Journal of Financial Economics 116 (2015) 219–236

Contents lists available at ScienceDirect

Journal of Financial Economics

journal homepage: www.elsevier.com/locate/jfec

Liquid-claim production, risk management, and bank capital structure: Why high leverage is optimal for banks ☆

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ARTICLE INFO

Article history:
Received 2 August 2013
Received in revised form
18 February 2014
Accepted 24 March 2014
Available online 2 December 2014

JEL classification:
G21
G32

Keywords:
Capital structure
Banks
Capital regulation

ABSTRACT

Liquidity production is a central function of banks. High leverage is optimal for banks in a model that has just enough frictions for banks to have a meaningful role in liquid-claim production. The model has a market premium for (socially valuable) safe/liquid debt, but no taxes or other traditional motives to lever up. Because only safe debt commands a liquidity premium, banks with risky assets use risk management to maximize their capacity to include such debt in the capital structure. The model can explain why banks have higher leverage than most operating firms, why risk management is central to banks' operating policies, why bank leverage increased over the last 150 years or so, and why leverage limits for regulated banks impede their ability to compete with unregulated shadow banks.

1. Introduction

Banks maintain capital structures with leverage ratios that are much higher than those of virtually all operating firms that are not in financial distress. Many economists accordingly see high bank leverage as puzzling from a positive-theory viewpoint and as normatively troubling. These reactions arise from viewing bank capital structure through the lens of Modigliani and Miller (1958, MM) augmented by consideration of moral hazard, taxes, and other leverage-related distortions. The MM debt-equity neutrality principle states that, absent frictions and holding operating policy fixed, all capital structures yield identical value. When leverage-related distortions are added to the debt-equity neutrality baseline, the resultant capital structure model has no efficiency-based motive that can explain why banks generally maintain leverage ratios that are so much higher than those of operating firms.

This capital structure model also implies there would be no social costs if regulators mandated severe reductions in bank leverage. Admati and Hellwig (2013) make this point forcefully with an argument that builds on Miller (1995), Pfleiderer (2010), and Admati, DeMarzo, Hellwig, and Pfleiderer (2011). As Myerson (2014, p. 200) notes, the

☆ We thank two anonymous referees as well as Michael Brennan and Jeremy Stein for especially helpful comments. We also thank Anat Admati, Charles Calomiris, John Cochrane, Peter DeMarzo, Doug Diamond, Ruediger Fahlenbrach, Nicola Gennaioli, Charles Goodhart, Gary Gorton, Martin Hellwig, Hamid Mehran, Stewart Myers, Paul Pfleiderer, Jim Poterba, Aris Protopapadakis, Richard Roll, Andrei Shleifer, Richard Smith, Andreas Stathopolous, Anjan Thakor, and Andrew Winton for useful comments. Brian Baugh and Yeejin Jang provided excellent research assistance. This paper was formerly titled "Why high leverage is optimal for banks." René M. Stulz serves on the board of a bank that is affected by capital requirements and consults and provides expert testimony for financial institutions.

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http://dx.doi.org/10.1016/j.jfineco.2014.11.011
0304-405X/

MM leverage irrelevance theorem is the foundation of the argument. With debt-equity neutrality as the baseline and only leverage-related distortions given meaningful weight, Admati and Hellwig (2013, p. 191) conclude: “[I]ncreasing 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.” They also argue that the far lower leverage of virtually all operating firms – especially firms such as Apple that have little or no debt – calls into question the existence of benefits to debt that could justify high bank leverage. Cochrane endorses this view of bank capital structure and notes that the argument favors increasing bank equity requirements to 50% or even 100% of assets (see Wall Street Journal, 2013).[1]

In the MM baseline view, there is no connection between bank leverage and what banks do. Banks are treated as firms that make loans, and they make the same loans irrespective of their debt-equity mix. Importantly, with its central principle that capital structure is irrelevant, this view leaves no room for a connection between bank leverage and the value that banks generate as producers of liquid financial claims. The idea that liquidity production is intrinsic to banking is discussed extensively by, among others, Diamond and Dybvig (1983), Diamond and Rajan (2001), Gorton (2010), Gorton and Pennacchi (1990), and Holmström and Tirole (1998, 2011). If banks' credit-screening technology enables them to make better loans than competitors could and all other MM assumptions hold, banks could adopt all-equity capital structures with no loss in value. However, if banks generate and capture value by producing financial claims to meet the demand for liquidity, those with high-equity capital structures are not competitive with otherwise comparable banks or bank substitutes that have less equity.

In this paper, we show that high leverage is optimal in a model of bank capital structure that has just enough frictions so that banks have a socially valuable role in supplying liquid claims (safe debt) to parties with imperfect access to capital markets. The model excludes taxes, moral hazard and other agency problems, deposit insurance, reaching-for-yield behavior, return-on-equity-based compensation plans, and all other distortionary motives to lever up. We exclude these factors to establish that high bank leverage arises naturally in the absence of distortions in an idealized world in which intermediation is focused on the production of socially valuable liquid claims.

Our stripped-to-the-basics model of banking has three key assumptions: (1) inclusion of an exogenous demand for liquid claims in the spirit of Diamond and Dybvig (1983) and the other pioneering studies referenced above, (2) the existence of costs of intermediation that are a function of bank scale, and (3) the ability of banks to engage in asset-side risk management that involves hedging in a perfect/complete capital market, exactly as in models that yield the MM theorem.

Together, (1) and (2) imply that a liquidity premium – a rate-of-return discount – on safe/liquid debt can obtain because scale-related costs of banking preclude the unfettered arbitrage that would make intermediation irrelevant. The existence of a liquidity premium is a common assumption in models of intermediation, and the available evidence supports this approach. In our model, a premium obtains under some, but not all, conditions. In the most basic case in which banks do not earn a spread on loans, a liquidity premium must obtain so that banks can cover the costs of intermediation. If banks earn a spread on loans and if liquid-claim demand is small relative to the efficient size of the banking sector, then liquidity does not command a premium. In this case, the loan spread covers the costs of intermediation. Although the leverage of any one bank is irrelevant, aggregate bank debt must be large enough to service the aggregate demand for liquid claims. Finally, if liquid-claim demand is sufficiently strong and bank scale is determinate, liquidity is priced at a premium and high leverage is optimal for individual banks and for banks in the aggregate.

Condition (3) is implicitly present in many prior analyses of bank capital structure. It is a previously unrecognized asset-side implication of models that apply the MM theorem to the liability side of bank balance sheets. When market prices embed a liquidity premium, banks in our model generate value by exploiting the hedging opportunities made possible by (3) to construct asset portfolios that support large amounts of safe/liquid debt issued to parties with imperfect access to capital markets.

When a liquidity premium exists, bank capital structure matters: Equity and safe/liquid debt are not equally attractive sources of capital. As Gorton and Pennacchi (1990) emphasize, debt has a strict advantage when it has the informational insensitivity property – immediacy, safety, and ease of valuation – desired by those seeking liquidity. In our model, this liquid-claim property applies only to perfectly safe deposit debt, but the reasoning of Gorton and Pennacchi implies that liquidity benefits can also be priced into relatively safe non-deposit debt, e.g., repos and commercial paper. In any case, our model's emphasis on deposit debt seems reasonable because, as Stein (2014, p. 4) indicates, “banks are almost always and everywhere largely deposit financed.” More concretely, as Hanson, Shleifer, Stein, and Vishny (2014) report, deposits averaged 80% of total assets at US commercial banks over 1896–2012.

Capital structure is a sideshow for value creation at operating firms, but it is the star of the show at banks in our model. The risky asset structures of most operating firms are poorly suited to support large-scale issuance of safe/liquid debt. In our model, banks exist because specialization and the associated cost efficiencies give them a comparative advantage over operating firms in arranging asset structures to support large amounts of safe debt and/or in contracting with parties that are willing to pay a premium for safe/liquid claims because they have impaired access to capital markets.

[1] This view has strong support among many other prominent economists. For example, in Financial Times (2010), 17 other well-known economists agree that, with much more equity funding, banks could perform all their socially useful functions and support growth without endangering the financial system. See also Myerson (2014) and Wolf's endorsement of this general view in Financial Times (2013).

Risk management is a major co-star of the show, as it provides the critical asset-side foundation that enables banks to produce large amounts of safe/liquid claims. Hedging, diversification, monitoring, the use of derivatives, and financial-engineering methods are the tools banks use to reduce asset-side risk to support greater amounts of safe debt. Banks generate value from the liability side of the balance sheet by efficiently constructing and maintaining safe asset allocations to support capital structures that supply abundant quantities of liquid claims to parties seeking assured access to capital.

Levering up with a risky asset structure does not generate greater value in our model as it does, for example, even for firms with highly risky asset structures in the MM corporate tax model. The reason is that a liquidity premium is paid only for safe debt. Risk management that expands the ability to issue safe debt is what enables banks to generate value by adopting high leverage capital structures in our model.

The general point is that, given a material demand for liquidity per se, intermediaries will emerge to meet that demand with high-leverage capital structures, which are made possible by asset-allocation choices optimized under conditions of uncertainty for maximal production of safe/liquid claims.

The latter property of our model – endogenous optimization of bank asset structures for maximal production of safe/liquid debt – is why we conclude that the MM debt-equity neutrality principle is an inappropriate equity-biased baseline for analyzing bank capital structure. In the MM analysis, of course, asset structure is assumed to be fixed at an arbitrary level. This assumption is problematic for analyzing bank capital structure because it suppresses the endogenous selection of asset structure, and therefore fails to incorporate banks' incentive to choose asset structures that foster production of safe/liquid debt.

Use of the MM theorem to analyze bank capital structure is also problematic for two other reasons. First, there is no reason for banks to exist – banks are redundant – in the MM model. Worse yet, the MM model is inconsistent with two empirically important capital structure-related features of real-world banking: the massive amounts spent on deposit-related intermediation and the existence of a liquidity premium (rate-of-return discount) on bank deposits and other money-like claims. The MM model's costless-contracting conditions imply that no resources will be spent on intermediation and that no agent will accept a rate-of-return discount on deposit debt or other liquid assets.

When we move beyond MM to consider a stripped-to-the-basics model that gives banks a meaningful role in liquid-claim production, high leverage coupled with low asset-side risk emerges as the baseline optimum expected of banks before introducing taxes, moral hazard, or other distortionary factors.

The analysis thus cautions against accepting the view that high bank leverage must be the result of distortionary motives to borrow. In our model, there are no such motives to lever up, yet high bank leverage is optimal. High leverage is the result of intermediation that is focused on the optimal production of (privately and socially beneficial) liquid financial claims.

The analysis also cautions against concluding that bank leverage must be too high because operating firms have much lower leverage. In our model, banks use risk management to create asset structures that support greater amounts of safe/liquid claims. In contrast, operating firms create value through real project choices, which are not well suited to support large amounts of safe debt because they commonly entail significant cash flow uncertainty. Operating firms specialize in producing goods and services, and their productive efficiency would suffer if they also sought to compete with banks in the production and delivery of safe debt to parties with impaired access to capital markets.

In addition to providing a simple fundamentals-based explanation for why banks have higher leverage ratios than most operating firms, our model yields some interesting ancillary implications about bank capital structure. For example, greater competition that squeezes bank liquidity and loan spreads diminishes the franchise value of (infra-marginal) banks, and the resultant reduction in equity value implies an increase in optimal bank leverage ratios. Also, if conventional banks face regulatory limits on leverage while shadow banks do not, the former would be at a competitive disadvantage to the latter, and liquid-claim production would migrate into the unregulated shadow-banking sector.

Our paper is not the first to recognize the inapplicability of the MM theorem to bank capital structure decisions when liquidity is priced at a premium. Hanson, Kashyap, and Stein (2011, p. 17 and note 1) and Flannery (2012) highlight this point, and it plays a major role in important recent papers by Stein (2012) and Gennaioli, Shleifer, and Vishny (2012, 2013). Our paper is differentiated by its focus on banks' incentive to use risk management strategies to expand their capacity to issue safe/liquid debt. Optimal risk management, coupled with an MM violation when liquidity per se is valuable, gives banks the incentive to lever up and generate value from the liability side of their balance sheets.

We characterize banks as producers of safe/liquid debt, which is a characterization that follows Gorton (2010) and that differs importantly from the way mainstream corporate finance theory portrays issuers of debt. Mainstream theory focuses on operating firms and ignores financial intermediation, and so it views debt as a source of funds for issuers, not as a good produced to meet a specific demand. More general theories recognize that intermediaries generate value by using financial-claim inputs to produce financial-claim outputs that have features tailored to meet the desires of particular clienteles. Viewed in this light, it makes sense to view the production of safe/liquid debt as an important function of banks, with risk management serving as the underlying asset-side technology that banks use to produce capital structures with abundant amounts of such debt.

The relation between risk management and the production of money-like debt claims is also analyzed by Hanson, Shleifer, Stein, and Vishny (2014), who focus on banks' choice between buy-and-hold and asset-collateralization strategies. In a contribution that set the foundation for the liquid-claim production view of bank capital structure, Gorton and Pennacchi (1990) discuss the role of asset diversification in fostering the production of safe/liquid debt. Gennaioli, Shleifer, and Vishny (2013) also recognize the incentive to diversify to support safe debt issuance, but they focus on a setting in which diversification is imperfect and therefore leaves banks exposed to correlated tail risk from related loan and security holdings. In tax/bankruptcy cost models of capital structure, high leverage is optimal given low asset-side risk, as can arise, e.g., when banks hold diversified loan portfolios. Gornall and Strebulaev (2013) and Sundaresan and Wang (2014) establish the latter result in tax/bankruptcy cost models that, respectively, exclude and include a liquidity premium on bank debt. Finally, in Diamond's (1984) delegated-monitoring model, asset diversification enables banks to issue more debt, which dominates equity when banks generate value by monitoring borrowers on behalf of capital suppliers.

Section 2 describes our model's basic elements. Section 3 characterizes optimal risk management for liquid-claim production. Sections 4 and 5 analyze optimal bank capital structure taking as given a premium for liquidity. Section 6 discusses conditions for a liquidity premium in equilibrium. Section 7 considers bank leverage and systemic risk when risk-management costs make it prohibitive for banks to produce perfectly safe claims. Section 8 discusses capital regulation. Section 9 concludes.

2. Basic model details

Our model includes just enough frictions for banks to have a meaningful role in liquid-claim production. There are no taxes, agency costs, or other leverage-related distortions. Nor is there deposit insurance. We also exclude informational asymmetries, e.g., as in the analysis of debt, asset collateral, and asset-quality disclosures in the intermediation models of Dang, Gorton, and Holmström (2013) and Dang, Gorton, Holmström, and Ordonez (2013).

Our conclusion that high leverage is optimal for banks rests on two key model properties: (1) the existence of a market premium (rate-of-return discount) for safe/liquid financial claims and (2) banks' ability to produce such claims efficiently by constructing suitable asset-side hedges.

The notion that bank debt commands a liquidity premium is well accepted in the intermediation literature and is supported by the available evidence. The existence of a liquidity premium has largely been ignored (or implicitly assumed away) in the mainstream literature's analysis of capital structure. Our objective in this paper is to apply ideas about liquid-claim demand from the intermediation literature to a stripped-to-the-basics model that, aside from the role of banks in meeting liquidity demand, conforms to the basic MM model that is the foundation of mainstream corporate finance analysis. We therefore work with a simple segmented-markets model that we believe offers the most intuitive, mainstream-like structure to show how the interplay of the demand for and supply of liquid claims can lead to a liquidity premium in equilibrium.

We assume specifically that the economy has two separate financial markets, with banks intermediating between the two. Market I is populated by operating firms, households, and banks that transact under the perfect and complete market conditions that lead to the MM theorem.[2] Market II is populated by a distinct set of agents that do not have access to Market I and that can trade among themselves, but not under perfect/complete market conditions. Given Market II's imperfections, there are firms and households in Market II that willingly pay a premium (over the relevant price in Market I) for liquid financial claims, i.e., claims that provide immediate, assured access to capital. Agents in Market II can buy such claims from banks that bridge the gap between Market I and Market II, and that have full access to the perfect markets of Market I. In our model, banks are the only channel between Market I and Market II. The underlying assumption is that, among the agents that have access to Market I, banks are those that face the lowest cost of accessing Market II.

Two analogies from outside the intermediation literature can help clarify the structure of this model of banking. The first is from international finance, with Markets I and II representing different countries. Trade between the two countries occurs only in interest-bearing liquid claims and cash. Country I can produce liquid claims, while Country II cannot. Agents in Country II that desire liquid claims must obtain them from I, and will generally have to pay a premium over the price that prevails in Country I to cover the costs of constructing such claims and delivering them to Country II. For a segmented-markets model of international finance that is similar in spirit, see Basak (1996).

The second analogy is from the literature on restricted capital-market participation. This literature features models in which a subset of agents does not participate in the stock market (see, e.g., Brennan, 1975; Allen and Gale, 1994). In our model, some agents cannot participate directly in Market I's perfect/complete capital market, which contains both safe and risky securities. They can, however, acquire safe/liquid financial claims produced by banks, which participate in Market I. This setup shares some common elements with the structure of Basak and Cuoco's (1998) general equilibrium model in which agents who do not participate in the stock market trade a risk-free bond with agents who do. A key difference is that, in our model, agents in Market II can acquire safe debt from banks, but not from other participants in Market I, with banks incurring costs to access Market II.

In general, there is of course no reason for banks or other intermediaries to exist in a model that has only Market I, which is perfect and complete. Banks could still be neutral mutations (in the sense of Miller (1977)) that raise funds in Market I and costlessly repackage claims for agents that could, at no cost, do on their own what banks

[2] Our arguments go through unchanged if banks have access to incomplete but otherwise frictionless markets in which a riskless claim can be constructed from securities traded in Market I. Our point here is that markets that are perfect and complete are sufficient, but not necessary, for banks to be able to construct perfect hedges on the asset side of their balance sheets. The role of perfect hedging (as in MM) in leading banks to adopt high leverage capital structures is treated in Section 3. Section 7 analyzes banks' incentive to lever up when hedging is imperfect.

do for them. If only Market I were operative, bank capital structure would not matter, while banks themselves would be redundant and generate no benefits.

With both Markets I and II in our model, banks serve a useful purpose by bridging the gap between the two markets and supplying debt to (accepting deposits from) the parties in Market II that are willing to pay a premium for safe/liquid claims. Specifically, banks can issue safe debt to agents in Market II that value having assured access to capital, while backing that safe debt with assets acquired at lower cost in Market I using resources obtained through debt issuance.

We assume that banks have a comparative advantage over operating firms in (1) managing asset-side risk to foster production of safe debt and in (2) constructing the banking infrastructure needed to access agents in Market II. This comparative-advantage assumption is rooted in the notion that operating firms specialize in real production, while banks specialize in intermediating between Markets I and II, with neither possessing the ability to be a low-cost competitor in areas of non-specialization.

In our model, then, intermediation is (socially valuable) arbitrage between Markets I and II. It is socially valuable because of the realization of potential gains from trade when banks use safe collateral constructed through hedging in Market I to meet the demand for safe debt in Market II.

Our conclusions about bank capital structure depend critically on the assumption that such arbitrage cannot be conducted at zero cost. Costless arbitrage would fully integrate Markets I and II into one perfect/complete capital market. The existence of a liquidity premium means that agents in Market II pay a higher price for a safe claim than the price that prevails for an identical (riskless) claim in Market I. This pricing differential would be eliminated by costless arbitrage between Markets I and II, and our model rules out such arbitrage so that intermediation has an economically meaningful role.

Specifically, we assume there are scale-related costs of banking that strictly determine the size of each bank and that limit the ability of all banks to generate value by producing safe debt claims for agents in Market II backed by asset collateral obtained in Market I. These costs represent outlays needed to capture the gains from trade by intermediating between Markets I and II.

The costs of banking also effectively serve as arbitrage impediments that prevent equalization of the rate of return on safe bank debt (deposits) issued to parties in Market II with the rate of return on safe portfolios constructed from assets in Market I. The reason such a rate-of-return differential – a liquidity premium – exists in equilibrium is to cover the costs for banks of bridging the gap between Markets I and II. We discuss these costs and their impact on bank capital structure in Section 4.

Although it is not required for our conclusions about bank leverage and risk management, our model can also accommodate agents that value opportunities to borrow, but do not have access to Market I, and instead must transact in Market II's imperfect capital market. Banks now serve a second useful purpose by screening credit risks and extending loans. They can generate value from the difference between what they earn on loans extended to borrowers in Market II and what they would have to pay for an equivalent risk asset under Market I's perfect market conditions.

We use this segmented-markets model structure to incorporate (through the agents in Market II) a demand for liquid claims per se. This approach seems reasonable because many individuals and businesses do not participate directly in the stock or bond market, but do hold cash balances in bank and money market accounts. Use of a segmented-markets model has precedent in the intermediation literature, most notably in the pioneering analysis of Merton (1990, p. 441). More recently, Allen and Carletti (2013) employ such a framework to model bank capital structure. More generally, Titman (2002) argues that segmented-markets models – which sustain deviations from MM through arbitrage impediments in the spirit of Shleifer and Vishny (1997) – can explain many otherwise puzzling aspects of corporate financial policies.

Our segmented-markets structure is not the only approach that is consistent with a liquidity premium (rate-of-return discount) on safe bank debt. For example, one could assume there are liabilities produced by banks – with special features referred to as liquidity – that economic agents value because they provide safe and easy access to resources in a way that other financial instruments cannot. These economic agents are willing to hold these liabilities because of their liquidity advantage, even if they have a lower pecuniary return than other financial instruments. This approach is akin to including money in the utility function, a model structure that is common in monetary economics and that is used by Stein (2012) in his analysis of bank liquidity production. With this approach, a market premium for bank debt is traceable to the liquidity demand that arises separately from the traditional portfolio demand for assets.

With either approach, high leverage is optimal for banks when there are agents who willingly pay a premium for liquid claims (bank debt) that provide immediate, assured access to capital. Sections 4 and 5 analyze bank capital structure assuming that liquidity commands a premium and that the bank can exploit access to Market I when optimizing its asset structure for liquid-claim production. In Section 6, we show that, when banks produce socially valuable liquid claims, there are two types of equilibria – one in which liquidity is priced at a premium and another in which it is not.

The focus in Sections 4 and 5 is on the empirically more relevant case in which liquid claims are priced at a premium. [See Krishnamurthy and Vissing-Jorgensen (2012a, 2012b) for evidence that Treasury security prices embed a liquidity premium, i.e., there is a premium for safe/liquid assets.] Section 6 shows that such an equilibrium obtains in our model given asset-side costs of banking, e.g., of operational infrastructure, risk management, etc., provided that the Market II demand for liquid assets is high enough. In this equilibrium, bank scale is determinate and individual banks are highly levered.

Allen and Carletti (2013) 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 safe debt issuance that banks generate greater value when liquidity is priced at a premium. Also, with agency costs ruled out, the attraction of bank leverage in our model is not due to favorable incentive effects of debt, e.g., as in Calomiris and Kahn (1991), Flannery (1994), and Diamond and Rajan (2000).

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; Tobin, 1958).

Given a premium for safe/liquid claims, we show in Section 4 that high bank leverage is optimal in our model. Importantly, the optimality of high leverage is conditional on a bank optimizing its asset structure to create suitable safe asset collateral to support abundant safe debt, as we detail next.

3. Risk management for maximal liquid-claim production

In our model, banks can make loans with risky payoffs and they can purchase a wide variety of (risky and safe) financial assets because they have access to perfect capital markets (Market I) just as in the perfect/complete market settings that yield the MM theorem. Consequently, in our model the investment opportunities of banks do not differ in any way from the investment opportunities that are typically assumed in the literature. In particular, the assumption that banks have access to a perfect capital market is implicit in prior studies that use debt-equity neutrality as the baseline to argue that mandated leverage reductions would not raise the social cost of funding banks.

Although this capital-market access assumption is commonplace, it has an important implication that has not been previously recognized: The perfect markets conditions that seemingly make MM applicable to bank capital structure actually enable banks to engage in risk-management strategies that create safe asset structures. In our model, banks can and will use such strategies to support large amounts of safe debt and capture the premium paid for liquid claims.

To see why banks in our model find it optimal to construct asset portfolios that are riskless, suppose a bank has hedged all of its loans and other assets to obtain such a portfolio. This is always possible when the bank has access to a complete market or access to an incomplete market in which it can create a riskless portfolio through suitable hedging. Now consider a hypothetical portfolio restructuring in which the bank sells off one dollar of its riskless asset holdings and uses that dollar to buy any other risky claim available in Market I. Because no arbitrage opportunities exist within that perfect market segment, the purchased claim must have a lower payoff than the sold riskless claim in at least one state of nature.[3] If the bank made this risk-increasing portfolio adjustment, it would now have a lower capacity for producing safe debt. If, in equilibrium, a bank has the incentive to maximize production of safe claims, then its value would be lower because the now-risky portfolio supports less safe debt. In Section 4, we show that a bank maximizes production of safe claims when such claims command a premium.

Intuitively, then, even if the loans that a bank originates are extremely risky, a bank with access to perfect markets can and will undertake security transactions to convert its overall risky portfolio into one with no risk. In our model, this portfolio transformation is the bank's optimal asset-side policy when safe/liquid claims (bank deposits) are priced at a premium. By engaging in risk management to transform a risky portfolio into a riskless portfolio, banks arrange collateral support for capturing the greatest possible value from the production of liquid financial claims.

4. Optimal capital structure with bank scale fixed

This section follows the standard MM approach of analyzing capital structure with investment policy (bank scale) fixed. Section 5 treats bank scale as endogenous. The analyses here and in Section 5 are partial equilibrium in that a liquidity premium is taken as given. Section 6 considers the conditions under which a liquidity premium obtains in equilibrium.

4.1. Liquid-claim production and bank free cash flow

We use an infinite-horizon ($t=0$, 1, 2, etc.) model as in Miller and Modigliani (1961). The model includes two distinct market segments (as described in Section 2) and allows for a potential premium (over and above the relevant price in Market I) for safe/liquid claims delivered to Market II. We analyze a given price-taking bank that has exploited the MM capital-market conditions to obtain a safe asset mix to foster liquid-claim production. The bank can issue equity or safe/liquid debt claims (deposits), which can be rolled over in perpetuity. With only safe debt in the capital structure, there is no chance of bank failure and, therefore, no possibility of runs that could lead to bank losses.

[3] The impediments to arbitrage in our model apply across Markets I and II, not within the perfect/complete structure of Market I. Safe debt claims supplied by banks to those willing to pay for liquidity are constructed from securities in Market I where safe asset portfolios command a higher return than the bank pays to depositors in Market II on the safe debt it creates from its asset collateral. (The same asset-liability return comparison holds when the model includes bank borrowers with impaired access to Market I because the risk-equivalent returns on bank loans are no lower than in Market I.) Such a rate-of-return differential could not survive absent costs that impede arbitrage across Markets I and II. In our model, scale-related costs of banking create such an impediment.

The natural interpretation is that the bank's capital-structure choice is among different mixes of liquid claims – immediately redeemable safe debt – and equity financing. To the extent that long-term debt issued by banks does not provide liquidity services, the MM leverage irrelevance result would apply to the choice between long-term debt and equity. However, if banks' long-term debt is sufficiently safe to yield liquidity benefits, then the arguments of Gorton and Pennacchi (1990) imply that banks would also find safe long-term debt to be superior to equity as a funding tool.

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. θ is the liquidity spread, or rate-of-return discount, that those purchasing liquid claims from banks accept in exchange for assured access to capital. ϕ is the loan spread, or rate-of-return premium, paid on bank loans by those with limited access to capital markets.

Our model formulation is compatible with, but does not require, synergies between bank lending and the production of liquid claims, e.g., as discussed by Kashyap, Rajan, and Stein (2002). In particular, our conclusion about the optimality of high leverage in no way depends on the bank earning a positive spread by making loans at a rate-of-return premium, as can be verified by setting $\phi=0$ in all that follows. In principle, ϕ is a certainty-equivalent parameter that is bank specific because it depends on the risk structure of the loans that a bank extends. We keep the notation simple and avoid indexing ϕ by bank because our capital structure conclusions hold for all non-negative finite values of ϕ.

A positive liquidity spread ($\theta>0$) is essential for banks to have a strict incentive to lever up. This incentive is present only to the extent that the bank's asset collateral supports safe debt. Levering up with risky debt does not capture a market premium for liquidity. Here and throughout, θ is parametric to any given bank. Section 6 discusses how $\theta>0$ can arise in equilibrium.

The asset side of the bank's balance sheet reflects its purchases of securities at a fair price to earn the rate r (when converted through risk management into a safe asset portfolio) and its extension of loans that yield the return $r(1+\phi)$ (again when optimally converted to a safe portfolio). These assets serve as collateral whose returns are used to pay interest on short-term debt and dividends that distribute free cash flow to a bank's shareholders. As discussed in Section 3, while the individual assets held by the bank can be risky (and they surely are for loans), the bank's portfolio of assets is not risky at the optimum. For each dollar of debt the bank issues at a given date, it pays $r(1-\theta)$ one period forward in time.

Perfect hedging implies that the return on a bank's assets is always sufficient to pay the interest on its debt. Here we have production of liquidity in the purest sense, as the purchaser of a debt claim has 100% assured access to capital at any future date. 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 on safe debt paid by those who seek assured access to capital. That demand is filled by bank production of safe debt claims.

Let I denote total bank assets at $t=0$ when the bank is formed. 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 free cash flow distributed to equity as it is earned. To analyze the bank's capital structure choices, i.e., the funding choices that affect the liability side of the bank's balance sheet, we further define x as the fraction of capital at $t=0$ raised by issuing debt ($0\le x\le 1$); $(1-x)$ as the fraction of capital at $t=0$ raised by issuing new equity; $D=xI$ as the value of debt (created at $t=0$ and rolled over in perpetuity); $(1-x)I$ as the value of equity contributed at $t=0$; z as the fraction of capital invested in loans that yield $r(1+\phi)$; and $(1-z)$ as the fraction of capital invested in securities purchased in the capital market to yield r.

The requirement that $x\le 1$ or, equivalently, that $D\le I$ precludes the bank from issuing debt above the level of assets and using the incremental proceeds to fund immediate payouts. If we instead allow $x>1$, then the bank can set $D>$ I, but not beyond the point where the interest on debt equals the earnings on assets. In this formulation, $\theta>0$ would lead banks to push D above I, with their ability to do so also limited by the scale-related costs of banking [see condition (5) in Section 5]. With the bank taking on a higher dollar amount of debt and paying out the additional proceeds to shareholders, this alternative formulation yields the same bottom line as our model formulation, namely that high leverage is optimal. For example, as Section 5 shows, $\theta>0$ implies that the marginal entrant into banking has an all-debt capital structure, and it is of course not possible to have higher leverage than that.

For all banks, we require $0\le z\le 1$. 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 have different levels of loan activity ($z<1$) 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 5 shows that banks that are more efficient at credit evaluation (i.e, those with higher values of z) are better able to compete (with unregulated shadow banks) when regulators impose ceilings on leverage ratios.

Let $C(I, z)$ denote the explicit costs of operating a bank, which are denominated in present value terms and which capture asset-side risk-management and operational infrastructure costs. In terms of the costs of intermediation, $C(I, z)$, we intuitively have in mind outlays for operational (physical and contractual) infrastructure for providing banking services and for risk management, e.g., identifying the right hedges to neutralize the risks borne by the bank from loans it has extended. In models that go beyond our (intentionally simplified) setup, scale-related costs of banking could also include agency costs and other costs caused by market imperfections. In extended models, there would also be ongoing costs associated with trading securities to maintain suitably hedged asset-side portfolio positions.

We assume that $C(I, z)$ includes the present value of a periodic fixed cost component and that marginal costs are positive and increasing in bank scale, I. The costs $C(I, z)$

dictate efficient scale for each bank (Section 5) and therefore also for banks in the aggregate (Section 6). Because these costs deter expansion in the aggregate supply of safe debt when $\theta > 0$, they effectively impede arbitrage (across Markets I and II) and, therefore, make it possible to have a liquidity premium ($\theta > 0$) in equilibrium.

At each future date $t > 0$, the bank's net interest margin is the cash inflow from loans, $r(1+\phi)Iz$, plus the cash inflow from securities, $rI(1-z)$, minus the interest it pays on its safe debt, $r(1-\theta)xI$. Free cash flow (FCF) is the net interest margin minus the current period cost of banking:

$$\begin{aligned}\mathrm{FCF} &= r(1+\phi)Iz + rI(1-z) - r(1-\theta)xI - rC(I,\ z)\\ &= [1+\phi z-(1-\theta)x]rI - rC(I,\ z).\end{aligned} \tag{1}$$

FCF is the residual cash flow owned by shareholders and does not include a charge for any equity raised when the bank was initially capitalized at $t=0$. It is each future period's total dollar return to all equity, including any contributed capital at $t=0$. (When $\theta > 0$, all funding is from debt, so that positive equity values are franchise values from liquidity and loan spreads, net of the costs of banking.) 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.

4.2. Optimal bank capital structure maximizes safe debt issuance against safe asset collateral

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

$$E = \mathrm{FCF}/r = [1+\phi z-(1-\theta)x]I - C(I,\ z). \tag{2}$$

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 Eq. (2) into the shareholder wealth expression yields

$$\begin{aligned}W &= [1+\phi z-(1-\theta)x]I-(1-x)I - C(I,\ z)\\ &= [x\theta+\phi z]I - C(I,\ z).\end{aligned} \tag{3}$$

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

$$\partial W/\partial x = \theta I. \tag{4}$$

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

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 issuing debt to parties in Market II at a rate that nets out the liquidity premium, θ. There is no spread earned by issuing equity or by issuing debt in Market I. The MM theorem holds for the choice between issuing debt and equity in Market I. The point here is that the theorem fails when banks have the opportunity to issue deposit debt at a premium to agents in Market II.

The bank's incentive to issue debt depends on θ, and not on ϕ or z (inspect (4)). Consequently, $x=1$ is the optimum regardless of the values of ϕ and z. With $\theta > 0$, all bank funding comes from debt: $D = \mathrm{I}$. Equity value, E, is accordingly positive when $x=1$ due solely to franchise or charter value, which equals $[\theta+\phi z]\mathrm{I} - C(I,\ z)$. Higher values of ϕ and z raise franchise value, which ceteris paribus implies lower leverage, $D/(D+E)$. However, an increase in franchise value does not diminish the bank's incentive to maximize issuance of liquid claims (set $x=1$) conditional on its asset structure when $\theta > 0$.

This maximization translates to high leverage only if the bank manages the risk of its assets so that its overall portfolio can support abundant safe debt. Absent such risk management, banks have no incentives to lever up. The reason is that, in our model, banks capture a liquidity premium only for safe debt. Once the bank's debt level has reached the point where the next dollar of debt would be risky because the underlying asset collateral is risky, there is no liquidity premium paid and no incentive to increase leverage further.

Hence, our argument is not a liquidity-based reworking of the MM corporate tax model, which has an incentive to lever up to the maximum extent possible, even when a firm has a highly risky asset structure. Rather, in our model, risk management focused on creating asset collateral that can support abundant safe debt is essential for banks to generate value from high-debt capital structures.

4.3. Deleveraging: equity-financed debt reductions and asset expansions

In our model, when liquid claims command a premium, shareholders would be worse off if the bank were to reduce leverage by issuing equity and using the proceeds to pay down debt. This hypothetical equity-for-debt substitution would hurt shareholders without generating any social gain, as it would reduce the dollar value of the liquidity spread the bank captures.

What if the bank raises equity and invests the proceeds in risky assets (with limited liability) that are priced to earn a normal return? There is no change in the dollar amount or the risk of the bank's debt, which is still safe because the new assets have limited liability. Shareholders are worse off if the bank was originally operating at optimal scale because the asset expansion has made the bank too large, given the scale-related costs of providing banking services. This hypothetical leverage reduction yields no social benefit because perfect-market hedging makes bank debt safe, so there is no chance of a run and no systemic risk either before or after the asset expansion.

In Sections 7 and 8, we discuss how regulation that mandates bank deleveraging can yield substantial social benefits when banks are unable to hedge perfectly, i.e., when the perfect/complete markets access assumptions of MM are not operative for banks.

4.4. Imperfect risk management and equity cushions to support safe debt issuance

By maximizing safe debt issuance against whatever safe asset collateral it has, a bank captures the greatest value from liquid-claim production. Suppose for the moment that a bank faces risk-management costs that impede attainment of a safe asset structure. Equity is, of course, no longer riskless when there is even a tiny asset-side risk. While the introduction of such costs would make our model more realistic, it would make no difference for our conclusions given that our perfect hedging formulation is simply the limiting case obtained as hedging impediments become arbitrarily small. We work with the latter formulation to keep the focus on the underlying intuition why high leverage is the idealized-world baseline for banks when they supply liquid claims to parties that value such claims but cannot obtain them costlessly from capital markets.

Importantly, even with imperfect hedging, $\theta>0$ and Eq. (4) together imply that a bank still has incentives to issue safe debt to the maximum extent possible, where that maximum is dictated by the left-tail properties of its now-risky asset portfolio. The key distinction of this imperfect hedging version of the model is that equity now has an important role as a cushion to bolster the bank's ability to issue safe debt.[4] We return in Sections 7 and 8 to a discussion of the role of equity cushions for bank leverage and regulation thereof when bank asset portfolios are risky because perfect hedging is not feasible.

5. Optimal bank leverage when bank scale is endogenous and $\theta>0$

Optimal bank scale, I^*, must satisfy two conditions when $\theta>0$:

$$W=[\theta+\phi z]I^*-C(I^*,\ z)\geq 0 \tag{5}$$

and

$$\partial W/\partial I=[\theta+\phi z]-\partial C(I^*,\ z)/\partial I=0. \tag{6}$$

Condition (5) stipulates that the bank must generate non-negative wealth for shareholders. We obtain W in condition (5) by evaluating Eq. (3) at x=1, as Eq. (4) implies that $x=1$ is optimal for all $I>0$ when $\theta>0$. Optimal scale is $I^*=0$ if there is no $I>0$ for which (5) is satisfied. Intuitively, the bank does not operate if the liquidity and loan spreads are unable to cover the cost of banking.

Condition (5) thus gives meaning in the context of our model to the intuitive notion that banking is a spread business. If banks do not earn positive spreads on liquid-claim or loan production (or both), they will not operate because they cannot cover costs: $\theta=\phi=0$ implies condition (5) is violated for all $I>0$. (The same implication holds for all $x\leq 1$, as can be verified by setting $\theta=\phi=0$ in Eq. (3).)

Condition (6) is a standard first-order condition, which stipulates that a bank increases its scale until the sum of the liquidity and loan spreads just covers the marginal cost of expansion. Condition (6) also sets $x=1$ because $\theta>0$. Because marginal cost is positive and increasing in I, optimal scale is strictly determinate, as is the optimal amount of debt.

[4] A more complete analysis would also recognize that having larger amounts of equity in the capital structure can offer other benefits. For example, Holmström and Tirole (1997), Allen, Carletti, and Marquez (2011), and Mehran and Thakor (2011) argue that more bank equity leads to better monitoring of borrowers.

When $\theta>0$, the bank's optimal leverage ratio at optimal scale, I^*, is

$$D/(D+E)=1/[1+\theta+\phi z-(C(I^*,\ z)/I^*)]. \tag{7}$$

This expression for optimal leverage follows from evaluating Eq. (2) at $x=1$ and I^* to obtain E, while noting that $x=1$ implies that all bank funding comes from debt, i.e., $D=I^*$.

How high is optimal bank leverage, $D/(D+E)$? The marginal entrant into banking is levered to the hilt with an optimal leverage ratio of $D/(D+E)=1$. To see why, note that condition (5) is satisfied as a strict equality for the marginal entrant. In this case, the sum of the liquidity and loan spreads, $(\theta+\phi z)$, just covers average cost at optimal scale, $C(I^*, z)/I^*$. Hence the denominator in Eq. (7) reduces to one.

This 100% debt corner solution is not only optimal, but it also is the only viable choice for the marginal entrant to banking. A bank just on the margin of entry will not be able to cover costs if it does not lever up to the maximum extent possible at the optimal scale when liquidity commands a premium.

The liquidity premium (i.e., the interest-rate spread on deposits) earned by the marginal entrant is not a free lunch from levering up. It is compensation that covers the costs of banking, i.e., the costs of supplying liquid claims to parties in Market II who value such claims, pay the premium, and capture consumer surplus.

Infra-marginal banks have positive equity values ($E>0$) so that their optimal leverage ratios are less than one. They have $E>0$ solely due to positive franchise values because, with $\theta>0$, all bank funding comes from debt. The positive franchise value for an infra-marginal bank reflects the difference between the sum of the liquidity and loan spreads, $(\theta+\phi z)$, and average cost at optimal scale, $C(I^*,\ z)/I^*$. (To see this point, evaluate Eq. (2) at $x=1$ and I^*.) Because marginal entrants face costs that equal the sum of the spreads, the franchise value of an infra-marginal bank reflects its cost advantage (at optimal scale) over marginal entrants. For infra-marginal banks, optimal leverage is also high, unless the bank in question has a huge cost advantage over marginal entrants that gives it a correspondingly high franchise value ($E\gg 0$).

We can think of increased competition in banking as manifesting through lower costs for marginal entrants to banking and, hence, as generally diminishing bank franchise values by reducing liquidity and loan spreads. Lower franchise values imply lower equity values and, other things equal, higher leverage. 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. The well-documented increase in bank leverage since the early 1800s could thus reflect 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 development of the junk-bond market and other such innovations. These developments likely put downward pressure on loan spreads, which similarly imply lower franchise values and higher leverage.

Gorton (2012), chapter 11, summarizes the US and international evidence 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).

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. Given that $\theta > 0$, each new entrant sets $x = 1$ to capture the largest possible amount of value from liquid-claim production. A necessary condition for equilibrium is that the sum of the loan and liquidity premiums is driven down to the point where W is zero at the asset and capital structure optimum:

$$W^* = [\theta + \phi z]I^* - C(I^*,\ z) = 0. \tag{8}$$

In equilibrium, the sum of the loan and liquidity spreads, $(\theta + \phi z)$, just covers a bank's average cost, $C(I^*, z)/I^*$, at the optimal scale, I^*. Any higher spreads would precipitate entry by new banks that see $W > 0$ at I^* and $x = 1$. Any lower spreads would precipitate exit because $W < 0$. Note that I^* is the bank scale that minimizes long-run average cost, $C(I, z)/I$. If I^* does not occur at minimum average cost, there is another $I > 0$ for which $W > 0$, and that would precipitate entry at that scale. (Note also that, given the fixed cost component of $C(I, z)$, minimum average cost does not occur at infinitesimal scale.)

The equilibrium relation in Eq. (8) is just an application of the standard price theory condition that, with competitive entry by identical firms, market prices adjust until firms are just able to cover long-run average cost. A comparison of Eqs. (8) and (6) indicates that marginal and average costs are equated to price (i.e., the sum of the liquidity and loan spreads) at the minimum point on the average cost curve. Here again we have a standard price theory property.

Now, suppose that conventional regulated banks face constraints on leverage that mandate $x < 1$, while shadow banks face no such constraints. Equilibrium spreads are set in accord with Eq. (8) by free entry by shadow banks. With regulations that place a ceiling on leverage, conventional banks have $W = [x\theta + \phi z]I^* - C(I^*,\ z)$. This expression is negative given that $x < 1$ is now required and that condition (8) describes market equilibrium. Conventional banks will therefore exit the market for liquid claims and be replaced by shadow banks that are not subject to regulatory limits on leverage.

The implication is that conventional banks will not be able to compete with shadow banks that have comparable technologies for liquid-claim production. Conventional banks capture $x\theta$ for each unit of scale, whereas shadow banks 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 due to higher z] or at the infrastructure and financial-engineering 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 on shadow banks – will induce a substitution of liquidity production into the unregulated shadow-bank sector. Such a substitution is not unique to our analysis; see, e.g., Hanson, Kashyap, and Stein (2011), Acharya, Mehran, and Thakor (2013), Harris, Opp, and Opp (2014), and Plantin (2014). In general, such a substitution is to be expected in every model in which bank leverage is not irrelevant and regulations capping leverage are binding for some, but not all, banks.

6. Market equilibrium with and without a premium for liquid claims

Our model has two possible types of equilibria: $\theta > 0$ and $\theta = 0$. In both cases, the aggregate quantity of bank-supplied liquid claims must be large enough to satisfy the aggregate demand for safe debt in Market II. When $\theta = 0$, no bank captures value privately as a result of its decision to supply safe debt to help meet the demand in Market II. [This property is similar to Miller's (1977) "Debt and Taxes," except that banks in our model optimize their assets for maximal production of safe debt, whereas, in a Miller-style tax-driven model, firms can have highly risky asset structures and correspondingly risky debt.] In contrast, when $\theta > 0$, every bank has a private-level incentive to lever up to capture the premium paid for (socially valuable) liquid claims issued to agents in Market II.

Formally, θ is the rate-of-return differential on safe debt between Markets I and II: r and $r(1-\theta)$ respectively denote the safe rates of return in Markets I and II. When there is no liquidity premium, i.e., when $\theta = 0$, safe claims command the same price in both markets. When there is a liquidity premium, i.e., when $\theta > 0$, agents in Market II pay a higher price for safe claims than the price that prevails for such claims in Market I. Given $\theta > 0$, banks generate value through intermediation that exploits this pricing differential. They issue safe debt in Market II backed by safe asset collateral that is more cheaply created by constructing suitable hedges in Market I. The extent to which banks produce safe debt for Market II also depends on the costs, $C(I, z)$, they face in realizing the potential gains from trade that come from bridging the gap between Markets I and II.

The equilibrium value of θ is accordingly determined by the aggregate demand for safe debt in Market II, and the aggregate supply of such debt to Market II, which banks construct from suitable hedges in Market I and which depends on the costs they face in intermediating between Markets I and II.[5]

[5] In our model, the equilibrium value of θ is determined by the aggregate supply of and demand for safe debt in Market II. This simplification is possible because the model assumes that only safe debt can command a liquidity premium and because banks can and do engage

Suppose for the moment that $C(I, z)=0$ so that banks face no costs of intermediating safe claims between Markets I and II. In this case, $\theta=0$ must hold in equilibrium because the prospect of costless arbitrage by competing banks ensures that safe debt commands the same price in both markets. At any $\theta>0$, competition among banks will drive up the prices of the constituent state claims in Market I that form the hedges needed to construct safe claims for delivery to Market II. This process will continue until the prices of those state claims have adjusted to eliminate any gain from constructing safe claims in Market I and costlessly delivering them to Market II.

In our model, there are positive costs of serving Market II ($C(I, z)>0$), and these costs serve as arbitrage impediments that make it possible to have $\theta>0$ so that safe debt prices differ across Markets I and II in equilibrium. Moreover, as we next show, a liquidity premium, $\theta>0$, is required in equilibrium when $C(I, z)>0$, provided that the liquid-claim demand in Market II is sufficiently strong. The intuitive reason is that banks will not supply safe debt to Market II unless they can cover their costs. To derive the conditions that must hold for $\theta>0$ to obtain in equilibrium, we provisionally take the discount rate on safe claims, r, in Market I as given and ask: Under what conditions will a rate lower than r prevail on safe bank debt issued to parties in Market II? We address the fact that the interest rate, r, is endogenous when we consider shifts in demand that in principle should affect that rate.

We begin by noting that the supply of safe debt to Market II is not infinitely elastic, which is true even when there are no costs of banking [$C(I, z)=0$]. The reason is that the amount of safe debt that banks can create (and supply to Market II) is always bounded (finite). It can never exceed the aggregate resources available from the real economy in the state of the world with the lowest resource total. In general, intermediation can alter the packaging of real state-contingent output into different types of financial claims, but by its very nature cannot increase the social total of that output. The total available quantity of safe claims can be increased by substitution into real production decisions that increase aggregate resources in the state with the lowest resource total. But because real resources are always finite, there is a limit to the supply impact of such substitution, and so it remains true that the supply of safe debt to Market II is always bounded.

The existence of positive banking costs [$C(I, z)>0$] implies that banks will generally not find it attractive to deliver the maximum feasible quantity of safe debt claims to Market II. Of course, if the premium paid for such debt were high enough relative to the costs of banking, they would deliver all safe claims to Market II. But there is no reason to expect such extreme conditions to obtain and, in any case, our model does not rest on the assumption that all safe claims are allocated to Market II.

Consider first the basic case in which banks produce liquid claims, but generate no value from loans so that $\phi=0$. In this case, if $\theta=0$, all banks fail to cover costs, $C(I, z)$, at all positive scales, $I>0$. Because condition (5) is violated for all $I>0$ when $\theta=\phi=0$, all banks shut down. No liquid claims are supplied to Market II. There is no banking sector when $\theta=\phi=0$ and $C(I, z)>0$.

This same logic conversely implies that $\theta>0$ is required for equilibrium if at least one bank operates at positive scale (and $\phi=0$). It follows that the demand for liquid claims in Market II must satisfy two conditions for $\theta>0$ to obtain in equilibrium. First, some agents are willing to pay a premium, θ^{**}, that covers average cost for at least one bank: $\theta^{**}=C(I^{**}, z)/I^{**}>0$ for some positive scale $I^{**}>0$ at that bank. Second, the aggregate quantity demanded of liquid claims at θ^{**} is at least I^{**}. If these conditions are met, liquid-claim demand in Market II is strong enough to induce a positive supply of safe bank debt at some $\theta>0$ that is large enough to cover costs for at least one bank, and perhaps many.

If banks generate value from loans ($\phi>0$), then whether a liquidity premium ($\theta>0$) arises in equilibrium depends on the strength of the demand for liquid claims in Market II. When $\phi>0$, the loan premium can, by itself, cover the costs of banking even when there is no liquidity premium. (With $\phi>0$ and $\theta=0$, conditions (5) and (6) can be satisfied at positive scale.) Suppose for the moment that we have an equilibrium with banks operating at positive scale given some $\phi>0$ and with $\theta=0$.

Starting from this $\theta=0$ equilibrium, consider progressive expansions in the demand for liquid claims in Market II, while holding fixed the demand for bank loans and the riskless interest rate, r. Because we continue to hold r fixed, this exercise should be interpreted as considering expansions in the Market II demand for safe claims in relative terms, i.e., Market II demand expansions accompanied by offsetting reductions in the demand for safe claims in Market I so that there is no impact on total demand and therefore no impact on the riskless rate, r. As long as $\theta=0$ continues to hold, banks will increase the supply of safe debt to Market II in response to such demand expansions. However, banks will capture no additional value in so doing. With no change in either θ or ϕ, every bank remains at the same optimal scale [as can be seen from conditions (5) and (6)]. The only change will be value-neutral debt issuances by banks that (i) increase the aggregate supply of safe debt to Market II and that (ii) reduce the amount of safe claims in Market I that is left for agents in that market.

With these progressive expansions in liquid-claim demand, there will eventually come a point where the maximum aggregate quantity of safe debt that banks supply to Market II at $\theta=0$ (given their optimal scale) falls short of aggregate demand in Market II. Given that our model posits diminishing returns to scale, there is no longer a zero net present value way of increasing the supply of debt to Market II at the current levels of ϕ and θ. There will accordingly be upward pressure on θ to induce

(*footnote continued*)
in perfect hedging in Market I to create the safe asset collateral that serves as input to produce the safe debt output for Market II. Our equilibrium analysis is accordingly simpler than the equilibrium analysis in closely related papers by Gorton and Winton (1995, 2000) who assume that liquid claims per se are valuable, but not necessarily perfectly safe, and that banks have risky asset structures. See also Diamond and Rajan (2001) and Holmström and Tirole (2011) for characterizations of equilibrium in other models of intermediation in which liquidity is valuable and assets are risky.

the bank expansion required to support the greater amount of debt needed to meet the unsatisfied liquid-claim demand in Market II.[6] The resultant positive value of θ will engender an increase in the scale of the banking sector to support production of more safe debt to satisfy liquid-claim demand in Market II. With $\theta > 0$, all external funding of banks comes from safe debt issued to parties in Market II.

7. Bank production of liquid claims that are nearly, but not perfectly, safe

When banks have access to perfect/complete markets, they can and will construct perfect asset-side hedges to support abundant safe debt that captures a liquidity premium. This risk-management principle drives our conclusion that high leverage is the right idealized-world baseline for analyzing bank capital structure: With perfect hedging, high leverage is optimal for banks and there is no need for capital regulation because there are no defaults, runs, or systemic risks.

When only imperfect hedging is possible, banks still have an incentive to lever up to capture a liquidity premium, but not as strongly as when they have access to perfect/complete markets. In this case, capital regulation can also generate social benefits. The same is true when banks can hedge perfectly, but some parties are willing to pay a liquidity premium for nearly, but not necessarily perfectly, safe debt. At the same time, however, regulations that limit bank leverage also generally entail social costs when liquid claims are socially valuable, as discussed in Section 8.

Real-world banks do not produce liquid claims that provide 100% assured access to capital with no information sensitivity, as they do in our model. Bank deposits that are nearly, but not perfectly, safe can still provide liquidity benefits and command a premium that encourages banks to have higher leverage than most operating firms. This situation can arise simply because perfectly safe liquid claims are viewed as too expensive, so that bank depositors prefer (suitably priced) liquid claims that pay off fully in almost all states of the world. It can also arise from behavioral factors. For example, as Gennaioli, Shleifer, and Vishny (2012, 2013) emphasize, reaching-for-yield behavior by agents who neglect or mistakenly assess risk can make it advantageous for banks to produce risky near money instead of completely safe debt.

7.1. *Risk-management efficiency governs banks' ability to capture a liquidity premium*

In our model, a liquidity premium is paid only for perfectly safe debt, and so banks focus on hedging strategies that eliminate asset-side risk because doing so maximizes the amount of debt priced to include a liquidity premium that they can issue. There is a similar incentive to build the capacity to issue nearly safe debt when such debt commands a liquidity premium. Now, $\theta > 0$ would apply to riskless and low-risk liquid claims, with θ declining as debt becomes more risky and reaching zero when repayment is sufficiently uncertain that bank debt is not valued for liquidity per se. In this case, banks will use risk-management strategies to dampen, not eliminate, asset-side risk and to create the capacity to produce abundant quantities of nearly safe financial claims that capture a liquidity premium.

The provision of liquid claims that are less than perfectly safe plausibly also reflects the inherent difficulties of constructing comprehensive hedges that eliminate all sources of risk that could prevent a bank from fully paying off its liquid claims in every state of nature. Such risk-management difficulties do not exist in the perfect/complete market settings that yield the MM theorem. But they surely exist in the real world where the relevant risks for liquid-claim production include unknown unknowns that govern left-tail outcomes and that are not easily integrated into conventional finance models.

Under these more realistic demand- and supply-side conditions, banks still have incentives to control the risk of their asset structures to foster liquid-claim production. The better they can control asset-side risks, the greater their ability to lever up and capture a liquidity premium. The main overall implication is that banks have incentives to lever up to capture a premium on liquid claims to the extent that risk management can be used to effectively limit the left-tail risks of their asset portfolios.

7.2. *The efficiency of risk management, left-tail risk, and bank equity*

The efficiency of risk management focused on limiting left-tail risk matters both for the production of liquid claims and for the magnitude of equity required as a cushion to support those claims. In thinking about the role of equity cushions in bank capital structures, it is natural to focus on the downside protection (loss-absorption capability) that equity provides. However, equity also has value because of the potential upside payoffs of the bank's underlying assets. Consequently, a bank can have a very high equity value and a correspondingly low leverage ratio, and yet be a poor producer of liquid claims because its portfolio focuses on assets with potentially large upside payoffs instead of on those with limited downside risk.

Higher bank leverage coupled with risk management that efficiently limits downside risk can therefore generate more value than lower leverage coupled with risk management that is poorly tailored to support safe debt. To see this point, consider a bank with \$1 billion in equity and \$9 billion in debt that receives an equity infusion of \$1 billion, which it invests in at-the-money and near-expiration call options on

[6] Note that ϕ will not increase since there has been no change in the demand for bank loans. Also, it is not possible to overcome the upward pressure on θ by simply expanding the aggregate supply of liquid claims to Market II through entry by additional (marginal) banks. Such entry implies a reduction in the dollar loan premium captured by each bank, i.e., $\phi z I^*$ in condition (5) must decline. The reason is that now more banks in total are pursuing the same total amount of loan business. That will put downward pressure on ϕ and z, which means that condition (5) becomes negative for formerly marginal banks seeking to operate at optimal scale, I^*. To keep those banks from shutting down requires an offsetting increase in θ so that (5) is not violated.

Standard & Poor's (S&P) 500 index. The bank's equity cushion in dollar terms doubles and its debt/(debt + equity) ratio declines from 90% to 82%. However, its capacity to support safe/liquid debt remains virtually unchanged because the incremental investment does essentially nothing to improve the left tail of its asset-value distribution if left-tail outcomes occur when the S&P 500 index performs poorly. A smaller equity infusion of $500 million that is invested in relatively safe assets would support more safe debt even though debt/(debt + equity) is now higher at 86% instead of 82%.

In a similar vein, Hanson, Shleifer, Stein, and Vishny (2014) conclude that different amounts of equity are needed to support buy-and-hold as opposed to collateralized asset-management strategies for liquid-claim production. The general point is that it is not meaningful to speak about the required or desirable magnitude of bank equity cushions without taking into account the nature of a bank's assets and the efficiency of its risk-management strategy.

7.3. Narrow banking

What about the narrow-banking strategy of buying Treasury securities to serve as collateral to support safe/liquid debt? With this approach, there is no left-tail risk only if the Treasuries are of sufficiently short maturity that the bank can use the Treasury proceeds to pay off all its liquid claims.

Narrow banking is potentially problematic for two reasons. First, banking is a spread business, and the return spread between deposits and Treasuries must be large enough to cover the costs of real-world banking. The evidence of Krishnamurthy and Vissing-Jorgensen (2012a, 2012b) indicates that Treasuries are priced at a liquidity premium, which should attenuate the return spread from buying Treasuries that a narrow bank can use to help cover its costs. Consistent with such attenuation, Hanson, Shleifer, Stein, and Vishny (2014) estimate that the returns from Treasury-based narrow banking would barely cover the deposit-related costs of real-world banks.

Second, narrow banks are vulnerable to competition from shadow banks that can offer nearly safe debt with a higher yield than the yield that is attainable if narrow banks invest only in Treasuries with the shortest maturity. This problem also exists for conventional banks, but it is more of an issue for narrow banks because they have less flexibility to adapt on the asset side. The problem is exacerbated in the presence of reaching-for-yield motives for investors, as in Gennaioli, Shleifer, and Vishny (2012, 2013).

These potential problems with narrow banking suggest that how a conventional bank invests the funds raised through deposits and how it manages the risk of its investments are important in enabling it to earn a low-risk return that is high enough to compete for deposits against both narrow and shadow banks. In particular, bank lending can play a complementary role in liquid-claim production. Banks that are efficient at screening credit risks create collateral well suited to supporting capital structures with large amounts of relatively safe debt priced to capture a liquidity premium. Also, as Kashyap, Rajan, and Stein (2002) argue, there are potential synergies in arranging asset collateral to support both deposits and credit-line extensions when deposit withdrawals and line drawdowns are imperfectly correlated.

7.4. Benefits of bank capital regulation

Risks of default, bank runs, and systemic meltdowns are absent from our model, but they are an inherent feature of banking when (i) liquidity demand applies to relatively (but not perfectly) safe debt, either for purely rational reasons or due to reaching-for-yield behavior, and/or (ii) purging of left-tail risk from bank asset portfolios is prohibitively costly. Such risks inevitably exist when these conditions are operative because they imply that risky debt is the only viable way to satisfy liquid-claim demand. Therefore, consistent with the analysis of Diamond and Dybvig (1983), bank defaults, runs, and systemic risks are not prima facie evidence of moral hazard, other agency problems, or tax motives to borrow, although these factors could increase the chances of defaults, runs, and systemic collapse.

As Stein (2012) emphasizes, social costs associated with bank leverage can arise when the production of risky debt comes with an externality – the risk of systemic meltdown – that is not fully priced in the market. The result is socially excessive production of risky liquid claims as banks compete to service the demand for liquidity. Gennaioli, Shleifer, and Vishny (2012, 2013) also discuss the over-production of risky liquid claims and argue that systemic risk arises from imperfect bank diversification coupled with risk-measurement errors, especially correlated mistakes in gauging tail risk.

Regulatory limits on leverage can thus make sense because real-world banks do not fully internalize the costs of system-wide collapse, and so they overproduce risky liquid claims. As we next discuss, there are also potential social costs of capital regulation that should be weighed against the social benefits when regulators set the appropriate ceiling on bank leverage ratios.

8. Capital regulation when liquid-claim production is socially valuable

The optimality of high bank leverage in our model is a baseline, or starting point, for analyzing bank capital structure. It is not a policy recommendation for regulators concerned with reining in systemic risk. The reason is that our stripped-to-the-basics model of banking focuses on banks' role as liquid-claim producers, and excludes taxes, agency problems, imperfect risk-management technologies, and other factors that plausibly influence the leverage of real-world banks.

In this section, we first show how, in our model and contrary to the social-cost neutrality of the debt-equity mix under the MM theorem, there are social costs from bank leverage reductions because of banks' role in producing socially valuable liquid claims. We then move beyond our model to consider real-world banks and discuss why it is implausible that significant decreases in their leverage ratios would neither affect the liquid-claim supply nor entail social costs.

8.1. *Capital regulation in our stripped-to-the-basics model of banking*

In our model, capital regulation that would force banks to reduce leverage has social costs and provides no social benefits. If bank assets are held fixed but banks are required to have more equity, the supply of liquid claims has to fall. Hence, demand for liquid claims that was satisfied before the imposition of capital regulation is no longer satisfied. There are no benefits to offset this social cost in our model because there are no risks of bank runs or systemic meltdown. Such risks are absent in all models, including ours, in which banks can access perfect/complete markets and have incentives to construct perfect asset hedges to support safe debt.

Allowing banks to change the size of their balance sheets in response to the imposition of capital regulation does not eliminate social costs of such regulation in our model. In this case, banks could keep the liquid-claim supply the same, while increasing their equity through stock sales and investing the proceeds in assets held on their balance sheets. This asset expansion would force banks to operate at a suboptimal scale (given that they were optimizing before the regulation was imposed). Alternatively, if banks were to operate at optimal scale and were forced to have more equity and less debt, more banks would be needed to satisfy liquid-claim demand. Consequently, whether individual banks are larger because of capital regulation or more banks are incurring greater total real-resource costs to provide banking services, such regulation imposes social costs in our model.

8.2. *Social costs of capital regulation when banks produce socially valuable liquid claims*

For banks in the real world, is it plausible that capital requirements could be increased at no social cost when they produce socially valuable liquid claims? In their general equilibrium analysis, Gorton and Winton (1995, 2000) show that social costs would arise from forced reductions in the aggregate amount of bank deposits, as households are forced to hold financial claims that are less liquid than they would ideally hold. Intuitively, if bank assets remain the same while banks are required to have more equity, they must have less debt. The greater equity cushion would, of course, make the remaining debt safer. However, the new lower leverage ratio was feasible prior to regulation, and so revealed preference indicates that the nature of liquidity demand by households gave banks the incentive to adopt a capital structure with a higher quantity of less-safe liquid claims. In this sense, capital regulation that curtails the supply of bank deposits entails social costs in terms of an impaired supply of liquid claims.

There is good reason to be concerned that increased capital requirements that force banks to replace a substantial amount of debt with equity would impair the supply of liquid claims. The reason is that most bank debt consists of liquid claims. As Stein (2014, p. 4) notes, "banks are almost always and everywhere largely deposit financed." He bases this conclusion on the descriptive portrait of the capital structures of US commercial banks in Hanson, Shleifer, Stein, and Vishny (2014) who report that, over 1896–2012, the deposit debt of banks averaged 80% of total assets. The remaining 20% of the capital structure contains other liquid claims (e.g., repos and commercial paper), liabilities other than financial debt, and equity, all in addition to non-liquid claim debt. Hence, there is limited scope to reduce the leverage of the commercial banking sector by replacing non-liquid claim debt with equity.

Of course, because leverage=debt/assets, banks could reduce leverage by issuing equity and using the proceeds to expand asset holdings, while leaving the numerator of the ratio unchanged. This scale-expansion strategy, discussed first by Gorton and Winton (2000), is the basis of Admati and Hellwig's (2013, pp. 149, 152) claim that, even when bank debt has social value for its liquid-claim properties, regulators can force severe reductions in bank leverage at zero cost to society. In the Admati and Hellwig view, an equity-financed expansion of bank assets can bear the full brunt of the deleveraging – no debt reduction is needed – and can be effected at no social cost. On the latter point, they disagree with Gorton and Winton (2000), who argue that there would be social costs from an expansion of bank asset holdings.

Paradoxically, these studies consider the same asset-expansion strategy as a way of satisfying mandates to reduce bank leverage, but they reach sharply conflicting conclusions about the existence of social costs of such regulation. Both can't be right.

The key to resolving this paradox is to distinguish between an on-the-margin purchase of one dollar of marketable securities and large-scale expansions in bank asset holdings. An on-the-margin purchase of a dollar of securities plausibly entails negligible social cost. Acceptance of this premise does not mean that the MM theorem applies to banks when liquid claims are socially valuable. The MM theorem is a statement about the value impact of changes in debt when investment policy (i.e., the asset side of the balance sheet) is held fixed. In contrast, the argument at hand that capital regulation has zero social cost holds fixed the dollar amount of debt (to service liquidity demand) and calls for reductions in leverage=debt/assets to be effected entirely through asset expansions. The MM theorem speaks to asset-constant changes in the debt-equity mix, not to the impact of changing asset scale, which is the issue at hand.

Importantly, something akin to a fallacy of composition arises from extrapolating a partial-equilibrium assumption that there are negligible social costs of an on-the-margin increase in assets to a general-equilibrium conclusion that there are no social costs of large-scale expansions in bank asset portfolios. For example, such extrapolation, when taken to the limit, implies the difficult-to-accept conclusion that there would be zero social costs of having one bank, or banks collectively, own all securities issued by all operating firms.

The critical issue, then, becomes the magnitude of security purchases required to effect economically meaningful reductions in bank leverage ratios by scaling up assets and equity. If small increases in bank asset holdings were sufficient to get the job done, then a reasonable basis would exist for viewing substantial limits on bank leverage as essentially free to society.

The problem, as Gorton and Winton (2000) have recognized, is that a massive increase in the size of the banking sector would be required if banks were to deleverage substantially by expanding their asset portfolios (and equity). For example, a 29% expansion in bank asset holdings would be needed to reduce debt/assets from 90% to 70%, while an 80% increase in assets would be needed to reduce debt/assets to 50%. Alternatively, the banking sector would be 4.5 times its current size – a 350% increase in asset holdings – if bank asset expansions were used to reduce debt/assets from 90% to the 20% ratio of the typical industrial firm. The industrial-firm benchmark is relevant here because many economists find it puzzling to observe that banks have much higher leverage than almost all operating firms. A good example is Admati and Hellwig (2013, pp. 7–8), who motivate their claim that there are no social costs of forcing banks to have much lower leverage by suggesting that there is no good reason that banks' leverage ratios are much higher than those of firms such as Apple that have little or no debt.

To put the envisioned banking sector expansion in perspective, note that US commercial banks had $13.9 trillion in assets as of November 2013.[7] A 29% expansion in bank assets would therefore be about $4 trillion. If banks were to replicate the leverage of the typical operating firm, the US banking system would have $62.4 trillion in assets, which is an increase of $48.5 trillion. In contrast, the total stock market capitalization of US equities was $18.7 trillion in 2012. Therefore, to have banks deleverage through a 29% asset expansion, the banking sector would need to buy and hold investments equal in value to 21.4% of all US equities. To have banks match the leverage of the typical operating firm, they could buy and hold securities equal in value to 100% of US equities and still need to find another $29.8 trillion in assets to buy and hold in their portfolios.

We use US equities as a benchmark here simply to demonstrate that a massive reallocation of asset ownership across the economy would be needed if banks deleveraged severely by equity-financed asset purchases. Potentially important social costs from such large expansions of the banking sector include

- exacerbated too-big-to-fail problems,
- portfolio reallocation costs for investors who would need to exchange trillions of dollars of assets (that they had wanted to hold) for newly issued bank equity claims (that they could not easily transform back to the preferred risk profiles of their original portfolios),
- incremental bank asset-management costs as they oversee trillions of dollars in additional investments, and
- the prospect of warped investment and financial decisions at operating firms if banks were to own large voting stakes or debt positions, or both, and exercise influence accordingly.

The general point is that capital regulation that forces material reductions in leverage can generate social costs in a variety of ways due to asset-side effects, as banks expand to satisfy regulatory constraints on leverage while continuing to service liquid-claim demand. It is true that, in principle, banks could preserve the full aggregate supply of liquid claims and deleverage markedly by expanding assets and equity. However, once the magnitude of the required asset expansion becomes clear, it seems doubtful that such a deleveraging of banks could be accomplished at zero social cost. At the very least, evidence is needed to credibly establish that these sources of social costs are empirically unimportant.

Admati, DeMarzo, Hellwig, and Pfleiderer (2011, pp. 50–51) recognize that capital regulation can engender asset-side costs when they note that a mandated decrease in bank leverage that takes place through an expansion of equity and assets could induce greater too-big-to-fail problems at now-larger banks. However, they do not assign much, if any, weight to this potential social cost, suggesting instead that these too-big-to-fail consequences could be offset by dividing banks into smaller entities. This conjecture could prove valid. Again, however, evidence is needed to establish its relevance.

9. Conclusions

High leverage is the baseline optimum for banks that obtains in a stripped-to-the-basics model that has just enough frictions for banks to have a meaningful role in producing socially valuable liquid claims. In this model, high bank leverage is not the result of moral hazard, taxes, or any other distortionary factor that could encourage banks to issue debt. All such factors are absent from our idealized setting. The only motive for banks in our model to issue debt comes from the value they generate by servicing the demand for socially valuable safe/liquid claims.

The model assumes the existence of an exogenous demand for liquid claims in the spirit of Diamond and Dybvig (1983) as well as costs of intermediation that are a function of bank scale and that prevent the unfettered arbitrage that would eliminate a liquidity premium from safe debt prices. (Ample evidence supports the existence of a liquidity premium; see, e.g., Krishnamurthy and Vissing-Jorgensen (2012a, 2012b).) Our model also assumes that banks have access to perfect/complete capital markets, just as in models that yield the MM theorem. It differs from the latter models in that banks have incentives to use their capital-market access to construct hedges that fully offset the downside potential in their risky asset holdings. In so doing, banks build maximum capacity to issue safe debt and generate maximum value from satisfying liquid-claim demand.

Because banks in our model use risk management to ensure that they issue only safe debt, the model contains

[7] The Federal Reserve System and the World Bank are the sources for the statistics given in this paragraph. For data on the total assets of US commercial banks, see http://research.stlouisfed.org/fred2/series/TLAACBQ158SBOG. For data on the total capitalization of US equities, see http://data.worldbank.org/indicator/CM.MKT.LCAP.CD.

no systemic risk and thus no reason for regulatory limits on bank leverage. When one moves beyond our basic setting, there can be large benefits to regulations that limit bank leverage, thereby making bank debt safer and reducing systemic risk.

Although a solid case can be made for capital regulation at real-world banks, the role of banks in producing socially valuable liquid claims indicates there is good reason to question Admati and Hellwig's (2013) claim that severe reductions in bank leverage would entail zero cost to society. The MM theorem does not apply to banks, and social costs can arise if mandated reductions in bank leverage are satisfied by a reduction in the supply of deposit debt or other socially valuable liquid claims.

Admati and Hellwig (2013, p. 149) dismiss liquidity-related concerns about their zero social-cost claim by arguing that large leverage reductions can be effected at zero social cost by increasing bank assets (and equity), while holding the level of bank debt fixed so that liquid-claim demand remains satisfied. This argument is not grounded in the MM theorem, which assumes investment policy (asset scale) is fixed and which is therefore silent about the welfare consequences of asset expansions. It is simply an empirical claim that there would be zero social costs of expanding bank asset holdings.

The problem with this claim is that meaningful reductions in bank leverage ratios (with debt fixed) require large expansions in asset holdings. And it is far from obvious that large expansions in the size of the banking sector could be accomplished at zero social cost. For example, banks would need 29% more in assets to reduce the debt-to-assets ratio from 90% to 70%. US banks had \$13.9 trillion in assets in 2013, and so a 29% expansion would be \$4 trillion, or 21.4% of the total market capitalization of US equities in 2012. Alternatively, if banks were to hold debt fixed and reduce the debt-to-assets ratio from 90% to the 20% ratio of the typical operating firm, they could buy securities equal in value to 100% of US equities and still need to acquire another \$29.8 trillion in assets for their portfolios.

Social costs from such massive expansions of the banking sector plausibly include (1) exacerbated too-big-to-fail problems, (2) portfolio reallocation costs for investors who have to absorb trillions of dollars of new bank equity in lieu of previously chosen (evidently preferred) security holdings, (3) asset-management costs for trillions of dollars in additional bank investments, and (4) warped investment and financial decisions at operating firms if banks were to have large voting stakes, debt positions, or both.

These sources of social cost cannot be dismissed as insubstantial on a priori grounds, as they have the potential to be economically large. A serious quantitative evaluation seems necessary before one could convincingly infer that capital requirements are a free lunch for society irrespective of their level. A more reasonable provisional conclusion is that there are social costs of such regulation that should be weighed against the benefits of reduced systemic risk when regulators set the maximum level of bank leverage.

At the broadest level, this logic indicates that, when liquid claims are socially valuable, an inherent tension exists between regulatory concerns about the appropriate leverage ratios of banks and the size of the banking sector. Because leverage = debt/assets, capital regulation must induce either a reduction in the level of debt, or an increase in bank asset holdings, or both. A reduction in debt runs the risk of materially impairing liquid-claim production, while an increase in assets threatens to exacerbate problems with having a large banking sector. The issues of appropriate leverage and scale for the banking sector are therefore inherently linked when liquid-claim production matters. There is no obvious easy way out.

At the most basic level, our analysis challenges the prominent view among economists that the MM theorem offers the right baseline for thinking about the debt-equity mix of banks. Banks' debt-equity choice matters in our model because the production of safe/liquid debt per se is socially valuable.

Although the MM theorem does not hold, our model's implications are fully compatible with the general MM principle that operating policy is the dominant source of firm value. The reason is that risk management that fosters issuance of abundant safe debt is the optimal operating policy of banks that specialize in liquid-claim production in our model. Without suitable attention to risk management of the asset side of the balance sheet, banks would not be able to generate significant value through their capital structure decisions.

When gauging the amount of safe debt a bank can support, the focus should be on the effectiveness of asset-side risk management in limiting left-tail risk rather than simply on having more equity to reduce leverage. To see why, it is useful to consider an extreme example in which a levered bank obtains a large equity infusion and invests the proceeds in call options on Standard & Poor's 500 Index that are at the money and near expiration. The bank's leverage is now lower, but its capacity to support safe debt is virtually unchanged because the new funds are invested in assets that do essentially nothing to improve the left tail of the distribution of value of its asset portfolio. With more judicious asset-side choices that mitigate downside risk, the bank could produce more safe debt with less equity and a higher leverage ratio. The important point is that, for a bank engaged in liquid-claim production, it is not meaningful to speak about the appropriate amount of equity capital without considering the nature of its assets and the efficiency of risk management in limiting the downside risk of its asset portfolio.

Risk management thus plays a crucial role in our conclusion that high leverage is the right idealized-world baseline for banks. With access to perfect/complete markets as in models that yield the MM theorem, banks can and will eliminate asset risk to support maximal production of safe/liquid claims. Real-world banks obviously do not have access to MM-style capital markets. Their hedging abilities are clearly imperfect, which makes their asset structures less than perfectly safe. Consequently, their ability and incentive to lever up to capture a liquidity premium are not as great as in our model.

Nevertheless, the qualitative effects we highlight are still relevant for understanding why banks pursue leveraged capital structures and why risk management is central to their operating policies. Intuitively, we would say that liquid-claim production by banks is a spread business in which (private and social) value creation comes from the ability to manage downside risk on the asset side of the balance sheet to create relatively safe debt that will command a liquidity premium. More formally, banks have incentives to use whatever (albeit imperfect) risk-management technologies they can to construct asset portfolios with maximal capacity to support the relatively safe debt that captures a liquidity premium. Whether or to what extent a bank should have high leverage thus depends on its ability to limit the left-tail risk of its asset portfolio. If a bank's ability to limit downside asset risk is poor, its capacity to issue relatively safe debt is correspondingly limited. If more extensive reduction of left-tail risk is possible and effective, higher bank leverage is optimal for shareholders and society.

In terms of a positive theory of capital structure, the analysis offers a simple fundamentals-based explanation for why banks have higher leverage than most operating firms. Banks are specialists with a comparative advantage in producing safe/liquid claims, which they supply to parties that willingly pay a premium (accept a rate-of-return discount) for assured access to capital. Banks accordingly generate value by using risk management to construct asset portfolios that can support capital structures with abundant amounts of relatively safe debt claims that command a liquidity premium.

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