Testing the Modigliani-Miller Theorem of Capital Structure Irrelevance for Banks

William R. Cline

Abstract

Some advocates of far higher capital requirements for banks invoke the Modigliani-Miller theorem as grounds for judging that associated costs would be minimal. The M&M theorem holds that the average cost of capital to the firm is independent of capital structure, because any reduction in capital cost from switching to higher leverage using lower-cost debt is exactly offset by an induced increase in the unit cost of higher-cost equity capital as a consequence of the associated rise in risk. Statistical tests for large US banks in 2002–13 find that less than half of this M&M offset attains in practice. Higher capital requirements would thus impose increases in lending costs, with associated output costs from lower capital formation. These costs to the economy would need to be compared with benefits from lower risk of banking crises to arrive at optimal levels of capital requirements.

JEL Codes: E44, G21, G28, G32

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INTRODUCTION

The financial crisis and Great Recession of 2008–09, like the banking crisis and Great Depression of the 1930s, have provoked regulatory reform in the financial sector. Internationally, the new “Basel III” rules approximately double minimum capital requirements for most banks and triple them (or more) for systemically important financial institutions (SIFIs).¹ The new requirements also introduce a minimum “leverage ratio” capitalization of 3 percent of total (as opposed to risk-weighted) assets in the Basel rules and 4 percent in the United States (BCBS 2014; Federal Reserve 2013).² A separate issue is whether to shift from risk-weighted assets to total assets as the base for applying capital requirements. Thomas Hoenig (2013) argues that the metric of risk-weighted assets is illusory and should largely be replaced by total assets and the regulatory emphasis shifted to the capital leverage ratio.

Some economists have called for far higher capital requirements. Anat Admati and Martin Hellwig (2013) propose a leverage ratio requiring equity capital of 20 to 30 percent of total assets (p.179). Considering that risk-weighted assets are typically only about half as large as total assets (Hoenig 2013), this target would correspond to a capital requirement of 40 to 60 percent of risk-weighted assets, about five times as high as the risk-weighted capital target for SIFIs in Basel III. The empirical tests in this study are motivated in considerable part by the apparent wide divergence in expert opinion about desirable capital requirements for banks.

A key theoretical element of arguments favoring far higher capital ratios is the “capital structure irrelevance” proposition of Franco Modigliani and Merton Miller (1958). This “M&M” hypothesis maintains that there is no optimal relationship of equity finance to debt finance for a firm, because any increase in profitability through greater leverage will be offset by an increase in the unit cost of the remaining equity capital as a consequence of greater risk. On this premise, some argue that there should in principle be no reason for banks to oppose far higher equity capital requirements because the resulting reduction in their leverage would result in a fully compensating reduction in the cost of equity capital.³

1. In the change from Basel II to Basel III, common equity is to rise from 2 percent of risk-weighted assets (RWA) to 4.5 percent. Total tier 1 capital (which includes common equity) is to rise from 4 percent of RWA to 6 percent. There is an additional “capital conservation buffer” of 2.5 percent, bringing the total to 8.5 percent (BCBS 2010a, 69). In addition, SIFIs are to maintain extra capital, set at 2.5 percent of RWA in the Basel rules and up to 4.5 percent in the United States (Yalman Onaran, Jesse Hamilton, and Ian Katz, “Big US Banks Face Capital Requirements of Up to 4.5% on Top of Global Minimum,” Bloomberg, December 9, 2014).

2. In the United States, for banks with assets over \$700 billion the requirement will be 5 percent (*Forbes*, “Steep Leverage Ratio Requirements Will Force Banks to Rethink Their Capital Plans,” April 9, 2014). Moreover, in the United States, the Volcker Rule of the Dodd-Frank legislation additionally seeks to constrain “trading” (as opposed to lending) activity that banks are allowed to pursue.

3. Admati and Hellwig (2013, chapter 5) emphasize the Modigliani-Miller theorem, although they recognize that subsidized funding through guaranteed bank deposits creates an incentive for banks to rely less on equity.

In contrast, the few analytical attempts at identifying optimal capital requirements from society's viewpoint tend to acknowledge that higher capital requirements will make banks less profitable, and reduce lending and economic activity somewhat as a consequence. In these studies such reductions are set against the corresponding reductions in probabilities of financial crises, and thus expected damages avoided, to arrive at the optimal increases in capital requirements.⁴

The purpose of this paper is to examine the empirical evidence on the M&M proposition as applied to the banking sector. The central question is whether more highly capitalized banks do indeed enjoy lower costs of equity capital. The actual extent of such a relationship can then be used as an input into a broader analysis of optimal bank capital requirements from the standpoint of society, taking account of risks of financial crises from insufficient bank capitalization.

IS BANKING SPECIAL?

At the outset it is useful to address in qualitative terms the question, "Why is banking different?" For the nonfinancial sector, shareholder equity capital typically accounts for about one-third of total assets, whereas debt and other liabilities amount to about two-thirds (see, e.g., Rajan and Zingales 1995, 1428). In contrast, in the postwar period US commercial banks have had equity-to-asset ratios (book value basis) of only 4 to 6 percent up to the 1970s, rising to 6 percent in the late 1980s and 9 percent by 2007 (Berlin 2011, 5). Leverage on the order of 10 to 1 (or higher) instead of 3 to 1 has meant that the literature in this area has tended to treat the financial sector as "different," typically excluding it from empirical tests.

It seems intuitively appealing that the sector of financial intermediation should rely more heavily on debt financing than nonfinancial sectors. The intensity of inputs in a sector should depend on the nature of the output of the sector. One would not expect oil refining to have the same ratio of crude oil to total output as, say, the computer industry. Financial intermediation is a sector that by definition involves as its main input debt in the form of deposits by households and corporations. The main product provided by the bank is a store of value that has a high degree of safety and liquidity: bank checking and saving accounts. The sector also is based on acting as the intermediary that transforms short-term claims (deposits) into long-term claims (e.g., mortgages). Deposits are financial liabilities. Replacing them entirely with equity would require that the public be told that henceforth bank deposits are not available and instead households and corporations must hold liquid assets in the form of equity shares (e.g., in

4. Thus, Miles, Yang, and Marcheggiano (2012, 18) apply an M&M offset of only about one-half in their cost of capital calculations, based on UK bank data. The Basel Committee on Banking Supervision (BCBS 2010b, 23) makes no allowance at all for an M&M offset, although it does so apparently in the spirit of concluding that its calculation of optimal capital requirements may correspondingly be conservative, and it cites Kashyap, Stein, and Hanson (2010) as supporting the M&M relationship of equity cost to leverage.

mutual funds).⁵ Considering that deposits amount to about one-half of assets for the large banks and much more for smaller banks, the deposit-taking nature of the banking sector inherently means that the ratio of “debt” (including “debt” to depositors) to assets will tend to be higher than in most sectors.

There is a considerable tradition in the literature that debt/equity characteristics of banking are likely to be different from those of other firms. Thus, in their analysis of equity returns Eugene Fama and Kenneth French (1992, 429) “exclude financial firms because the high leverage that is normal for these firms probably does not have the same meaning as for nonfinancial firms, where high leverage more likely indicates distress.” In a recent survey, Mitchell Berlin (2011, 8) essentially adopts the proposition that financial intermediation is inherently levered when he states: “Since liquid liabilities are a primary output of the banking firm, we should expect banks to be highly levered.” Similarly, Richard Herring (2011, 9) observes that “Since some liabilities are really a product supplied by the bank rather than simply a means of funding the bank, we know that a 100% equity-to-asset ratio cannot be the correct answer.” Although Miller (1995) himself informally discussed whether M&M applies to banking, his answer was an ambivalent “Yes and No.”⁶

One key reason that has been given for observed high leverage in banking is that deposits are subsidized by publicly provided deposit insurance (e.g., Admati and Hellwig 2013). However, it turns out that nonbank financial firms that do not enjoy deposit insurance also have high leverage. Thus, in 2001–07, the median ratio of total assets to shareholder funds was 19.1 for banks, and 12.1 for nonbank financial firms, but only 3.0 for nonfinancial sectors (Herring 2011, 17). Once again the implication is that something is different about leverage for the financial sector even after removing the influence of deposit insurance.

Perhaps the most explicit analysis finding that banking is different is that by Harry DeAngelo and René Stulz (2013, 1, 3), who conclude that “MM’s leverage irrelevance theorem is simply inapplicable to banks. ... given a material market demand for liquidity, intermediaries will emerge to meet that demand with high leverage capital structures (made possible by asset structures optimized to produce liquidity).” In their model, with the bank choosing a portfolio of assets that is “not risky at the optimum” (p. 8), debt as a share of debt plus equity turns out to be the ratio $1/[1+\theta+\phi z]$. Here θ is the “liquidity spread” that those purchasing liquidity from banks accept for assured future access to capital, and ϕ is the “loan spread” paid on bank loans by those with limited access to capital markets. With reasonable values for θ

5. As proposed by Kotlikoff (2010).

6. This was the three-word abstract of his article. In the article he also acknowledged that “taken literally, they [the M&M Propositions] would not apply anywhere else either. Much of the research focus in finance in the last 30 years has been precisely on those departures from the strict M&M assumptions—things like taxes and agency costs—that will give a push or a tilt towards more or less leverage.... No very simple or coherent set of tilting principles has yet emerged, however, nor, for that matter, has any clear pattern of capital structures been observed across firms” (p. 487).

and ϕ , this ratio will be high, relatively close to unity. Moreover, the contrast with lower bank leverage in earlier historical times can be explained by the bidding down of θ over time as financial markets developed. Similarly to the analogy suggested above to oil refining, DeAngelo and Stulz (2013, 9) state that “Banks are different because financial flows are the inputs and outputs they utilize to generate value for their shareholders.”

Charles Calomiris and Richard Herring (2011) also take issue with the notion that equity capital can be increased indefinitely without costs to the banks. They cite Anil Kashyap, Raghuram Rajan, and Jeremy Stein (2008) regarding the adverse influence of too much equity on agency problems, as reduced leverage could insulate bank managers from market discipline if leverage is low and stock ownership is more fragmented than borrowing. Calomiris and Herring believe that although an increase in capital is necessary, “... we recognize that there are negative, not just diminishing, social returns to achieving that higher amount of capital solely by raising equity capital requirements beyond some point” (p. 14). Their solution instead is to supplement the equity capital requirement with required contingent capital (CoCo) in the form of debt that would convert to common equity upon a trigger (based on 90-day average of bank stock prices). Their objective is to make the conversion so unattractive to the banks that managers would have an extreme incentive to issue more equity early in an emerging deterioration rather than wait too late. They propose a (book value) leverage ratio of 10 percent equity relative to assets, supplemented by required CoCo funding of 10 percent of book assets (Calomiris and Herring 2011, 29). Their equity capital requirement would thus be only one-third to one-half the level proposed by Admati and Hellwig (2013), although it would be about twice the Basel III level for SIFIs (9.5 percent of RWA, corresponding to about 5 percent of total assets).

CAPM BETAS VERSUS DIRECT ESTIMATION

It is important to emphasize that unlike the few existing empirical estimates of the M&M effect for banks, the tests in this study do not use the indirect route of identifying the stock price “beta” for banks within the framework of the Sharpe-Lintner-Black capital asset pricing model (CAPM). In that framework, the riskiness of a given stock relative to a diversified equity portfolio is measured by the parameter beta, which tells the percent by which the stock price rises when the overall market rises by one percent, or falls when the overall market falls by one percent. Given the CAPM theory, the equity yield of a stock should equal the risk-free return plus the stock’s “beta” multiplied by the excess of the diversified market yield over the risk-free rate (the “equity premium”). For example, if the beta is 1.5, the risk-free return is 4 percent, and the general diversified stock market premium is an additional 4 percent (placing average equity return at 8 percent), then the return on the stock in question would be expected to be 10 percent.⁷ The leading

7. That is: $4 + 1.5 \times (8 - 4) = 10$.

empirical studies of M&M for banks conduct statistical tests that calculate beta as a function of the bank leverage ratio (capital relative to assets).⁸ Considering that the analytical objective for policy purposes is to calculate the extent to which a reduction in the unit cost of equity can be expected to offset the shift from low-cost debt to high-cost equity in the process of increasing regulatory capital requirements, in principle the CAPM framework can provide a means of accomplishing this objective.

However, it is much more direct to apply the estimation form implied by the original M&M article (as set forth in equation 1 below) than to infer the M&M influence through the bank beta in the CAPM framework. Such a test provides direct evidence on how much the equity yield can be expected to decline when the ratio of debt to equity is reduced. Because the CAPM has been found to provide poor explanation of equity prices with regard to the beta coefficient, it is problematical to rely on use of the beta as the indirect means to identify the M&M influence.⁹ Fama and French (2004) find that the response of the equity return to changes in the stock's beta is only about one-third the size of what is predicted by the CAPM, such that stocks with low betas have higher than expected return and stocks with high betas have lower than expected returns.¹⁰ On this basis, those who apply a bank beta estimated in relationship to leverage to calculate the reduction in required equity yields in response to higher capital should presumably shrink their raw estimates by two-thirds.

At a broader level, it is curious to accept the CAPM beta framework to estimate how much additional bank capital would reduce equity capital cost without recognizing that the banking sector already has an average beta of about unity.¹¹ If bank stocks are already about as safe as the equity market as a whole, what are the grounds for arguing that the sector is unduly risky and needs deeper capitalization in comparison with other sectors?

ARBITRAGE VERSUS OPTIMIZATION

A final introductory remark concerns the framework of M&M and its relationship to other frameworks of optimization. At its core, M&M is based on an arbitrage proposition. It is a logical syllogism that holds: (a) any debt-equity configuration chosen by the firm can be “unwound” by investors, who can sell shares

8. King (2009); Kashyap, Stein, and Hanson (2010); Yang and Tsatsaronis (2012); and Miles, Yang, and Marcheggiano (2012).

9. Fama and French (1992) state that “Our bottom line results are: (a) β [beta] does not seem to help explain the cross-section of average stock returns, and (b) the combination of size and book-to-market equity seems to absorb the roles of leverage and E/P in average stock returns...” (p. 428).

10. The authors report that for 1928–2003, average monthly returns are what CAPM would predict for a beta of 1.25, but for a beta of 1.8 the predicted return is considerably higher (at 17 percent) than the actual observed (14 percent), whereas for a beta of 0.6 the predicted return (8 percent) is considerably lower than the actual observed (11 percent). The ratio of the actual difference between the two ends of the spectrum to the CAPM-predicted is thus $[14 - 11]/[17 - 8] = 0.33$ (Fama and French 2004, 33).

11. King (2009, 71) estimates that the banking sectors in Canada, France, Germany, Japan, the United Kingdom, and the United States had an average beta of 0.95 in 1990–2000 and 0.74 in 2005–09.

of a highly leveraged firm and purchase shares in unleveraged firms using the proceeds plus borrowed funds, bidding down the share price of the leveraged firm and bidding up the share price of the unleveraged firm. (b) Market arbitrage will eliminate any profitability advantage of a more highly leveraged firm. (c) Therefore the capital structure (ratio of equity to debt) is irrelevant. The authors do not formally introduce risk. It is telling that their equations do not include an investor utility function, and they do not posit a typical degree of risk aversion. Nor do their equations set forth a probabilistic profile of returns in relationship to the debt-equity ratio, nor any hypothesized distribution function for returns. With such a function it would be possible to explore the optimal debt-equity ratio as a function of the risk aversion characterizing financial markets. Instead the authors appeal to “risk” only qualitatively and by implication maintain that any risk aversion whatsoever will suffice to drive their arbitrage process and rule out any superiority of one debt-equity ratio over any other.

SPECIFYING THE TESTS

As set forth in appendix A, the M&M proposition leads to a straightforward specification for an empirical test. The theorem yields the result that:

$$1) i_j = \rho + (\rho - r) \frac{D_j}{S_j}$$

where i is the cost of equity capital as measured by ratio of earnings per share to price per share (the earnings yield or inverse of the price/earnings ratio); ρ is the “capitalization rate” at which expected streams of future earnings are capitalized (discounted) for the “class” (by implication, sector) of the firms in question; r is the rate of interest at which both the firm and investors can borrow; D is the firm’s debt, and S is shareholder equity in the firm. Subscript j refers to the firm observed. Because the capitalization rate exceeds the interest rate ($\rho > r$), reducing debt relative to equity will reduce the earnings yield demanded by the market, thanks to reduction in perceived risk. The formulation turns out to cause exactly the amount of reduction in the earnings yield that is needed to have the average cost of capital remain constant. Moreover, this average cost of capital must equal the capitalization rate ρ (appendix A, equation A4).

The average cost of capital will be the weighted average of the cost of equity capital and the interest rate cost of debt. Defining V as the value of the firm, setting this value as being equal to debt plus equity ($V = D + S$), and defining the debt financing share y as the fraction of total value attributable to debt rather than equity (such that $y = D/V$), it follows that:

$$2) ACC_j = y_j r + (1 - y_j) i_j$$

As demonstrated in appendix B, given equation (1), the derivative of ACC (average cost of capital) in equation (2) with respect to the ratio of debt to equity is zero. Capital structure (i.e., the decision to finance through debt as opposed to equity) therefore has no influence on the average cost of capital in the M&M framework.

For purposes of empirical implementation, equation (1) can be estimated as:

$$3)i = a + bz$$

where z is defined as the debt to equity ratio ($z = D/S$), $a = \rho$, and $b = (\rho - r)$. To support the M&M hypothesis, the constant a should be found to have a value that plausibly represents the return to capital in the banking sector (ρ), and the coefficient b should be such that $a - b$ yields a plausible value for the difference between this rate and the interest rate r .

DATA

The database developed for the tests in this study is drawn from the annual filings of form 10-K with the Securities and Exchange Commission for the 54 largest US banks, for the period 2001–13.¹² These banks range in size from assets of \$2.4 trillion at the end of 2013 for JP Morgan Chase to \$6.5 billion for PacWest Bancorp (Los Angeles, California). They accounted for total assets of \$13.2 trillion at the end of 2013, representing 82.7 percent of total assets of US depository institutions (Federal Reserve 2014, 77).

The 10-K data report total assets, total liabilities, and shareholder equity (the difference). Total liabilities are used as the estimate of debt (D in equation 1), and shareholder equity as the estimate of equity (S). The dependent variable i , cost of equity capital, is estimated as the inverse of the price/earnings ratio for the year in question, using the fourth-quarter average stock price and trailing 12-month earnings.¹³ These data are also from the 10-K filings for most banks, or from Bloomberg otherwise.

It is a standard principle of corporate finance that the “earnings yield,” or inverse of the price/earnings ratio, should be higher when the riskiness of the asset is greater.¹⁴ There should be no ambiguity whatsoever that the “expected” earnings yield should be higher for higher risk, other things being equal. Ambiguity does arise, however, in measuring what investors expect future returns to be, because recently observed actual returns may or may not reflect those expectations. The price of a stock should be the

12. For most banks, the corporate website provides the 10-K filings on its investor portal (see, for example, www.citigroup.com/citi/investor/sec.htm). Note that for four large banks the data end in 2007 because subsequently during the financial crisis they were either taken over by other banks (Washington Mutual by JP Morgan Chase, Countrywide by Bank of America, and Wachovia by Wells Fargo) or failed (IndyMac).

13. Modigliani and Miller (1958, 271) identify i as the inverse of the price/earnings ratio in stating that “...the market price of any share of stock is given by capitalizing its expected return at the continuously variable rate i .”

14. See, for example, Damodaran (2007, chapter 2). Or, for standard analysis for the general investing public, see Malkiel (2015, 125).

discounted present value of its future stream of earnings. Expected future earnings depend on the base period earnings and the expected rate of growth of earnings in the future. The appropriate discount rate to apply equals the risk-free rate of return plus a premium to reflect the riskiness of the firm. In the M&M framework, this riskiness varies directly with the ratio of debt to equity. The discount rate will thus be higher for a more leveraged firm. Accordingly, for a specific class of firms (such as banks) in which the growth rate of future earnings is expected to be similar among the firms in question, the earnings yield is expected to be higher for firms with greater risk. Application of a higher risk premium in the discount rate will translate the future stream of earnings into a lower present value (stock price) relative to earnings.

Although stock valuation is based on expected future earnings, empirical estimates require the use of actual observed earnings as the proxy for expected future earnings. However, use of the observed earnings yield as the measure of the cost of equity capital raises the problem of interpreting data for a year of losses. The problem is that in such years actual net earnings will not be a meaningful proxy for the expected stream of future earnings, the relevant concept in M&M. Investors would not supply capital if they believed future earnings would be negative, so by definition a year of losses does not provide a meaningful proxy of future expected earnings. Negative net earnings occur in about 8 percent of the bank-year observations, with heavy concentration (83 percent of negative instances) in the Great Recession years of 2007–10. The solution adopted here is to constrain the earnings yield observation to be no lower than the real return on US Treasury inflation-protected (TIP) five-year bonds, plus a risk spread of 100 basis points, as the lowest meaningful rate at which investors might be prepared to provide equity capital.¹⁵ Choice of the real rate reflects the fact that when inflation is expected the nominal stream of earnings will be expected to rise over time, automatically providing inflation protection, such that inclusion of the inflation rate for the year in question would be double-counting expected inflation.

As an alternative measure of the cost of equity capital, a second test uses the ratio of net income in the year in question to the book value of equity at the end of the previous year. The same imposed floor replaces observations for years with negative income.

Figure 1 shows the trends in the simple averages of these ratios for the 54 large US banks in 2002–13. The earnings yield (EY) refers to the inverse of the price/earnings ratio using trailing earnings and fourth-quarter average stock price, in percentage terms. (Flanking confidence intervals for two standard deviations, or the 5 percent level, for each year are also shown.) Net income relative to equity (NI/Eq) refers to net income for the year shown as a percent of equity (assets minus liabilities) at the end of the previous year, again in percentage terms. Both series are the constrained observations, overriding negative observations as just discussed. The unconstrained series are shown in appendix D, figure D.1. They

15. The five-year TIP rate averaged 1.27 percent in 2003–05, 1.91 percent in 2006–08, but fell to an average of –0.23 percent in 2009–14 (Federal Reserve 2015a).

indicate average losses in 2008 and 2009 for the earnings yield measure and near zero averages for the net income relative to equity measure.

Figure 1 also shows the ratio of debt to equity (lagged one year), this time as a pure number. It turns out that there has already been significant deleveraging for US banks since 2007 (i.e., 2008 in the figure with respect to the debt/equity ratio). The ratio of debt to equity has fallen from an (unweighted) average of about 10.5 to about 8. Based on the same 10-K filings data, tier 1 capital is persistently an average of about 83 percent of book equity. By implication, the ratio of tier 1 capital to total assets has already risen from about 7.2 percent of assets to about 9.2 percent of assets.¹⁶

The (constrained) earnings yield, in contrast, has remained relatively steady within a range of 6 to 8 percent during this period, with the exception of a dip to as low as about 4 percent in 2009 in the Great Recession. However, the (constrained) ratio of net income to book equity capital has substantially declined, from about 16 percent to a range of 8 to 10 percent. The contrast between the income-book equity ratio and the earnings yield is a manifestation of the decline in the ratio of market capitalization to book value of equity, which fell from an average of 2.26 in 2001–06 to 1.23 in 2007–09 and 1.15 in 2010–13.¹⁷

It is informative to consider the distribution of net income for these large banks over the 12-year period 2002–13. Figure 2 is a histogram showing the distribution of net income as a percent of total assets at the end of the previous year. The left panel shows the full distribution. The right panel shows the distribution for just the cases of losses. The right-hand bucket “0” refers to the percent of bank-year observations with net income between –1 percent and zero. A total of 8.3 percent of bank-year cases had negative income in this period (which included the worst recession since the 1930s). Only 1.1 percent had losses exceeding 3 percent of assets; and only 0.7 percent had losses exceeding 5 percent of assets, respectively the new Basel III and US largest-bank capital leverage standards. Critics of the low Basel ratio often seem to consider it self-evident that the 3 percent level is far too low given what might be expected losses, but it turns out that the frequency of larger losses is relatively low. Of course, a major caveat is that the book income may be overstated (and losses understated) by failing to capture erosion in market value of assets in periods of stress.¹⁸ Nonetheless, the distribution of income results in figure 2 suggests that

16. For a given ratio of debt to equity (D/E), the corresponding ratio of assets to equity (A/E) is higher by unity. That is: $A/E = (D+E)/E = (D/E) + 1$. With tier 1 capital at 83 percent of equity, a reduction in the debt/equity ratio from 10.5 to 8 represents an increase in the (inverse) leverage ratio of tier 1 capital to assets from 7.2 percent ($= 1/(11.5/0.83)$) to 9.2 percent ($= 1/(9/0.83)$).

17. Market capitalization data are from Bloomberg.

18. Thus, IndyMac consistently had positive earnings in 2002–06, and its losses in 2007 were only 2.1 percent of end-2006 assets. Those losses amounted to only 30 percent of book equity at the end of 2006, so technically the bank does not seem to have been insolvent when it was closed down.

setting the capital leverage ratio far higher than the US level would amount to addressing a small fraction of cases based on the most recent decade's experience.

Test Results

The tests here estimate equation (3) using a pool of 12 years' observations on 51 of the 54 largest US banks.¹⁹ Because of the unusual conditions during the Great Recession, the tests include a dummy variable for the years 2008–10. For the earnings yield variant of the unit cost of equity capital, the results are:²⁰

$$4) ey_t = 6.63 + 0.0513 z_{t-1} - 1.89 D_{0810}; \text{ Adj. } R^2 = 0.088$$

(19.5) (1.62) (-7.2)

where ey is the earnings yield (percent), or inverse of the price/earnings ratio; z is the ratio of debt to equity (with equity defined as the excess of book assets over book liability); and D is a dummy variable with value 1 for 2008–10 and 0 otherwise. T-statistics are in parentheses.

The coefficient on the leverage ratio is not significant. Importantly, the size of the coefficient is relatively small, about 5 basis points for each unit change in the leverage ratio. Instead, the M&M value for the coefficient should be $\rho - r$. It seems unlikely that the interest rate r would be so close to the bank “class” rate of return on capital that the difference would be this small.

When the net income/equity variant is applied instead as the measure of the unit cost of equity capital, there is a considerably stronger relationship:

$$5) NI_t/E_{t-1} = 7.206 + 0.636 z_{t-1} - 5.823 D_{0810}; \text{ Adj. } R^2 = 0.268$$

(10.0) (9.4) (-10.5)

where NI_t/E_{t-1} is the ratio of book net income to equity at the end of the previous year (percent). This time the coefficient on the leverage ratio is highly significant. Moreover, its size is substantial, at about 60 basis points for each increment by unity in the ratio of debt to equity. Nonetheless, even this magnitude is small as a likely gauge of the excess of the banking sector return on capital minus the interest rate.

19. The tests exclude three of the top 54 banks: Ally Financial (which was not publicly listed during most of this period), UnionBanCal (which was acquired by Mitsubishi UFJ in 2008), and, as an outlier, Synovus Financial (which had extreme swings in earnings yield from –164 percent in 2008 to +41 percent in 2011).

20. Tests on the earnings yield variant apply 564 bank-year observations; tests on net income relative to equity apply 579 bank-year observations.

Application of fixed-effects tests for an unbalanced panel yields results that are very close to those of equations (4) and (5).²¹ Because of their simplicity and transparency, the results in equations (4) and (5) are applied in the impact estimates below.

IMPLICATIONS FOR THE AVERAGE COST OF CAPITAL

Table 1 considers the implications of a sharp increase in bank capital requirements on the average cost of capital for banks. The table uses the estimates in equations (4) and (5) to assess the effects of raising bank capital from a benchmark of 10 percent of total assets to 25 percent (the midpoint of the range suggested by Admati and Hellwig 2013). This increase is equivalent to reducing the debt/equity ratio from 9 to 3.²² The cost of equity capital is obtained using equation (4) or (5) (with no dummy variable) as applied first to $z = 9$ and next to $z = 3$.²³ The table considers two cases: one (A) with the interest rate at 3 percent and the other (B) at 2 percent.

The table then shows average cost of capital before the reform (0) and after (1), for each of the two alternative interest rate assumptions. The table also shows the corresponding changes in average cost of capital. Surprisingly, the two models show identical changes in the average cost of capital: an increase of 54 basis points if the real interest rate is 3 percent, and 69 basis points if the real interest rate is 2 percent. Essentially the larger coefficient b in the NI/E model and higher base level of equity cost provide a substantially larger absolute reduction in the cost of equity, but because the equity cost (both before and after) is substantially higher in the NI/E model than in the equity yield model, there is a fully offsetting effect from a more powerful impact of shifting from low-cost debt to high-cost equity.

The table next shows the change in average capital cost that would occur if there were no M&M effect at all (namely, the unit cost of equity capital after the reform is identical to that before the reform). Finally, the table reports the corresponding percent of total potential increase in average cost of capital that is offset by the induced reduction in equity capital cost as a consequence of the M&M effect. As expected from the small size of coefficient b in the ey model and large size of this coefficient in the NI/E model, the percentage offset is much smaller in the earnings yield model (only about 10 percent) than in the net-income model (about 60 percent).

Taking the averages over the two models and two alternative interest rates, the expected change in the average cost of capital from the higher capital requirement would amount to 61.5 basis points. In the

21. Using fixed effects, which is equivalent to having individual dummy variables for each bank and each year, yields the following coefficients on the debt/equity ratio $z_{i,t}$: 0.063 (1.31) for the earnings yield (instead of 0.0513, equation 4) and 0.708 (8.12) for net income relative to equity (instead of 0.636, equation 5), with t-statistics in parentheses.

22. That is, with the shares of D and E, respectively, at 0.9 and 0.1, $D/E = 0.9/0.1 = 9$. With these shares instead at 0.75 and 0.25, $D/E = 0.75/0.25 = 3$.

23. The value for b estimated in equation (4) is applied even though it is not significantly different from zero.

absence of any M&M offset the average increase would be 112.5 basis points. So on average, the M&M offset amounts to 45 percent of the potential increase in the weighted average cost of capital.²⁴ Banks could be expected to pass along the net increase to household and corporate borrowers. Permanently higher real interest rates would reduce the amount of capital formation and thus reduce future GDP from levels otherwise reached.

The central estimate, an increase of approximately 62 basis points in average cost of capital for a 15 percent of total assets increase in capital, is considerably more modest than would be implied by the findings of Benjamin Cohen and Michela Scatigna (2014) for actual behavior of lending rates so far during the phase-in of Basel III. They estimate that for a sample of 94 banks in both advanced and emerging-market economies, common equity capital rose from 11.4 percent of risk-weighted assets in 2009 to 13.9 percent in 2012 (p. 12). Net interest income rose from 1.37 percent of total assets to 1.67 percent. The authors state that the 30 basis point increase translates to 12 basis points per percentage point increase in the (risk-weighted) capital/asset ratio. Considering that risk-weighted assets would likely be no more than 50 percent of total assets going forward (the 2012 ratio was only 0.42; p. 11), each percentage point of total assets increase in capital would impose at least 24 basis points increase in lending cost based on the Cohen-Scatigna results. In the exercise of this study, the 15 percentage point increase in capital relative to total assets would thus boost bank lending costs by 360 basis points. So the estimates here can be seen as substantially on the conservative side in comparison with actual experience under increased capital requirements in 2009–12.

Similarly, the increase of 62 basis points estimated here is more modest than the corresponding increase implied by the estimates of David Miles, Jing Yang, and Gilberto Marcheggiano (2012), which would amount to 81 basis points for the same increase in capital. As discussed in appendix C, they estimate that raising capital by 3.33 percent of total assets (reducing the asset/capital leverage ratio from 30 to 15) would increase the weighted average cost of capital by 18 basis points after taking account of the M&M offset (induced reduction in equity cost). Applying an increment of 15 percentage points of assets would thus imply an increase of 81 basis points ($= 18 \times [15/3.33]$). Another study discussed in appendix C, by Jing Yang and Kostas Tsatsaronis (2012), obtains results that imply a 15 percentage point increase in the ratio of capital to total assets would boost the weighted average cost of capital by 120 basis points. The findings of these two studies thus also imply that the estimates in the present study for the impact on lending rates from a 15 percentage point increase in capital relative to assets may be understated rather than overstated, although not by as wide a margin as implied by comparison to the findings of Cohen and Scatigna (2014) for increases that have already occurred from the much smaller capital increases already incurred in the initial phase-in of Basel III.

24. Note that this turns out to be the same offset as identified by Miles, Yang, and Marcheggiano (2012). See appendix C.

IMPACT ON THE ECONOMY

Miles, Yang, and Marcheggiano (2012, 15–16) provide a methodology for calculating the impact of higher capital costs on the economy. As the point of departure, the share of capital in national income (define it as α) is the benchmark for the elasticity of output with respect to the stock of capital. Output will thus fall by a percentage equal to $\alpha \times \% \Delta K$, where the final term is the percent reduction in the capital stock. This reduction in turn will depend on the sensitivity of capital used to the price of capital, which depends on the degree of ease in substituting capital for labor and the change in the price of capital relative to the price of labor. The substitution effect depends on the elasticity of substitution, σ , which the authors place at 0.5 on the basis of the literature. The change in the price of capital relative to the price of labor turns out to be greater than just the initial increase in the price of capital, because with less capital to cooperate with, the marginal product of labor will fall and so will its price. This final relative price term turns out to be a factor of $1/(1-\alpha)$. The combined effect of a “ v ” percent rise in the cost of capital will then be to reduce output by $v \times \alpha \times \sigma \times (1/[1-\alpha])$ percent. With $\alpha = 0.33$ and $\sigma = 0.5$, the change in output will be a decline by $0.25 v$ percent.²⁵

How much would the increase in capital requirements in the exercise above increase the average cost of capital to the economy? Again following Miles, Yang, and Marcheggiano (2012), assume that one-third of financing of the nonbank economy comes from banks. Considering that one-third comes from equity (Rajan and Zingales 1995, as cited earlier), by implication nonbank firms secure one-third of financing from nonbank borrowing (for example, in the corporate bond market).²⁶ The cost of equity in the United States can be gauged by the earnings yield. This yield has been an average of 6.8 percent from 1960 through 2014 (Damodaran 2015). As for debt, the proper concept is a real interest rate on say 5-year obligations. Assuming that the normal inflation-protected Treasury bond of this maturity would be 1.5 percent, and assuming an average credit risk spread of 200 basis points, a reasonable benchmark for debt cost in the United States would be 3.5 percent. So benchmark average cost of capital would stand at: $1/3 \times 6.8\%$ (for equity) + $2/3 \times 3.5\%$ (for debt) = 4.6 percent.

If the central estimate of the increase in bank lending rates caused by the rise in banks’ capital requirements from 10 percent of total assets to 25 percent is 62 basis points (the result above), and if banks provide one-third of total financing, then the increase in the average cost of capital to the economy will be $1/3 \times 62$ basis points $\cong 20$ basis points (in the absence of any spillover to higher lending rates by nonbank financial intermediaries). This increase would constitute an increase in the average cost of capital

25. That is: $0.33 \times 0.5 \times (1/0.67) = 0.246$.

26. This share would likely be considerably lower in the euro area than in the United States and the United Kingdom (the country considered in Miles, Yang, and Marcheggiano 2012).

by 4.3 percent.²⁷ Based on the capital share and substitution elasticity relationships just discussed, the consequence would be to reduce the level of the future path of GDP by 1.08 percentage point.²⁸ Consider the significance of this reduction over a tangible time horizon such as 30 years. Assuming baseline GDP growth at 2 percent, and discounting by a social rate of time preference of 1.5 percent, the present discounted value of the loss of output over this horizon would amount to 35 percent of the base year's GDP.²⁹

FURTHER CONSIDERATIONS

Social versus Private Returns. Admati et al. (2011, 22–23) argue that even if higher bank capital requirements cause an increase in bank lending rates, the result is likely to be welfare-enhancing from the viewpoint of society as opposed to private shareholders and borrowers. Their reason is that existing government guarantees of deposit, as well as implicit guarantees of too-big-to-fail, give a distorted incentive to banks to take excessive risks that can damage the economy in a financial crisis. These distorted incentives are additive to the general distortion from tax favoritism to debt relative to equity.

Identifying socially optimal increases in bank capital, however, would require taking into account a realistic evaluation of costs to the economy from raising bank lending rates and as a consequence reducing capital formation. It may well be that the corresponding reduction in expected social losses from financial crises would warrant substantial costs from lower capital formation. But in principle there is likely to be some optimal limit to the socially beneficial increase in capital if the operational effect is some loss in output because the M&M offset is in fact far from complete. It is further worth noting that social benefits are associated with the service of providing bank deposits, because they constitute money performing

27. That is: $20/460 = 0.043$. Note that Miles, Yang, and Marcheggiano (2012, 16) get a much smaller proportionate increase in the cost of capital: only 0.6 percent, for a halving of leverage. The much lower figure results from a lower estimate of the impact on bank lending rates (18 basis points instead of 62) and a substantially higher estimate of average equity cost (10 percent instead of 6.8 percent) and borrowing costs (5 percent instead of 3.5 percent). The lower impact in part reflects the fact that their halving of leverage is less aggressive than the two-thirds reduction in leverage (from 9:1 to 3:1) examined here and implied by the preferred range of Admati and Hellwig (2013). The lower estimates in Miles, Yang, and Marcheggiano (2012) translate to a present value loss equal to 6 percent of one year's GDP, much smaller than the 35 percent estimate here (despite their discounting over an infinite horizon rather than just 30 years).

28. That is: 0.25×4.3 . It should be emphasized that the 1.08 percent reduction refers to the *level* of GDP at each future point in time, not to the annual average *growth rate* over the period.

29. See Cline (1992, 255) for derivation of a long-term rate of social time preference of 1.5 percent. This parameter is based on an elasticity of marginal utility of -1.5 , combined with a long-term growth rate of per capita income of 1 percent. (The social rate of time preference equals the rate of pure time preference, for myopia, plus the elasticity of marginal utility multiplied by the growth rate of per capita consumption; see Ramsey 1928. I have argued, following Ramsey, that there is no justification for pure time preference from the standpoint of society.) Define $g = 0.02$ as the baseline growth rate, $\delta = 0.015$ as the social rate of time preference, and $\lambda = 0.0108$ as the fraction of output lost because of the lower capital stock. The stream of output lost is then (in year t): $\lambda Q_0 e^{gt}$. When this stream is discounted at δ , the present value of the stream of losses over the first 30 years is 35 percent of the base-year GDP. That is: $\lambda Q_0 \sum_{t=1}^{30} (1+g)^t / (1+\delta)^t = 0.35 Q_0$

its three basic functions: liquidity, store of value, and medium of exchange. It is not clear that the social subsidy to banks from government deposit guarantee is greatly larger than the social externality provided by banks in the form of providing money in the form of deposits.

In short, although recognition of the need to take societal externalities into account could indeed lead to identification of optimal capital requirements that are significantly higher than in the past, the calibration of appropriate policy is considerably more complicated than implied by a general proposition that higher capital requirements are costless and existing capital arrangements subsidize banks and encourage them to take risks at the expense of the public.

Monetary Policy Offset? Another central policy question is whether to be concerned at all about possible increases in bank lending rates as a consequence of higher capital requirements, on grounds that any such increase in interest rates could be offset by a relaxation in monetary policy. A major problem with this “monetary policy offset” argument is that monetary policy should be reserved for the task of achieving a balanced macroeconomic outcome regarding inflation and unemployment. It is unlikely that any increase in private sector borrowing costs resulting from higher bank capital requirements could be exactly offset by precisely the same reduction in interest rates that would be optimal from the standpoint of addressing the induced changes in inflation and unemployment. This task would of course be even more difficult if the risk-free interest rate were already at the zero bound (as in 2008–15 in the United States following the Great Recession). Moreover, to the extent that over a period of years a higher bank lending rate had the consequence of reducing potential supply because of less capital formation, the central bank could have less scope for reducing interest rates without inflationary consequences because of more constrained supply.

CONCLUSION

Higher capital requirements may still be socially beneficial, but they are not free, and by implication it is desirable to compare social benefits of higher capital requirements against social costs associated with higher average capital cost and lower capital formation. If the rough calculations here are indicative, the implication would be that the sum of financial crisis losses avoided over the next 30 years as a consequence of a much higher capital requirement (benchmarked at an additional 15 percent of total assets) would need to be on the order of one-third of one-year’s GDP to warrant the output costs of the additional bank capital. These costs would arise because, on the basis of statistical estimates for large US banks, less than half of the M&M offset (reduction in unit equity cost in response to reduction in leverage and thus risk) would be likely to occur.

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Figure 1 Trends in net income relative to equity, earnings yield, and debt/equity ratio for 54 largest US banks, 2002–13^a

NI/Eq = net income relative to equity; EY = earnings yield; D/E - 1 = debt to equity (lagged one year)

a. For observations with earnings constrained to exceed zero; see text.

Note: Also shown in the figure are flanking confidence intervals for two standard deviations, or the 5 percent level, for each year.

Source: Calculated from annual filings of Form 10-K with the Securities and Exchange Commission.

Figure 2 Distribution of annual bank net incomes relative to assets, 54 largest US banks, 2002–13

Sources: 10-K filings with the Securities and Exchange Commission; Bloomberg.

Table 1 Impact of raising capital/asset ratios from 10 to 25 percent^a

Concept	Symbol	ey model (equation 4)	N/E model (equation 5)
Debt/equity (ratio)	z_0	9	9
	z_1	3	3
Cost of equity (percent)	i_0	7.09	12.93
	i_1	6.78	9.11
Interest rate (percent)	r_A	3	3
	r_B	2	2
Average cost of capital (percent): A	ACC_{A0}	3.41	3.99
	ACC_{A1}	3.95	4.53
Change (percentage points)		0.54	0.54
Average cost of capital (percent): B	ACC_{B0}	2.51	3.09
	ACC_{B1}	3.2	3.78
Change (percentage points)		0.69	0.69
Change if M&M effect 0: (percentage points)	Change A	0.61	1.49
	Change B	0.76	1.64
M&M offset (percent of potential)	A	12.5	64
	B	10.1	58.2

a. Refers to total assets, not risk-weighted.

Source: Author's calculations.

APPENDIX A THE MODIGLIANI-MILLER MODEL

Modigliani and Miller (1958, 267–71) posit that for any given “class” of firms (implicitly, for example, a particular industrial sector), in the absence of any debt financing the price of a share of a given firm j will be the expected annual stream of income earned (“expected return”) discounted by the expected rate of return for that class. Thus:

$$A1) p_j = \frac{1}{\rho} \bar{x}_j, \text{ or equivalently:}$$

$$A2) \frac{\bar{x}_j}{p_j} = \rho$$

where p_j is the share price of firm j , $\bar{x}_j$ is the annual future steady stream of returns (earnings, abstracting from taxes) per share, and ρ is the characteristic rate of return to that class of firms.³⁰

They then introduce debt financing and examine its influence on share pricing. Their first proposition is that “the market value of any firm is independent of its capital structure and is given by capitalizing its expected return at the rate ρ_k appropriate to its class” (p. 268). Thus:

$$A3) V_j \equiv (S_j + D_j) = \bar{X}_j / \rho$$

where V_j is the market value of the firm, S_j is the market value of its common shares, $\bar{X}_j$ is expected return on assets owned by the company (before deduction of interest), and D_j is the market value of the debt of the company.³¹

The authors define the “average cost of capital” as the ratio of expected return to the market value of all the firm’s securities. Their proposition is then that this average cost is constant at the rate ρ applicable to the class in question, and consequently is “completely independent of the capital structure and is equal to the capitalization rate of a pure equity stream of its class” (p. 268). Thus:

$$A4) ACC_j \equiv \frac{\bar{X}_j}{S_j + D_j} \equiv \frac{\bar{X}_j}{V_j} = \rho$$

where ACC is average cost of capital (my addition). This proposition challenged the then dominant view that average cost of capital was a declining function of leverage until leverage reached so high that the average cost rose once again because of rising risk, with the implication that there was some optimal

30. For convenience and because this study refers to a single sector, banking, I omit the subscript “ k ” that M&M include for the “class.” Note further that M&M are not explicit about the role of inflation, but by implication their setup refers either to real values or to nominal values under the assumption of a constant rate of inflation.

31. D would thus include preferred shares. M&M do not address a situation in which default risk has sharply depressed the market value of a firm’s debt below nominal value, considering that their construct treats D at face value (hence it can be applied directly to arrive at interest costs).

leverage ratio.³² The conventional view apparently reflected the sense that debt capital was cheaper than equity capital so higher leverage would reduce the average cost of capital, whereas the central proposition of M&M was that higher leverage would introduce higher risk and increase the cost of equity capital enough to offset the rising share of debt capital.

To demonstrate this proposition, the authors invoke arbitrage between the share prices of two firms, one leveraged and the other not. Both firms have the same expected return (gross of interest), stated thus as simply X . The authors first suppose that the value of the levered firm, V_2 , is larger than that of the unlevered one, V_1 . They then consider an investor holding s_2 dollars' worth of shares in firm 2, constituting the fraction α of total shares in the firm worth S_2 . The return to this investor, Y_2 , will be the owned fraction of the firm times its income net of interest costs, or:

$$A5) Y_2 = \alpha(X - rD_2)$$

where D_2 is the amount of debt of firm 2, r is the interest rate, and $\alpha \equiv s_2/S_2$.

The authors next have the investor sell his αS_2 worth of shares in company 2 and purchase the larger amount $s_1 = \alpha(S_2 + D_2)$ of shares in company 1. In doing so, the investor borrows the amount αD_2 to supplement the proceeds of the sale of company 2 shares. Keeping in mind that in firm 1 there is no debt so the value of the firm is solely total equity share value S_1 , the investor's income from the new holding in company 1 net of interest paid on the amount borrowed is then:

$$A6) Y_1 = \frac{\alpha(S_2 + D_2)}{S_1} X - r\alpha D_2 = \alpha \frac{V_2}{V_1} X - r\alpha D_2$$

So long as $V_2 > V_1$ other holders of company 2 shares will find it attractive to imitate the first investor, because Y_1 (equation A6) will exceed Y_2 (equation A5). This process will bid up the price of company 1 shares and bid down the price of company 2 shares until $V_2 = V_1$. The authors conclude "levered companies cannot command a premium over unlevered companies because investors have the opportunity of putting the equivalent leverage into their portfolio directly by borrowing on personal account" (p. 270).

Of course, this conclusion requires that the outside investors can borrow at the same interest rate as that paid by company 2 on its debt, " r ". It is not clear in general that this would be the case; certainly retail investors seem likely to pay higher interest on stock margin debt than the typical borrowing cost of a sound firm. For banking, it is even more unlikely that outside investors can borrow at the same rate, because one-half or more of the funding of the bank is likely to come from deposits that bear extremely

32. M&M attributed this view for example to Graham and Dodd (1951).

low interest rates (if any). One can thus begin to see limitations on application of the model, especially for banks.³³

Modigliani and Miller then show that conversely, if the unlevered firm were more valuable than the levered firm, the investor in the unlevered firm could sell stock, use the proceeds to buy shares in the levered firm and invest what is left over in bonds, until the value of the levered firm were bid up to that of the unlevered firm. This process would amount to “an operation which ‘undoes’ the leverage” (p. 270). However, the general presumption had been that if there were any difference, levered firms would be more valuable, so the algebra going in the opposite direction need not detain this appendix.

The authors then turn to the result that is key for the empirical test here: The earnings yield of the stock in question should equal the capitalization rate appropriate to the class of the firm plus a constant times the ratio of debt to equity. The constant in question is the excess of the capitalization rate over the interest rate. This result is derived as follows. The earnings yield on a share of the stock will be:³⁴

$$A7) i_j = \frac{\bar{X}_j - rD_j}{S_j} = \frac{\rho(S_j + D_j) - rD_j}{S_j}$$

That is, total net earnings are the gross return less interest paid. But gross earnings are simply the constant capitalization rate for the class, ρ , times value of the firm ($S+D$). Simplifying:³⁵

$$A8) i_j = \rho + (\rho - r) \frac{D_j}{S_j}$$

The earnings yield should thus be a linear function of the ratio of debt to equity, with a constant intercept equal to the capitalization rate for the class, and a coefficient on the debt/equity ratio equal to the excess of the capitalization rate over the borrowing rate. To illustrate, M&M set $\bar{X} = 1000$, $D = 4000$, $S = 6000$, $\rho = 10$ percent, and $r = 5$ percent. Expected yield or rate of return per share is then 13.3 percent.³⁶ In their example, if the capital structure reverses from 60 percent equity to 40 percent equity, the earnings yield should rise from 13.3 to 17.5 percent.³⁷ This linear relationship of earnings yield to leverage (defined as the debt-equity ratio) holds the average cost of capital constant regardless of leverage. Thus, in the first case capital costs an average of $0.4 \times 0.05 + 0.6 \times 0.133 = 0.1$, or 10 percent. In the second case, capital costs an average of $0.6 \times 0.05 + 0.4 \times 0.175 = 0.1$, again 10 percent.

33. In particular (but not discussed by M&M), if the investor can borrow only at the higher rate r' , then the interest rate applicable to equation (A6) becomes r' , and (setting equation A5 equal to A6) arbitrage will stop when $V_j/V_i = 1 + (r' - r)(D_j/X)$.

34. Equation (9) in Modigliani and Miller (1958).

35. That is: dividing each part of the numerator of the final right-hand-side of equation (A7) by S , and rearranging. Equation (8) in Modigliani and Miller (1958).

36. That is: $0.1 + (0.1 - 0.05)(4000/6000) = 0.133$.

37. Or: $0.1 + (0.1 - 0.05)(6000/4000) = 0.175$.

In the case of US banks, with equity capital at about 10 percent of total assets and thus the debt-equity ratio at about 9, these same postulated rates would place the earnings yield implausibly high at 55 percent (and the price/earnings ratio implausibly low at 1.8). Instead, at the end of 2014 the median trailing price/earnings ratio for the seven largest US banks was approximately 16, placing the earnings yield at about 6 percent.³⁸ For the same banks, the median credit default swap (CDS) rate spread above 5-year US Treasury bonds in 2013 was 78 basis points, placing the corresponding borrowing rate at 2.73 percent.³⁹ By implication equation (A8) would require that the bank sector capitalization rate (ρ) was only 3.06 percent.⁴⁰ This capitalization rate is implausibly low, however. By implication, the sensitivity of the earnings yield to leverage may be overstated by the M&M model.

38. See www.finance.yahoo.com. The seven largest banks are JP Morgan, Bank of America, Citigroup, Wells Fargo, Goldman Sachs, Morgan Stanley, and Bank of New York Mellon.

39. CDS rates are from Bloomberg. The 5-year Treasury rate averaged 1.95 percent in 2013 (Federal Reserve 2015a).

40. That is: $0.06 = 0.0306 + (0.0306 - 0.0273) \times 9$.

APPENDIX B DEMONSTRATING CONSTANT AVERAGE COST OF CAPITAL IN M&M

The original equations in Modigliani and Miller (1958) show a clear negative relationship between the unit cost of equity and the amount of debt leverage. The authors use a numerical example to demonstrate that as a consequence the average cost of capital is constant and does not depend on leverage. It is useful to show that this result is general for their setup. Especially for banks, with high leverage, the ratio of debt to equity might be thought to have nonlinear consequences for the average cost of capital as leverage rises even higher, if only because in the limit this term (the final variable in equation A8 , appendix A) would approach infinity.⁴¹ This appendix shows that the derivative of the average cost of capital with respect to the debt/equity ratio is zero, demonstrating that the result of constant average cost of capital is general.

Define w as the average cost of capital, and y as the ratio of debt to total enterprise value. (In the terms of appendix A, $y = D/V = D/(D + S)$.) With the interest rate at r and the cost of equity capital at the rate i (and with i in turn equal to the net earnings yield per share), average cost of capital will be:

$$B1) w = yr + (1 - y)i$$

Because debt will be $D=yV$ and equity value $S = (1-y)V$, it follows that the key debt to equity ratio (D/S , equation A8) can be written as:

$$B2) z \equiv \frac{D}{S} = \frac{y}{1 - y}$$

From equation (A8) of appendix A, the unit cost of equity capital will be:

$$B3) i = \rho + (\rho - r)z$$

It will be helpful to use the relationship:⁴²

$$B4) y = \frac{z}{1 + z}$$

From equation (B1), the derivative of the average cost of capital with respect to the leverage ratio will be:⁴³

$$B5) \frac{dw}{dz} = r \frac{dy}{dz} + (1 - y) \frac{di}{dz} + i \frac{d(1 - y)}{dz}$$

41. Their numerical example involves intermediate levels of leverage, with the debt to equity ratio rising from only 2/3 to 1.5, well below the range observed in the banking sector.

42. That is: from equation (B2), $z(1-y) = y$, so $z-y+yz = y(1+z)$. Rearranging yields equation (B4).

43. The last two terms in equation (B5) apply the standard formula for the derivative of a product of two variables, uv , namely: $d(uv) = u dv + v du$, where $u = (1 - y)$ and $v = i$.

From equation (B4), the derivative of y with respect to z will be:⁴⁴

$$B6) \frac{dy}{dz} = \frac{d \frac{z}{1+z}}{dz} = \frac{(1+z)(1) - z(1)}{(1+z)^2} = \frac{1}{(1+z)^2}$$

Similarly, it can be shown that:⁴⁵

$$B7) \frac{d(1-y)}{dz} = -\frac{1}{(1+z)^2}$$

From equation (B3),

$$B8) \frac{di}{dz} = \rho - r$$

Substituting into equation (B5),

$$\begin{aligned} B9) \frac{dw}{dz} &= \frac{r}{(1+z)^2} + \left(1 - \frac{z}{1+z}\right)(\rho - r) + [\rho + (\rho - r)z] \left[\frac{-1}{(1+z)^2}\right] \\ &= \frac{r}{(1+z)^2} + \frac{\rho - r}{1+z} + \frac{-\rho - \rho z + rz}{(1+z)^2} \end{aligned}$$

Combining the first and third terms and cancelling $(1+z)$ yields:

$$B10) \frac{dw}{dz} = \frac{r - \rho}{1+z} + \frac{\rho - r}{1+z} = 0; \text{ QED}$$

44. Applying the standard derivative formula $d(u/v) = (v du - u dv)/v^2$.

45. This result is also intuitive as it should be simply the negative of dy/dz .

APPENDIX C ALTERNATIVE ANALYSES OF THE COSTS OF INCREASING BANK CAPITAL

As discussed in the introduction, there is a surprisingly wide divergence of expert opinion on the costs of increasing bank capital requirements (let alone on the social benefits). Several academic studies tend to invoke the M&M theorem as grounds for judging these costs to be minimal. The official sector studies have tended to quantify costs without explicit allowance for the M&M offset (lower cost of equity capital thanks to less risk as leverage declines) but with qualitative recognition of the potential offset. One important industry study, in contrast, took note of the theorem but rejected it and arrived at relatively high costs of increased capital requirements. This appendix examines both that study (IIF 2011) and three leading papers on the other side of this spectrum to shed further light on the debate.

IIF (2011). In a key study by the leading global association of financial institutions, the Institute of International Finance examined the prospective impact of the set of regulatory reforms in Basel III, including especially the increased capital requirements for banks. The Institute's report estimated that the reforms would cause an increase in bank lending rates to the private sector averaging 364 basis points in 2011–15 and 281 basis points over 2011–20, for the United States, the euro area, Japan, the United Kingdom, and Switzerland (IIF 2011, 54).⁴⁶ As a consequence of the higher private sector borrowing costs, real GDP by 2015 was projected to be 3.2 percent below the level otherwise attained (p. 55).⁴⁷ So far actual experience in 2011–15 has not been kind to this projection. As shown in figure C.1, average bank lending rates in the United States and in France and Germany have fallen rather than rising in this period.

In panel A for the United States, the spread between the prime rate and the 5-year US Treasury rate was an average of 362 basis points in 2007, fell to an average of 173 basis points in 2011, and instead of rising fell slightly further to 163 basis points for 2014 and early 2015. The corresponding spreads for consumer installment loans averaged 334, 429, and 262 basis points, so on this measure, from 2011 to 2014–15 the lending cost to private borrowers relative to the risk-free benchmark fell rather than rising.⁴⁸ In panel B for France and Germany, interest rates for new bank lending to nonfinancial corporations are shown, along with the 5-year rate for the German treasury bond. The average spread for the two countries above the 5-year German bund did edge up, from 130 basis points in 2011 (already up from 89 basis points in 2007) to 173 basis points in 2014–January 2015. The increase of 43 basis points from 2011 to

46. *Disclosure:* The author was deputy managing director and chief economist of the Institute of International Finance in 1996–2001, with supervisory responsibility for its analysis of emerging-market economies.

47. Based on an application of the NIESR National Institute Global Econometric Model (NiGEM).

48. The IIF estimate instead was that the lending cost (and hence spread) should have risen by 468 basis points from 2011 to 2015, for the United States. For the euro area, the corresponding estimate was 291 basis points (IIF 2011, 54).

2014–15 is consistent with some impact of higher capital requirements on lending rates, but far less than had been projected in the IIF study.⁴⁹

The report acknowledged the Modigliani-Miller theorem but stated: “Most Industry practitioners question the validity and applicability of the M-M theorem. This...[is] likely to reflect the outcome of experience.” On the contrary, “in the short run, as ownership dilution concerns dominate,... heavy required (and/or feared) equity issuance could depress bank equity prices, thus raising the short-run cost of equity finance” (IIF 2011, 45). Regarding official sector studies, the IIF considered them “too sanguine about funding implications” (IIF 2011, 16).

In its equation for the “return on equity,” the study calculates the “shadow” cost of equity as equal to the target return on equity plus a coefficient of 0.5 multiplied by the excess in the growth of core tier 1 equity over the growth rate of nominal GDP. It does allow an M&M offset of 0.25 times the excess of the core tier 1 capital ratio over 7 percent.⁵⁰ It is this formulation that generates an increase in lending rates by 364 basis points over 5 years.

The overall thrust of the study is that rising equity costs associated with dilution effects in the face of relatively rapid phase-in of higher capital requirements would far outweigh M&M effects, such that the average cost of capital would rise not only from an increase in the fraction of financing coming from equity but also because of an increase in the cost of equity capital itself. However, the report does not provide specifics on these funding shares or the pre- and post-reform levels of equity capital costs. The report does state that “everyone accepts that most of the costs will be borne in the near term, whereas the benefits will be longer term in accruing” (IIF 2011, 11). If this view is combined with the apparent outcome that effects in the near term have not been as severe as anticipated by the IIF, the broad implication would seem to be that the tradeoff will not have been as adverse as the IIF feared in 2011. In contrast, the analysis of the present study focuses on persistent rather than short-term costs of higher equity requirements. Moreover, the estimates in the main text concern much larger capital increases than those agreed in Basel III.

Miles, Yang, and Marcheggiano (2012) conduct tests for 7 UK banks for the period 1997–2010 to estimate the influence of leverage on equity cost of capital. They apply the CAPM framework and thus focus on estimating market betas rather than directly investigating the relationship of equity yield to leverage. In their main finding, the equity beta equals a constant 1.07 plus the estimated coefficient 0.03

49. As noted in the main text, Cohen and Scatigna (2014) found that for 94 large banks internationally, actual experience in 2009 to 2012 showed an increase of 30 basis points in lending rates in association with an increase of 2.5 percentage points in capital relative to risk-weighted assets.

50. In addition, the equation includes the coefficient 0.5 times the excess of target return on equity minus realized return on equity.

times the ratio of assets to capital (pp. 10, 13). With an average asset to capital ratio of 30, by implication the average beta was approximately 2.⁵¹ They translate the implications for equity cost of higher capital requirements as follows. They place average return on equity at approximately 15 percent, average bank borrowing cost at 5 percent, and average leverage at 30, implying weighted average cost of capital (WACC) of 5.33 percent.⁵² They then consider the impact of doubling required capital, or lowering the leverage ratio from 30 to 15. In the absence of any M&M offset the effect would be to boost WACC to 5.66 percent, an increase of 33 basis points.⁵³

The authors then calculate the impact of higher capital requirements taking account of their estimated M&M offset. In the CAPM, the equity cost of a firm equals the risk-free rate plus the firm's beta multiplied by the market average risk premium. They place the risk-free rate at 5 percent, and the general market risk premium at 5 percent. With their regression estimate, the cost of equity capital at the lower leverage ratio (15 instead of 30) would fall to 12.6 percent.⁵⁴ As a consequence, the new WACC would be 5.51 percent.⁵⁵ The rise in the WACC would be 18 basis points instead of 33, indicating that the M&M effect would offset 45 percent of the potential rise in average cost of capital.

As it turns out, the central estimate in this study is also that the M&M offset would be 45 percent of the potential rise in the average cost of capital for bank lending. That estimate involves a more ambitious increase in capital (reducing the asset to capital ratio from 10 to 4, rather than from 30 to 15).

Finally, the authors acknowledge that the alternative of directly testing the relationship of required return on bank equity to bank leverage “has the advantage of not assuming the CAPM holds”(p. 14). Unlike the present study, they find that in a regression of realized earnings relative to price (the equity yield) on leverage, “the impact on the required return on equity of changing leverage is about as big as if MM held exactly”(p. 15). Unfortunately, they do not report these results.⁵⁶

Yang and Tsatsaronis (2012) use a CAPM framework incorporating leverage as a shift variable affecting estimated betas. They find a statistically significant influence of leverage on the cost of equity capital. However, this influence turns out to be relatively small. The estimates indicate that “if the ratio of a bank's total assets to its equity increases by 10 and the market return is 4% in excess of the risk-free rate,

51. The authors do not clarify why this ratio is about twice the average beta shown in their figure 3. Moreover, King (2009, 71) places the UK bank betas at a median of 0.87 in this period, more consistent with that figure.

52. That is: $(1/30) \times 14.85 + (29/30) \times 5$.

53. That is: $(1/15) \times 14.85 + (14/15) \times 5$.

54. That is: $5\% \text{ risk free} + 5\% \text{ market premium} \times (1.07 + 0.03 \times 15)$.

55. That is: $(1/15) \times 12.6 + (14/15) \times 5$.

56. Note also that testing earnings yield as a function of the asset/capital ratio would be a misspecification of M&M, which instead has the earnings yield as a linear function of the debt/equity ratio. At high leverage ratios the difference is not great but at intermediate and low ratios more characteristic of nonbank corporations the difference becomes large.

the bank pays 0.4% more for every unit of equity” (p. 51). Correspondingly, the authors calculate that if average leverage fell from 20 to 10, the cost of equity capital would fall from 13.4% to 13.0%. Taking into account a 5% cost of debt, the weighted average cost of capital would rise from 5.4% to 5.8%.⁵⁷

The M&M offset in the Yang-Tsatsaronis results is also relatively small. With no induced change in the cost of equity capital, doubling equity from 5 to 10 percent of total assets would raise the average cost of capital from 5.42 to 5.84 percent, an increase of 42 basis points. After taking account of induced reduction in the cost of equity capital, the average cost of capital would still rise to 5.80 percent, a net increase of 38 basis points.⁵⁸ The M&M offset from induced reduction in the equity rate would thus be only 4 basis points, or about one-tenth of the increase at ex ante returns. The main text above instead places the offset at about 45 percent.

An increase of 40 basis points in the average cost of capital for an increase in capital of only 5 percent of total assets, moreover, would imply an increase in average cost of capital of 120 basis points for a capital increase amounting to 15 percent of total assets, the exercise considered in the main text here. This increase would be considerably larger than the corresponding increase of 62 basis points estimated in the main text.

Kashyap, Stein, and Hanson (2010). In another study employing the CAPM framework for US banks, these three authors estimated that the long-run steady-state impact of higher capital requirements on lending rates should be modest, only 25 to 45 basis points for a (large) 10 percentage point increase in capital relative to total (not risk-weighted) assets. They noted, however, that short-run frictions associated with raising capital could be substantial, implying the need for gradual phase-in. They also suggested increased regulation of the shadow-banking sector to avoid increased fragility in the system as a consequence of possible migration of financing out of banking in response to higher capital requirements.

The authors regress bank betas on the capital/asset ratio for US banks in 1976–2008. They find a significant coefficient of -0.045 . With the median bank beta at 0.90 and capital/asset ratios at a median of 7 percent, they argue that this finding is “broadly in line with what is predicted by the [M&M] conservation-of-risk principle” (p. 17). Namely, doubling capital to 14 percent of assets would reduce the beta by 0.32 ($= 0.045 \times 7$) to a level of 0.58, not far from the level of 0.45 that would be half the original median beta. However, they do not formally demonstrate that the original M&M formulation should translate to a reduction in bank market beta proportionate to a reduction in the asset/capital ratio.⁵⁹

57. That is: $0.95 \times 5 + 0.05 \times 13.4 = 5.42$ percent; and $0.90 \times 5 + 0.10 \times 13.0 = 5.8$ percent.

58. That is: $0.90 \times 5 + 0.10 \times 13.4 = 5.84$ percent.

59. It would be surprising if this transform could be shown to be exact, considering that M&M employ the debt/equity ratio rather than the asset/equity ratio.

The authors apply a prior assumption of strong M&M effects to calibrate the impact of higher capital requirements on lending rates. In their preferred variant, the effect is complete except for the distortion from corporate tax deduction for interest but not dividends. They estimate this effect as causing a 25 basis point increase in the lending rate as a consequence of 10 percent of assets in additional capital. With a corporate tax rate of 35 percent, the effect of shifting this amount of finance from debt to equity, even with induced reduction in the unit cost of equity, would be $0.35 \times 700 \times 0.1 = 25$ basis points. The upper bound of their range adds another 10 basis points for loss of convenience of short-term debt as well as a further 10 basis points catch-all for all other violations of M&M (“arbitrary fudge factor,” p. 18), to arrive at a maximum of 45 basis points increase in the bank lending rate (for 10 percentage points increase in the capital/asset ratio). Surprisingly, the authors do not specify the ex ante equity capital cost. They do cite a debt cost of 7 percent (which seems high, certainly for a real concept that should be used for comparison to equity). By implication, if they considered the equity cost to be 14 percent ex ante, then in the absence of any M&M effect at all the total increase in weighted average cost of capital would be 70 basis points.⁶⁰ The authors thus implicitly judge that the M&M offset amounts to at least 36 percent of the otherwise potential increase in lending cost $([70 - 45]/70)$ and, in their preferred estimate, as much as 64 percent $([70 - 25]/70)$.

The authors further seek to show that lending rates have not been influenced much by capital/asset ratios in the past (from the 1920s to the present), but their message is somewhat clouded by the fact that of their three alternative measures the only one with a statistically significant coefficient on the capital/asset ratio must be rejected out of hand because it indicates an excessively large increase in lending cost for a given rise in capital.

Despite their strong prior on full M&M effects, the upper end of the range identified by the authors is surprisingly similar to the estimate of the present study. The lending-cost impact for 15 percentage points of assets in additional capital would be 67.5 basis points (applying their upper-bound 4.5 basis points per percentage point increase in the capital/asset ratio), slightly above the 62 basis points estimated in the main text of the present study.

60. The initial weighted average would be $0.07 \times 14 + 0.93 \times 7 = 7.49$ percent. The ex post weighted average with no offset would be $0.17 \times 14 + 0.83 \times 7 = 8.19$ percent.

Figure C.1 Bank lending rates in the United States and euro area

Sources: European Central Bank (ECB 2015); Federal Reserve (2015a, 2015b); Datastream.

APPENDIX D TRENDS IN UNCONSTRAINED EARNINGS INDICATORS OF THE COST OF EQUITY CAPITAL

The tests in the main text constrain observations on equity yield and net income relative to equity to be positive. For cases where earnings are negative, these two proxies for cost of equity capital are constrained to be greater than zero and are set equal to the real 5-year Treasury bond rate plus a moderate spread, as discussed in the main text. Figure D.1 shows the paths of the averages for the 54 banks using the unconstrained data, whereas figure 1 in the main text shows the constrained data. Confidence intervals (5 percent level) for each year are shown as well.

Figure D.1 Trends in net income relative to equity and earnings yield for 54 largest US banks: Unconstrained data, 2002–13

NI/Eq = net income relative to equity; EY = earnings yield

Note: Also shown in the figure are flanking confidence intervals for two standard deviations, or the 5 percent level, for each year.

Source: Calculated from annual filings of Form 10-K with the Securities and Exchange Commission; Bloomberg.