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Capital ratios and the Weighted Average Cost of Capital: Evidence from Chilean banks[☆]

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ABSTRACT

This paper finds that an additional percentage point in the ratio of Common Equity Tier 1 (CET1) capital to risk-weighted assets is associated with an increase in the Weighted Average Cost of Capital (WACC) of Chilean banks by a maximum of only 11.7 basis points. This result is found by evaluating the impact of capital ratios on the return on capital and on the return on debt, following alternative empirical strategies which consider both market data and bank balance sheet information. Higher capital ratios decrease the return on banks' capital – partly because more capital makes banks less risky – in magnitudes similar to those found in the literature for other countries. Second, we study the role of capital in the return of bank debt. We see a strong impact of capital ratios on the return of subordinated debt and no effect on senior debt.

1. Introduction

One of the critical lessons learned from the Global Financial Crisis was the need to enhance the resilience of banks through new regulations aiming at improving banks' solvency by requiring better and more capital. That is why Basel III introduced additional capital requirements under different forms of capital "buffers" (countercyclical, conservation, and systemic importance capital buffers) to reduce the undesired real and fiscal effects associated with tightened financial conditions and the need for public support that typically characterize financial crises (BCBS, 2017). Banks' owners typically argue against this type of regulation claiming that "capital is expensive", and that, consequently, higher capital requirements will increase the cost of credit with the corresponding detrimental effect on the economy.¹ In Chile, the reforms of the General Banking Act in 2019 introduced these recommendations, which are gradually being implemented (Aguilera et al., 2020). Consequently, depending on the state of the financial cycle and its systemic importance, banks in Chile are likely to require more capital to meet these new requirements.

This article contributes to both academic literature and public policy discussions by examining the effects of increasing capital share in bank funding structures (that is, reducing leverage) on the total cost of funds for banks. Specifically, it assesses how increased

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¹ See examples of these claims in Admati et al. (2013) and Cochrane (2014).

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capital reliance, as opposed to debt, affects the weighted average cost of funding for these financial institutions.² In doing so, we provide an estimate of the potential adverse effects that increased safety requirements, which require banks to maintain higher capital levels, may have.

We do this using data for the Chilean banking system. Chile offers an interesting case study for other emerging market economies because not all of its banks trade their equity in the stock market. Therefore, in addition to using stock market data for our analysis (which is what most literature addressing this question does, as will be reported later), we also conduct our empirical work with bank balance sheet data to include all banks in our analysis. Having both types of results allows us to assess whether balance sheet data leads to similar results to using stock market data. The answer to this question can be useful for countries with limited or non-existent stock markets.

For the purpose at hand, we first estimate the impact that additional capital has on the market returns of that bank's equity, showing that this effect is negative and statistically different from zero. At the same time, we tested the impact of higher capital ratios on the return on equity (ROE), which allows us to include in the analysis banks that do not trade their equity in the stock market. Our findings are consistent with the former calculations, but the magnitude of the effect found is somewhat larger. In a second step, we assess the marginal effect of banks' capital ratios on the return on their debt. In particular, we look at the correlation between the market's internal rate of return on debt securities issued by banks and the level of banks' capital ratios. We do so after controlling for a set of characteristics of bonds (subordinated vs. senior, maturity, risk) and of banks (size, liquidity, among others). In general, we find a significant effect of capital ratios on the return of subordinated debt and no effect on senior debt.³ Considering the impact found on the return of capital and on the return on debt, we show that an additional percentage unit of the capital-to-risk-weighted assets ratio potentially increases banks' weighted average cost of capital (WACC) by a maximum of only 11.7 basis points, on average.

Theoretically, the classical result of [Modigliani and Miller \(1959\)](#) (MM) on the irrelevance of a firm's funding structure on its value implies that its degree of capitalization should not affect its average cost of funds. This result follows from the core of MM's main theorem, i.e., that a firm's value depends on the level and risk of the return of its assets, and not on its funding structure. MM call this principle the "law of conservation of value". Furthermore, by a simple accounting identity, the average cost of a firm's funds should be equal to the return on its assets. It follows that the average cost of funds is not related to the funding structure of a firm. When applied to banks and in the stylized context in which MM derive their result, the previous statement implies that increasing the degree of capitalization of banks should not impact their overall cost of funds.⁴

Therefore, we should explain why we may have found that a higher share of capital in banks' funding increases its funding cost. Certainly, MM's theorem does not imply that the cost of debt and equity, when taken separately, do not depend on the funding structure. On the contrary, they depend very much on that structure. However, the weighted average of the cost of debt and equity does not. If, for example, equity increases relative to debt, debtholders will be willing to accept a lower interest rate since a higher capital buffer provides them better insulation from risk. Shareholders also demand a lower return since a higher capital buffer will now absorb certain shocks and, therefore, bankruptcy is less likely. However, even though both returns are reduced, their weighted average remains constant and equal to the return on assets. Similarly, shareholders and debtholders will demand a higher return if equity falls relative to debt. Still, the average will remain constant since it equals the return on assets, according to MM's main theorem.

Therefore, changes in the funding structure should not affect the average cost of funds. The previous analysis provides a solid argument against the idea that the average cost of funds will increase in that scenario since "equity is more expensive than debt".⁵ However, the MM theorem is derived under extremely stylized assumptions. In practice, there are several deviations from them, some of which we present here:

1. The existence of taxes implies that a higher level of leverage increases the return on equity because interest expenses reduce the tax base, while the payment of dividends, in contrast, does not. This provides an incentive to increase the leverage of the firm.
2. If the return on debt is not sensitive to increases in risk because of implicit guarantees, shareholders, as residual claimants, will be left with a return higher than the minimum they would demand in the event of higher leverage (higher debt-to-capital ratio). Therefore, without sensitivity of the return on debt to leverage, shareholders will have incentives to increase leverage.
3. A higher leverage may not increase the cost of all existing debt, but that of the marginal, newly issued debt only. This limited impact occurs if the terms of existing debt are fixed, and no clauses allow existing debtholders to receive compensation for the higher risk they face when leverage increases. If this is the case, an increase in leverage will positively impact the return on equity, since they receive the additional return not paid to existing debtholders. Therefore, existing debtholders will be expropriated by shareholders. If such an increase in leverage is possible—contractually or regulatory—there will be an incentive to do it ([Admati et al., 2018](#)). For this reason, contractual constraints, typically called covenants, in the degree of leverage and minimum capital requirements provide the right incentives for shareholders not to fall into these dynamics that increase leverage.

² It should be noted that we assess the cost implications of raising capital ratios, regardless of whether such increases are mandatory or voluntary.

³ Notice that in applying all these alternative approaches, we do not claim to assess a causal relationship between capital and the cost of capital or debt. Instead, we make our best attempt to estimate the correlations between them and then use these correlations to calibrate the weighted average cost of capital.

⁴ A reduction would not impact the costs of funds either.

⁵ Supporters of this view would argue that higher banks' capital requirements will necessarily increase banks' lending rates ([Elliott, 2013](#)). However, this argument forgets that higher capital requirements reduce the return required in both debt and equity, as the risk is lower for shareholders and debtholders, as explained here.

Therefore, deviations from the MM assumptions tend to generate capital ratios that are too low compared with what correct risk pricing would imply. This justifies the mandatory minimum capital requirements. Now, how much capital should the regulatory authority require banks to hold? [Cochrane \(2014\)](#) argues that capital requirements should increase until they eliminate the distortionary advantages resulting from deposit insurance and the externalities associated with the existence of banks that are too big to fail. [Miles et al. \(2012\)](#), in turn, highlights the role of externalities arising from the position of banks in a monetary economy. In particular, they show that when banks' bankruptcy social costs are higher than private losses, the "optimal bank capital ratio" should be around 20% of risk-weighted assets or more. Finally, [Kashyap et al. \(2010\)](#) argues that banks tend to adopt funding structures that minimize their funding costs. Since the only comparative advantage banks have is their cost of funds, they will aim to increase their leverage as much as possible to maximize their profits. Therefore, imposing higher capital requirements would move the financial system towards a more capitalized equilibrium and higher social welfare. However, determining the appropriate level of minimum capital requirements is beyond the scope of this paper.

At a practical level, the implementation of higher capital requirements faces some challenges. First, as raised by [Myers and Majluf \(1984\)](#), the market could punish increases in banks' capitalization, as it could be interpreted as if current shareholders would like to dilute expected adverse results. Nevertheless, the fact that banks' regulation on capital requirements is exogenous to each institution weakens the power of this argument. Second, we must address two additional practical issues: (i) how gradual the implementation of higher capital requirements should be, and (ii) whether the additional capital required should be constituted only through the accumulation of profits, or other methods should be considered. This last issue is important because banks might prefer to "adjust" to higher capital requirements by reducing assets instead of profit retention or issuing new equity. Therefore, it is usually desirable to introduce an ad hoc regulation that limits asset reduction, ensuring that new capital requirements are not met that way.⁶

The remainder of this article is organized into the following sections. Section 2 outlines the empirical strategies implemented to estimate the marginal effects of capital. Section 3 describes the data and sample of banks used in the empirical strategy. Section 4 presents the results of our estimations. Section 5 calibrates the overall impact of higher capitals on the WACC of banks. Finally, Section 6 concludes with final remarks, a policy discussion, and directions for future research.

2. Empirical strategy

2.1. Weighted average cost of capital (WACC)

To estimate the potential long-term impact of a higher capital ratio on bank funding costs, we measure the weighted average cost of capital (WACC). In this definition, "capital" should be understood as "funds" in general, that is, debt or equity. Then, the WACC is equivalent to a weighted average return of equity (r^e) and bond return (r^d), with the weights being the participation of each one in the bank funding structure, K/A and $(1 - K/A)$, respectively:

$$WACC = r^e \left(\frac{K}{A} \right) + r^d \left(1 - \frac{K}{A} \right) \quad (1)$$

Following this definition, an increase in the capital ratio, K/A , affects the WACC through its direct impact on the return on equity $\frac{\partial r^e}{\partial(K/A)}$, on the return on debt $\frac{\partial r^d}{\partial(K/A)}$, and the fact that changes in leverage change weights, having an impact on the WACC whenever r^e is different from r^d . More specifically:

$$\frac{\partial WACC}{\partial(K/A)} = \frac{\partial r^e}{\partial(K/A)} \left(\frac{K}{A} \right) + \frac{\partial r^d}{\partial(K/A)} \left(1 - \frac{K}{A} \right) + (r^e - r^d) \quad (2)$$

In what follows, we provide alternative empirical strategies to estimate both derivatives in Eq. (2), that is, the impact of a higher share of capital in banks' funding structure on the return on equity and on the return on debt. Later, in Section 5, we use the results of these estimates to calibrate the impact of higher capital ratios on the WACC of Chilean banks.

2.2. Capital ratios and the return on equity

We use two approaches to assess the impact of the increase in the share of capital on the return on equity. The first approach uses data on the returns on bank stocks. We look at the subset of four banks in Chile that trade their shares in the stock market. Following [Kashyap et al. \(2010\)](#) and [Miles et al. \(2012\)](#), we apply the capital asset pricing model (CAPM) to evaluate whether the sensitivity of bank stocks' returns to market fluctuations (β s) is affected by banks' capital ratios. Our second approach involves studying the relationship between the return on equity (ROE)—obtained directly from bank income statements—and the capital ratios. This last exercise is implemented on a broader set of 11 medium- and large-sized banks, including those considered when applying the CAPM approach.

⁶ The conservation capital buffer introduced in the Basel III framework addresses this issue by constraining banks' profit distribution depending on the level of common equity Tier 1 that is above and beyond the conservation range or the sum of all capital buffers that each institution must hold at each given time.

2.2.1. The CAPM approach

We implement the CAPM approach to estimate the relationship between the expected return of bank equity (r^e), measured by the effective return on bank b stocks and the expected market return. In particular, we know that:

$$r_b^e = r^{rf} + \beta_b \cdot RiskPremium \quad (3)$$

where r^{rf} represents the return on a risk-free asset, and $RiskPremium$ is the difference between the effective overall market return and r^{rf} . Therefore, it follows that an increase in capital in the funding structure of bank b (K/A , which we denote by k_b) affects the return on equity (r_b^e) through its impact on β_b , that is,

$$\frac{\partial r_b^e}{\partial k_b} = RiskPremium * \left(\frac{\partial \beta_b}{\partial k_b} \right) \quad (4)$$

To determine the impact of k_b on β_b , we first estimate Eq. (3) for each bank separately using daily returns within a moving average window.⁷ Then, we compute monthly averages for each estimated β_b and merge them with the monthly characteristics of the banks. Finally, as Section 4 explains, we construct a quarterly panel dataset and estimate the average relationship between β_b and k_b from the following specification:

$$\beta_{bt} = \alpha + \gamma k_{bt-1} + \eta X_{bt-1} + \delta_b + \delta_t + \epsilon_{bt} \quad (5)$$

k_b refers to the capital ratio of the bank b , while X_b represents the set of bank characteristics, such as size, a measure of credit risk and a liquidity ratio.⁸ Finally, δ_b , δ_t , and ϵ_{bt} are the banks and time fixed effects, and the error term, respectively.

From Eq. (5), we obtain $\hat{\gamma}$, that is, the average relationship between banks' capital ratios and their β , or an estimate of $\frac{\partial \beta_b}{\partial k_b}$. Finally, the variable $RiskPremium$ in Eq. (3) represents the average excess return of the stock market observed during the sample period. Thus, from Eq. (4), we obtain the impact of banks' capital ratios on the return on equity, as follows:

$$\frac{\partial r_b^e}{\partial k_b} = RiskPremium * \hat{\gamma} \quad (6)$$

2.2.2. Capital ratios and the accounting return on equity (ROE)

As a second approach, we compute the relationship between the return on equity (ROE) obtained directly from banks' income statements and alternative measures of capital. In particular, we construct a quarterly panel dataset for ROE, measuring annualized cumulative after-tax profits as a percentage of total assets. Then, instead of following the two-step procedure described above, we estimate the following equation directly:

$$ROE_{bt} = \alpha + \gamma k_{bt-1} + \eta X_{bt-1} + \delta_b + \delta_t + \epsilon_{bt} \quad (7)$$

The set of controls variables for banks X_{bt} , as well as the banks and time-fixed effects, are the same as in Eq. (5). However, in this case, the impact of the capital ratio on the return on equity is directly given by the parameter $\hat{\gamma}$.

2.3. Banks' capital ratio and the return on debt

To account for the relationship between banks' capital ratios and debt returns ($\frac{\partial r^d}{\partial (K/A)}$), we estimate a bilateral relationship at the bond-bank level. In particular, we relate the internal rate of return (IRR) of the instrument i issued by the bank b at time t (r_{ibt}^d) with a set of characteristics of bonds (X_i), such as duration, volume involved in the transaction and whether the bond is senior or subordinated ($Subordinated_i$). In addition, we control for the characteristics of the issuers (X_{bt}), including different measures of the capital ratio (k_{bt}), and the characteristics of the banks, including size and liquidity.

This bilateral panel structure allows us to differentiate between subordinated and senior bonds to account for potential differences in the impact of capital ratios on their debt returns. This distinction is important because the sign and significance of this relationship and the size and significance of the impact of the control variables on bond yields could differ between these two types of instrument.⁹ Taking this into account, we estimate the following regression.

$$r_{ibt}^d = \alpha + \gamma k_{bt} + \theta Subordinated_i + \eta_1 X_i + \eta_2 X_{bt} + \mu_1 Subordinated_i * k_{bt} + \mu_2 Subordinated_i * X_{it} + \mu_3 Subordinated_i * X_{bt} + \delta_b + \delta_t + \epsilon_{bt} \quad (8)$$

Under this specification, γ measures the relationship between banks' capital ratios and the return on debt for senior bonds. At the same time, $\gamma + \mu_1$ captures the relationship between bank capital ratios and the return on the debt of subordinated bonds; this will be called "aggregate impact". In Section 4.2, we report these results, including the average marginal effect of capital ratios on the return on debt, which is the average change in the dependent variable associated with a one-unit change in the independent variable of interest, calculated across all the observed values of the other variables in the model.

⁷ We use different sizes for this moving-average window, but our results do not change substantially. Therefore, following Kashyap et al. (2010), we decide to keep a 2-year window as our benchmark result.

⁸ We also include a dummy variable to account for mergers and acquisitions that occurred during the sample period.

⁹ Senior and subordinated bonds differ in terms of the risk taken by debtholder since, in the event of a liquidation, subordinated bondholders are only paid when there are sufficient resources available once senior bondholders have been paid.

Table 1

Summary statistics: Market return on equity data.

Source: Authors' calculations are based on information obtained from Bloomberg.

	N	mean	p25	p50	p75	sd	min	max
β	8184	0.89	0.79	0.88	1.01	0.15	0.49	1.26
Stock return	8184	0.05	-0.65	0.00	0.74	1.42	-14.75	10.59
Risk premium	8184	0.04	-0.41	0.02	0.50	0.94	-6.48	5.67

Note: β refers to the estimated coefficient as in the Eq. (3). Stock returns refer to the daily market return on equity of four publicly listed banks in the Chilean stock market from 2010–2017. The risk premium is the average excess return of the stock market observed during the sample period.

2.4. Identification

Empirical studies often face the challenge of endogeneity. Our approach is no exception. The capital structure of a company is not randomly assigned. On the contrary, the funding structure is a business choice of a bank. This endogenous relationship makes it difficult to isolate the adequate causality of increasing capital levels and its related cost of funding. We acknowledge that it would be beneficial to examine whether a completely exogenous increase in capital requirements could potentially increase banks' overall cost of capital. However, until now, the literature has struggled to identify natural experiments in this matter appropriately.

Against these identification challenges, we took adequate steps to attenuate them and get as close as possible to proving that changes in relative capital and debt levels push a change in WACC instead of just reflecting it. On the one hand, we mitigate reverse causality by using lagged independent variables, as it is implausible to change former funding allocations with the present costs of funding outputs. At the same time, there is always a chance that unobserved variables affect the cost of funds, which we must take into account. We considered managing this issue by complementing our set of bank controls with fixed effects that will account for time-invariant bank characteristics and standard shocks to all the panels in a certain period. We know that these are two substantial statistical assumptions. Still, since the literature has yet to agree on how to deal with identification issues in this context, we consider them necessary to interpret our results correctly.

Despite our meticulous methodology, we must acknowledge certain inherent limitations. Nonetheless, these limitations do not compromise the validity of our empirical strategy and results; instead, they underscore the need for continued research in this area. As Baker and Wurgler (2015) suggests, the presence of estimated endogenous effects may obscure the detection of a definitive relationship between capital ratios and their associated costs in empirical data. Even with robust measures to mitigate endogeneity, it is reasonable to hypothesize that exogenously increasing capital levels would produce effects analogous to those observed empirically. Furthermore, Kashyap et al. (2010) observes that banks with varying risk profiles may adopt various capital structures, which requires caution when interpreting any observed correlations between risk and leverage as indicative of causality. It is also crucial to consider that even if bank risk decreases with an increase in capital buffers, the market may require time to adjust and reflect this in the expected returns on equity. However, these insights provide empirical support for applying the Modigliani-Miller (MM) framework in our final calibration, suggesting its relevance and utility in understanding capital structure implications.

3. Data

The empirical strategies outlined are applied across distinct sets of banks. Initially, we employed the CAPM approach to estimate the relationship between banks' capital ratios and their return on equity, focusing on the four publicly listed banks in the Chilean stock market, designated as 'Sample 1'.¹⁰ Using the market stock return, as indicated by the Index of Selective Share Prices (IPSA) of the Santiago Stock Exchange, we calculated a set of β s from Eq. (3). The detailed statistics for these estimations are shown in Table 1, and Fig. B.1 illustrates the evolution of the distribution of β s within the estimation period, with values ranging between 0.5 and 1.3. It is important to note that this range is in agreement with the studies conducted by Kashyap et al. (2010) and Baker and Wurgler (2015). We then integrated these results with the balance sheet information from the Chilean Financial Markets Commission (CMF),¹¹ and panel A of Table 2 presents the descriptive statistics for this combined dataset. Fig. B.2 and Fig. B.3 complement Table 2 by illustrating the distribution evolution of ROE, core capital, and r^d across different samples. (Table A.1 includes all variables' definitions and sources).

We use the same bank balance sheet information for our second approach, which estimates the relationship between bank capital ratios and return on equity (Eq. (7)). However, we now apply this strategy to 11 medium and large banks. The four banks whose stocks are publicly traded are included in this sample. As shown in the summary statistics, note that the banks that complement this group tend to be relatively smaller in terms of asset size, have lower return on equity, and are less capitalized than the four publicly listed banks. In this case, the return on equity is estimated by the variable after-tax profits as a percentage of the CET1 capital. See the descriptive statistics of the variables in this estimation in "Sample 2" in panel B of Table 2. Finally, "Sample 3" includes

¹⁰ This sample includes Santander, BCI, Bank of Chile, and Scotiabank. Banco Security is excluded as its shares represent a financial group rather than the bank itself.

¹¹ As of June 1st, 2019, the former Chilean bank supervisor *Superintendencia de Bancos e Instituciones Financieras* (SBIF) was incorporated into the CMF, which now supervises not only banks, but also other financial intermediaries.

Table 2

Summary statistics: Regressions samples.

Source: The authors' calculations are based on information obtained from the Chilean Financial Markets Commission and the Santiago Exchange.

A. Sample 1: CAPM								
	N	mean	p25	p50	p75	sd	min	max
β	124	0.92	0.81	0.95	1.00	0.14	0.51	1.19
ROE	124	17.76	13.96	18.72	21.79	6.01	0.06	30.33
Common equity tier 1 (% total assets)	124	8.72	7.85	8.25	8.82	1.58	7.17	14.57
Log(total assets)	124	23.66	23.51	23.87	24.06	0.63	21.90	24.38
M&A's dummy	124	0.01	0.00	0.00	0.00	0.09	0.00	1.00
B. Sample 2: ROE								
	N	mean	p25	p50	p75	sd	min	max
ROE	334	13.97	10.14	13.63	18.08	5.84	-0.24	30.33
Common equity tier 1 (% total assets)	334	7.67	6.50	7.62	8.45	1.80	4.39	14.57
Log(total assets)	334	22.98	22.38	23.12	23.85	0.99	20.42	24.38
Loan loss provisioning (% total assets)	334	0.84	0.63	0.84	1.09	0.34	0.08	1.65
M&A's dummy	334	0.00	0.00	0.00	0.00	0.05	0.00	1.00
C. Sample 3: Debt								
	N	mean	p25	p50	p75	sd	min	max
Debt Return (r^d)	11 064	2.71	2.01	2.68	3.48	0.84	0.89	4.37
Amount(Q)	11 064	19.89	19.36	19.98	20.48	0.83	16.09	24.46
Duration	11 064	4.55	2.34	3.50	5.84	3.07	0.32	19.30
Subordinated dummy	11 064	0.09	0.00	0.00	0.00	0.28	0.00	1.00
Common equity tier 1 (% total assets)	11 064	7.85	6.89	7.74	8.55	1.81	4.58	20.32
Loan loss provisioning (% total assets)	11 064	0.90	0.67	0.94	1.04	0.27	0.23	1.34
Assets market share	11 064	13.32	12.75	13.60	13.96	0.71	10.39	14.20
Liquid assets (% total assets)	11 064	13.87	10.30	12.56	16.36	5.06	4.34	31.12
Subordinated debt share	11 064	2.91	2.11	2.89	3.60	1.02	0.59	5.86
ROA	11 064	1.16	0.74	1.14	1.61	0.53	0.01	2.43
M&A's dummy	11 064	0.80	1.00	1.00	1.00	0.40	0.00	1.00

Note: Sample 1 refers to the subgroup of 4 publicly listed banks in the stock market. Sample 2 refers to Chile's 11 medium and large banks. Sample 3 refers to the senior and subordinated bonds issued by 11 banks in Chile during the 2010m1–2017m12 period. All banks in the three samples can be classified as medium or large banks according to [Jara and Oda \(2015\)](#).

bond securities from the same 11 banks as before. In particular, our data set is based on daily debt securities transactions of 573 instruments traded 553.152 times. Panel C of [Table 2](#) provides summary statistics on the variables used to estimate Eq. (8). Finally, [Table A.2](#) presents the main summary statistics of the bonds issued by banks, differentiating whether the bond is subordinated or senior, including the internal rate of return, the volume of transactions, and the average duration.

All databases are unbalanced and include information for the 2010–2017 sample period. As some banks appear and others disappear throughout the sample period, we include a dummy variable to account for the impact generated by mergers and acquisitions.¹² If a bank that issued a bond security is absorbed, the debts owed are reassigned to the institution that takes over. We add a series of dummy variables to indicate this switch in the property of bonds' liabilities. At the end of 2017, Sample 1 represents approximately 54% of the total assets of the banking system, while Samples 2 and 3 represent approximately 95%.

We conduct our estimations on observed changes in the capital share of banks' funding structures rather than changes in regulatory caps on capital requirements. Although estimating the impact of this latest concept would be desirable, during the period considered in this study, there are no variations in the regulatory capital requirements to follow such an approach in Chile.

To construct the capital ratio, we use different definitions of capital. Our benchmark measure of bank capital is *basic capital*, equivalent to *common equity Tier 1* (CET1), after deductions.¹³ CET1 capital is the highest quality capital a bank holds, consisting primarily of common shares, retained earnings, and other forms of capital that are fully available to absorb losses. Additionally, we use alternative capital measures, such as *Tier 1* capital, which combines CET1 with *additional Tier 1* (AT1) capital. *Tier 1* capital can absorb losses in the event of a bank's winding-up, as AT1 capital typically includes instruments that do not have a fixed maturity date, but have the ability to absorb losses either through conversion into common equity or through a write-down mechanism that triggers at the point of nonviability. Furthermore, we consider *effective capital*, which represents the total regulatory capital, including

¹² During the past two decades, the number of banks in Chile has dropped due to mergers and acquisitions, while foreign banks increased their market share during the same period. Fortunately, the most significant mergers and acquisitions in Chile occurred during the 1990s and early 2000s and therefore do not alter the results of this study.

¹³ Deductions refers typically to certain assets or exposures that are considered less reliable or more risky, and typically include intangible assets, deferred tax assets, among others.

Table 3Capital ratio, β_b and ROE.

Source: Authors' calculations are derived from information obtained from the Chilean Financial Markets Commission.

	A. β_b		B. ROE		
	(1)	(2)	(3)	(4)	(5)
CET1 _{t-1}	-0.04***	-0.05***	-0.62***	-0.66***	-0.57***
Log(total assets) _{t-1}	0.24***	0.25***	-5.24***	-2.91*	-3.69***
Loan loss provisioning (% total assets) _{t-1}				-5.68***	-5.74***
M&A's dummy _t		0.17***			-3.88***
Observations	124	124	301	301	301
F test	6.90	5.54	23.21	37.29	34.41
R ²	0.75	0.76	0.85	0.85	0.86
R ² adjusted	0.66	0.66	0.82	0.83	0.84
R ² within	0.23	0.25	0.16	0.20	0.26

Note: The dependent variable in columns (1) and (2) is the market β driven by Eq. (5) with quarterly data from 2010Q1 to 2017Q4 for a panel of all resident banks with a presence in the domestic stock market. In columns (3) to (5), the dependent variable is the market ROE as in Eq. (7) with quarterly data from 2010Q1 to 2017Q4 for a panel of 11 banks. CET1 denotes the common equity Tier 1 to total assets. All specifications include fixed effects on time and bank, and standard errors are robust. ***, **, and * indicate significance at the level 1%, 5%, and 10%, respectively.

the Tier 1 capital (CET1 and AT1) and the Tier 2 capital, after accounting for regulatory deductions and adjustments.¹⁴ Finally, we include a measure of excess capital, defined as the difference between the effective capital held by banks and the individual minimum capital requirement.¹⁵ With all these different definitions of capital, we construct ratios over total assets and RWA.

From Tables A.3 to A.5, it can be seen that the different measures of capital ratios vary between the different samples. For example, taking only the four banks listed on the stock market, the average Tier 1 capital is 8.72% and has relatively low dispersion. This ratio drops to 7.67% for large and medium banks. Regarding regulatory capital as a percentage of risk-weighted assets, the median value is 13.4, 12.7, and 12.9%, respectively.

4. Results

In this section, we first discuss the results of the econometric specifications of Eq. (5) using β_k and Eq. (7) with ROE as the dependent variable. Second, we look at Eq. (8), which accounts for the relationship between the capital ratios and the return on debt. For the results of the first two exercises, we compute $\frac{\partial r_k}{\partial(K/A)}$, while for the third, we compute $\frac{\partial r^d}{\partial(K/A)}$. After estimating all these derivatives, we replace them with Eq. (2).

4.1. Capital ratios and the return on equity

Panel A of Table 3 shows the general results of Eq. (5) with β_b as the left-hand side variable and CET1 over total assets as the capital ratio used as the control variable.¹⁶ We find a negative relation between capital ratio and β_b . Column (2) shows that the negative sign persists when adding a dummy variable for mergers and acquisitions (M&A). A negative relation for these two variables means that banks with higher capital ratios are less synchronized with the rest of the stock market because higher capitalized banks are more stable or less risky.¹⁷

Table 4 shows that our result matches similar estimations in the literature. In comparison, Kashyap et al. (2010) obtain a coefficient of -0.04 for US banks, just one basis point over our -0.05 . As an alternative measure of the capital variable, Miles et al. (2012) used bank leverage for UK banks. By construction, the sign of the variable is expected to be positive. When using leverage instead of CET1 capital, we obtain an estimate for the coefficient identical to that of Miles et al. (2012). In addition, Baker and Wurgler (2015) estimated a similar model, forcing the regression intercept to zero due to the assumption of risk-free debt and achieving a coefficient of equity beta on leverage of 0.074 for US banks. In general, our results support the idea that more capital makes banks less risky, independent of the measure of the capital ratio used (see Table C.1).

¹⁴ Effective capital is a comprehensive measure that includes not only the core equity but also subordinated debt and other instruments that can absorb losses in the event of insolvency. It is used to ensure that banks have sufficient capital to cover risks and comply with the legal limits established in Chile's banking regulation. Tier 2 capital is used in the liquidation of a bank (*gone concern*), consisting mainly of subordinated bonds and voluntary provisions.

¹⁵ Typically, the minimum capital requirement corresponds to 8% of the risk-weighted assets (RWA). However, in Chile, prior to the recent adoption of Basel III standards, certain banks faced additional capital requirements arising from systemic concerns related to mergers or acquisitions.

¹⁶ Given the trajectory shown by the estimated β s, we tested the null hypothesis of the no-existence of autocorrelation, which was rejected at 1% by applying the Wooldridge (2002) test. Therefore, to ensure the robustness of our findings, we re-estimate Eq. (5) using Driscoll and Kraay (1998) standard errors, which are computed using a non-parametric covariance matrix robust to different ways of cross-sectional or temporal dependence. Like the Newey–West standard error correction, this approach guarantees the consistency of the covariance matrix despite the low “N” and large “T”. After the correction, most of the coefficients displayed in Table 3 have retained their significance. This methodology alters only standard errors and not the magnitude of the coefficients, so it will not modify our final calibration. These corrected results are available upon request.

¹⁷ These results complement the approach followed by Beas Lagos (2020) which finds that higher capital requirements improve the resilience of Chilean banks, reducing the probability of a systemic crisis.

Table 4Capital ratio and banks' equity β : literature comparison.

Source: Authors' calculations from information obtained from the Chilean Financial Markets Commission, Kashyap et al. (2010) and Miles et al. (2012).

	Coefficient	Confidence interval		Kashyap et al. (2010)	Miles et al. (2012)
		Lower 5%	Upper 95%		
CET1 _{t-1}	-0.05***	-0.07	-0.02	-0.04	
Leverage ratio _{t-1}	0.03**	0.01	0.06		0.03
Observations	124			1226	156
Bank FE	YES			NO	YES
Time FE	YES			YES	YES
Bank controls	YES			YES	NO

Then, to compute the impact of capital ratios on capital return, we take the mean return in the domestic stock price index (*IPSA*) minus the risk-free rate as *RiskPremium* and the estimated $\hat{\gamma} = -0.05$ to replace them in Eq. (6).¹⁸ Therefore, $\frac{\partial r_k}{\partial (K/A)} = -0.29$, meaning that, on average, an additional unit of CET1 as a percentage of total assets reduces the returns of capital by 29 basis points.

We now turn to the direct impact of banks' capital ratios on the return on equity (ROE). panel B of Table 3 shows the results of the panel regression with 11 banks during the 2010q1–2017q4 sample period. Our results are consistent with previous findings. In particular, we get a negative relationship after controlling by banks' fixed effects, which also turns out to be statistically significant when the banks' size is included as an additional control variable. Notice that the CET1 capital over total assets ratio keeps its negative relationship with ROE and statistical significance after adding banks' controls. Thus, in column (5), we get a statistically significant coefficient at 1% equal to -0.57 . Moreover, these results are again consistent with different definitions of capital ratios. (see Table C.1).

Given the characteristics of this estimate, we can directly attribute this coefficient to the marginal effect of capital on the return on capital, i.e. $\frac{\partial r_k}{\partial (K/A)} = \hat{\gamma} = -0.57$. Thus, an additional unit of the capital of the banks' CET1 as a percentage of total assets, on average, and *ceteris paribus*, decreases the return on equity of the banks by 57 basis points.

4.2. Capital ratios and the return on debt

We now discuss whether banks' capital has any significant effect on banks' debt returns. For this purpose, we take advantage of a large data set of bank bond securities transactions. Following the specification of Eq. (8), we estimate the differentiated impact that bank capital ratios have on bond returns, distinguishing between subordinated and senior bonds. Table 5 shows the direct result of this estimate when considering the CET1 capital measure on total assets as a measure of the capital ratio. In particular, column (1) shows the results of the estimate Eq. (8) when the characteristics of the bonds and the banks and time-fixed effects are included in the regression. Column (2), on the other hand, considers the specific set of banks' controls and their interactions with the subordinated versus senior bonds dummy.¹⁹ Finally, column (3) presents the complete set of the characteristics of bonds and banks (which vary over time), as well as the fixed effect of banks, similar to the full specification described in Eq. (8). Then Table 6 summarizes the aggregate impact of the control variables after accounting for the role of the interaction terms. We also show in this table the average marginal effect for the whole sample. In addition, Table C.2 highlights the main results of the previous two (Tables 5 and 6), but this time considering alternative definitions for the capital ratio.

The main results from these estimations are the following²⁰:

1. Bonds' characteristics matter for the return on debt. In particular, the marginal effects in Table 6 show a premium associated with subordinated debts, debt securities of longer duration and involving higher transaction volumes.
2. The characteristics of the issuers are also important determinants of debt returns, but, overall (that is, when all types of debt securities are considered), capital ratios do not appear to affect the return on debt.²¹ These findings are true, regardless of the capital ratio considered.
3. However, higher capital ratios are an important determinant of subordinated debt returns. In particular, higher capital ratios reduce the subordinated debt returns, except for the CET1 to RWA ratio (see Table C.2).

Therefore, as can be seen in panel B of Table 6, on average, there is no statistically significant relationship between banks' capital ratios (CET1) and debt returns. This result is explained mainly by the role that senior debt securities play. When looking at

¹⁸ This mean return was equal to 5.8% during the 2010–2017 period.

¹⁹ Notice that the individual bonds' characteristics are dropped since they tend to be constant over time, and we include the bonds' fixed effects as a control variable in this particular specification.

²⁰ These conclusions are drawn from the following rows show the individual coefficients associated with $\hat{\gamma}$ and the vectors $\hat{\eta}_1$ and $\hat{\eta}_2$ of Eq. (8). These coefficients capture the effects of nonsubordinated debt instruments, i.e., when the subordinated bonds' dummy equals zero. Thus, the overall effect is equivalent to the sum of $\hat{\gamma}$ and the vectors $\hat{\eta}^j$ and $\hat{\eta}^b$ to $\hat{\mu}$, $\hat{\beta}^j$ and $\hat{\beta}^b$.

²¹ Notice that banks with higher credit risk have, in general, higher debts' returns. Furthermore, banks that rely more on subordinated debt face higher yields.

Table 5

Capital ratio and the return on debt: full specification.

Source: Authors' calculations from information obtained from the Chilean Financial Markets Commission and Santiago Exchange.

	(1)	(2)	(3)
Subordinated, CET1 _{<i>t-1</i>}	0.73		0.08
Amount, Duration,	0.03*** 0.09***	-0.01	-0.01 0.04*** 0.10***
Loan loss provisioning (% Total assets) _{<i>t-1</i>}		0.00	0.00**
Assets market share _{<i>t-1</i>}		0.01	0.03***
Liquid assets (% Total assets) _{<i>t-1</i>}		0.01*	0.00
Subordinated debt share _{<i>t-1</i>}		0.08***	0.05***
ROA _{<i>t-1</i>}		-0.02	0.05
Subordinated _{<i>t</i>} * CET1 _{<i>t-1</i>}		0.11***	0.08***
Subordinated _{<i>t</i>} * Amount,	-0.02		0.02
Subordinated _{<i>t</i>} * Duration,	-0.04***		-0.06***
Subordinated _{<i>t</i>} * Loan loss provisioning (% Total assets) _{<i>t-1</i>}		-0.00	-0.00*
Subordinated _{<i>t</i>} * Subordinated debt share _{<i>t-1</i>}		0.01	-0.00
Subordinated _{<i>t</i>} * Liquid assets (% Total assets) _{<i>t-1</i>}		-0.03**	0.00
Subordinated _{<i>t</i>} * Subordinated debt share _{<i>t-1</i>}		-0.14**	-0.06
Subordinated _{<i>t</i>} * ROA _{<i>t-1</i>}		0.18	-0.08
M&A's dummy _{<i>t</i>}	0.02	-0.31***	-0.30***
Observations	13 810	11 037	11 064
F test	126.31	8.45	74.95
R ²	0.87	0.91	0.88
R ² adjusted	0.87	0.91	0.88
R ² within	0.47	0.04	0.47
Fixed-Effects	Time & Bank	Time & Bond	Time & Bank

Note: The dependent variable is the internal rate of return of the market (*IRR*). CET1 refers to the Common Equity Tier 1 to the total assets ratio. Subordinated refers to the subordinated debt dummy. Data are monthly from 2010m1 to 2017m12 for a panel of all resident banks. All specifications include time-fixed effects. Standard errors are clustered by bonds. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 6

Capital ratio and the return on debt: aggregate impact and marginal effects.

Source: Authors' calculations from information obtained from the Chilean Financial Markets Commission and the Santiago Exchange.

	(1)	(2)	(3)
A. Aggregate Impact			
CET1 _{<i>t-1</i>}		0.108***	0.070***
Amount,	0.017		0.054
Duration,	0.048***		0.038***
Loan loss provisioning (% Total assets) _{<i>t-1</i>}		-0.000	-0.001
Subordinated debt share _{<i>t-1</i>}		0.015	0.030**
Liquid assets (% Total assets) _{<i>t-1</i>}		-0.027*	0.005
Subordinated debt share _{<i>t-1</i>}		-0.060	-0.008
ROA _{<i>t-1</i>}		0.161	-0.024
B. Marginal Effects			
Subordinated, CET1 _{<i>t-1</i>}	0.213***	0.001	0.299***
Amount,	0.030***	0.004***	0.002
Duration,	0.081***		0.038*** 0.096***
Loan loss provisioning (% Total assets) _{<i>t-1</i>}		0.189***	0.001*
Subordinated debt share _{<i>t-1</i>}		0.010	0.032***
Liquid assets (% Total assets) _{<i>t-1</i>}		0.003	0.003
Subordinated debt share _{<i>t-1</i>}		0.069***	0.044**
ROA _{<i>t-1</i>}		-0.003	0.046

Note: The dependent variable is the market Internal Rate of Return (*IRR*). CET1 refers to the Common Equity Tier 1 to total assets ratio. Subordinated refers to the subordinated debt dummy. "Aggregate impact" refers to the addition of the indicated variable main coefficient and its interaction with the subordinated debt dummy, while "Marginal Effects" represents the average change in the dependent variable associated with a one-unit change in the indicated independent variable, calculated across all the observed values of the other variables in the model. Data are monthly from 2010m1 to 2017m12 for a panel of all resident banks. Standard errors are clustered by bonds. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

the differentiated effect of subordinated debt securities, we get that, generally, higher banks' capital ratios reduce the subordinated debts' returns, on average.

5. Calibrating the impact on WACC and policy implication

We now compute the overall impact of our results on banks' weighted average cost of capital. In particular, we take the average differential $\frac{\partial WACC}{\partial(K/A)}$ of Eq. (2) from the average data of (K/A) , r^e and r^d , and the estimated coefficients of our regression are used to compute $\frac{\partial r^e}{\partial(K/A)}$ and $\frac{\partial r^d}{\partial(K/A)}$. According to this, our WACC impact equation is as follows:

$$\frac{\partial WACC}{\partial(K/A)} = \frac{\partial r^e}{\partial(K/A)} \left(\frac{K}{A} \right) + (r^e - r^d) \quad (9)$$

Notice that we take the averages of K/A , r^e and r^d from Table 2. Finally, for $\frac{\partial r^e}{\partial(K/A)}$ we use two alternatives, both shown in Table 7. In the second and third rows of Table 7, we show the non-MM cases when keeping r^e and r^d unchanged and adding percentage points of CET1 capital over the total assets ratio or the risk-weighted assets ratio, respectively. Thus, when capital levels do not matter for the return on equity, increasing banks' capitalization by one percentage point will increase WACC by 15.0 or 11.3 basis points, depending on the estimations.

When introducing the MM effect, i.e., when $\frac{\partial r^e}{\partial(K/A)} = -0.05$ from the CAPM's analysis and $\frac{\partial r^e}{\partial(K/A)} = -0.57$ from the direct ROE's estimation, the overall impacts on WACC of a percentage point of higher banks' capital ratios is now 12.5 and 6.9 basis points, i.e., 83% and 61% below the non-MM impact.

These results can now be used to compute a proxy for the effect of rising capital ratios on banks' WACC. Taking the ratio $\frac{RWA}{A}$ from the division $\frac{(K/A)}{(K/RWA)}$, the transformation of the WACC partial is direct:

$$\frac{\partial WACC}{\partial K/RWA} = \frac{\partial WACC}{\partial K/A} \left(\frac{RWA}{A} \right) = \frac{\partial r^e}{\partial(K/A)} \left(\frac{K}{A} \right) * \left(\frac{RWA}{A} \right) + (r^e - r^d) * \left(\frac{RWA}{A} \right) \quad (10)$$

Thus, Table 7 shows that for one additional unit of the capital ratio, the average impact on WACC is 10.42 basis points, using the CAPM's exercise, i.e., 83% relative to the 12.53 of the highest non-MM result. Furthermore, the impact effect is lower when using direct ROE estimations and is equivalent to 5.63 basis points, representing 61% of the non-MM result.

Finally, Table 8 shows the impact on WACC of four scenarios for increases in the CET1 to risk-weighted asset ratio, which goes from 0.9% to a maximum of 2.7%.²² As expected from our previous analysis, the results show a limited impact on the weighted average cost of capital. An increase in a 0.9% of additional capital ratio can increase 11.27, 9.38, or 5.07 basis points in WACC, depending on the model considered (No-MM, CAPM's approach, and ROE's estimation, respectively). While in the extreme case of a 2.7% rise, which is of similar size to those additional capital charges included in Basel III, the weighted average cost of capital could increase by 28.13 or 15.21 basis points, depending on the model considered. In the Appendices, Tables C.3 and C.4 perform the same exercises but calibrated for the end of the sample (2016–2017). In those results, the magnitudes of the impacts were even lower using both strategies, CAPM and ROE.

6. Concluding remarks

Increasing banks' capital has been at the core of the response of the international financial regulatory community after the Global Financial Crisis. This article analyzes the impact of such an increase in Chile. We estimate the impact of increased capital ratios on both the return on capital and debt. On the former, we find a negative impact similar in sign and magnitude to that found in the literature for other countries. This result means that equity holders demand less return when the share of capital in the funding structure is higher, as Modigliani and Miller's main theorem would predict. In the case of debt, while senior debt is not sensitive to the capital ratio, subordinated debt is. This latest result has not been previously reported in the literature. In general, we find that higher capital ratios have a small impact on the weighted average cost of capital. In particular, one additional percentage point of CET1 capital as a percentage of risk-weighted assets ratio has a maximum increase in WACC of only 11.7 basis points.

CRedit authorship contribution statement

Rodrigo Cifuentes: Conceptualization, Writing – original draft, Writing – review & editing. **Tomás Gómez:** Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Alejandro Jara:** Data curation, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

²² Notice that applying this methodology implies that the capital ratio impact on WACC is linear. Therefore, the analysis of higher levels of capital ratios, such as those that account for the complete set of capital buffers included in Base III, is straightforward.

Table 7

Impact on WACC.

Source: Authors' calculations are based on information obtained from the Chilean Financial Markets Commission.

	A. CAPM		B. ROE			
WACC		4.03		3.57		
<i>Non-MM effect</i>						
$\frac{\partial WACC}{\partial(K/A)}$		15.04		11.26		
$\frac{\partial WACC}{\partial(K/RWA)}$		12.53		9.21		
	Coefficient	Confidence interval		Coefficient	Confidence interval	
		Lower 5%	Upper 95%		Lower 5%	Upper 95%
<i>MM effect</i>						
$\frac{\partial WACC}{\partial(K/A)}$	12.51	11.50	14.03	6.89	3.97	9.80
$\frac{\partial WACC}{\partial(K/RWA)}$	10.42	9.58	11.68	5.63	3.25	8.02
% max	83%	76%	93%	61%	35%	87%

Note: This table shows the estimated impacts on WACC of an additional capital point measured as CET1 on total assets or the ratio of risk-weighted assets (RWA) as depicted in Eq. (2). We present the estimated impact (Est.) and the 5% confidence intervals, all in basis points. The case of non-Modigliani and Miller (Non-MM effect) refers to only adjusting the ratios K/A and $(1 - K/A)$, while the Modigliani and Miller case (MM) includes the empirically estimated impact of capital on equity rates.

Table 8

Impact on WACC - RWA.

Source: Authors' calculations are derived from information obtained from the Chilean Financial Markets Commission.

Factor	No-MM	CAPM			ROE		
		Coefficient	Confidence interval		Coefficient	Confidence interval	
			Lower 5%	Upper 95%		Lower 5%	Upper 95%
0.90	11.27	9.38	8.62	10.52	5.07	2.92	7.21
1.00	12.53	10.42	9.58	11.68	5.63	3.25	8.02
1.80	22.55	18.76	17.24	21.03	10.14	5.85	14.43
2.70	33.82	28.13	25.86	31.55	15.21	8.77	21.64

Note: This table shows the estimated impact of increasing CET1 capital as a percentage of the risk-weighted assets ratio. Here, we evaluate four potential tightening scenarios (first column). We present the estimated impact and the 5% confidence intervals (CI), all in basis points. The Non-Modigliani and Miller cases (non-MM) refer to only adjusting the ratios K/A and $(1 - K/A)$, while the Modigliani and Miller case (MM) includes the empirically estimated impact of capital on equity rates.

Appendix A. Additional statistics

See [Tables A.1–A.5](#).

Appendix B. Additional figures

See [Figs. B.1–B.3](#).

Appendix C. Additional results

See [Tables C.1–C.4](#).

Table A.1
Variables' definitions and sources.

Variable	Definition	Source
A. Banks' variables		
β	Correlation between the equity return of each bank and the average market return estimated by equation Eq. (3)	Authors based on Bloomberg
Total Assets	Bank's balance sheet total assets measured in real terms (CPI adjusted)	CMF and BCCh
RWA	Risk-weighted assets	CMF and BCCh
ROE	Return on equity	CMF and BCCh
ROA	Return on assets	CMF and BCCh
Assets market share	$\frac{Assets_{b,t}}{\sum_{i=1}^B Assets_{i,t}}$	CMF and BCCh
Loan loss provisioning (% total assets)	Provision expenses as a percentage of total assets	CMF and BCCh
Liquid assets (% total assets)	Liquid assets as a percentage of total assets	CMF and BCCh
Subordinated debt share	Subordinated as a percentage of total assets	CMF and BCCh
M&A's dummy	Dummy equal to 1 on the date of M&A	Authors
B. Capital Measures		
CET1	Common equity Tier 1, consisting primarily of common shares, retained earnings, and other forms of capital that are fully available to absorb losses	CMF and BCCh
Tier 1	CET1 + AT1	CMF and BCCh
AT1	Additional Tier 1, which typically includes instruments that do not have a fixed maturity date, but have the ability to absorb losses either through conversion into common equity or through a write-down mechanism that triggers at the point of nonviability	CMF and BCCh
Tier 2	Tier 2 capital includes subordinated debt and other instruments that can absorb losses in the event of insolvency	CMF and BCCh
Regulatory capital	Effective capital for regulatory purposes equivalent to Tier 1+ Tier 2 capital	CMF and BCCh
Excess capital	Difference between the regulatory capital held by banks and the individual minimum capital requirement	CMF and BCCh
C. Debt Variables		
Debt Return (r^d)	Bond internal return rate	Santiago Exchange
Amount (Q)	Amount traded of each bond	Santiago Exchange
Duration	Duration of each bond (in days)	Santiago Exchange
Subordinated (dummy)	Dummy equal to 1 for subordinated debt instruments and 0 for senior debt instruments	Santiago Exchange

Note: CMF refers to the Chilean Financial Markets Commission, and BCCh to the Central Bank of Chile.

Table A.2
Summary statistics: subordinated and senior bonds.

Source: Authors' calculations from information obtained from Santiago Exchange.

	N	mean	p25	p50	p75	sd	min	max
SB = 0								
Debt return (r^d)	10 080	2.64	1.97	2.59	3.41	0.83	0.89	4.37
Amount (Q)	10 080	19.89	19.36	19.95	20.46	0.80	16.09	24.46
Duration	10 080	4.05	2.31	3.43	5.61	2.26	0.32	19.30
SB = 1								
Debt return (r^d)	984	3.40	2.98	3.64	3.91	0.68	1.07	4.37
Amount (Q)	984	19.88	19.38	20.25	20.62	1.08	16.29	21.94
Duration	984	9.66	5.36	9.72	13.67	5.02	0.40	19.03

Note: Includes descriptive statistics of subordinated debt (SB = 1) and senior bonds (SB = 0) issued by 11 large and medium banks during the 2010m1–2017m12 period.

Table A.3

Summary statistics Sample 1 - CAPM: Additional capital measures.

Source: The authors' calculations are based on information obtained from the Chilean Financial Markets Commission.

	N	mean	p25	p50	p75	sd	min	max
Regulatory capital (%Total assets)	124	11.04	10.39	10.95	11.36	1.25	8.72	14.89
CET1 (% Risk Weighted Assets)	124	10.47	9.78	10.36	10.79	1.25	8.26	16.13
Regulatory capital (% Risk Weighted Assets)	124	13.29	12.89	13.44	13.87	0.93	10.90	17.20
Assets to CET1 ratio	124	11.74	11.34	12.11	12.74	1.56	6.86	13.95
Assets to regulatory capital ratio	124	9.17	8.80	9.13	9.62	0.96	6.71	11.47
Excess capital (%)	124	24.22	15.56	20.98	34.36	11.44	6.32	71.97
Excess capital (level)	124	2.54	1.72	2.31	3.46	1.08	0.76	7.20

Note: Sample 1 refers to the subgroup of 4 publicly listed banks in the stock market. All banks in the three samples can be classified as medium or large banks according to [Jara and Oda \(2015\)](#).

Table A.4

Summary statistics Sample 2 - ROE: Additional capital measures.

Source: The authors' calculations are based on information obtained from the Chilean Financial Markets Commission.

	N	mean	p25	p50	p75	sd	min	max
Regulatory capital (%Total assets)	334	10.40	9.37	10.37	11.09	1.73	7.00	18.14
CET1 (% Risk Weighted Assets)	334	9.38	8.18	9.16	10.35	1.64	6.38	16.13
Regulatory capital (% Risk Weighted Assets)	334	12.77	11.90	12.72	13.61	1.20	9.17	17.20
Assets to CET1 ratio	334	13.72	11.83	13.13	15.38	3.07	6.86	22.79
Assets to regulatory capital ratio	334	9.85	9.01	9.65	10.67	1.48	5.51	14.29
Excess capital (%)	334	24.45	15.87	22.47	32.32	11.96	-8.25	71.97
Excess capital (level)	334	2.49	1.68	2.29	3.32	1.18	-0.83	7.20

Note: Sample 2 refers to Chile's 11 medium and large banks. All banks in the three samples can be classified as medium or large banks according to [Jara and Oda \(2015\)](#).

Table A.5

Summary statistics Sample 3 - Debt: Additional capital measures.

Source: Authors' calculations are based on information obtained from the Chilean Financial Markets Commission and Santiago Exchange.

	N	mean	p25	p50	p75	sd	min	max
Market capital (%Total assets)	7705	19.13	12.70	20.04	25.72	8.41	2.77	54.35
Regulatory capital (%Total assets)	11 064	10.44	9.59	10.42	11.04	1.65	7.50	18.43
CET1 (% Risk Weighted Assets)	11 064	9.64	8.47	9.60	10.51	1.56	6.53	15.86
Regulatory capital (% Risk Weighted Assets)	11 064	12.86	11.99	12.97	13.52	1.01	10.10	15.78
Assets to CET1 ratio	11 064	13.40	11.71	12.93	14.54	2.94	6.01	21.87
Assets to regulatory capital ratio	11 064	9.81	9.06	9.60	10.44	1.37	5.57	13.34
Excess capital (%)	11 064	22.84	15.76	19.84	27.96	10.04	1.03	57.82
Excess capital (level)	11 064	2.36	1.66	2.14	2.88	0.97	0.10	5.78

Note: Sample 3 refers to the senior and subordinated bonds issued by 11 banks in Chile during the 2010m1–2017m12 period. All banks across the three samples can be classified as medium or large-size banks according to [Jara and Oda \(2015\)](#).

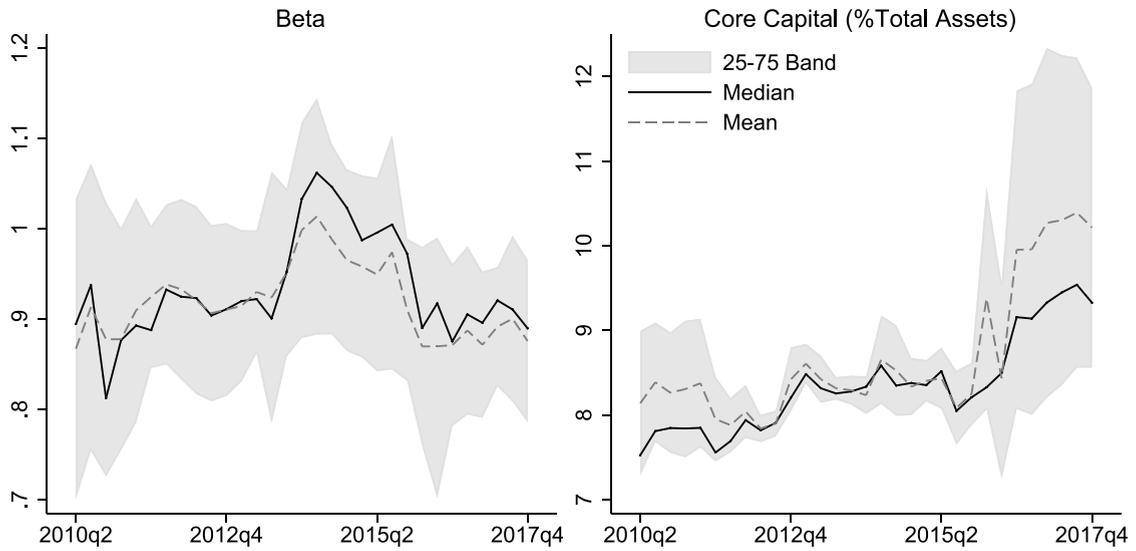


Fig. B.1. Beta and capital distributions. Note: Distribution of β calculated as shown in Eq. (3) and the series of CET1 capital as percentage of total assets. Data are quarterly from 2010q1 to 2017q4 for a panel of all resident banks with presences in the domestic stock market. Source: Authors' elaboration.

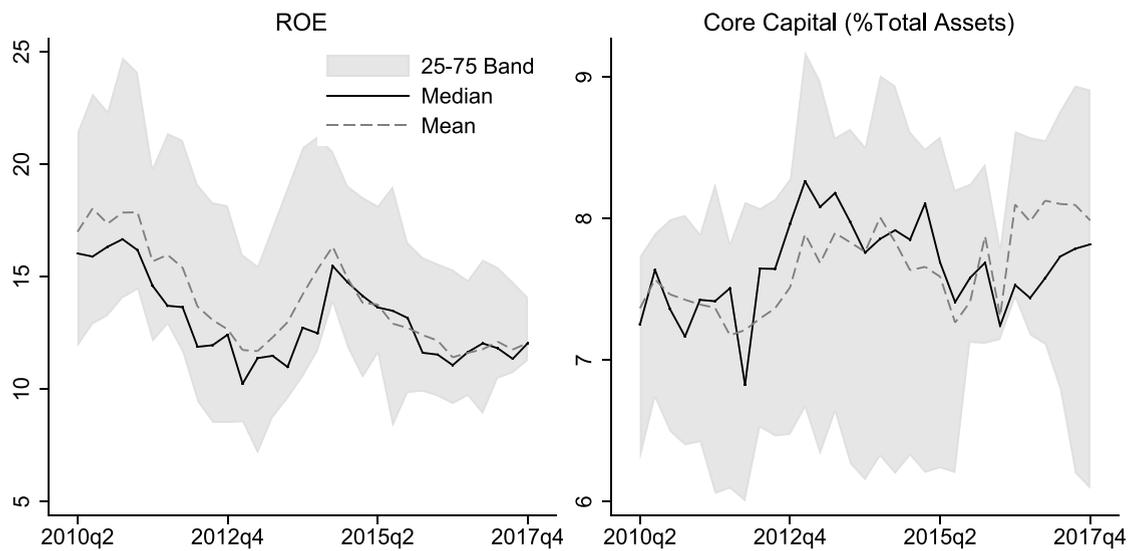


Fig. B.2. ROE and capital distributions. Note: Distribution of ROE and the series of CET1 capital as percentage of total assets. Data are quarterly from 2010q1 to 2017q4 for a panel of 11 banks. Source: Authors' elaboration.

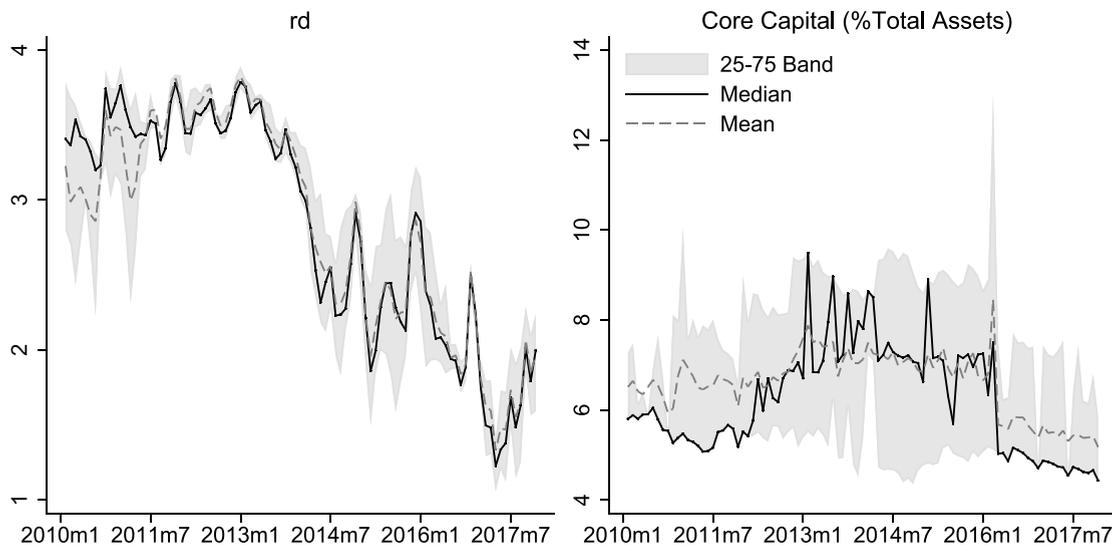


Fig. B.3. r^d and capital distributions. Note: Distribution of rd and the series of CET1 capital as percentage of total assets. Data are monthly from 2010m1 to 2017m12 for a panel of bonds transactions from 11 banks.
 Source: Authors' elaboration.

Table C.1

Capital ratios, market β and the return on equity (ROE): results for different measures of capital ratios.
 Source: Authors' calculations from information obtained from CMF.

	β	ROE
Regulatory capital (% of total assets)	-0.032**	-0.291*
CET1 (% Risk Weighted Assets)	-0.060***	-0.698***
Regulatory capital (% Risk Weighted Assets)	-0.044**	-0.325
Assets to CET1 ratio	0.030**	0.396***
Assets to regulatory capital ratio	0.034*	0.460**
Excess capital	-0.005***	-0.033
Excess capital (level)	-0.044**	-0.325
Observations	124	301

Note: Each column shows the estimators $\hat{\gamma}$ using as dependent variable the market β driven by Eq. (5) or ROE, and with the listed capital measures as the independent variable k_{t-1} . Data are quarterly from 2010Q1 to 2017Q4 for a panel of all resident banks. All specifications include bank and time fixed effects and bank controls. Standard errors are robust. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table C.2

Capital ratios and the return on debt: results for different measures of capital ratios.

Source: Authors' calculations from information obtained from CMF and the Santiago Exchange.

	k_{t-1}	$SB_t * k_{t-1}$	$k_{t-1} + SB_t * k_{t-1}$	$EfMg(k_{t-1})$
Market capital (% of total assets)	0.00	-0.02***	-0.02***	0.00
Regulatory capital (% of total assets)	-0.01	0.10***	0.08***	-0.00
CET1 (% Risk Weighted Assets)	0.02	0.03	0.04*	0.02*
Regulatory capital (% Risk Weighted Assets)	0.01	-0.07**	-0.06**	0.01
Assets to CET1 ratio	-0.00	-0.06***	-0.06***	-0.01
Assets to regulatory capital ratio	0.01	-0.11***	-0.11***	-0.00
Excess capital (%)	0.00	-0.01***	-0.01***	0.00
Excess capital (Level)	0.02	-0.09***	-0.08***	0.01
Market capital (in logs)	0.02	0.17	0.19	0.04

Note: The dependent variable is the market *IRR*. Data are monthly from 2010m1 to 2017m12 for a panel of all resident banks. All specifications include bank and time-fixed effects. Standard errors are clustered by bonds. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table C.3

Impact on WACC 2016–2017.

Source: Authors' calculations from information obtained from CMF.

	CAPM		ROE			
WACC	3.15		2.77			
<i>No-MM effect</i>						
$\frac{\partial WACC}{\partial(K/A)}$	11.36		9.83			
$\frac{\partial WACC}{\partial(K/RWA)}$	10.02		8.09			
	Coefficient	Confidence interval		Coefficient	Confidence interval	
		Lower 5%	Upper 95%		Lower 5%	Upper 95%
<i>MM effect</i>						
$\frac{\partial WACC}{\partial(K/A)}$	5.52	3.19	9.03	5.25	2.20	8.30
$\frac{\partial WACC}{\partial(K/RWA)}$	4.9	2.8	8.0	4.3	1.8	6.8
% max	49%	28%	79%	53%	22%	84%

Note: Estimated impacts on WACC of one additional point of capitalization measured as common equity Tier 1 over total or risk-weighted assets (RWA) as depicted in Eq. (2), evaluating each derivative in the average values of 2016–2017. We present the estimated impact and the 5% confidence intervals, all in basis points. The Non-Modigliani and Miller case (Non-MM) refers to only adjusting the ratios K/A and $(1 - K/A)$, while the Modigliani and Miller case (MM) includes the empirically estimated impact of capital on equity rates.

Table C.4

Impact on WACC - RWA 2016–2017.

Source: Authors' calculations are based on information obtained from the CMF.

Factor	No-MM	CAPM			ROE		
		Coefficient	Confidence interval		Coefficient	Confidence interval	
			Lower 5%	Upper 95%		Lower 5%	Upper 95%
0.9	9.02	4.38	2.53	7.17	3.89	1.63	6.15
1	10.02	4.87	2.81	7.96	4.32	1.81	6.83
1.8	18.04	8.77	5.06	14.33	7.78	3.26	12.30
2.7	27.06	13.15	7.59	21.50	11.67	4.89	18.45

Note: Estimated impact of increasing the Chilean capital requirement (core capital as a percentage of risk-weighted assets), evaluating each derivative in the average values of 2016–2017. Here, we evaluate four potential tightening scenarios that differentiate each other in their rising factor (first column). We present the estimated impact and the 5% confidence intervals, all in basis points.

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