxpayers, or society. Nevertheless, we justify our choice to focus on market values for four reasons.

First is that the aim of the post-GFC regulation was to reduce procyclical amplification of financial shocks throughout the banking system, financial markets and the broader economy (BCBS, 2010a). The regulatory adjustments introduced by Basel III contribute to the reduction of procyclicality. This is important, because, as we show, some variation of market values can be attributed to regulatory adjustments.

Second, central bankers and bank supervisors have become increasingly aware of the risks of low bank valuations. Vice-President de Guindos of the ECB recently drew attention to the poor profitability outlook of European banks, which "is reflected in rock-bottom bank valuations, with the stock prices of euro area banks recovering less than the overall market over the summer." (ECB, 2020). Former ECB supervision official Lautenschläger identified low bank profits as a prudential risk in 2016 (ECB, 2016).

Third, banks are worried about the effects of regulatory adjustments on equity and share prises. Many of the submissions from banks on the initial Basel III proposal express worries about increased earnings volatility (presumably associated with book and market volatility) caused by the proposed adjustments. Credit Suisse, for example states: "Pension assets often stem from the off-balance sheet treatment of estimated future pension liabilities (actuarial losses). We understand regulators' preference for an on-balance sheet treatment of such losses, as this would provide a snapshot of a bank's capital base. However, such a treatment would lead to significant volatility in banks' capital bases. We believe this to be undesirable both from capital planning and pro-cyclicality perspectives." Other submitters worried that dilution of ordinary equity may interfere with recapitalization or refinancing. Standard Chartered Bank, for example, fears that the "inclination towards Core Tier 1 capital assumes that there is a very significant appetite for new equity capital during the transition to the new capital framework. Any new capital raised will dilute earnings and lead to lower returns on equity which will compound the difficulty of raising new capital." (BCBS, 2010b).

Moreover, in communications with shareholders, banks highlight the adjusted measures of bank capitalization, as the reference to JPMorgan Chase in the introduction shows. Other banks do so too. Citibank and Barclays bank mention their Common Equity Tier 1 capital ratios, i.e. ratios based on adjusted equity, prominently in their earnings announcements.[4]

Last, shareholders do not operate in a vacuum. Going back at least to Myers (1977) and Jensen (1986), there is a literature on capital structure choice that focuses on the trade-offs between holders of equity and debt. For banks, this literature includes papers such as Miller (1995) and Kashyap, Stein & Hanson (2010).

4. Sample selection and data

Our main sample uses quarterly data from U.S. bank holding companies submitted on report FR Y-9C to the Federal Reserve System.[5,6] The regulatory adjustments are from the report's Schedule HC-R–Regulatory Capital. The starting point of the sample is the first quarter of 2001. From that quarter onward, the reporting schedule for regulatory capital on FR Y-9C retained its current structure with only minor changes. The sample period ends at 2020Q2. We include only banks with December 31 year-ends. We match market data for bank holding companies using the link to CRSP data from the New York Federal Reserve Banking Research Dataset website.[7] Table 1 specifies the adjustments, as well as their average impact on regulatory

[4]For the Citibank 2020Q3 announcement see www.citigroup.com/citi/investor/data/p201013a.pdf and for Barclays 2020Q3 see home.barclays/investor-relations/reports-and-events/results/q3-2020-results/.

[5]To compare our results against data from non-financial companies, we also use data from Compustat where we exclude firms with SIC codes between 6000 and 6799 (financials) and between 4000 and 4999 (regulated industries), see Table 3 and Figure 1.

[6]CRSP-Compustat data that support the findings of this study are available via WRDS. Restrictions apply to the availability of these data, which were used under licence for this study. The bank holding companies data is publicly available.

[7]See: www.newyorkfed.org/research/banking_research/datasets.html

capital. The table shows that non-common equity instruments (e.g. Trust Preferred Securities, Additional Tier 1, Perpetual Stock) and minority interests dominate the positive adjustments.

[Table 1 about here]

The negative adjustments are dominated by Goodwill and Intangibles, unrealized gains on Available-For-Sale (AFS) securities, and Deferred Tax Assets (DTAs).

Table 2 reveals that size variables, e.g. market value (M), book value of equity (BV), Total Assets are skewed, with the largest bank more than 45 times larger than the bank at percentile 95. We further examine the effects of size in Section 6.3.

[Table 2 about here]

A comparison of Tier 1 capital to book equity (BV) shows that the former is generally smaller than the latter, which is the result of negative adjustments on average being larger ($1,053M) than positive adjustments ($561M), resulting in an average net deduction from equity of $492M.

The average Tier 1 ratio is 13.0 percent, which is comparable to existing studies. Under pre-Basel III rules, banks were allowed to report the same amount of Tier 2 capital as Tier 1 capital. In practice, however, average Tier 2 capital ($612M) is visibly less than Tier 1 ($2,444M).

The average regulatory adjustments are relatively small. The mean net adjustment is –98 basis points of RWA, with negative adjustments depressing the Tier 1 ratio by 2.54 percent of RWA. However, maximum and minimum values of the adjustments and values at the outer percentiles show that the regulatory adjustments can have a significant effect on regulatory capital.

Our sample contains 26,476 quarterly observations, with the number of observations varying from 1,747 in 2001 to 380 in 2020, with a peak of 1,865 in 2003. The primary cause of the drop in the number of banks after 2005 is a change in the filing requirements for bank holding companies: in 2006, the threshold for filing a FR Y-9C report changed from $150 million in total assets to $500 million in total assets (Federal Reserve, 2006). The low number of observations in 2020 is because we only include data from the first two quarters.

During the sample period, the Tier 1 ratio ranged between 11.3 percent and 14.9 percent, with lows during crises. Financial gearing, i.e. the ratio of Total Assets to book equity, reaches a value of 15.04 in 2009. It then drops to its minimum value of 8.66 in 2019. The lower panel of Table 2 shows the effect of Basel III: from 2015 on, deductions are higher and positive adjustments are lower than before. The table also reports negative minimum values for book equity and Tier 1. These minima are exceptional: eliminating the associated bank-year observations would reduce our sample by 17 observations.

5. Results

5.1. Main results

Table 3 reports the main results of our analysis. It shows results of panel data regressions, with time fixed effects and t-values that are robust to two-way clustering of observations. The summed coefficients in the column next to the column of intercepts should be closer to one than any of the single coefficients, which is the case for all regression models shown in the table.[8] The underlined entries are t-values that test if a coefficient differs from exactly 1. The $\overline{R}^2$ values show that, with respect to banks, our model explains at least 88 percent of the variation in market values.

[Table 3 about here]

The first row shows a significant coefficient value of 1.04 on book value of bank equity (BV). Although the associated t-value in the indicates a significant difference from 1, the difference is relatively small and the

[8] Appendix A, Section A.2 explains why the coefficients should sum to one.

t-value is the lowest of all underlined t-values. Moreover, Table 4 will show that the divergence from the value of one occurs in specific time periods. We infer from this that a one percent change in book value is associated with an approximately one percent change in market value, thus confirming our expected dollar-for-dollar relationship for market and book equity values. Row II shows book value elasticities for non-financial firms based on Compustat data. The elasticities are also close to but lower than 1, demonstrating the model we use is applicable across all industry sectors.

Rows III and IV show results of log-linear regressions of market values on Tier 1 and Total capital (TC). The elasticity on Tier 1 is larger than the one on book value of equity and the coefficient on Total Capital is larger than the one on Tier 1. These findings offer support for hypothesis 1. However, the coefficients on book equity, Tier 1 and Total Capital exceed the value of 1, albeit modestly. We further examine this in Section 5.2 and Section 6.1.

Row IV of Table 3 reports negative elasticities for Tier 2. Note that an increase in Tier 2 capital can be the result of an issuance of subordinated debt or the recognition of loan losses. Descriptive data in Table 2 shows that Tier 2 capital increased during the global financial crisis and the first half of 2020, which is unlikely the result of new issuances. Untabulated results confirm that the recognition of loan losses drives these increases of Tier 2 capital. The negative sign on the Tier 2 elasticity indicates that investors respond negatively to increases in Tier 2 (i.e. loan losses), which is plausible given Ng & Roychowdhury (2014).

Regarding the coefficients on regulatory adjustments, Row III shows that the elasticity of net regulatory adjustments is negative. Similarly, row V shows negative elasticities on positive regulatory adjustments and positive elasticities on negative regulatory adjustments. The elasticities of positive adjustments more than offset those of the deductions, which explains the negative elasticities on net regulatory adjustments.[9]

[9]The drop in sample size to 22,370 is because we use logged variables and some of the gross positive and negative adjustments are zero, where the net of both is non-zero.

Row VI repeats the regressions and controls for the change in the filing requirements for bank holding companies in 2006 when the threshold for filing a FR Y-9C report changed from $150 million of total assets to $500 million of total assets (Federal Reserve, 2006). The coefficients are not overly sensitive to this change: Row VI shows virtually the same coefficient values as those reported in Row III.

5.2. The evolution of elasticities over the sample period

Table 4 and Figure 1 show the evolution of elasticities of book equity, Tier 1, and Total Capital over our sample period. Figure 1 shows results from quarterly regressions and it adds coefficient estimates for non-banks (in blue) and a red dashed line for the S&P/TSX Composite Index for Banks (TXBA.TS).

[Table 4 and Figure 1 about here]

Table 4 shows coefficient estimates for distinct sub-periods. In defining these periods we follow Berger & Bouwman (2013) and Demirgüç-Kunt et al. (2013) and designate non-crisis quarters as those from 2002Q4 to 2007Q2 and from 2013Q3 to the present. We designate as "DotCom Crisis" the period from 2001Q1 (the start of the sample period) to 2002Q3, as "Pre-Crisis" the period from 2002Q4 to 2007Q2, and as "GFC onset" the period 2007Q3 to 2009Q1. This period includes the fall of Lehman Brothers on 15 September 2008. "Post-Lehman" is the period starting from the London G20 (G20, 2009) and the 2009 Supervisory Capital Assessment Program (Federal Reserve, 2009) and ending after the Federal Reserve Board approved the final rule on the implementation of Basel III in July 2013 (Federal Reserve, 2013). "Basel III" is the period from 2013Q3 to 2020Q2, marking an era of relative regulatory and financial calm.

The figure shows that in the years before the global financial crisis (the area between the two grey bands), the elasticities of book values, Tier 1, and Total Capital remained relatively stable, and above the value of one. During the global financial crisis, the elasticities of Tier 1 and Total Capital start rising and from mid-2010 through to the end of 2019 the elasticities converge to 1 and to each other. We will show that the convergence is associated with improvements in the capitalization of banks and lower market uncertainty, see Section 6.1. The dashed red line shows that elasticities coincide with drops in the (sectoral) market index, but less so with its increases. Regarding non-financial firms, the blue line shows that the book value elasticities are more stable over all years, and slightly below one. To the far right end of the graph we observe an increase in the elasticity of Total Capital, which coincides with increased provisioning under the recently introduced current expected credit loss model (CECL) and its effect on Tier 2.

The table confirms the observations from Figure 1. Book value elasticities are close to one. More importantly, after the entry into force of Basel III, the slope coefficient on book values is indistinguishable from 1. The elasticities of Tier 1 are all higher than those of book values; the coefficients for Total Capital exceed those of Tier 1. We see a significant uptick of the Tier 1 and Total Capital elasticities during the onset of the global financial crisis and subsequent years. After the entry into force of Basel III, the elasticities start converging to one. These findings offer further support for hypothesis 1.

Figure 2 shows the evolution of elasticities on regulatory adjustments. Panel 1 of the figure shows that market values are generally insensitive to net regulatory adjustments in the lead-up to the global financial crisis. Only from the onset of the global financial crisis, the elasticities of net regulatory adjustments start to turn negative. The adjustment elasticity turns positive in 2015, which coincides with the drop in positive regulatory capital additions shown in Table 2. The book value elasticity remains relatively close to the value of one, whereas the elasticity of Tier 1 increases after the onset of the global financial crisis.

[Figure 2 about here]

Panel 2 of Figure 2 shows a sharp decline in the coefficient value for additions during the fourth quarter of 2008, while the elasticity on Tier 1 increases at the same time. Panel 3 shows a similar pattern for the elasticities of Tier 2 and Total Capital. These results indicate that a one percent change in Total Capital

(Tier 1) is associated with a two (1.3) percent change in market value. The excess sensitivities coincide with more negative elasticities on net adjustments and Tier 2, suggesting that shareholders benefit from the positive adjustments to Tier 1 and Total Capital.

5.3. Results for Goodwill and Intangibles, DTAs, MSRs, unrealized gains and losses, and for minority interests

Table 5 shows results for the regulatory adjustments that top the two panels of Table 1 or that attracted regulatory attention during the finalisation of Basel III. These are *i*) the deduction of Goodwill and Intangibles, *ii*) the deduction of Deferred Tax Assets (DTAs), *iii*) the deduction of Mortgage-Servicing Rights (MSRs), *iv*) the prudential filter on unrealized gains and losses on available for sale (AFS) securities, and *v*) the inclusion of qualifying minority interests in consolidated subsidiaries. We refer to Figure 3 to illustrate our results.

[Table 5 and Figure 3 about here]

The first column of Table 5 shows that the elasticity of goodwill is positive and significant, albeit small (0.04, t-value of 6.57). Over our sample period, the elasticity on goodwill remains below 0.10, see Figure 3, Panels 1 and 2. Despite regulators excluding goodwill from equity without a great deal of discussion (the deduction has basically not changed since the first Basel accord (BCBS, 1998)), markets value this adjusted item positively. This is noteworthy. A large literature on accounting conservatism places low value on soft assets such as goodwill and intangibles on the basis that they cannot be used for contracting purposes and do not contribute to an orderly liquidation of a company (Holthausen & Watts, 2001).

The elasticity of DTAs is negative (-0.02, t-value of -3.20), indicating that market values decrease with an increase in DTAs. The elasticity on Mortgage-Servicing Rights is insignificant. This is also noteworthy given that at the time of the Basel III negotiations, MSRs were controversial. One the one hand, they are believed to create value:[10]

> "It's just astonishing to me that you would give zero value to a fundamental element of the mortgage business." Harper (2010)

On the other hand, a study by the Federal Reserve Board presented a more critical view on MSRs, claiming that their valuations are inherently subjective and uncertain. According to this study, MSRs were a factor contributing to the failure of four insured depositories, supporting the exclusion of MSRs from capital (Federal Reserve, 2016).

The elasticity on the prudential filter on AFS securities is insignificant for the add-back of unrealized losses, despite being controversial (Ball, 2008; Collins, 2010). The deduction of unrealized gains is statistically significant, but small: 0.02 (t-value 4.62). Overall, these results show a limited economic significance of the prudential filter on AFS securities, contrary to what the financial press and existing studies suggest (Becker, 2013; Chircop & Novotny-Farkas, 2016).

The negative elasticity for minority interests suggests that these are viewed by investors as more debt-like than equity-like, despite the Financial Accounting Standards Board (FASB) Statement No. 160, which classifies minority interests as equity (FASB, 2008; Frankel, Lee & McLaughlin, 2010). Again, however, the coefficient is small (-0.01).

The results of this subsection confirm hypothesis 2: when compared to the elasticities of book equity, Tier 1, and Total Capital, the elasticities of regulatory adjustments are close to zero see.

Our interpretation of the overall results thus far is that the book equity elasticity of market values dovetails with a proportionate dollar-for-dollar relation between market and book values. Moreover, elasticities

[10] This position was supported by the American Bankers Association, who opposed the deduction of MSRs in its comment on the Basel III consultative document BCBS (2009), (BCBS, 2010b).

of the two other measures of bank capitalization, e.g. Tier 1 and Total Capital, appear to converge to the elasticity of book equity when market uncertainty is low. Further, positive regulatory adjustments and their negative elasticities are generally associated with elevated Tier 1 and Total Capital elasticities, while elasticities on negative adjustments tend to be small and less significant.

6. Additional tests

6.1. Results for capitalisation, gearing, and market volatility

Our results show that the elasticities on Equity, Tier 1, and Total Capital often exceed the value of one, in particular after the onset of the global financial crisis. This prompts the question as to why these elasticities are higher than one. To answer this question, we perform three empirical tests and refer to results from simulated data in Appendix A. Firstly, we partition our sample in deciles based on Tier 1 capital ratios for each sample quarter. Table 6 and Panel 1 of Figure 4 show the results based on ordering the sample by Tier 1-ratio decile.

[Table 6 and Figure 4 about here]

The elasticities of book equity decline until the third decile and then level out. This convergence of elasticities for well-capitalized banks is confirmed by the BIS Annual Economic Report 2018, which shows that the differences between measures of bank solvency become smaller when bank resilience increases and PD values drop (BCBS, 2018, Graph III.4).

Moreover, the Tier 1 ratio that corresponds with the levelled-out elasticities is about 12-13 percent, which closely matches results of Firestone et al. (2017), who document optimal Tier 1 ratios exceed 13 percent. In line with this result, BCBS (2019) shows that the marginal benefits of augmenting capital requirements diminish once banks reach a Tier 1 ratio of about 12 percent. Lastly, the convexity shown in

Panel 1 of Figure 4 aligns with results of Arnould et al. (2020), who show that the cost of bank funding increases once a bank reaches a Common Equity Tier 1 ratio of 12 percent.

Secondly, we compare financial gearing to the Tier 1 elasticity of market values, where we define financial gearing as the mean of $\frac{TA}{BV}$ for all sample bank-quarters. Panel 1 of Figure 4 superimposes the gearing variable over Figure 2, Panel 2. The green line shows the evolution of gearing and reflects the values of the right-hand side vertical axis.

[Figure 4 about here]

The figure in Panel 1 shows a strong correspondence between gearing and Tier 1 elasticity values. The correlation coefficient between gearing and the Tier 1 elasticity is 0.77 (p-value: 0.00). Results from simulated data confirm this result: high elasticities are associated with banks that are highly geared, during times of high market volatility (See Appendix A and Panel 2 of Figure A2). Exponentiated intercept values (e^{β_0}) indicate that banks with the lowest Tier 1 ratios have the lowest market-to-book ratios.

Thirdly, Panel 2 of Figure 4 superimposes a measure of market volatility, the CBOE-VIX, over Figure 2, Panel 2. The green line shows the evolution of the VIX, where we use its logged values for the right-hand side vertical axis. The figure shows a fair correspondence between the VIX and Tier 1 elasticity values (ρ: 0.32, p-value: 0.00). Results from simulated data confirm this result: high elasticities are associated with banks that are highly geared, during times of high market volatility (See Appendix A and Panel 1 of Figure A2).

The results of this subsection confirm that poorly capitalized banks display higher Tier 1 elasticities of market value, particularly when the banking sector is highly leveraged, i.e. when systemic risks are elevated, a result in line with Kashyap et al. (2010), Bhagat, Bolton & Lu (2015) for leverage, and with Koziol & Lawrenz (2012) and Chan & Van Wijnbergen (2014) for systemic or market-wide risks. Further, it appears as if Tier 1 ratios of about 12-13 percent are associated with regulatory adjustments that contribute the least to the excess sensitivity of market values.

6.2. The relevance of non-common equity of financials and non-financials

Our results show that the elasticities of non-common equity items (e.g. preferred stock) are generally negative, which is characteristic for debt instruments. In this subsection we examine if the elasticities of preferred stock of non-financial firms show the same characteristic. We use quarterly market values from CRSP and Compustat items *ceqq* and *pstkq* for the book value of common equity and preferred stock, respectively. From the CRSP and Compustat data, we exclude firms with SIC codes between 6000 and 6799 (financials) and between 4000 and 4999 (regulated industries). Figure 5 shows the results.

[Figure 5 about here]

The figure shows positive elasticities for preferred stock of corporates in general. The overall coefficient on preferred stock is 0.03, t-value of 3.80 (untabulated). From this result we infer that non-common equity items for banks are different, the main difference being that they contribute to regulatory capital, and in doing so help prevent a bank from losing its banking license.

6.3. Does bank size matter?

The size of banks varies considerable. Table 2 shows that bank size, measured by total assets, ranges from $141 million to $3.2 trillion. This subsection examines the effects of size on our results. We sorted our bank sample in annual size deciles, then re-ran our log-linear models for each decile. Table 7 shows the results of this examination.

[Table 7 about here]

The table shows that the elasticities are fairly close to 1 over the entire size range. Again, the book value elasticity is generally closest to 1 for the full size range. Given the extraordinary size range that characterizes the banking industry, we infer from this examination that size does not unduly affect our inferences.

6.4. European data

Using data from the EBA transparency exercises over the periods 2015Q2–2020Q2 we find results similar to our main study. The elasticity of book equity (Tier 1) is 1.02 (1.05), with t-values that indicate these values are insignificantly different from 1. Net adjustment are just positive, as in Panel 1 of Figure 2 for the same period. We also find a negative and significant coefficient on positive adjustment (-0.09, t-value of -2.01). The coefficient on negative adjustments is positive but insignificant. One handicap with European regulatory bank data is that it is not as standardized as the U.S. bank holding company data that we use in the main analysis. Moreover, the number of listed European banks we could use for our examination is limited to 63, the sample period shorter. Nevertheless, the important estimated coefficients are in agreement with the results of our main study.

7. Conclusion

We measure the sensitivity of bank market values to bank capital using a log-linear model. Results for the years 2001-2020 show that banks' market value sensitivity, in the form of elasticities, to measures of bank capital, e.g. book equity, Tier 1, and Total Capital, converges to a one-to-one relationship when market uncertainty is low and when banks' Tier 1 ratios reach 12 percent of RWAs. Market values are particularly sensitive to changes in Tier 1 and Total Capital of poorly capitalized banks during times of elevated market uncertainty. We attribute the excess sensitivity largely to capital components that increase regulatory capital. The Total Capital elasticity during the global financial crisis reaches a value of 2, while the Tier 1 elasticity reaches a value of 1.3: a one percent change in Total Capital (Tier 1) is associated with a two (1.3) percent change in market value. Shareholders apparently gain from increases in non-common equity regulatory bank capital when the continuation of banks as a going concern is at stake. Analysis of five regulatory adjustments, some quite controversial, shows that market values are not particularly sensitive to these prudential filters.

We performed many robustness checks. For example, we ran simulations to show that excess elasticity values are associated with gearing and market volatility. Our results are also largely insensitive to the size of banks. The main elasticity coefficients are comparable to those estimated using European banks and non-banks. We ran regressions with alternative model specifications, following the approach of Aledo Martínez et al. (2020). None of the alternative regression designs offer insights that are more consistent or easier to map to economic events than the research design we employ.

With respect to policy issues, regulators spend considerable time tweaking regulatory adjustments. Recently the European Banking Authority approved a new adjustment for the treatment of capitalized software (EBA, 2020a), which was subsequently heavily criticized by Andrew Bailey of the Bank of England (BoE, 2021). The results in this paper, specifically the low elasticity values on Goodwill and Intangibles, indicate that such adjustments have a limited effect on the market values of banks. More importantly perhaps, despite studies supporting "simple" and "pure" measures of bank capital, the results show no superiority of a single measure, especially under sanguine economic conditions and when banks are well-capitalized. On the other hand, when markets are volatile and when banks are poorly-capitalized, the results show that the market positively values increases in non-equity capital. This may contribute to a lower probability of default, perhaps at the expense of fixed income investors, depositors, and creditors. Whether that is desirable is an open question.

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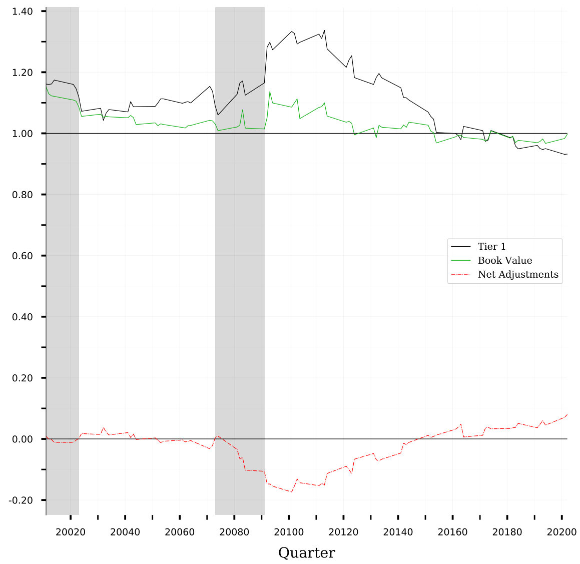
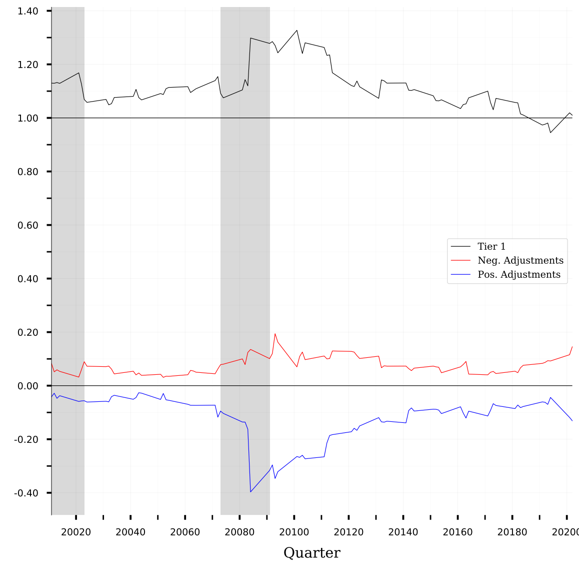
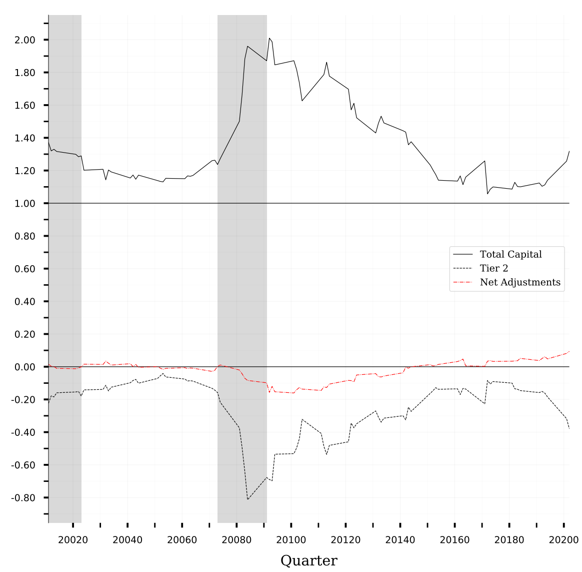
Figure 1: Comparison of elasticities estimated over the sample period using log-linear regression models. $m = f(bv)$, $m = f(t1, \Delta)$, $m = f(tc, t2, \Delta)$, where all variables are logged values. m is the log of market value two months after the end of the quarter; *t1* is the log of Tier 1; *t2* is the log of Tier 2 or Supplementary Capital; *tc* is the log of total regulatory capital; and *bv* is the log of book equity excluding perpetual preferred stock at the end of the quarter. Δ is the log of the absolute net value of regulatory adjustments. Only slope coefficients (elasticities) of *bv*, *t1*, *tc* are shown. The dashed line shows shows the S&P/TSX Composite Index for Banks (TXBA.TS).



Panel 1: Elasticities for $m = f(bv)$ and $m = f(\mathit{t1}, \Delta)$.

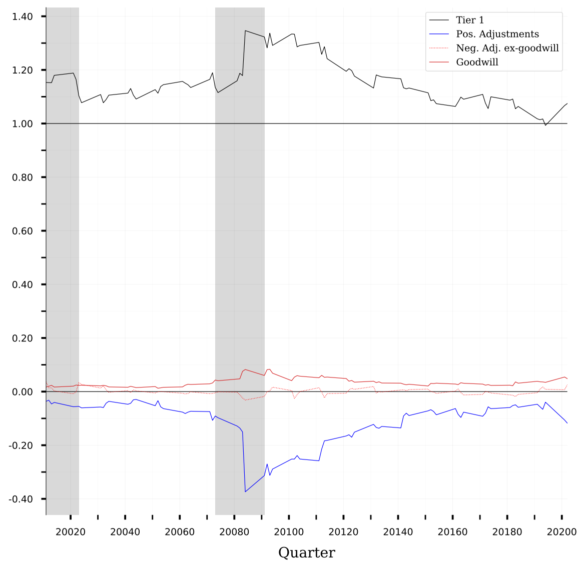


Panel 2: Elasticities for $m = f(\mathit{t1}, \Delta^{+}, \Delta^{-})$.

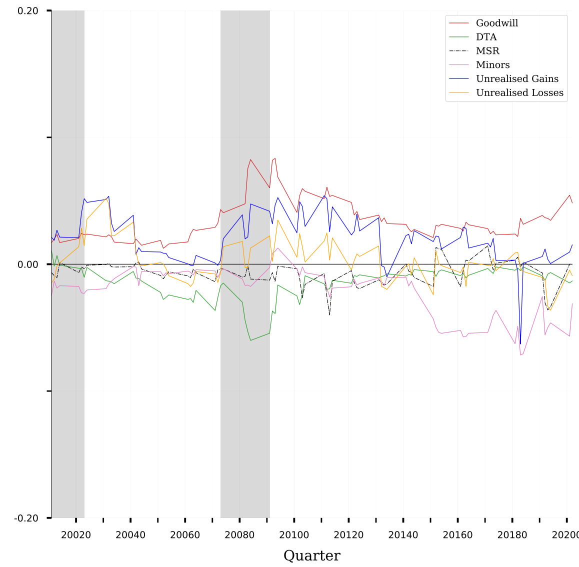


Panel 3: Elasticities for $m = f(tc,\ \mathit{t2}, \Delta)$.

Figure 2: Elasticities of capital components. Variables are logged absolute values. m is the log of market value two months after the end of the quarter; *t1* is the log of Tier 1; *bv* is the log of the book equity excluding perpetual preferred stock at the end of the quarter. Δ is the log of the absolute net value of regulatory adjustments; adjustments that increase (decrease) Tier 1 relative to equity are Δ^{+} (Δ^{-}); *t2* is the log of Tier 2 or Supplementary Capital; and *tc* is the log of Total Capital. Only slope coefficients are shown.

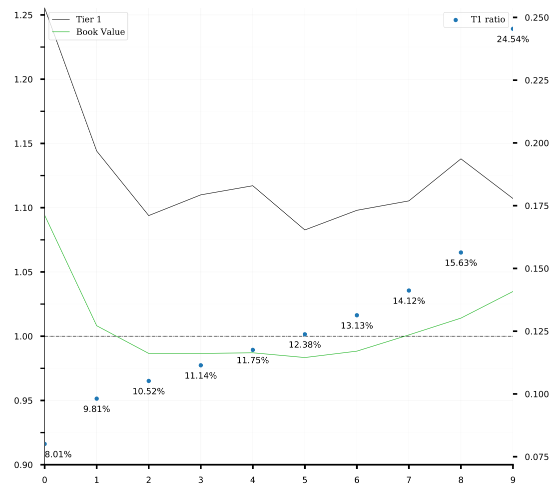


Panel 1: Elasticities of deducted Goodwill and Intangibles: $m = f(t1,\ gw, \Delta^{-'}, \Delta^{+})$, where variables are logged absolute values. $\Delta^{-'}$ is negative regulatory adjustments excluding the prudential adjustment for Goodwill and Intangibles. Δ^{+} are adjustments that increase Tier 1. Only slope coefficients are shown.

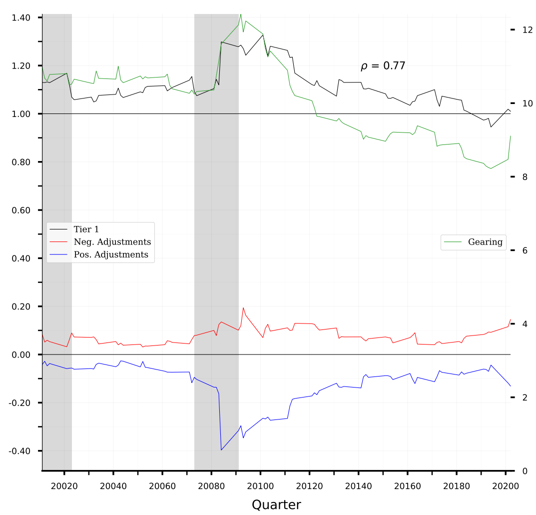


Panel 2: Elasticities of the main regulatory adjustments– enlarged. $m = f(t1,\ x, \Delta^{-'}, \Delta^{+'})$, where x is one of the regulatory adjustments. Only slope coefficients are shown. Unlike the graph to the left, the elasticities of Tier 1 and aggregate positive and negative regulatory adjustments are not shown.

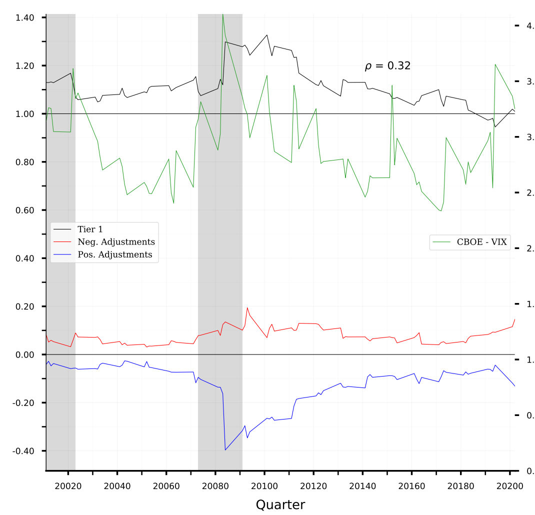
Figure 3: Elasticities for distinct regulatory adjustments.



Panel 1: Book value and Tier 1 elacticities for portfolios of bank capitalisation.



Panel 2: Tier 1 elacticities and gearing.



Panel 3: Tier 1 elacticities and volatility.

Figure 4: Panel 1 shows elasticities for $m = f(t1, \Delta)$ and $m = f(bv)$, slope values only. Variables are logged absolute values. m is the log of market value two months after the end of the quarter; *t1* is Tier 1 and (bv) the book value of equity excluding perpetual preferred stock at the end of the quarter. Δ is the log of the absolute net value of regulatory adjustments. Panels 2 and 3 compare elasticities from Figure 2 with gearing and the CBOE-VIX. Gearing is the sample average ratio of total assets over book equity. Volatility is measured by taking the log of the CBOE-VIX.

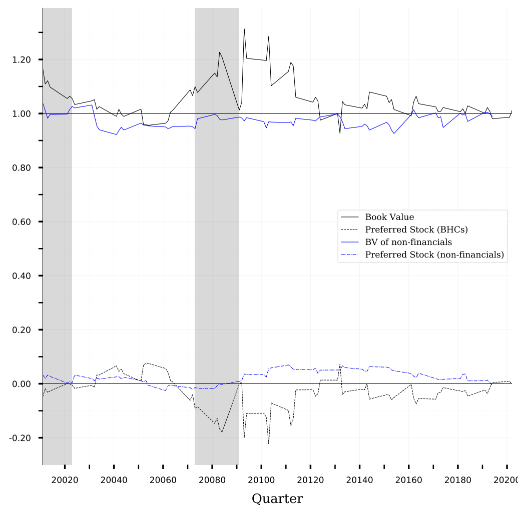


Figure 5: Elasticities of book values and preferred stock for banks (BHCs) and non-financials. Only slope coefficients are shown. For non-financial firms, the relevant variables are Compustat items *book value of common equity* and *preferred stock*.

Table 1 Regulatory adjustments

Positive adjustments are:	Impact on Tier 1 in bp of RWA
Qualifying Trust Preferred Securities [C502], Qualifying restricted core capital elements [G215]	91.5
Minority interests in consolidated subsidiaries [G214], [B589], and [P839]	26.6
Additional Tier 1 capital instruments [P860] and [P861]	18.2
Net unrealized holding losses on Available-For-Sale securities [8434] and [P844]	10.1
Accumulated loss on cash-flow hedges and Defined benefit post-retirement plans [4336], [P846], [P847] and [P849]	7.85
Perpetual Preferred Stock including Related Surplus (pre-Basel III) [3283]	3.92
Tier 1 Minority Interest Not Included In Common Equity Tier 1 Capital [P862]	3.70
Net unrealized losses on held-to-maturity securities that are included in AOCI [P848]	0.19
Qualifying mandatory convertible preferred securities of internationally active bank holding companies [G216]	0.07
Unrealized loss in fair valued financial liabilities attributable to changes in own creditworthiness [F264] and [Q258]	0.02
Other	1.83
Negative adjustments are:	**Impact on Tier 1 in bp of RWA**
Goodwill and Intangibles [B590], [P842], [P841]	215.2
Net unrealized holding gains on Available-For-Sale securities [8434], [A221], [P844], and [P845]	18.4
Deferred Tax Assets [5610], [P843], [P855]	11.5
Additional Tier 1 capital deductions, [P864]	5.96
Mortgage servicing rights and purchased credit card relationships [P854], [B591]	1.09
Accumulated gains on cash-flow hedges and Defined benefit post-retirement plans [4336], [P846], [P847] and [P849]	0.58
Non-qualifying Perpetual Preferred Stock [B588]	0.55
Unrealized gain in fair valued financial liabilities attributable to changes in own creditworthiness [F264] and [Q258]	0.08
Investments in the capital of unconsolidated financial institutions that exceed the relevant 10 % threshold [P851] and [P853]	0.05
Net unrealized gains on held-to-maturity securities that are included in AOCI [P848]	0.03
Significant investments in financial institutions, MSR, and DTAs over the 15 % CET1 deduction threshold [P856]	0.02
Other	0.72

Notes: Regulatory adjustments for U.S. bank holding companies covering the quarters 2001Q1–2020Q2. *Positive adjustments* increase, and *Negative adjustments* decrease *Tier 1 capital [8274]* relative to the book value of common equity. The items are sorted on their mean values divided by risk weighted assets (*RWA*). *bp* is basis points. The mnemonics in square brackets refer to the item codes from the Consolidated Financial Statements for Bank Holding Companies (FR Y-9C); their definitions are from www.federalreserve.gov/apps/mdrm/data-dictionary.

Table 2 Descriptive statistics

$n = 26,476$	Mean	Min	p5	p25	p50	p75	p95	Max	StDev
M	3,842	1.00	27.9	86.6	250	972	11,987	429,913	20,802
BV	2,936	-510	27.9	70.6	166	621	7,346	250,136	17,568
Tier 1	2,444	-505	30.6	75.4	171	573	6,616	220,674	14,677
Additional Tier 1	588	0.00	0.00	2.52	25.0	79.4	1,788	29,815	2,941
Tier 2	612	0.00	2.61	7.27	17.2	62.8	1,486	66,951	3,857
Net Adjustments	-492	-65,600	-1,196	-49.3	-1.93	11.35	88.5	52,237	3,528
Pos Adjustments	561	-1.48	0.00	5.16	23.6	77.2	1048	116,129	4,052
Neg Adjustments	1,053	0.00	0.07	3.77	21.1	132	2,067	106,163	6,820
Total Assets	31,468	141	354	828	1,878	6,283	70,141	3,213,115	195,115
Tier 1 ratio	13.0	0.00	8.53	10.5	12.0	14.1	19.2	100	5.78
Tier 2 ratio	1.54	0.00	0.73	1.09	1.25	1.68	3.46	24.4	0.88
Net Adj over RWA (%)	-0.98	-97.1	-5.84	-2.14	-0.48	0.83	2.71	26.1	3.52
Pos Adj over RWA (%)	1.39	0.00	0.00	0.08	1.05	2.37	3.75	26.1	1.46
Neg Adj over RWA (%)	2.54	0.00	0.01	0.50	1.60	3.63	7.44	97.1	3.38

Year	M	BV	Tier 1	Tier 2	Net Adj	Pos Adj	Neg Adj	$\frac{\text{Tier 1}}{RWA}$ (%)	$\frac{\text{Tier 2}}{RWA}$ (%)	Gearing	$\frac{\text{NetAdj}}{RWA}$ (%)	$\frac{\text{Pos}}{RWA}$ (%)	$\frac{\text{Neg}}{RWA}$ (%)	# of obs.
2001	2,542	993	853	312	-140	117	257	12.6	1.52	12.2	-0.54	0.96	1.50	1,747
2002	2,378	1,067	900	320	-168	138	305	13.0	1.55	11.8	-0.52	1.29	1.80	1,822
2003	2,487	1,144	966	337	-177	150	327	13.0	1.62	11.8	-0.43	1.53	1.95	1,865
2004	2,958	1,347	1,054	356	-294	169	463	12.9	1.58	11.7	-0.21	1.85	2.05	1,812
2005	2,978	1,539	1,158	389	-382	196	578	12.5	1.48	11.7	-0.23	1.99	2.22	1,824
2006	3,795	1,953	1,466	501	-487	282	770	12.1	1.49	11.6	-0.47	2.24	2.71	1,581
2007	3,707	2,197	1,586	627	-611	355	967	11.7	1.49	11.3	-0.91	2.07	2.98	1,497
2008	2,516	2,227	1,914	755	-314	787	1,101	11.3	1.61	12.4	-0.52	2.37	2.89	1,421
2009	2,088	2,413	2,395	766	-18	1,045	1,063	12.1	1.68	15.0	0.96	3.46	2.50	1,419
2010	2,953	3,000	2,515	763	-485	676	1,161	13.1	1.70	15.0	0.68	3.29	2.61	1,346
2011	2,797	3,353	2,750	738	-603	607	1,209	14.4	1.60	12.8	0.40	3.06	2.66	1,287
2012	3,254	3,667	2,947	654	-720	523	1,244	14.9	1.50	11.5	-0.11	2.67	2.78	1,268
2013	4,125	3,848	3,106	637	-742	455	1,197	14.8	1.43	10.8	-0.21	2.31	2.52	1,268
2014	4,746	4,051	3,365	634	-686	626	1,311	14.5	1.39	10.3	-0.76	1.81	2.57	1,285
2015	5,731	5,049	4,278	813	-772	970	1,741	13.3	1.41	9.67	-1.17	1.89	3.06	1,016
2016	5,997	5,729	4,874	922	-854	1,159	2,013	12.8	1.46	9.66	-1.35	1.62	2.97	952
2017	7,789	5,806	4,980	898	-826	1,184	2,010	13.0	1.47	9.37	-1.55	1.45	3.00	962
2018	7,948	5,955	5,091	890	-864	1,217	2,081	12.9	1.50	9.08	-2.01	1.45	3.46	953
2019	9,447	7,580	6,384	1,109	-1,196	1,454	2,650	12.8	1.53	8.66	-2.86	1.20	4.06	771
2020	6,455	7,717	6,538	1,336	-1,179	1,694	2,873	12.5	1.87	9.24	-2.76	1.45	4.21	380

Notes: Descriptive statistics of variables from U.S. bank holding companies over the 2001Q1 to 2020Q2. *M* is market value two months after the end of the quarter *BV* is book value of equity excluding perpetual preferred stock at the end of the quarter [3210] – [3283]. *Tier 1* is Tier 1 capital [8274]. *Tier 2* is Supplementary Capital [5311]. *Gearing* is Total Assets over Book Value (BV). *Net Adjustments* is the net of prudential adjustments, defined as *Tier 1* minus *BV*, both as previously defined. *Pos (Neg) Adjustments* are adjustments that increase (decrease) *Tier 1* relative to equity. *Total assets* is item [2170]. *RWA* is Risk-Weighted Assets [A223]. Amounts are in millions of USD. The number of observations reported in a row is the sum of the quarterly observations. Flow variables, if any, are annualized for 2020. Mnemonics in square brackets refer to the item codes from the Consolidated Financial Statements for Bank Holding Companies (FR Y-9C); their definitions are from www.federalreserve.gov/apps/mdrm/data-dictionary.

Table 3 Log-linear model results

Pooled		BV	Tier 1	TC	Net Adj	Pos Adj	Neg Adj	Tier 2	Intercept	$\Sigma\beta_{1..N}$	$\bar{R}^2$	# of obs.
I	β	1.04							-0.24	1.04	0.91	26,476
	t	85.8							-1.60			
	$t_{\beta:1}$	12.6										
II*	β	0.89							1.47	0.89	0.89	186,925
	t	63.8							13.7			
	$t_{\beta:1}$	61.4										
III	β		1.13		-0.03				-1.03	1.10	0.89	26,452
	t		49.6		-1.74				-5.51			
	$t_{\beta:1}$		32.3									
IV	β			1.37	-0.02			-0.24	-1.73	1.10	0.89	26,404
	t			23.6	-1.68			-6.06	-5.98			
	$t_{\beta:1}$			39.8								
V	β		1.12			-0.11	0.07		-0.84	1.08	0.90	22,370
	t		49.5			-9.43	8.24		-4.33			
	$t_{\beta:1}$		28.7									
VI**	β		1.12		-0.03				-0.98	1.10	0.88	23,906
	t		47.9		-1.73				-4.94			
	$t_{\beta:1}$		19.3									

Notes: The table reports results of panel data regressions that rely on data of U.S. bank holding companies over the 2001Q1 to 2020Q2, where the dependent variable (m) is the log of the market value of the bank two months after quarter end:

$$m_{i,t} = \beta_0 + \sum_n \beta_n \cdot |a|_{n,i,t} + \varepsilon_{i,t} \tag{4}$$

$a_{n,i,t}$ is from the following list of regressors, which are logged absolute values of: *BV* is book value of equity excluding perpetual preferred stock at the end of the quarter [3210]–[3283]. For non-financials, this is item common/ordinary equity ($ceqq$) from the CRSP-Compustat merged quarterly database. *Tier 1* is Tier 1 capital [8274]. *TC* is total qualifying capital allowable under the risk-based capital guidelines [3792]. *Net Adj* is the net of prudential adjustments, defined as *Tier 1* minus *BV*, both as previously defined. *Pos Adj* is adjustments that increase *Tier 1* relative to equity. *Neg Adj* is adjustments that decrease *Tier 1* relative to equity. *Tier 2* is Tier 2 or Supplementary Capital [5311]. $\Sigma\beta_{1..N}$ is the sum of the coefficients, excluding the intercept. The mnemonics in square brackets refer to the item codes from the Consolidated Financial Statements for Bank Holding Companies (FR Y-9C); their definitions are from www.federalreserve.gov/apps/mdrm/data-dictionary. The regression model relies on t-values that account for two-dimensional cluster correlation. We employ time fixed-effects. $t_{\beta:1}$ denotes t-values for *BV*, *Tier 1*, and *TC* that test if the coefficient differs from one (1).
*: Non-financial firms only: all Compustat firms excluding those with SIC codes between 6000 and 6799 (financials) and between 4000 and 4999 (regulated industries).
**: Only banks with Total Assets $> \$500M$.

Table 4 Log-linear model results – elasticities by period

Period		Book Value	δ	p_δ	$\overline{R}^2$	Tier 1	δ	p_δ	$\overline{R}^2$	Total Capital	δ	p_δ	$\overline{R}^2$	nobs
DotCom Crisis	β	1.12			0.96	1.15			0.96	1.31			0.95	3,099
	$t_{\beta:1}$	89.6				117				46.3				
Pre-Crisis	β	1.04	-0.08	0.00	0.96	1.09	-0.06	0.00	0.96	1.17	-0.14	0.01	0.96	8,284
	$t_{\beta:1}$	14.5				48.0				26.6				
GFC onset	β	1.03	-0.01	0.29	0.84	1.13	0.04	0.15	0.81	1.61	0.43	0.00	0.82	2,517
	$t_{\beta:1}$	1.73				16.8				21.0				
Post-Lehman	β	1.06	0.04	0.10	0.91	1.27	0.15	0.00	0.88	1.74	0.14	0.20	0.90	5,566
	$t_{\beta:1}$	11.4				60.5				69.5				
Basel III	β	1.00	-0.06	0.00	0.96	1.04	-0.24	0.00	0.95	1.23	-0.51	0.00	0.95	6,938
	$t_{\beta:1}$	0.00				1.58				19.4				

Notes: The table reports results from panel regressions that rely on data of U.S. bank holding companies over the 2001Q1 to 2020Q2. Slope coefficients are shown for $m = f(bv)$, $m = f(t1,\Delta)$, and $m = f(tc,t2,\Delta)$, where variables are logged absolute values. m is the log of market value two months after the end of the quarter, bv is the log of the book value of equity excluding perpetual preferred stock at the end of the quarter. $t1$ is the log of Tier 1; Δ is the log of the absolute net value of regulatory adjustments, tc is the log of total regulatory capital, $t2$ is the log of Tier 2 or Supplementary Capital. δ shows the difference in coefficient values between periods. p_δ values show the significance of that difference. We define these periods: *DotCom Crisis* is the period from 2001Q1 (the start of the sample period) to 2002Q3. *Pre-Crisis* is the period from 2002Q4 to 2007Q2. *GFC onset* is the period 2007Q3 to 2009Q1. *Post-Lehman* is the period from 2009Q2 to 2013Q2. *Basel III* is the period from 2013Q3 to 2020Q2. We use 1 (one) as a reference value to determine the t-values for Book Value, Tier 1 and Total Capital. The regression model relies on t-values that account for two-dimensional cluster correlation. We employ time fixed-effects.

Table 5 Log-linear model results for Goodwill and Intangibles, DTAs, MSRs, unrealized Gains and Losses, and Minority Interests

	Goodwill & Intangibles		DTA		MSR		UR Gain & Loss		Minority interests	
	β	t	β	t	β	t	β	t	β	t
Tier 1	1.15	62.6	1.14	48.7	1.16	53.96	1.09	23.26	1.08	11.18
Pos. adjustments (ex AFS, Minority interests)	-0.10	-9.62	-0.10	-9.43	-0.11	-9.42	-0.03	-9.48	-0.04	-8.51
Neg. adj. (ex Goodwill, DTA, MSR, AFS, Minors)	0.00	-1.16	0.05	6.61	0.04	5.98	0.02	6.30	0.06	7.76
Goodwill and Intangibles	0.04	6.57								
DTA			-0.02	-3.20					-0.04	-8.51
MSR					0.00	-1.10				
Unrealised Gains							0.02	4.62		
Unrealised Losses							0.00	1.19		
Minority interests									-0.01	-2.27
Intercept	-0.89	-4.76	-0.89	-5.27	-1.01	-5.17	-0.89	-4.82	-0.87	-3.89
$\Sigma\beta_{1..n}$		1.08		1.07		1.09		1.11		1.08
$\overline{R}^2$		0.90		0.90		0.90		0.89		0.90
# of obs.		23,178		23,178		23,178		26,476		25,647

Notes: The table reports results of panel regressions that rely on data of U.S. bank holding companies over the 2001Q1 to 2020Q2, where the dependent variable (m) is the log of the market value of the bank two months after quarter end:

$$m_{i,t} = \beta_0 + \sum_n \beta_n \cdot |a|_{n,i,t} + \varepsilon_{i,t} \tag{5}$$

$a_{n,i,t}$ is from the following list of regressors, which are logged absolute values of: *Tier 1* is Tier 1 [8274] *Positive Adjustments* is adjustments that increase *Tier 1* relative to equity. *Negative Adjustments* is adjustments that decrease *Tier 1* relative to equity. *Goodwill* is disallowed Goodwill and Intangibles [B590], [P842], [P841]. *Deferred Tax Assets* is Deferred Tax Assets disallowed for regulatory capital purposes [5610, P843, P855]. *Mortgage-Servicing Rights* (MSR) is disallowed mortgage-servicing rights and purchased credit card relationships [P854], [B591]. *Unrealized Gains (Losses)* represent the prudential filter on net unrealized holding gains (losses) on Available-For-Sale securities [8434], [A221], [P844], and [P845]. *Minority interests* is qualifying minority interests in consolidated subsidiaries. The mnemonics in square brackets refer to the item codes from the Consolidated Financial Statements for Bank Holding Companies (FR Y-9C); their definitions are from www.federalreserve.gov/apps/mdrm/data-dictionary. The regression model relies on t-values that account for two-dimensional cluster correlation. We employ time fixed-effects.

Table 6 Log-linear model results for Tier 1 ratio deciles

Decile	Tier 1 Ratio	Book Value β_{bv}	$t_{\beta:1}$	β_0	t_{β_0}	e^{β_0}	$\overline{R}^2$	Tier 1 β	$t_{\beta:1}$	$\overline{R}^2$
0	8.01	1.09	4.63	1.09	-3.04	0.38	0.91	1.26	5.57	0.89
1	9.81	1.01	0.43	1.01	1.15	1.34	0.86	1.14	4.03	0.83
2	10.52	0.99	-0.88	0.99	2.78	1.74	0.90	1.09	3.20	0.89
3	11.14	0.99	-0.89	0.99	2.56	1.66	0.92	1.11	3.53	0.90
4	11.75	0.99	-0.90	0.99	2.38	1.60	0.92	1.12	3.73	0.90
5	12.38	0.98	-1.22	0.98	2.75	1.67	0.92	1.08	2.84	0.90
6	13.13	0.99	-0.73	0.99	1.97	1.51	0.93	1.10	3.14	0.91
7	14.12	1.00	0.07	1.00	1.36	1.27	0.94	1.11	3.58	0.92
8	15.63	1.01	0.72	1.01	0.23	1.06	0.91	1.14	3.52	0.88
9	24.54	1.03	1.06	1.03	-0.35	0.87	0.91	1.11	2.62	0.90

Notes: The table reports results of regressions of data sorted on a bank's quarterly Tier 1 ratio. The regressions rely on data of U.S. bank holding companies over the 2001Q1 to 2020Q2, where the dependent variable (m) is the log of the market value of the bank two months after quarter end:

$$m_{i,t} = \beta_0 + \sum_n \beta_n \cdot |a|_{n,i,t} + \varepsilon_{i,t} \quad (6)$$

For the Book Value regression model, $a_{1,i,j}$ is the log of the book equity excluding perpetual preferred stock at the end of the quarter. For the Tier 1 regression model, $a_{1,i,j}$ is the logged value is Tier 1 capital [8274], and $a_{2,i,j}$ is the logged value of the net prudential adjustments, the latter defined as *Tier 1* minus *BV*. e^{β_0} is the exponentiated intercept. Regressors are absolute values of the logged values. The mnemonics in square brackets refer to the item codes from the Consolidated Financial Statements for Bank Holding Companies (FR Y-9C); their definitions are from www.federalreserve.gov/apps/mdrm/data-dictionary. The regression model relies on t-values that account for two-dimensional cluster correlation. $t_{\beta:1}$ means that 1 (one) is used as a reference value to determine the t-values. The number of observations per decile is 2,645.

Table 7 Log-linear model results for size deciles

Decile	Average Total Assets	Book Value β	$t_{\beta:1}$	Tier 1 β	$t_{\beta:1}$	Total Capital β	$t_{\beta:1}$
0	381	0.85	-3.05	0.95	-0.68	1.05	0.54
1	610	1.06	0.64	1.00	0.01	1.06	0.38
2	828	0.94	-0.47	1.03	0.20	1.12	0.66
3	1,133	1.17	1.16	1.21	2.03	1.49	3.14
4	1,570	1.18	1.86	1.24	1.23	1.29	1.40
5	2,280	1.03	0.15	1.20	1.60	1.25	1.78
6	3,523	1.15	1.41	1.03	0.17	1.14	0.81
7	6,288	0.97	-0.32	0.95	-0.28	1.01	0.05
8	12,611	0.94	-0.49	0.91	-0.50	1.05	0.35
9	71,590	0.92	-2.92	0.88	-3.16	0.93	-0.75

Notes: The table reports results of regressions of data sorted on size (*Average Total Assets* [2170], in millions of USD.) The regressions rely on data of U.S. bank holding companies over the 2001Q1 to 2020Q2, where the dependent variable (m) is the log of the market value of the bank two months after quarter end:

$$m_{i,t} = \beta_0 + \sum_n \beta_n \cdot |a|_{n,i,t} + \varepsilon_{i,t} \quad (7)$$

$a_{1,i,j}$ is the log of book equity excluding perpetual preferred stock at the end of the quarter, or Tier 1 capital [8274], or *Total Capital*, which is Total Qualifying Capital Allowable under the Risk-based Capital Guidelines [3792]. For the Tier 1 regression model and the Total Capital regression model, $a_{2,i,j}$ is the logged value of the net prudential adjustments (*Tier 1* minus *BV*). For the Total Capital regression model, $a_{3,i,j}$ are logged values of *Tier 2* [5311]. Regressors are absolute values of the logged values. The mnemonics in square brackets refer to the item codes from the Consolidated Financial Statements for Bank Holding Companies (FR Y-9C); their definitions are from www.federalreserve.gov/apps/mdrm/data-dictionary. The regression model relies on t-values that account for two-dimensional cluster correlation. The number of observations per decile is 2,645.

Appendix A: A brief explanation of the log-linear models

We use log-linear models as an alternative to the additive-linear models because the coefficients of the latter are sensitive among other things to, sample choice, choice of time period and the treatment of outliers. As the replication in Appendix B shows, the coefficients of the additive-linear models are volatile and change significantly from quarter to quarter. Lubberink & Willett (2020) then show that log-linear models produce much more stable and valid coefficients that can be interpreted more easily.

A.1. The proportional dollar-for-dollar relation for book value of equity

This appendix explains the intuition behind the log-linear models and the way we use them. We start with the intercept, which measures scale (i.e. not size) independently of the slope coefficients. See Panel 1 of Figure A1. For 40 sample portfolios sorted on the book to market ratio, the figure shows the average market-to-book ratio (in red) and the exponentiated intercept values of a regression of the log of market values on the log of book values (in black). The panel shows a clear correspondence between Market-to-Book ratios and (exponentiated) intercept values of the log-linear regression model.

[Figure A1 about here]

Moving to the slope estimates from the log-linear model, these provide strong support for the dollar-for-dollar hypothesis linking the book value of a firm's equity to its market value (Miller & Modigliani, 1961; Penman, 1996). Throughout this paper, the tables and graphs show book elasticity values close to the value of one. Figure 1, for example, shows that the elasticity on book value is close to one for both financial firms and non-financial firms, with the former being slightly greater than one and the latter slightly less; a feature most likely due to the greater importance of earnings influencing the share price of non-financial firms.

Note that we estimate elasticities: the dollar-for-dollar relation applies to relative changes in values: a one percent change in book value explains a one percent change in market capitalization. Because we isolate the effects of scale (via the intercept), the interpretation of elasticities for banks and firms with market to book ratios unequal to one is not problematic.

Comparing our results to those of the additive-linear model, we see its intercept term estimates firms' market values when the accounting variables are zero. The slope coefficient in the additive-linear model is an estimate that confounds the scale effect with the change in the accounting values effect. In the additive-linear model these effects are inseparable. Attempting to interpret the slope coefficient in the additive-linear model as a measure of the effect of a change in an accounting variable on market value is an example of estimation using a misspecified model. Such misspecification leads to unwanted noise in estimation and therefore increased volatility, making interpretation of coefficient estimates more difficult than it should be.

A.2. Multivariate analyses

A property of the log-linear model that is useful in interpretating the relative strength of the variables on the RHS of a regression in measuring their effects on the dependent variable is that elasticities of the components in a sum of the RHS variables add up to the elasticity of the sum with respect to the dependent variable. Thus, if M is regressed on A and A is the sum of mutually exclusive $A = \Sigma_i A_i$, then the elasticity of A with respect to M, β, is such that $\beta = \Sigma_i \beta_i$, where β_i is the elasticity of A_i with respect to M in a multivariate regression of the latter on the former. Consequently, a valid application of estimation using the log-linear model shows the percent contribution of each variable in explaining a percent change in the dependent variable. This clarity of interpreting the relative effects of different explanatory variables in models is evident in the figures in this paper and illustrates again an advantage of using elasticities estimated from a log-linear model. Panels 2 and 3 of Figure A1 demonstrate this for a log-linear regression model that regresses the log of Total Assets and the log of Total Liabilities on the log of market values.

A.3. Elasticities exceeding the value of one

Our analyses show elasticities that exceed the value of one. Our interpretation of the excess elasticities is that these reflect systemic risk (because of poorly-capitalized banks, see e.g. Bhagat et al. (2015)) and market volatility. To support this interpretation, we simulate market values, book values, and earnings for 100 firms and 100 periods. The initial book value is 100, then grows by 1 percent per year. The earnings elasticity is $1-\varepsilon_{BV}$, or one minus the book elasticity (ε_{BV}). For Panel 1 the market value follows this model: $M = f(BV_0^{\varepsilon_{BV}} \times earn^{1-\varepsilon_{BV}}, N(\mu, sd(t)))$, where the last term is random normal distributed with constant mean μ of 0 and a standard deviation that increases over time t.

For Panel 2 the market value follows a model that acknowledges the call option value of book equity: $M = f(Call(TA, L, T, r, \sigma)^{\varepsilon_{BV_t}}, N(\mu, sd(t)))$. $Call$ is the value of equity based on Merton (1974), where TA, L, T, r, σ are total assets, total liabilities, time to maturity, risk-free rate, and volatility, respectively. Initial values for $\{TA, r, \sigma\}$ are $\{5, 0.01, 0.35\}$. The initial book value is 100, then grows by 1 percent per year. $TA = \frac{BV}{LR}$ where the leverage ratio is $LR = \{0.01, 0.045, 0.10, 0.25\}$. Total liabilities (L) are $TA - BV$.

[Figure A2 about here]

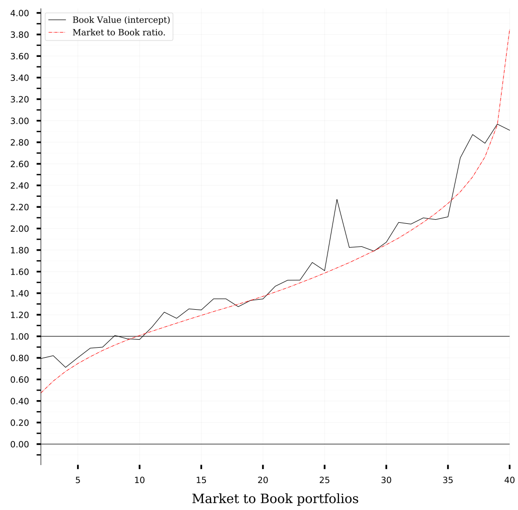
For both panels, Figure A2 plots the average standard deviation of the simulated market values for a range of book elasticity values (ε_{BV}). Panel 1 shows that book elasticity values that exceed the value of one are associated with higher market value variability. Panel 2 shows these excessive elasticities are more manifest in banks that are poorly capitalized.

A.4. Absolute values of variables

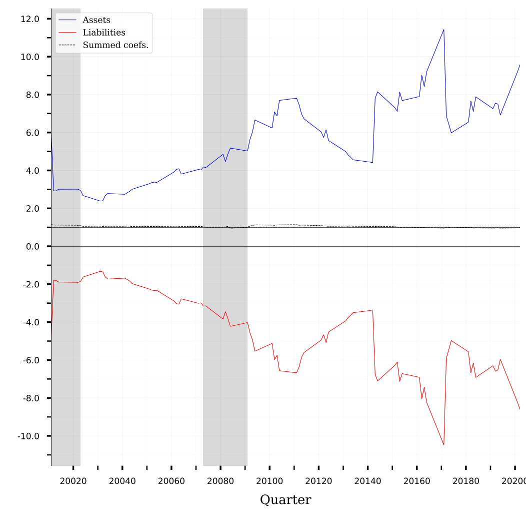
As negative values of variables have no logarithm, the estimates of the effect of changes in accounting variables on market values in the form of elasticities are based upon the absolute magnitudes of the model variables, without regard to their sign. When estimation is approached in this way, an increase in the magnitude of book value or earnings is expected to have a positive effect, i.e. a positive elasticity, with respect to market value. This is invariably the case. In contrast, an increase in the magnitude of a loss is expected to be associated with a negative magnitude of change or, at least, a much reduced and usually smaller positive magnitude of change in market value, i.e. a negative or small positive elasticity. This is usually what occurs.

When data with negative and positive values are pooled, as with data containing some observations with positive earnings and some with losses, or negative earnings, the resulting estimates of the market elasticities on earnings are a weighted average of the generally more positive elasticities on positive earnings and the more negative market elasticities on the losses. The matrix form of the weights for this averaging process is discussed in Lubberink & Willett (2020) and its application to the separate positive and negative parts of any earnings data produces exactly the same result as would be obtained from estimating the elasticities for the positive and negative earnings data pooled into a single sample. Although it is more complicated than a simple weighted average of elasticities based upon the number of positive and negative observations, that calculation typically does explain most of the averaging effect.

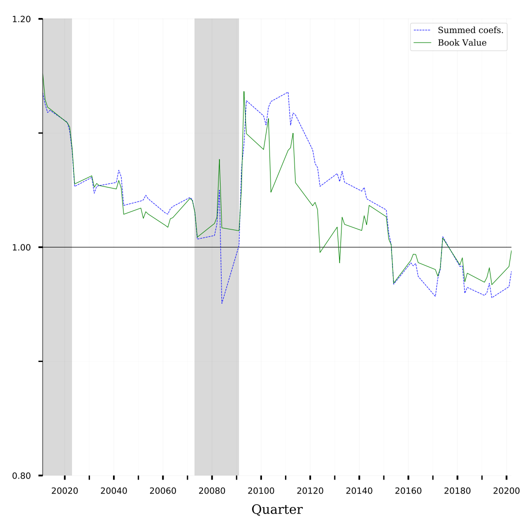
It should be noted that market values, book values, Tier 1, and Total Capital are generally positive (except for the 17 sample observations with a negative sign on one of these variables). Taking the absolute values of the logs of these variables has no measurable effect on the results. Moreover, we partition almost all regulatory adjustments into positive and negative adjustments. The prudential filter for Goodwill and Intangibles, for example, is always a deduction. The exception are net adjustments, which can be negative, see Table 2. Figure 2 in the main text then shows that taking absolutes does not alter our inferences. Lastly, untabulated results confirm that excluding the 17 observations with negative values for book values, Tier 1, and Total Capital do not alter our inferences either.



Panel 1: A comparison of Market to Book ratios of U.S. Bank Holding Companies to exponentiated intercept values of the following log-linear Book Value regression model, 2001Q1-2020Q2. $m_{i,t} = \beta_{0,i,t} + \beta_1 \cdot bv_{i,t} + \varepsilon_{i,t}$. In red is the Market to Book ratio. In black are exponentiated intercept values of the Book Value model.

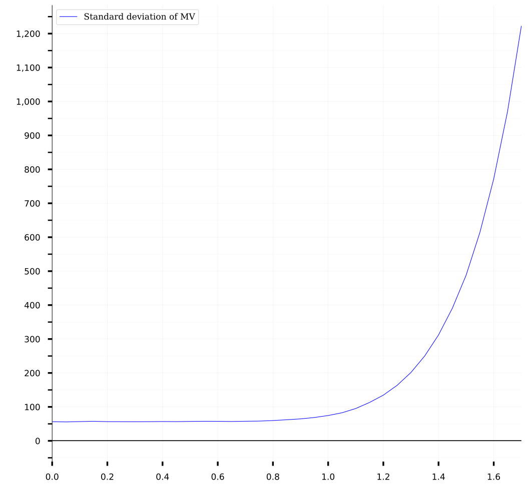


Panel 2: Comparison of market elasticities for $m = f(ta, tl)$. The variables are logged values. m is the log of market value two months after the end of the quarter; ta is the log of Total Assets; and tl is the log of Total Liabilities. The dotted line shows the sum of coefficients on ta and on tl benchmarked against the horizontal line of $\varepsilon = 1$.

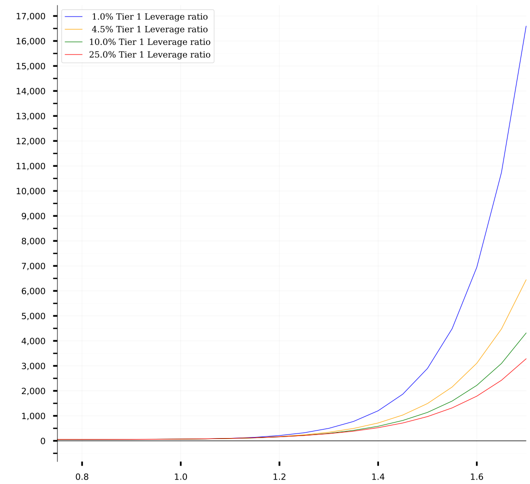


Panel 3: The sum of coefficients from the previous panel and the coefficient on book values from a univariate regression of logged absolute values of market and book values: $m = f(bv)$.

Figure A1: Intercepts (top left) and slope coefficients (top right, bottom) of the log-linear model.



Mean standard deviations of MV for a range of book equity elasticities.



Mean std. deviations of MV for a range of book equity elasticities and capitalizations.

Panel 1: A plot of the standard deviation of market values against a range of book elasticity of market values (ε_{BV}). Underlying data are simulated market values, book values and earnings for 100 firms and 100 periods. Initial book value is 100. Book values grow by 1 percent per year. The earnings elasticity is $1-\varepsilon_{BV}$. The market value follows this model: $MV = f(BV_0^{\varepsilon_{BV}} \times earn^{1-\varepsilon_{BV}} + N(\mu, sd(t)))$, where the last term is random normal distributed with constant mean μ and a standard deviation that increases over time t.

Panel 2: A plot of the standard deviation of market values against a range of book elasticity of market values (ε_{BV}), for different levels of capitalization $\frac{TA}{BV}$. The market value follows this model: $MV = f(Call(TA, L, T, r, \sigma)^{\varepsilon_{BV_t}} + N(\mu, sd(t)))$, where the last term is a random value drawn from for a normal distribution with constant mean c and a standard deviation that increases over time t. *Call* is the value of equity based on Merton (1974), where TA, L, T, r, σ are total assets, total liabilities, time to maturity, risk-free rate, volatility, respectively. Initial values for $\{T, r, \sigma\}$ are $\{5, 0.01, 0.35\}$. Initial book value is 100, then grows by 1 percent per year. $TA = \frac{BV}{LR}$ where the leverage ratio is $LR = \{0.01, 0.045, 0.10, 0.25\}$. Total liabilities are $TA - BV$.

Figure A2: Market value volatility and elasticities.

Appendix B: A replication of an existing study that relies on scaled variables.

To compare our results to the existing literature, we replicate some of the analyses of Demirgüç-Kunt et al. (2013) (DK). This paper is a close equivalent to ours, it compares various measures of bank capitalization, but relies on deflated variables, ratios. The research design is common in the literature, so we could have used other papers for this replication as well. However, papers such as DK influence policies, see for example a World Bank report, an RBNZ study of the leverage ratio, and a Bank of England consultation paper that highlight the importance of the leverage ratio (BoE, 2014; Brunton, 2018; World Bank, 2019).[11]

Our objective is to demonstrate the importance of a well-specified model and that the choice of models makes a difference. Specifically, we use the following model that regresses returns on capital components and other control variables:

$$r_{i,t} = \beta_0 + \sum_n \beta_n \cdot X_{n,i,t-1} + \varepsilon_{i,t} \tag{8}$$

where r (or *return*) is the share return over the current quarter.

$X_{n,i,t-1}$ are observations from the following set of variables: *i*) *Total Capital Ratio* is Total Qualifying Capital Allowable under the Risk-based Capital Guidelines divided by RWAs. *ii*) *T1 Leverage Ratio* is the Tier 1 Leverage Capital Ratio; *iii*) *Tangible Equity Ratio* is book equity minus Goodwill and Intangibles divided by total assets. *iv*) *Acc Leverage Ratio* is book equity divided by total assets. *v*) *Liquid Assets ratio* is the sum of noninterest-bearing balances and currency and coin, interest-bearing balances in U.S. Offices, and interest-bearing balances in foreign offices edge and agreement subsidiaries and IBFS, divided by total assets; *vi*) *Deposits ratio* is Deposits: noninterest-bearing and total interest-bearing deposits in foreign and domestic offices, divided by total assets; *vii*) *Asset Quality* is allowance for loan and lease losses, divided by total assets; *viii*) *Size* is the log of total assets; *ix*) *M2B* is the market to book ratio; *x*) *PER* is the ratio of price to net interest income; and *xi*) *Beta* is a bank's stock beta, estimated using 60 monthly observations of bank returns. We employ time fixed-effects regressions. The regression model relies on t-values that account for two-dimensional cluster correlation.

Table B1 shows the descriptive statistics of the variables we use for the model above.

[Table B1 about here]

[11]Note that our replication is on a best efforts basis. There may be small differences between Demirgüç-Kunt et al. and our research design given that we rely on data definitions of the Federal Reserve and on CRSP, whereas Demirgüç-Kunt et al. rely on global data from Bankscope and Datastream.

The statistics are comparable to those reported by DK. The mean (median) of Total Capital Ratio for our sample is 14% (14%), where DK report 12.6% and 11.9%. Our Tier 1 Leverage Capital Ratio is higher than the one reported by DK: 10% versus 6.7%. Given that DK use a global sample, this difference is likely the result of a stronger reliance by prudential supervisors on risk-weighted ratios outside the U.S. The market to book ratio (1.47), Loans (66%), Deposits (76%) and Size (15) are also comparable with the ratios reported by DK (1.35, 64.3%, 73.4%, and 16 respectively). Ratios that diverge because of different definitions are those of Liquid assets and Asset quality.

Given the similarities between our data and the data reported by DK, we are confident that we can compare our results to those of DK. Table B2 reports the regression results, which we compare to those reported in Table 2 of DK, the full sample.

[Table B2 about here]

Most of our results differ from those reported by DK. For example, we find that the coefficient of the Risk Weighted Capital ratio is positive (0.34) and significant, whereas DK report an insignificant coefficient with a value of 0.023 pre-crisis and a significant coefficient with a value 0.114 during the global financial crisis.

Figure B1 reports the behaviour of coefficient values of the main capital ratios over time. The figure shows that the four bank capital ratios move with a large amplitude and display swings that are difficult to explain.

[Figure B1 about here]

The figure indicates the four capital ratios move in sync. Consequently, none of the ratios clearly dominates the other. The large, rapid, swings in coefficient values are the result of estimation using a misspecified model. We thus cannot confirm claims made by DK about the relevance of specific measures of capital.

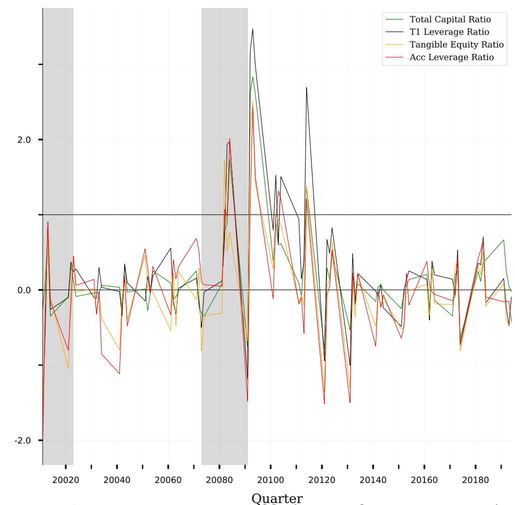


Figure B1: Response coefficients from regressions of share price returns on capital ratios: $r_{i,t} = \beta_0 + \sum_n \beta_n \cdot X_{n,i,t-1} + \varepsilon_{i,t}$ where r is the share return over the quarter, net of the stock market value-weighted returns including distributions. $X_{n,i,t-1}$ are lagged observation of four capital ratios and a set of control variables.

Table B1 Descriptive Statistics – Traditional Approach

$n = 22,548$	Mean	Min	p5	p25	p50	p75	p95	Max	StDev
Return	0.01	-1.93	-0.27	-0.05	0.02	0.09	0.25	1.26	0.18
Total Capital Ratio	0.14	0.00	0.11	0.12	0.14	0.15	0.20	1.00	0.05
T1 Leverage Ratio	0.10	-0.09	0.07	0.08	0.09	0.10	0.13	10.6	0.10
Tangible Equity Ratio	0.08	-0.12	0.05	0.07	0.08	0.09	0.12	0.77	0.04
Acc Leverage Ratio	0.10	0.00	0.06	0.08	0.09	0.11	0.14	0.81	0.04
Liguid assets ratio	0.04	0.00	0.01	0.02	0.03	0.05	0.12	0.46	0.04
Deposit ratio	0.76	0.00	0.58	0.71	0.78	0.82	0.88	1.00	0.10
Loan Ratio	0.66	0.00	0.43	0.60	0.68	0.75	0.83	0.95	0.13
Asset quality	0.01	0.00	0.00	0.01	0.01	0.01	0.02	0.11	0.01
Size	15.0	13.1	13.3	13.9	14.6	15.8	18.3	21.9	1.58
Market to Book Ratio	1.47	0.03	0.41	0.98	1.36	1.87	2.79	8.96	0.74
PE ratio	8.98	0.06	1.71	4.40	6.85	11.6	23.1	49.4	6.79
beta	0.70	-0.99	-0.13	0.28	0.65	1.06	1.69	4.85	0.58

Notes: The table presents descriptive statistics of variables from U.S. bank holding companies over the 2001Q1 to 2015Q4. The mnemonics in square brackets refer to the item codes from the Consolidated Financial Statements for Bank Holding Companies (FR Y-9C); their definitions are from https://www.federalreserve.gov/apps/mdrm/data-dictionary. *Return* is the share return over the quarter. *Capital* is Total Qualifying Capital Allowable under the Risk-based Capital Guidelines [3792] divided by RWAs. *T1 Leverage Ratio* is the Tier 1 Leverage Capital Ratio [7204]. *Tangible Equity Ratio* is book equity minus Goodwill and Intangibles divided by total assets [2170]. *Acc Leverage Ratio* is book equity divided by total assets [2170]. *Liquid Assets* is the sum of Noninterest-bearing Balances and Currency and Coin [0081], Interest-bearing Balances in U.S. Offices [0395], and Interest-bearing Balances in Foreign Offices Edge and Agreement Subsidiaries and IBFS [0397], divided by total assets [2170]. *Deposit ratio* is Deposits: Noninterest-bearing [6631] and Total Interest-bearing Deposits in Foreign and Domestic Offices [6636], divided by total assets [2170]. *Asset Quality (%)* is Allowance for Loan and Lease Losses [3123] divided by total Assets [2170]. *Size* is the log of Total Assets [2170]. *M2B* is the market to book ratio. *PER* is the ratio of Price to Net Interest Income [4074]. *Beta* is a bank's stock beta.

Table B2 Traditional Model - Results

	β	*t*	β	*t*	β	*t*	β	*t*
Total Capital Ratio	0.34	2.44						
T1 Leverage Ratio			0.01	0.77				
Tangible Equity Ratio					0.36	2.10		
Acc Leverage Ratio							0.42	2.55
Liguid assets ratio	-0.04	-0.86	-0.04	-0.89	-0.04	-0.98	-0.02	-0.51
Deposit ratio	-0.03	-1.58	-0.05	-1.82	-0.04	-1.78	-0.05	-2.03
Loan Ratio	0.05	2.20	0.02	1.11	0.01	0.55	0.01	0.40
Asset quality	-4.20	-3.49	-4.10	-3.39	-4.11	-3.44	-3.90	-3.33
log of TA	0.00	-1.47	0.00	-2.98	0.00	-1.78	0.00	-2.99
Market to Book Ratio	0.06	4.1	0.05	4.1	0.05	4.2	0.06	4.1
PE ratio	0.00	-2.26	0.00	-1.56	0.00	-2.77	0.00	-3.55
beta	0.00	-0.45	0.00	-0.47	0.00	-0.42	0.00	-0.52
Intercept	-0.03	-0.59	0.08	2.39	0.04	0.98	0.05	1.42
$\Sigma\beta_{1..N}$		-3.83		-4.11		-3.77		-3.49
$\overline{R}^2$		0.06		0.05		0.06		0.05
# of obs.		22,546		22,548		22,548		22,518

Notes: The table reports results of regressions that rely U.S. Bank Holding Companies over the 2001Q1 to 2019Q4, where the dependent variable r or *return* is the share return over the quarter, net of the stock market value-weighted return including distributions:

$$r_{i,t} = \beta_0 + \sum_n \beta_n \cdot X_{n,i,t-1} + \varepsilon_{i,t} \tag{9}$$

where $X_{n,i,t-1}$ are lagged observation from the following set of variables: *Total Capital Ratio* is Total Qualifying Capital Allowable under the Risk-based Capital Guidelines [3792] divided by RWAs. The mnemonics in square brackets refer to the item codes from the Consolidated Financial Statements for Bank Holding Companies (FR Y-9C); their definitions are from https://www.federalreserve.gov/apps/mdrm/data-dictionary. The regression model relies on t-values that account for two-dimensional cluster correlation. The sample contains only banks with Total Assets $> \$500M$, this is because in 2006, the threshold for filing a FR Y-9C report changed from $150 million of total assets to $500 million of total assets (Federal Reserve, 2006).