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WHY HIGH LEVERAGE IS OPTIMAL FOR BANKS

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ABSTRACT

Liquidity production is a central role of banks. We show that, under idealized conditions, high leverage is optimal for banks when there is a market premium for (socially valuable) liquid financial claims and no deviations from Modigliani and Miller (1958) due to agency problems, deposit insurance, taxes, or any other distortions. Our model can explain (i) why bank leverage increased over the last 150 years or so, (ii) why high bank leverage per se does not necessarily cause systemic risk, and (iii) why limits on the leverage of regulated banks impede their ability to compete with unregulated shadow banks. Our model indicates that MM's debt-equity neutrality principle is inapplicable to banks. Because debt-equity neutrality assigns zero weight to the social value of liquidity, it is an inappropriately equity-biased baseline for assessing whether the high leverage ratios of real-world banks are excessive.

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Why High Leverage is Optimal for Banks

1. Introduction

Many economists believe that bank leverage is excessive, and should be curtailed by regulations requiring much larger equity cushions. For example, twenty prominent economists conclude that, with much more equity funding, banks could perform all their socially useful functions and support growth without endangering the financial system.¹ Admati and Hellwig (2013), building on Miller (1995), Pflleiderer (2010), and Admati, DeMarzo, Hellwig, and Pflleiderer (2011), detail the case for strong regulatory limits on bank leverage. As Myerson (2013, p. 3) discusses, the case rests on Modigliani and Miller's (1958, MM) leverage irrelevance theorem, which shows that, in perfect markets, equity is no more expensive than debt as a source of capital. MM's debt-equity neutrality principle leads Admati and Hellwig (2013, p. 191) to conclude: "increasing equity requirements from 3 percent to 25 percent of banks' total assets would involve only a reshuffling of financial claims in the economy to create a better and safer financial system. There would be no cost to society whatsoever." In fact, with the MM theorem at work, increasing bank equity requirements well above 25 percent would have no social costs.

This argument treats banks as firms that make loans and ignores banks' role as producers of liquid financial claims. The idea that liquidity production is intrinsic to financial intermediation is discussed extensively in the literature by, among others, Diamond and Dybvig (1983), Diamond and Rajan (2001), Gorton (2010), Gorton and Pennacchi (1990), and Holmstrom and Tirole (1998, 2011). If banks' credit-screening technology enables them to make better loans than other parties could and all other MM assumptions hold, banks could adopt all-equity capital structures with no loss in value. However, if banks generate value by producing liquid claims for financially constrained firms and households, those with high-equity capital structures are not competitive with banks or bank-substitutes that have less equity.

We analyze bank capital structure in a simple segmented-markets model that deviates from MM by inclusion of some financially constrained firms (non-banks) and households that willingly pay a premium

¹ See "Healthy banking system is the goal, not profitable banks," letter published in the Financial Times, November 9, 2010.

for liquid financial claims to provide assured access to capital. The model also allows, but does not require, the existence of some financially constrained parties that willingly pay a premium to obtain bank loans because their access to capital markets is costly or otherwise impaired. Our model indicates that:

- High leverage is an essential, uniquely optimal feature of bank capital structures when liquidity is priced at a premium due to demand for assured access to capital.
- Banks choose high leverage despite the absence of agency costs, deposit insurance, tax motives to borrow, reaching for yield, ROE-based compensation, or any other distortion.
- Greater competition that squeezes bank liquidity and loan spreads diminishes equity value and thereby raises optimal bank leverage ratios.
- If conventional banks face regulatory limits on leverage while shadow banks do not, the former will be at a competitive disadvantage to the latter. Liquidity production will migrate from regulated banks into the unregulated shadow-banking sector.
- When liquidity is priced at a premium, banks can and will choose safe *asset* structures to support *capital* structures that maximize the production of safe financial claims to satisfy the demand for liquid claims.
- Because the MM capital-market conditions enable banks to construct perfectly safe asset and liability structures, there is no chance of bank default and no chance of systemic meltdown when these conditions hold.

These conclusions reflect the fact that a market price premium to induce banks to produce (socially valuable) liquid financial claims is incompatible with MM's leverage irrelevance result. A liquidity premium is a price signal sent to banks and other liquidity producers to supply liquid financial claims that meet the demand for such claims from financially constrained firms and other parties that desire assured access to capital. The liquid financial claims (cash balances and similar claims) held as *assets* by financially constrained parties are drawn from the supply of safe claims produced by the *liability* structure decisions of banks and other liquidity suppliers.

When market prices embed a liquidity premium, bank capital structure decisions matter and are jointly optimized with asset structure to capture the maximum value from liquid-claim production. Debt and equity are not equally attractive sources of bank capital. Debt has a strict advantage because it has the informational insensitivity property – immediacy, safety, and ease of valuation – desired by those seeking liquidity. High bank leverage is accordingly optimal when the MM model is modified to include

a price premium to induce (socially valuable) liquidity production.

Because MM's debt-equity neutrality principle assigns zero weight to the social value of liquidity, it is an inappropriately equity-biased baseline for assessing whether the high leverage ratios of real-world banks are excessive or socially destructive.

Nor does the MM theorem imply that regulatory limits on bank leverage are desirable because they would reduce systemic risk without increasing banks' funding costs. In our idealized setting, such regulations would raise banks' funding costs without changing systemic risk (which is nil because banks' asset structures are optimized to produce safe financial claims).

The analysis thus cautions against accepting the view that high bank leverage must be the result of moral hazard, other agency problems, or tax motives to borrow. In our modified MM model, there are no agency costs or taxes, yet high bank leverage is optimal. High leverage is simply the result of intermediation focused on producing (privately and socially beneficial) liquid financial claims.

The analysis also cautions against concluding that bank leverage must be too high because operating firms maintain much lower leverage. In our idealized setting, banks construct safe asset structures (from loans and securities) to support greater production of liquid financial claims, which manifests in high debt capital structures. In contrast, operating firms create value through real project choices, which commonly entail significant cash flow uncertainty.

Capital structure is a sideshow for value creation at operating firms, but it is *the* star (or at least a star) of the show at banks. The risky asset structures of most operating firms are poorly suited to support high leverage or large-scale production of liquidity. In our model, banks exist because specialization and the associated cost efficiencies give them a comparative advantage over operating firms in arranging their asset structures to support capital structures that produce liquid financial claims to meet demand.

The general point is that, 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). This is the fundamental reason why MM's debt-equity neutrality principle is an inappropriate equity-biased baseline for concluding that bank leverage should be curtailed significantly.

The paper thus shows that, if we take an idealized model (as MM do) and include a demand for liquid claims, the right baseline for banks is high leverage, not indifference to leverage. An important caveat is that real-world banks fall far short of the perfect asset-side diversification they adopt under the idealized conditions we study. Therefore, in models that relax our idealized conditions, there can be legitimate, and potentially substantial, benefits to regulations that limit bank leverage. Our model is silent about whether such regulation is warranted. It simply highlights the possibility that such regulations could impair production of socially valuable liquidity, and perhaps exacerbate systemic risk by inducing a substitution of liquid-claim production into the unregulated shadow-banking sector.

Section 2 describes the MM framework augmented to include socially productive roles for banks in the supply of liquid claims and in the screening and granting of loans. Section 3 derives the optimal bank capital structure in the presence of a market premium for liquidity. Section 4 discusses the equilibrium pricing of liquid claims. Section 5 considers bank leverage and systemic risk when banks produce near-moneys because the production of safe claims is prohibitively costly. Section 6 concludes.

2. MM model with a productive role for banks

We start with the most basic perfect-markets setting in which the MM theorem applies to all operating firms and banks. There are no taxes, agency costs, bankruptcy costs, or any other frictions. Nor is there deposit insurance. The capital market is complete, with costless access for all households, operating firms, and banks.² Intermediation is redundant because all operating firms and households can directly access capital markets at zero cost. Banks can still exist as “neutral mutations” that generate no (private or social) benefits, but do no harm. The choice of debt-equity mix does not matter for banks. In this most basic of models, there is no social cost to requiring that banks maintain large equity cushions.

We modify the basic MM model to include two productive roles for intermediation using the general approach of Merton (1990, p. 441) in which some agents face significant transactions costs of accessing

² Complete markets are sufficient but not necessary for the MM theorem. Our arguments go through unchanged if the bank has access to incomplete but otherwise frictionless markets in which a riskless claim can be constructed from the set of existing securities. See footnote 3.

capital markets, while financial intermediaries do not. Specifically, we assume that banks continue to have access to perfect capital markets, just as in the basic model. But now the model includes two additional types of financially constrained households and operating firms that benefit from banking services. The first set of agents would like to borrow, but has impaired access to the capital market. The second set of agents also has impaired access to the market, but would like assured access to capital to hedge against future liquidity shocks.

If we include agents of the first type, banks are privately and socially valuable because they screen credit risks and extend loans to financially constrained parties. Banks capture value from the spread between what they earn on loans and their cost of capital. All debt-equity mixes are equally costly means of raising funds to make loans priced to earn a premium over the cost of capital. The MM theorem continues to apply to banks (but not to financially constrained parties in the other market segment).

High leverage is optimal for banks when we include agents of the second type who pay a premium for liquid financial claims (bank debt) that provide them with immediate, assured access to capital. In section 3's partial equilibrium analysis, we consider a single bank facing an *assumed* liquidity premium. This analysis shows that, conditional on any given asset scale, high leverage is optimal because issuing debt is how banks profit from producing (socially valuable) liquidity. The MM theorem no longer applies.

Section 4 shows that a liquidity premium obtains in equilibrium when bank scale is determinate due to asset-side costs, e.g., of financial-engineering, operational infrastructure, etc. Even when bank size is indeterminate due to constant returns to scale, aggregate bank debt is strictly determinate. A liquidity premium obtains with constant returns when liquidity demand exceeds the (finite) upper bound on the supply of riskless debt dictated by the real economy. When demand falls below that bound, the equilibrium is as in Miller (1977), except now the segmentation is not due to taxes: Any one bank's leverage is a matter of indifference because liquidity is not priced at a premium, but the aggregate supply of liquid claims is strictly determined to meet the demand for (socially valuable) liquidity.

Allen and Carletti (2013) also develop a segmented markets model in which short-term bank debt is differentiated from other sources of funding. In their model, bank capital structure matters in the presence

of bankruptcy costs, but the MM leverage irrelevance result applies when such costs are zero. In our model, there are no bankruptcy costs, and bank capital structure choice matters because it is through short-term debt issuance that banks generate greater value when liquidity is priced at a premium.

Consistent with Diamond and Dybvig (1983) and Gorton (2010), we define a perfectly liquid financial claim to be one whose value is not sensitive to the arrival of new information. Such a claim provides assured access to capital in the intuitive sense of a riskless security that provides its owner the same amount in every state of the world. As Diamond and Dybvig emphasize, the demand for such claims reflects uncertainty and the prospect that future liquidity shocks (arrival of new information) will dictate a need for funds for the party seeking liquidity. This general view of liquidity as a valuable asset has a venerable history (see, e.g., Keynes (1936) and Tobin (1958)). Krishnamurthy and Vissing-Jorgensen (2012a, 2012b) provide evidence that debt prices embed a liquidity premium.

Banks select asset structures to support capital structures that efficiently produce liquid financial claims for those parties willing to pay a premium for assured access to capital. Banks (and shadow banks) also optimize their asset structures for liquidity production in Gennaioli, Shleifer, and Vishny (2013), but they have limited ability to diversify, thus ultimately leaving the possibility of systemic meltdown through bad outcomes from correlated tail risk.

In our model, with the MM capital-market access assumptions still operative, a bank can and will choose a portfolio of assets that is completely riskless.³ A riskless asset structure provides collateral support for capturing the most value from production of (privately and socially) valuable liquid claims.

³ To see why a riskless asset structure is optimal in our model, suppose the bank has traded all of its loan holdings for a riskless portfolio. This is always possible when the bank has access to a complete market, or access to an incomplete market in which a riskless asset (or portfolio of assets) exists among the traded claims. Now consider a hypothetical asset restructuring in which the bank sells off one dollar of its riskless portfolio holdings and uses that dollar to buy any other risky claim available in the market. Since MM's assumptions rule out arbitrage opportunities in the pricing of all claims, the purchased claim must have a lower payoff than the sold riskless claim in at least one state of nature. Consequently, the bank would now have a lower capacity for producing liquid claims. The bank's value would be lower due to its reduced ability to capture the premium for supplying liquidity.

3. Optimal bank capital structure

This section follows the standard MM approach of analyzing capital structure with investment policy fixed. We incorporate asset-side costs of banking in section 4, which treats bank scale as endogenous and analyzes the conditions leading to a liquidity premium in equilibrium.

We use an infinite-horizon ($t = 0, 1, 2, \text{etc.}$) model as in MM (1961), with modifications to include liquid-claim production. We analyze a given price-taking bank that has exploited the MM capital-market conditions to obtain a riskless asset mix to foster liquid-claim production. The bank can issue equity or short-term debt, which can be rolled over in perpetuity. The natural interpretation is that the bank's capital-structure choice is among different mixes of liquid claims (immediately redeemable riskless claims) and equity financing. To the extent that long-term debt issued by banks does not provide liquidity services, the MM (1958) analysis would apply to the choice between long-term debt and equity. However, if long-term debt has liquidity benefits, as argued by Gorton and Pennachi (1990), the MM analysis would not apply to banks' long-term debt either.

For simplicity, we take the capital market's one-period rate of interest, r , to be constant and assume the same is true for θ and ϕ , which are defined as:

θ = "liquidity spread" or rate-of-return discount that those purchasing liquidity from banks accept in exchange for assured future access to capital.

ϕ = "loan spread" or rate-of-return premium paid on bank loans by those with limited access to capital markets.

The optimality of high leverage in no way depends on the bank earning a positive loan spread, as can be verified by setting $\phi = 0$ in all that follows. In principle, ϕ is a certainty-equivalent parameter that is bank specific, since it depends on the risk structure of the loans that a bank extends. We keep the notation simple and avoid indexing ϕ by bank since our capital structure conclusions hold for all values of ϕ .

A positive liquidity spread ($\theta > 0$) is essential for banks to have a strict incentive to lever up. We provisionally treat θ as parametric to a given bank, but we return in section 4 to a discussion of the conditions on the supply of liquidity that sustain $\theta > 0$ in market equilibrium.

The asset side of the bank's balance sheet reflects its purchases of securities at a fair price in the

capital market (to earn the rate r) and its extension of loans that yield the return $r(1 + \phi)$. These assets collectively serve as collateral whose returns are used to pay interest on short-term debt and dividends that distribute the bank's free cash flow (FCF) to its shareholders. As discussed earlier, while the individual assets held by the bank can be risky – and surely are for loans – the bank's portfolio of assets is not risky at the optimum. For each dollar of debt that the bank issues at a given date, it pays $r(1 - \theta)$ at the next date, i.e., one period forward in time.

The return on a bank's assets is always sufficient to pay the interest on its debt. This is production of liquidity or money in the purest sense. It provides the purchaser of a debt claim with 100%-assured access to capital in the future. When $\theta > 0$ and $\phi = 0$, we have MM with one new feature: The existence of a demand for liquidity that results in a market premium paid by those who seek assured access to capital. That demand is filled by the production of riskless debt claims by banks.

Let I denote total bank assets at $t = 0$. The same asset level is maintained at each future date $t = 1, 2, 3$, etc. Consistent with MM, the bank's investment policy is fixed, with all FCF distributed to equity as it is earned. Since we take the asset side of a bank's balance sheet as given, the only choices left for us to analyze are the bank's choices that are related to capital structure, i.e., funding choices that affect the liability side of the bank's balance sheet. We further define:

- x = fraction of capital at $t = 0$ raised by issuing debt ($0 \leq x \leq 1$).
- $(1 - x)$ = fraction of capital at $t = 0$ raised by issuing new equity.
- $D = xI$ = value of debt (created at $t = 0$ and rolled over in perpetuity).
- $(1 - x)I$ = value of equity contributed at $t = 0$.
- z = fraction of capital invested in loans that yield $r(1 + \phi)$.
- $(1 - z)$ = fraction of capital invested in securities purchased in the capital market to yield r .

This formulation assumes that shareholders only contribute capital and do not receive dividends at $t = 0$ when the bank is formed. The requirement that $x \leq 1$ (equivalently, $D \leq I$) precludes the bank at all dates from issuing debt above the level of assets and using the excess resources to fund immediate payouts. If we instead allow $x > 1$, the bank could accelerate payout of the present value of the FCF stream. In that case, the highest feasible value of x depends on the PV of the FCF stream (defined below) optimized for maximal debt issuance (and that bound is an increasing function of θ). Banks would then

push D above I as far as possible when $\theta > 0$.

For all banks, we require $0 \leq z \leq 1$. Within these bounds, higher values of z imply greater bank value through the capture of the loan premium ϕ . We treat z as parametric and allow different banks to face different loan ceilings ($z < 1$) due to differences in their credit-evaluation abilities: Banks that are more efficient at credit evaluation extend a larger volume (zI) of loans earning ϕ .

Treating z as parametric makes no difference for this section's basic capital structure analysis, which shows that high leverage is optimal for all z and ϕ when $\theta > 0$. Section 4 shows that banks that are more efficient at credit evaluation (i.e, those with higher z -values) are better able to compete (with unregulated shadow banks) when regulators impose ceilings on their leverage ratios.

In each future period $t > 0$, the bank's free cash flow (FCF) equals its cash inflow from loans plus its cash inflow from capital market securities minus the interest it pays on its debt:

$$FCF = r(1 + \phi)Iz + rI(1 - z) - r(1 - \theta)xI = [1 + \phi z - (1 - \theta)x]rI \quad (1)$$

Note that FCF is the bank's net interest margin in dollar terms. It is the residual cash flow owned by shareholders. It does not include a charge for equity capital raised when the bank was initially capitalized at $t = 0$. The FCF term is each period's total dollar return to all equity, including the newly contributed capital at $t = 0$. In operating firms, FCF excludes financial policy flow variables. Banks are different because financial flows are the inputs and outputs they utilize to generate value for their shareholders.

The value of bank equity, E , at $t = 0$ is the discounted value of the FCF (and dividend) stream:

$$E = FCF/r = [1 + \phi z - (1 - \theta)x]I \quad (2)$$

The current (initial) shareholders' wealth at $t = 0$ is $W = E - (1 - x)I$, which nets out the value of any capital contribution they make. Substitution of (2) into the shareholder wealth expression yields:

$$W = [1 + \phi z - (1 - \theta)x]I - (1 - x)I = [\phi z + x\theta]I \quad (3)$$

MM (1958) show that, holding investment policy fixed, capital structure has no effect on value. From (3), in our model, the value impact of changing leverage while holding investment policy fixed is:

$$\partial W / \partial x = \theta I \quad (4)$$

The MM result holds here when $\theta = 0$, since then (4) implies $\partial W / \partial x = 0$ for all x ($0 \leq x \leq 1$).

The MM theorem does not hold when $\theta > 0$. Now, the optimal financing mix is $x = 1$ because $\partial W/\partial x = \theta I > 0$ for all x . Debt dominates equity for any investment scale, I , because of the spread earned by borrowing at a rate that nets out the liquidity premium, θ . There is no spread earned by issuing equity.

The bank's incentive to issue debt depends on θ , and not on ϕ or z . ϕ and z affect the asset side of the bank's balance sheet, and thus affect the scale of collateral used to produce liquid claims. Consequently, $x = 1$ is the unique optimum regardless of the values of ϕ and z . Higher values of ϕ and z raise the value of equity. That has an indirect effect on the bank's leverage ratio at the optimum, as detailed immediately below. However, it does not diminish the bank's incentive to maximize the issuance of liquid claims (set $x = 1$) conditional on its asset structure when $\theta > 0$.

The key point: The bank's optimal capital structure maximizes liquid claim issuance against its asset collateral. The optimal leverage ratio (based on the values of D and E when $x = 1$ and $\theta > 0$) is:

$$D/(D + E) = 1/[1 + \theta + \phi z] \quad (5)$$

This leverage optimum reflects the fact that equity has a positive value equal to the present value of the FCF stream generated by issuing debt to capture the positive liquidity spread $\theta > 0$ (and by extending credit to capture the loan spread when $\phi z > 0$). Equity value is $E = [\theta + \phi z]I$, and debt value is $D = I$, when the bank sets $x = 1$. This says that the bank generates value for shareholders from the sum of the liquidity and loan spreads that it earns.

As the liquidity premium, θ , declines, optimal leverage increases (see (5)) due to the fall in FCF from liquidity production, which erodes equity value. The leverage increase is not due to incentives to issue more short-term debt (because $x = 1$ was optimal and remains so as long as $\theta > 0$).

Optimal bank leverage is generally high. To see why, examine (5) and note that one would as an empirical matter expect θ and ϕz to be small positive numbers. Huge liquidity premiums ($\theta \gg 0$) or huge loan spreads ($\phi \gg 0$) seem implausible as an equilibrium property in today's market where shadow banks produce massive supplies of relatively liquid claims and junk bonds are used aggressively as substitutes for bank loans. Hanson, Kashyap, and Stein (2011) apply the estimates of Krishnamurthy and Vissing-Jorgensen (2012a) to argue that a plausible upper bound on θ is 0.01.

We can think of very low levels of θ as capturing market settings with strong competition among producers of liquidity. The development of financial-engineering tools and, more generally, of shadow banking – including but not limited to money-market funds – implies downward pressure on liquidity spreads (θ), which according to (5), implies upward pressure on optimal bank leverage.

The well documented increase in bank leverage since the early 1800s could thus be explained by a long-term trend toward greater competition in the supply of liquid claims. Upward pressure on bank leverage from advances in financial engineering and shadow banking was plausibly reinforced by the development of the junk-bond market and other such innovations. These developments likely put downward pressure on loan spreads, ϕ , which (per (5)) also leads to higher optimal bank leverage.

Gorton (2012, chapter 11) summarizes the evidence for the U.S. and internationally of the long-run evolution toward higher bank leverage ratios. He discusses a broad variety of institutional changes that plausibly contributed to this trend, including changes in bankruptcy laws and technological improvements in portfolio management. He also discusses how competition from money-market funds and junk bonds eroded bank profitability in the 1980s (see especially pp. 126-129).

In our idealized world, high bank leverage generates no systemic risk because MM's capital-market conditions are operative for banks. We maintain these conditions to clarify the problems with the widely held view that the MM theorem implies there is no socially productive reason for banks to have high leverage. This view is problematic because the MM capital-market conditions enable banks to construct perfectly safe asset structures. Such asset structures foster the production of greater quantities of (privately and socially) valuable liquid claims. These liquid claims are riskless in this idealized setting, and so there is no chance of bank default or systemic meltdowns triggered by bank defaults.

Banks always have incentives to maximize liquid-claim production against whatever safe asset collateral they have. That is how they capture the greatest value from liquidity production. Suppose for the moment that a bank faces transactions and other risk-management costs that impede the attainment of a perfectly safe asset structure so that $x = 1$ is infeasible. With even the tiniest such impediment, bank equity is, of course, no longer riskless. However, $\theta > 0$ and (4) together imply that the bank still has the

incentive to produce liquid claims (issue riskless debt) to the maximum extent possible, where that maximum is dictated by the left-tail properties of its now-risky asset portfolio. [The benefit of increasing x shrinks on the margin as θ falls, but it is always positive.] In sections 4 and 5, we return to a discussion of the implications of risk-management costs for bank asset and capital structures.

Many papers argue that banks benefit from high leverage because it maximizes the value of the put option they have against a deposit-insurance fund. In our model, there is no deposit insurance, and so there is no put-option motive for high leverage.

In this idealized world, there is also no need for bank leverage limits, as they yield no social benefits. Banks optimally choose riskless asset structures and so there is no default risk and therefore no systemic risk. Hence, there is no systemic-risk reduction from regulations that restrict bank leverage.

What if a bank bolsters its equity by selling new shares at a fair price? Bank scale is unchanged if the equity proceeds are used to reduce debt or fund equity payouts. If the bank reduces debt, shareholders are worse off by the decline in the dollar value of the liquidity spread they capture. If the bank uses the equity proceeds to pay dividends or repurchase stock, current shareholders obviously are no better or worse off (per MM (1961)) and both leverage and scale are unchanged.

What if the equity proceeds are invested in securities that earn a normal return? Bank scale increases and leverage decreases with equity issuances that leave the dollar amount of debt unchanged. Bank leverage is now sub-optimal (per (4)) relative to its greater scale. Shareholders would be better off if the bank had raised debt instead of equity to capture the liquidity spread, while using the proceeds to create more riskless collateral (to support the additional liquid-claim production). The new bank scale is also sub-optimal when the model is enriched (per section 4) to determine scale, and the bank is initially at its optimum. There is no impact on systemic risk, which is nil both before and after the issuance.

Admati, DeMarzo, Hellwig, and Pfleiderer (2011, pp. 50-51) indicate that equity infusions that fund asset purchases are attractive because they hold bank debt (liquid-claim output) fixed, while reducing leverage and its distortions. The social costs of this strategy include greater potential “too-big-to-fail” problems at now-larger banks. Admati et al. suggest those costs could be mitigated by combining

regulations splitting banks up with requirements of more equity for the banking sector. They also note that the issue of efficient bank size is a controversial unresolved topic. That caveat implies potential efficiency losses from the bank regulations they suggest. How these tradeoffs are best resolved is an empirical issue we do not address. The analysis below does indicate there are interactions among liquid-claim production, leverage, and scale that are relevant for any such empirical assessment.

4. Equilibrium in the market for liquid financial claims

There is a natural instinct to think that, when banks have access to perfect capital markets in the MM sense, liquid claims can be produced in unlimited quantity at zero cost, thereby always dictating a zero price for liquidity. Not so.

Even when banks can access perfect capital markets, the aggregate supply of liquid financial claims is bounded (finite) and can fall short of the aggregate demand for such claims when there is no market premium for liquidity ($\theta = 0$). To see why, consider a simple example in which each operating firm generates value only in a single state of nature so that the securities that it issues are Arrow-Debreu state-contingent claims. No operating firm is technologically able to supply securities to meet the demand for liquid claims from those with imperfect access to markets. Meeting that demand requires the aggregation of securities over many firms to create riskless claims. That is what banks do.

Liquidity is always a scarce asset. The ability of banks to construct asset structures to support the creation of riskless claims is bounded by the aggregate resources available from the real economy in the state of the world with the lowest resource total. It is impossible to create riskless claims in quantities beyond the level of resources in the state with the worst payoff. With sufficient demand for liquid claims by parties with impaired access to capital, supply cannot satisfy demand when $\theta = 0$. The result is upward pressure on θ to ensure that liquidity is allocated to those who value it most highly.

The same rationing problem exists when we consider operating firms that issue normal debt and equity securities (not Arrow-Debreu claims). Some of these firms may have sufficiently safe operating policies that they can issue some high-quality (riskless) debt that provides the holder with assured access

to capital. The amount of liquidity they can supply is limited by the risk of their operating policies. If the market price of liquidity is sufficiently high, they will tilt their operating policies toward the production of riskless cash flows. Those cash flows, in turn, serve as asset-side collateral that is capable of supporting a capital structure that supplies safe debt claims to meet liquidity demand.

The point is that some operating firms will be attracted by a positive price of liquidity to enter the intermediation business. They will compete (as shadow banks) through their capital structure decisions to supply liquid claims. There are technological limits to operating firms serving as intermediaries since their real production is inherently risky and therefore poorly suited to support liquidity production.

Intermediaries are firms whose asset structures are *designed* to mitigate such difficulties. Risk-management techniques, including basic diversification principles and financial-engineering methods, are the tools banks use to create asset structures well suited to support production of liquid financial claims. The banks that survive in equilibrium will be those that are most efficient at producing asset structures to support capital structures that supply liquid claims to those parties seeking assured access to capital.

Suppose that banks collectively are large enough to have extracted the full potential of the real economy to generate riskless claims. Suppose also that they have attained this scale at zero real-resource cost. If the greatest potential aggregate supply falls short of liquidity demand when $\theta = 0$, there will be (i) upward pressure on θ (so that liquidity flows to those who value it most highly), and (ii) downward pressure on r (so that the real economy produces a larger potential supply of riskless claims).

If aggregate demand for liquid claims when $\theta = 0$ falls short of the potential aggregate supply, then the market-clearing price of liquidity is $\theta = 0$. The resultant equilibrium is analogous to Miller (1977), except now taxes are not the cause of the market segmentation. The aggregate supply of liquidity by the banking sector is determinate, and matched to satisfy the aggregate demand for assured access to capital from financially constrained parties. Any one bank viewed in isolation is indifferent to low, medium, or high debt at the market-clearing price of liquidity ($\theta = 0$).

However, markets will not clear if all banks try to choose low debt capital structures, as the aggregate supply of liquid claims would not satisfy demand. This will put pressure on the banking sector to produce

more liquidity. Banks will comply because each one views the quantity of liquid claims that it produces to be a matter of indifference when $\theta = 0$.

A richer model incorporates explicit costs of operating a bank, $C(I, z)$, which capture *asset-side* risk-management and operational infrastructure costs. It is clearly trivial to “show” that bank capital structure matters when there are direct operational costs of producing liquid financial claims ($C(I, x) > 0$, with $\partial C(I, x)/\partial x \neq 0$). Although such costs plausibly exist, we are *not* invoking them here. We are simply recognizing that there are asset-side costs to operating a bank, which dictate efficient bank scale.

With this richer specification, current shareholders’ wealth is now given by (3) modified to net out $C(I, z)$, which is denominated in present-value terms:

$$W = [\phi z + x\theta]I - C(I, z) \quad (3a)$$

The marginal impact of increasing debt is still given by (4) so that, with $\theta > 0$, optimal capital structure entails maximal production of liquid claims ($x = 1$). Because W is no longer linear in I , the optimal scale of each bank is now strictly determinate. The first-order condition is $\partial W/\partial I = [\phi z + x\theta] - \partial C(I, z)/\partial I = 0$. With increasing marginal costs, bank scale and debt are uniquely determined.

At each $\theta > 0$, the supply of liquid claims by any one bank – and by all banks in the aggregate – will be smaller as the marginal cost curve ($\partial C(I, z)/\partial I$) shifts upward. [Optimal scale – and, with it, liquid-claim output – shrinks as the marginal cost curve shifts upward.] When marginal costs are substantial and the demand for liquid financial claims is nontrivial, $\theta > 0$ is required for equilibrium.

Bankers often argue that regulatory caps on leverage will damage their banks’ ability to compete. Our model indicates there is merit in this view. To see why, suppose there is free entry into banking with all entrants having access to the same technology. Let I^* denote the bank scale that minimizes long-run average cost, $C(I)/I$. With $\theta > 0$, each new entrant sets $x = 1$. Entry by new banks will continue until $\phi z + \theta$ is driven down to the point where W is zero when capital structure is optimized ($x = 1$):

$$W^* = [\phi z + \theta]I^* - C(I^*, z) = 0 \quad (3b)$$

In equilibrium, the sum of the loan and liquidity spreads ($\phi z + \theta$) just covers average cost, $C(I^*, z)/I^*$, at the optimal bank scale. Any higher ($\phi z + \theta$) precipitates entry by new banks that see $W > 0$ at I^* and $x =$

1. Any lower $(\phi z + \theta)$ precipitates exit because $W < 0$ at I^* and $x = 1$.

Now, suppose that “conventional” regulated banks face constraints on leverage that mandate $x < 1$, while “shadow” banks face no such constraints. Equilibrium θ is set in accord with (3b) by free entry by shadow banks. With regulations that cap leverage in (3a), conventional banks have $W = [\phi z + x\theta]I^* - C(I^*, z)$. This expression is negative given that $x < 1$ and that (3b) describes market equilibrium.

Conventional banks will not be able to compete with shadow banks that have access to comparable cost technologies. They capture $x\theta$ for each unit of scale with $x < 1$, whereas shadow banks, which set $x = 1$, capture θ per unit of scale. With the higher payoff to liquidity production, shadow banks just cover average cost at the efficient bank scale. With a lower liquidity payoff and the same technology, conventional banks cannot cover costs.

Conventional banks can offset the disadvantage of regulatory limits on leverage if they are better than shadow banks at loan extension (their ϕz is higher) or at the financial-engineering and infrastructure elements of delivering banking services (their $C(I, z)$ is lower).

However, even if conventional banks had such technological advantages, the imposition of regulatory caps on their leverage – but not at shadow banks – will induce a substitution of liquidity production into the unregulated shadow-bank sector.

5. Near-money production, bank leverage, and systemic risk

In the real world, it is clear that liquid-claim production does not occur costlessly. Huge amounts of resources are devoted to financial intermediation and the production of liquid claims. It is equally clear that real-world banks and shadow banks fall short of producing perfectly safe claims that meet the theoretical ideal of zero information sensitivity. The enormous scale of near-money liquidity production makes no sense, absent a market liquidity premium to induce such production.

The fundamental tension that exists for real-world banks is between (i) their incentive to adopt high leverage capital structures to generate value by supplying liquidity and (ii) the costs of constructing relatively safe asset structures to support the production of relatively safe claims.

If banks have little ability to create perfectly safe claims, the premium paid for such claims will become exorbitant. Such pricing, in turn, will encourage a substitution of liquidity demand away from perfectly safe debt into near-moneys that provide relatively assured access to capital.

In this (realistic) world, banks struggle to find asset structures that approximate the perfectly safe ideal attainable when MM's capital-market conditions are operative. They instead issue relatively safe near-moneys, not the theoretically ideal riskless claims that provide 100%-reliable access to capital.

Banks do so because they perceive they can capture a liquidity premium by producing relatively safe near-moneys. The existence of such a premium is incompatible with debt-equity neutrality in bank capital structure decisions. The provision of liquid claims – both near-moneys and riskless perfect money – inherently requires banks to have levered capital structures.

High bank leverage now comes with risks of default and systemic meltdown. These problems are an inherent feature of banking when near-money creation is the only economically viable way to meet liquidity demand. They are not prima facie evidence of moral hazard, other agency problems, or the effect of tax motives to borrow, although the latter factors may exacerbate the problems.

Whether banking entails large systemic risk turns on the costs of constructing (relatively) safe asset structures to support production of (relatively) liquid financial claims. In the idealized world of sections 2-4, those costs are trivial, and so banks' high leverage generates no systemic risk. However, because those asset-structure costs are substantial in the real world, large-scale use of (relatively but not perfectly) liquid near-moneys comes with risks of systemic meltdown and associated social costs.

As Stein (2012) emphasizes, these social costs arise because the production of near-money comes with an externality – the risk of systemic meltdown because risky collateral supports near-money creation – that is not priced in the market. The result is socially excessive production of near-moneys. This logic is consistent with Gennaioli, Shleifer, and Vishny (2013), who argue that systemic risk arises from imperfect bank diversification (risky collateral) coupled with risk-measurement errors, especially correlated mistakes in gauging tail risk.

Regulatory limits on bank leverage can thus make sense because real-world banks do not fully

internalize the costs of system-wide collapse, and therefore over-produce risky near-moneys. The downside is that such limits could impair liquidity production by relatively efficient producers, while shifting production to shadow banks and, in so doing, preserve or perhaps even exacerbate systemic risk. Hanson, Kashyap, and Stein (2011, pp. 15-16) discuss this danger and argue that, if capital standards are imposed, similar standards should be applied to similar credit exposures at both banks and shadow banks.

6. Conclusions

Since 1958, financial economists have approached capital structure issues by starting with MM's "anything goes" (debt-equity neutrality) baseline to which various frictions are added one-at-a-time. This baseline makes sense for operating firms. It does not make sense for banks because their capital structure decisions are linked to liquid-claim production, which is a major element of their business model.

The right baseline for banks is high leverage, not anything goes, when we take MM's idealized model and include a market segment of agents who value liquidity *per se* because they have imperfect access to capital markets. In our model, there are no distortionary motives to issue debt – no agency problems, deposit insurance, too-big-too-fail problems, or tax motives to borrow. High bank leverage is privately optimal and generates no systemic risk under our model's idealized conditions.

In models that move beyond our idealized setting to have banks generating systemic risk while over-producing risky near-moneys, there is a stronger case for reining in bank leverage than in our framework. Our analysis is relevant to the debate over bank capital regulation only in that it challenges the MM-based premise that severe limits on bank leverage would be essentially free to society. It suggests instead that, in assessing proposed regulations, the social costs of potentially impairing liquidity production should be weighed against the probable changes in systemic risk, including the effect on systemic risk of shifting the production of liquid financial claims to unregulated shadow banks.

References

- Admati, A., DeMarzo, P., Hellwig, M., Pfleiderer, P., 2011. Fallacies, irrelevant facts, and myths in the discussion of capital regulation: Why bank equity is *not* expensive. Stanford University working paper.
- Admati, A., Hellwig, M., 2013. The Bankers' New Clothes. Princeton University Press. Princeton, NJ.
- Allen, F., Carletti, E., 2013. Deposits and bank capital structure. University of Pennsylvania working paper.
- Diamond, D., Dybvig, P., 1983. Bank runs, deposit insurance, and liquidity. *Journal of Political Economy* 99, 689-721.
- Diamond, D., Rajan, R., 2001. Liquidity risk, liquidity creation, and financial fragility: A theory of banking. *Journal of Political Economy* 109, 287-327.
- Gennaioli, N., Shleifer, A., Vishny, R., 2013. A model of shadow banking. Forthcoming, *Journal of Finance*.
- Gorton, G., 2010. Slapped By the Invisible Hand: The Panic of 2007. Oxford University Press. Oxford, England.
- Gorton, G., 2012. Misunderstanding Financial Crises. Oxford University Press. Oxford, England.
- Gorton, G., Pennacchi, G., 1990. Financial intermediaries and liquidity creation. *Journal of Finance* 45, 49-72.
- Hanson, S., Kashyap, A., Stein, J., 2011. A macroprudential approach to financial regulation. *Journal of Economic Perspectives* 25, 3-28.
- Holmström, B., Tirole, J., 1998. Private and public supply of liquidity. *Journal of Political Economy* 196, 1-40.
- Holmström, B., Tirole, J., 2011. Inside and Outside Equity. MIT Press. Cambridge MA.
- Keynes, J., 1936. The General Theory of Employment, Interest, and Money. Macmillan. London.
- Krishnamurthy, A., Vissing-Jorgensen, A., 2012a. The aggregate demand for treasury debt. *Journal of Political Economy* 120, 233-267.
- Krishnamurthy, A., Vissing-Jorgensen, A., 2012b. Short-term debt and financial crises: What we can learn from U.S. Treasury supply. Northwestern University working paper.
- Merton, R., 1990. Continuous-Time Finance. Blackwell.
- Miller, M., 1977. Debt and taxes. *Journal of Finance* 32, 261-275.
- Miller, M., 1995. Do the M&M propositions apply to banks? *Journal of Banking and Finance* 19, 483-489.

- Miller, M., Modigliani, F., 1961. Dividend policy, growth, and the valuation of shares. *Journal of Business* 34, 411-433.
- Modigliani, F., Miller, M., 1958. The cost of capital, corporate finance, and the theory of investment. *American Economic Review* 48, 261-297.
- Myerson, R. Review of Admati and Hellwig's Bankers' New Clothes. University of Chicago working paper, <http://home.uchicago.edu/~rmyerson/research/newcloth.pdf>
- Pfleiderer, P., 2010. On the relevancy of Modigliani and Miller to Banking: A parable and some observations. Stanford University working paper.
- Stein, J., 2012. Monetary policy as financial-stability regulation. *Quarterly Journal of Economics* 127, 57-95.
- Tobin, J., 1958. Liquidity preference as behavior toward risk. *Review of Economic Studies* 25, 65-86.