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The leverage ratchet effect

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The Leverage Ratchet Effect

Abstract

Shareholder-creditor conflicts can create leverage ratchet effects, resulting in inefficient capital structures. Once debt is in place, shareholders may inefficiently increase leverage but avoid reducing it no matter how beneficial leverage reduction might be to total firm value.

We present conditions for an irrelevance result under which shareholders view asset sales, pure recapitalization and asset expansion with new equity as equally undesirable. We then analyze how seniority, asset heterogeneity, and asymmetric information affect shareholders' choice of leverage-reduction method.

Our results are particularly relevant to banking and highlight the benefit and importance of capital regulation to constrain inefficient excessive borrowing.

1. Introduction

Firms in financial distress can alleviate their distress (assuming they are solvent) by buying back their debt with funds raised through some combination of new share issuance, assets sales, and retained earnings. Yet shareholders often resist such actions and might instead look for additional funding by borrowing, thus increasing their leverage. Firms also tend to increase their leverage in response to changes in the tax code that make borrowing more attractive, but fail to reduce leverage when the tax advantage of debt over equity is reduced.¹ Shareholders, and managers acting to raise shareholder value, consider reducing leverage to be “expensive.”

In this paper we show that conflicts of interest between shareholders and creditors can explain all these observations. Whereas it is well known that such conflicts can lead to inefficient investment decisions, our analysis focuses instead on the agency cost associated with *inefficient capital structure choices* that result from high leverage. We identify a *ratchet effect* that drives shareholders to favor leverage increases even when increases reduce firm value and to resist leverage reductions even when they increase firm value. In other words, leverage begets more leverage, and can become “addictive.” This ratchet effect exacerbates the inefficiencies often attributed to high leverage, namely underinvestment and excessive risk taking (asset substitution).

We show that the effects that existing leverage have on future funding choices are related to, but distinct from, the agency costs of debt that are associated with distortions of investment decisions. The agency costs we study concern the funding side and arise even in a context where real investments are fixed. Resistance to leverage reduction bears similarity to the

¹ See Heider and Ljungqvist (2012).

underinvestment problem typically referred to as debt overhang (Myers, 1977), where a beneficial action is not taken because it benefits existing creditors at shareholders' expense. Inefficient increases in leverage resemble risk-shifting problems, where shareholders take an action for their own benefit that harms existing creditors.

Our analysis assumes that creditors are small and dispersed so that conflicts of interest cannot be dealt with by collective bargaining. Although the terms of existing debt cannot be renegotiated, the debt can be bought back in the open market. In such a buyback, each creditor can choose whether to sell his claims back to the firm or hold on to them. The price at which debt is repurchased must therefore reflect the value of the option of holding on to the debt. This value will be greater than the pre-buyback value of the debt if the leverage reduction reduces the borrower's default probability.²

We show that the resistance of shareholders (or managers working on their behalf) to reducing the firm's leverage once debt is in place applies to any and all forms of leverage reduction. In particular, shareholders will resist leverage reduction even if it does not involve the sale of new shares in the open market but is achieved, for example, selling assets to buy back debt or by retaining earnings.

Asset substitution and underinvestment can lower the total value of the firm. The leverage ratchet can also lower the value of the firm since it induces an inefficient capital structure. However, in sharp contrast to the underinvestment problem, which only occurs when the net

² Such effects are well known from the literature concerning market-based solutions to the sovereign debt crisis of the 1980s. See e.g. the contributions in Frenkel et al. (1989) and Bulow and Rogoff (1990).) The theory developed in that literature was confirmed in the Bolivian debt buyback of 1988 and more recently the Greek debt buyback of 2012. By contrast, van Wijnbergen (1991) showed that, in the 1990 buyback of Mexican debt under the Brady plan, which involved collective bargaining, creditors were forced to agree to terms under which they neither gained nor lost from the buyback. The importance of the difference between collective bargaining and unilateral actions of the debtor is also stressed by Strebulaev and Whited (2012). However, they do not consider buybacks in markets, but study callable debt, where the call option requires a repayment of the amount that was originally borrowed, plus a premium.

present value of the project is not large enough for the shareholders' share of the benefits to cover its cost, shareholders' resistance to leverage reductions can persist no matter how much leverage reduction would increase the total value of the firm. The reason is that shareholders do not capture any benefit brought about by leverage reduction. Hence, the conflict can be extreme.

The leverage ratchet is particularly strong for highly leveraged firms, such as banks. It is therefore critical to understanding the capital structure choices of financial institutions that obtain most of their funding from debt. If their debts are implicitly guaranteed, banks' creditors have fewer incentives to put in place debt covenants that might mitigate the leverage ratchet. Leverage choices can therefore become extremely inefficient, especially since banks have many ways to issue debt that is effectively more senior to prior claims (e.g., because it has shorter maturity or is backed by collateral). Moreover, banks' distress or default can have significant negative external effects. Since the market fails to correct the social inefficiency, effective regulation is essential to correct the resulting distortions.

There are three distinct ways that shareholders can reduce leverage in order to meet covenant restrictions or regulations: (i) pure recapitalization, which involves issuing equity (via a market offering or a rights issue) and using the proceeds to buy back debt without any change in (operating) assets, (ii) "deleveraging" which involves selling assets to generate the proceeds used to buy back debt, and (iii) asset expansion in which the proceeds of a new equity issuance are used to acquire new assets.³ We examine shareholder incentives to choose one of these ways over the others.

³ The requirements specified in Basel II and Basel III are based primarily on the ratio of equity to risk-weighted assets, rather than the ratio equity to total assets, the so called "leverage ratio." We abstract from risk weights in much of our analysis by assuming that assets are homogenous. The general case of non-homogeneous assets and the effect of risk weights are discussed in Section 4.2.3.

In comparing these three modes of leverage reduction, we obtain a striking irrelevance result: If there is one class of debt outstanding, assets are homogeneous, and sales or purchases of assets do not, by themselves, generate value for shareholders, then shareholders are indifferent between asset sales, pure recapitalization and asset expansion. All are equally undesirable from the perspective of shareholders.

We then examine a number of factors that influence shareholders' choice of how to reduce leverage when the conditions of the irrelevance results do not hold. For example, we show that when there are multiple classes of debt and in the absence of covenants that prevent it, shareholders will buy back the most junior debt before repurchasing debt with higher priority. When shareholders have the ability to buy back junior debt in this way, they will tend to prefer deleveraging through asset sales over the other two approaches. We discuss how transaction costs and asymmetric information can potentially make each of the other modes preferable from the shareholders' perspective.

The ratchet effect we identify is related to the concept of debt overhang in Myers (1977). Myers showed that when debt is in place, shareholders may avoid taking valuable projects that they would have undertaken in the absence of debt. This underinvestment can occur when the shareholders bear the full costs of any project the firm undertakes, but the benefits are shared with existing creditors. Our analysis shows that a similar conflict of interest arises in shareholder attitudes towards reducing leverage. However, as mentioned above, unlike the underinvestment problem which is resolved when the benefits of investing are large enough, the leverage ratchet problem persists no matter how large are the benefits of reducing leverage.

Resistance to raising new equity is often explained by alluding to asymmetric information along the lines of Myers and Majluf (1984).⁴ The Myers-Majluf analysis, however, is strictly limited to situations in which the firm issues new shares to raise equity and is based solely on the dilution that occurs when the market undervalues the firm's shares due to asymmetric information. The Myers-Majluf effect cannot in any way explain shareholders' unwillingness to reduce leverage in ways that do not involve the issuance of common shares, e.g., through rights offerings or retaining earnings, since neither of these involve a loss due to the market undervaluing shares. The behavior of heavily indebted firms such as banks, which often make payouts to shareholders and avoid making rights offerings, is much more consistent with the ratchet effect that we discuss here than with problems related to asymmetric information

Asymmetric information also cannot explain the universal resistance to increases in equity requirements in the banking industry. If leverage reductions are imposed by regulation, there is not much room for adverse selection. Any "dilution costs" for the shareholders of firms with above-average return prospects should be matched by benefits for the shareholders of firms with below-average return prospects. Yet all banks resist higher equity requirements.

In an earlier paper (Admati et al. 2011) we considered banks' total funding costs and argued that there are essentially no social costs to having significantly less leverage in banking, because the benefits to banks from high leverage are only due to debt subsidies, which come at taxpayers' expense despite the fact that high leverage increases the fragility of the financial system and makes for inefficient investment decisions due to the agency costs of debt. The current paper, in contrast to Admati et al. (2011), considers leverage decisions from the perspective of shareholders and managers in the already-indebted firm.

⁴ See for example Bolton and Freixas (2006), Kashyap, Hansen, and Stein (2010).

The resistance of shareholders to leverage reduction due to conflicts between shareholders and creditors does not rely on frictions created by government policies, and is present even under the “no friction” assumptions of the Modigliani-Miller (1958) irrelevance result. We do show that the effect is exacerbated by debt subsidies and, as discussed above, by explicit and especially implicit debt guarantees. The results of this paper strengthen our conclusion that in the context of banking effective capital regulation is essential and have other implications for both the transition to higher equity requirements and to its ongoing practice.

In theoretical and empirical studies of capital structure, the standard assumption is that firms act to maximize their total value. Although it is widely recognized that the interests of shareholders are no longer consistent with maximizing the total value of the firm, this observation is almost exclusively applied to investment decisions once debt is in place, and it has not been carefully explored, as we do here, with respect to funding decisions.

In the literature on dynamic capital structure, it is common to explore shareholders’ decisions with respect to payouts and default without allowing changes in the capital structure (prior to default). Papers that allow adjustments in capital structure often assume that it is prohibitively costly to reduce leverage in distress, or that debt can only be recalled at par or at a premium.⁵ By contrast, our analysis realistically allows debt to be bought back in the market at competitive prices.⁶ In addition, we allow funds to be raised by selling assets or issuing equity through common share or rights offerings. Unlike much of the literature, our key results do not depend on any assumptions about exogenous transactions costs.

⁵ For discussion and references to the literature, see Strebulaev and Whited (2012).

⁶ Some papers make the assumption that new debt can be issued *pari passu* with existing debt, which can help overcome the underinvestment problem identified in Myers (1977). Unless existing creditors benefit from additional investments, issuing such debt can reduce the value of existing creditors and violates their seniority. In the spirit of Myers (1977), we assume for most of our analysis that violating the seniority of existing creditors is not possible.

The paper is organized as follows. Section 2 presents the basic model. Section 3 analyzes pure recapitalization as viewed from shareholders’ perspective and derives the key ratchet effect of leverage. In Section 4 we consider alternative ways for a firm to reduce leverage other than pure recapitalization. Section 5 discusses the application of our analysis to banking and the role of capital regulation. Section 6 provides concluding remarks.

2. The Basic Model

We consider a firm that has made an investment in risky assets and has funded itself with debt. To explain our results in the simplest possible terms, we begin with a simple and standard “tradeoff” model of capital structure, which we will generalize later as we examine additional frictions. For our basic argument, we make the following assumptions:

Firm Investment: The firm has made a real investment A in the past (“date 0”). Investment returns are realized at date 2 and are given by a random variable $\tilde{x}A$.

Firm Liabilities: We assume that the firm is funded by equity, and a total debt claim of D against the firm that is due at date 2, the date at which the asset return of $\tilde{x}A$ is realized. If $\tilde{x}A \geq D$, debt claims are honored in full.

We begin by considering three “frictions” that affect the payouts of the firm’s securities at date 2. These are taxes, bankruptcy costs, and third party (government) subsidies.

Taxes: We assume that a tax may be applied to those returns earned on the firm’s assets that exceed what is paid to the debt holders. The tax is given by $t(\tilde{x}, A, D) \in [0, \tilde{x}A - D]$ when $\tilde{x}A > D$. We assume that no tax is paid when $\tilde{x}A \leq D$. Finally, we assume that the total tax liability is weakly decreasing in D , i.e. $t_D(\tilde{x}, A, D) \leq 0$.⁷

Net default costs: If $\tilde{x}A < D$, the firm is unable to fulfill its obligation to debt holders and must default unless it receives a subsidy from the government or some

⁷ Note that there may be other effects of leverage on equity holders that can be included in the function t . For example, if debt plays a “disciplining role” as in Jensen (1986) or we can think of t as capturing any losses resulting from a lack of discipline. Alternatively, there may be ex ante costs to equity associated with leverage, such as increased wages as in Berk, Stanton, and Zechner (2010). The key assumption is that on the margin, tax shields and disciplining benefits, net of any costs, are weakly increasing in D .

other third party. Let $n(\tilde{x}A, D)$ be the *net* default costs for the firm, which is the difference between the bankruptcy cost and any third party subsidy. In the event that $\tilde{x}A > D$, there are no subsidies and no bankruptcy costs and thus $n(\tilde{x}A, D) = 0$. If $\tilde{x}A < D$, we assume that $\tilde{x}A - n(\tilde{x}A, D) \in [0, D]$. Note that the net default costs could be negative if the subsidy exceeds the bankruptcy cost – which means that the firm’s debt holders will receive *more* than $\tilde{x}A$ – but we assume that, at best, subsidies bring the available funds up to the amount that is needed to avoid default

Given these assumptions, the payoffs on the firm’s debt and its equity are those given in the following table:

	If $\tilde{x}A < D$	If $\tilde{x}A \geq D$
Payoff to Shareholders	0	$\tilde{x}A - t(\tilde{x}, A, D) - D$
Payoff to Debt Holders	$\tilde{x}A - n(\tilde{x}A, D)$	D

Pricing at Date 1: All securities are traded in perfect Walrasian markets. The prices of securities at date 1 are equal to the expectations of their payoffs with respect to the *risk-neutral* distribution function F of the return on the firms’ asset, \tilde{x} . The distribution function F has full support on $[0, \infty)$. We assume that the firm takes F as given and independent of its leverage choice.⁸

Given our assumptions about payouts and pricing, it follows that at date 1 the values of the firm’s debt and its equity are:

$$\begin{aligned} \text{Total value of debt} &= V^D(D, A) \\ &= \int_{D/A}^{\infty} D \, dF(x) + \int_0^{D/A} (\tilde{x}A - n(\tilde{x}A, D)) \, dF(x) \end{aligned} \quad (1)$$

and

$$\text{Value of equity} = V^E(D, A) = \int_{D/A}^{\infty} (\tilde{x}A - t(\tilde{x}, A, D) - D) \, dF(x). \quad (2)$$

⁸ The existence of such a distribution (or pricing kernel) F follows from the absence of arbitrage opportunities. We assume the firm acts as a price-taker with respect to this pricing kernel. Thus, as is standard in the corporate finance literature, we are ignoring any general equilibrium consequences of the individual firm’s security choices on the equilibrium pricing kernel.

3. Debt Overhang and Recapitalization

In this section, we assume that the real investments of the firm, which were made in date 0, are fixed and will not be changed. We examine the effects of reducing the firms' leverage through a pure recapitalization that involves the firm issuing new equity and buying back some of its debt. We assume that the debt must be bought back at the prevailing market price. Because debt holders are free to choose between selling the debt securities and keeping them, the market price must be such that, at the margin, debt holders are indifferent. We also assume that new equity will be issued at the market price, reflecting the post-recapitalization value of a share.⁹

In Section 3.1 we show that incumbent shareholders are made worse off by a recapitalization that reduces leverage, and thus they would not voluntarily choose to engage in it. While it is perhaps not surprising that debt overhang can create a cost to shareholders associated with a recapitalization, we demonstrate that the resistance to leverage reduction is much more powerful than the underinvestment identified by Myers (1977) in that it is *universal*: shareholders will resist a recapitalization that involves repurchasing risky debt no matter how little the leverage the firm currently has, and no matter how large the benefit is in terms of reduced default costs.

In Section 3.2, we generalize our model to consider additional costs of leverage stemming from shareholder-debt holder conflicts. Specifically, we consider the possibility of asset substitution (risk-shifting) and future underinvestment. These costs raise the potential benefits to the firm from reducing leverage. Nonetheless, we show that no matter how large these costs are, and how over-leveraged the firm currently is, shareholders will still resist any attempt to recapitalize the firm in order to reduce these costs. Indeed, their resistance is stronger if the leverage reduction reduces future incentives for asset substitution and underinvestment.

Thus, we can think of shareholder resistance to value-enhancing leverage reductions as an additional agency cost associated with debt overhang that lowers the *ex ante* value of the firm. The resulting dynamics of capital structure choices have a ratchet effect, where once leverage is in place, shareholders frequently have incentives to increase it when permitted to do so, but will resist decreasing it unless forced to do so, since decreases transfer wealth from them to

⁹ Of course, the issuance and buyback prices may also be affected by transactions costs and asymmetric information, which we consider in Section 4.

incumbent debt holders. The ratchet effect effectively creates an “addiction” to leverage which we formalize in Section 3.3. As a result, regulation that forces recapitalization can actually serve as a commitment device that can increase the ex-ante value of the firm.

3.1 The Impact of Recapitalization on Shareholders

We begin by assuming that the firm has issued at time 0 a single class of debt with face value D . Equation (1) above implies that the current market price of debt per unit of nominal face value is equal to:

$$\begin{aligned}
 q(D, A) &= \frac{V^D(D, A)}{D} \\
 &= \int_{D/A}^{\infty} dF(x) + \int_0^{D/A} \frac{x A - n(\tilde{x} A, D)}{D} dF(x).
 \end{aligned} \tag{3}$$

Suppose that, at date 1, the firm considers buying back debt with a nominal claim equal to Δ . If the firm wants to buy back debt in the open market, it cannot do so at the price given in (3). The repurchase price must be such that debt holders are at the margin indifferent between selling debt and holding on to it. The buyback price of the debt must therefore be equal to the market price $q(D - \Delta, A)$ that prevails at the post-buyback debt level.¹⁰

We assume that incumbent shareholders assess such a buyback only on the basis of what it does to their wealth.¹¹ This assessment depends only on whether the difference between the market value of the firm’s equity with and without the buyback, $V^E(D - \Delta, A) - V^E(D, A)$, exceeds the cost $q(D - \Delta, A) \times \Delta$. The following proposition shows that the answer to this question is unambiguously negative.

Proposition 1 (Shareholder resistance to Recapitalization): *Equity holders are strictly worse off issuing securities to recapitalize the firm and reduce its outstanding debt. The loss to equity holders is mitigated by bankruptcy costs, and increased by the presence of taxes or default subsidies.*

¹⁰ For extensive discussions of this point, see Frenkel et al. (1989) and Bulow and Rogoff (1990).

¹¹ Recall that we are assuming that security values are determined by the pricing kernel F , which is unaffected by the firm’s leverage. Thus the impact on investor wealth is sufficient to determine shareholder preferences.

Proof: From (2) we have:

$$\begin{aligned}
V^E(D-\Delta, A) - V^E(D, A) &= \Delta \times \left(1 - F\left(\frac{D-\Delta}{A}\right) \right) + \int_{(D-\Delta)/A}^{D/A} (xA - D) dF(x) \\
&\quad - \int_{(D-\Delta)/A}^{\infty} t(x, A, D-\Delta) dF(x) + \int_{D/A}^{\infty} t(x, A, D) dF(x)
\end{aligned} \tag{4}$$

In words, the first term captures the fact that the firm avoids paying the incremental debt Δ when it remains solvent, the second term captures the loss of equity's default option given final asset values between $D-\Delta$ and D , and the final two terms capture the change in the tax burden. Therefore, because the second term is negative and because taxes are non-increasing in D , we have

$$V^E(D-\Delta, A) - V^E(D, A) < \Delta \times \left(1 - F\left(\frac{D-\Delta}{A}\right) \right) \leq \Delta \times q^D(D-\Delta, A). \tag{5}$$

The second inequality holds because, by (3), the final price of the debt, $q(D-\Delta, A)$, cannot be lower than the probability that the firm does not default (and will be strictly higher if there is a positive expected recovery value).

Thus, the increase in the total value of equity from a recapitalization, $V^E(D-\Delta, A) - V^E(D, A)$, is more than offset by the cost $\Delta \times q(D-\Delta, A)$ of the debt repurchase. The loss to shareholders is magnified if the debt tax shield increases with increases in debt, which we can see from (4). The loss is decreasing in expected net default costs, $\int_0^{(D-\Delta)/A} n(xA, D-\Delta) dF(x)$, as default costs reduce the expected recovery value of the debt and thus lower the difference between $q^D(D-\Delta, A)$ and the probability the firm does not default, i.e., $1 - F((D-\Delta)/A)$ in the final inequality. ■

The shareholders' resistance to a recapitalization in Proposition 1 does not depend on the tax benefits of leverage. Even though shareholders may buy back debt at a discount relative to its face value, this discount is insufficient. By reducing the firm's debt from D to $D-\Delta$,

shareholders forfeit the option to default when returns are between $D - \Delta$ and D ; in a buyback at the price $q^D(D - \Delta, A)$, they do not receive compensation for the loss of this option. If the recapitalization makes expected tax payments go up, shareholder resistance intensifies, and the conclusion of the proposition remains true even if the distribution F does not have full support and the option to default when returns are between $D - \Delta$ and D plays no role.

Finally, note that shareholders will resist a recapitalization even if the benefit to firm value will be large due to a reduction in default costs. Indeed, the magnitude of current default costs (with debt level D) does not enter the proof at all. Default costs only matter in that they may reduce the buyback price $q^D(D - \Delta, A)$, but they cannot reduce it sufficiently to make a recapitalization attractive to shareholders.

So far we have assumed that the firm has only a single class of debt outstanding. If the firm has several classes of debt outstanding, shareholders will find it most attractive to buy back the cheapest class first, which will be the most junior class of debt? The buyback price of these junior classes must be at least $(1 - F((D - \Delta) / A))$ and will not exceed $q(D - \Delta, A)$. Since $(1 - F((D - \Delta) / A))$ is the lower bound on the buyback price, the proof of Proposition 1 therefore establishes that a debt repurchase is unattractive to shareholders even if the firm is able to repurchase the least expensive debt claims when multiple claims exist. This gives us the following important generalization:

Proposition 2 (Shareholder Resistance to any debt buybacks): *Equity holders are strictly worse off issuing securities to recapitalize the firm by repurchasing any class of outstanding debt.*

Propositions 1 and 2 refer to the preferences of equity holders. When default is costly to the firm, the interests of equity holders will be in conflict with maximization of total firm value. For example, if taxes and subsidies are zero while bankruptcy costs are not, then a recapitalization and buyback of risky debt raises the value of the firm (i.e. the combined wealth of shareholders and debt holders jointly). Yet, shareholders consider such a move harmful to their interests.

It follows that debt overhang can give rise to situations in which shareholders and debt holders jointly would benefit from a recapitalization, yet shareholders would not find it in their interest to recapitalize. The benefits from the debt buyback are due to the reduction of bankruptcy costs. However, with debt already in place, all of the benefits produced by a debt buyback accrue to debt holders. Since shareholders are unable to appropriate any of the gains due to reduced bankruptcy costs, and since they must buy back the debt at a price that reflects the reduced risk of debt holders after the buyback, shareholders will resist a recapitalization.

The observation that shareholders resist a recapitalization even when it would raise the value of the firm stands in contrast to the standard “tradeoff theory” of capital structure that was pioneered by Modigliani and Miller (1963), where firms choose their debt levels so as to maximize total firm value given the countervailing frictions of tax benefits and distress and agency costs associated with leverage. In the standard “tradeoff theory”, where capital structure decisions are taken *ex ante*, before any debt has been issued, shareholder value maximization and firm value maximization lead to the same results. However, once there is debt overhang, shareholder value maximization and firm value maximization may be in conflict as shareholders do not take sufficient account of the effects of their choices on debt holders.¹²

Our results show that the consequences of debt overhang in the context of recapitalization differ from those in the standard debt overhang problem described in Myers (1977), which can lead to underinvestment. When a firm must issue equity to undertake a valuable project, the loss to the shareholders due to the wealth transfer to risky debt holders brought about by the reduction in leverage can be more than offset by the positive net present value (NPV) of the project, a portion of which the shareholders capture. Thus, if the NPV of the project is large enough, there is no underinvestment problem and the outcome is efficient. By contrast, when a debt buyback would increase the total firm value, debt overhang always results in a loss of efficiency. No matter how large the gain in value, shareholders will always resist the recapitalization.

¹² This point is central to the literature on dynamic theory of capital structure, see for example Strebulaev and Whited (2012). However, despite its name, this literature is more concerned with the dynamics of default and investment decisions for a given capital structure than with the evolution of capital structure through new issues and repurchases of debt and equity. Moreover, leverage changes are often restricted exogenously; e.g. Bhamra et al. (2010, p. 1499) state “In common with the literature, we assume that refinancings are leverage increasing transactions since empirical evidence demonstrates that reducing leverage in distress is much costlier.”

Matters would be different if there were collective bargaining about the price of debt in the buyback.¹³ For example, if debt contracts had collective action clauses, the firm's management, acting on behalf of shareholders, could negotiate a buyback agreement with debt holder representatives. In such negotiations, and with the no-buyback outcome as a default option, debt holders would end up sharing their gains from the buyback with the shareholders. This sharing of gains cannot be achieved in a market buyback. And even in a negotiation, if debt holders are dispersed, holdouts could be likely. In other words, at terms for which shareholders would not resist a recapitalization, we would expect (at least some) debt holders to resist, precluding a purely voluntary leverage reduction.

3.2. Leverage and Investment Distortions

Our analysis thus far has focused on a specific debt-equity conflict, recapitalization. But the presence of leverage in the firm is likely to lead to additional debt-equity conflicts related to investment. In particular, leverage may induce equity holders to increase the risk of the firm's assets via asset substitution (as in Jensen and Meckling, 1976), or to fail to undertake new investment opportunities (as in Myers, 1977). In this section we generalize our analysis to allow for both asset substitution and underinvestment. These agency frictions raise the cost of leverage for total firm value, and thus increase the potential benefit of a recapitalization. Yet we will show that despite this benefit, future debt-equity conflicts only *increase* shareholder resistance to any recapitalization.

To see the intuition for this result, consider first the case of asset substitution. Suppose the distribution of asset returns, x , may be affected by actions taken by shareholders (or managers acting on behalf of shareholders). We denote these actions by θ , and the resulting asset returns by x_θ , which has distribution $F(x|\theta)$. In this setting, it is natural to extend our notation and define the value of equity as follows:

¹³ In a different setting the impact of collective bargaining on debt dynamics is also noted by Strebulaev and Whited (2012).

$$\begin{aligned}
V^E(D, A) &\equiv \max_{\theta} V^E(D, A, \theta) \\
&= \max_{\theta} \int_{D/A}^{\infty} (xA - t(x, A, D) - D) dF(x|\theta)
\end{aligned} \tag{6}$$

We assume in (6) that the actions θ are taken to maximize the value of equity. Let θ^* be the action choice at the target level of debt, $D - \Delta$, i.e.,

$$\theta^* \equiv \arg \max_{\theta} V^E(D - \Delta, A, \theta) \tag{7}$$

To see that asset substitution increases shareholder resistance to a recapitalization, note that

$$\begin{aligned}
V^E(D - \Delta, A) - V^E(D, A) &= V^E(D - \Delta, A, \theta^*) - \max_{\theta} V^E(D, A, \theta) \\
&\leq V^E(D - \Delta, A, \theta^*) - V^E(D, A, \theta^*)
\end{aligned} \tag{8}$$

Thus, the increase in the value of equity post-recapitalization is even smaller now than in the setting without agency costs (that is, with θ fixed at θ^* , the level of risk that shareholders would choose given lower leverage).

As the above argument reveals, the result that agency costs increase shareholders' resistance to recapitalization follows directly from their most basic consequence for the equity value function. Thus, we can apply the same argument to demonstrate that *any* shareholder discretion over future firm investment will lead to a similar result.

For example, suppose that in addition to determining asset risk θ , management (on behalf of shareholders) has the opportunity to invest in additional assets a by raising capital k from shareholders (or reducing planned equity payouts). Moreover, suppose these decisions will be made at a later date and conditional on some future information z that is relevant to both asset returns and the profitability of the investment opportunity. In this case, in addition to asset substitution, leverage may lead to future underinvestment due to the traditional debt overhang problem identified by Myers (1977). The next result demonstrates that, once again, the possibility of future underinvestment and risk shifting, while detrimental to total firm value, will only increase the cost to shareholders from a current recapitalization.

Proposition 3: *Although shareholder-creditor conflicts regarding investment may raise the benefits of a leverage-reducing recapitalization for total firm value, they also raise the costs of a recapitalization for shareholders relative to a setting in which investments were fixed at the optimal policy given lower leverage.*

Proof: Letting $k(a, z)$ be the cost of making investment a given information z , we have the following representation for the equity value function conditional on the investment policy functions $a(z)$ and $\theta(z)$:

$$V^E(D, A) \equiv E_z \left[\int_{D/(A+a(z))}^{\infty} (x(A+a(z)) - t(x, A+a(z), D) - D) dF(x|z, \theta(z)) - k(a(z), z) \right] \quad (9)$$

Note that the expectation in (9) is with respect to the information z . Then, using the same argument as in Proposition 1, holding the policy functions fixed,

$$\begin{aligned} V^E(D - \Delta, A) - V^E(D, A) = & E_z \left[\Delta \times \left(1 - F \left(\frac{D - \Delta}{A + a(z)} \middle| z, \theta(z) \right) \right) + \int_{(D - \Delta)/(A + a(z))}^{D/(A + a(z))} (x(A + a(z)) - D) dF(x|z, \theta(z)) \right. \\ & - \int_{(D - \Delta)/(A + a(z))}^{\infty} t(x, A + a(z), D - \Delta) dF(x|z, \theta(z)) \\ & \left. + \int_{D/(A + a(z))}^{\infty} t(x, A + a(z), D) dF(x|z, \theta(z)) \right] \quad (10) \\ < E_z \left[\Delta \times \left(1 - F \left(\frac{D - \Delta}{A + a(z)} \middle| z, \theta(z) \right) \right) \right] \\ = \Delta \times \Pr [x_{\theta(z)}(A + a(z)) > D - \Delta] \end{aligned}$$

As in Proposition 1, the inequality follows because shareholders forfeit their default option for final asset values between $D - \Delta$ and D , and have a higher expected tax burden. The last equality states that the increase in the value of equity per dollar of debt repurchased is less than the ex-ante probability of no default at the lower level of leverage.

The proof then follows using exactly the same argument as in (8) above. Let θ^* and a^* be the optimal risk and investment policy functions for equity holders given debt $D - \Delta$:

$$V^E(D - \Delta, A) = \max_{\theta, a} V^E(D - \Delta, A, \theta, a) = V^E(D - \Delta, A, \theta^*, a^*) \quad (11)$$

Then,

$$\begin{aligned} V^E(D - \Delta, A) - V^E(D, A) &= V^E(D - \Delta, A, \theta^*, a^*) - \max_{\theta, a} V^E(D, A, \theta, a) \\ &\leq V^E(D - \Delta, A, \theta^*, a^*) - V^E(D, A, \theta^*, a^*) \\ &< \Delta \times \Pr \left[x_{\theta^*(z)}(A + a^*(z)) > D - \Delta \right] \\ &\leq \Delta \times q^D(D - \Delta, A) \end{aligned} \quad (12)$$

The first inequality follows since we have fixed the investment policy functions at a level that may not be optimal with higher leverage (due to agency costs), the second follows from (10) above, and the third follows since the repurchase price of the debt will be at least the no default probability (and will be strictly higher if the debt has a non-zero recovery rate in any default states). ■

3.3. The Leverage Ratchet Effect

The standard “tradeoff theory” of capital structure posits that firm’s choose debt in order to maximize total firm value given the countervailing frictions of tax benefits and distress and agency costs associated with leverage. Our prior results suggest, however, that once leverage is already in place, debt overhang will create a powerful dynamic that will distort shareholder incentives. In particular, we show that not only will the shareholders not choose to reduce leverage, they will *always* prefer to *increase* leverage if they have the opportunity to do so, and even if this additional leverage further reduces firm value. In other words, leverage begets additional leverage, creating a leverage ratchet effect.¹⁴

To demonstrate the leverage ratchet effect, consider our setting with taxes, default costs, and asset substitution, and suppose that debt is “fully prioritized” so that any debt repurchased or

¹⁴ This result is closely related to results in Bizer and DeMarzo (1992) and Brunnermeier and Oehmke (2012), where they show that given an inability to commit, shareholders will prefer to issue additional debt. Brunnermeier and Oehmke focus on the case of short-term debt (which has effective seniority over existing debt), whereas Bizer and DeMarzo demonstrate that the incentive exists even with long-term junior debt, if there are additional investment distortions induced by agency costs of leverage.

issued is junior to all other outstanding debt claims. Because junior debt is the cheapest to repurchase and the least attractive to issue, this assumption makes repurchasing debt as attractive as possible, and avoids any direct “dilution” of debt if new debt is issued. Nonetheless, we show that a levered firm will always find it optimal to increase its leverage. To see why, note that the gain to shareholders to changing debt from D to $D + \Delta$ is

$$G(D, D') = V^E(D', A) - V^E(D, A) + (D' - D)q^J(D, D', A) \quad (13)$$

where $q^J(D, D', A)$ is the average price of the junior debt with face value from D to D' . We have the following result:

Proposition 4: (Leverage Ratchet Effect) *Given initial debt D , suppose the firm has the opportunity to adjust its debt on a one-time basis. Then,*

- *If the firm has no initial debt, then the amount of debt D to issue that maximizes shareholders' gain $G(0, D)$ also maximizes the total value of the firm.*
- *If the firm has outstanding debt $D > 0$, and the marginal tax benefit of debt is positive ($t_D(x, A, D) < 0$ for some non-null set of x), then it is always optimal for shareholders to increase leverage by issuing new junior debt ($\arg \max_{D'} G(D, D') > D$), even if this new debt reduces total firm value.*

Proof: Note that $q^J(0, D, A) = q(D, A)$, and therefore $Dq^J(0, D, A) = V^D(D, A)$. Hence,

$$\begin{aligned} G(0, D) &= V^E(D, A) - V^E(0, A) + Dq^J(0, D, A) \\ &= V^E(D, A) + V^D(D, A) - V^E(0, A) \end{aligned} \quad (14)$$

Thus, D maximizes $G(0, D)$ if and only if it maximizes total firm value.

For the second result, note that our earlier results already establish $G(D, D') \leq 0$ if $D' \leq D$; that is, equity holders will not benefit from a reduction in leverage. Therefore, it is enough to establish that the marginal benefit of an increase in leverage from its current level is positive. Note that

$$\left. \frac{\partial G(D, D')}{\partial D'} \right|_{D'=D} = \left. \frac{\partial (V^E(D', A) + (D' - D)q^J(D, D', A))}{\partial D'} \right|_{D'=D} \quad (15)$$

Let θ^* be the optimal risk choice with debt level D . From the definition of V^E ,

$$\begin{aligned} \left. \frac{\partial V^E(D', A)}{\partial D'} \right|_{D'=D} &= \max_{\theta} \frac{\partial}{\partial D'} \left[\int_{D'/A}^{\infty} (xA - t(x, A, D') - D') dF(x|\theta) \right] \Big|_{D'=D} \\ &= - \int_{D'/A}^{\infty} dF(x|\theta^*) - \int_{D'/A}^{\infty} t_D(x, A, D) dF(x|\theta^*) \end{aligned} \quad (16)$$

Next, note that

$$\left. \frac{\partial ((D' - D)q^J(D, D', A))}{\partial D'} \right|_{D'=D} = q^J(D, D, A) \geq \int_{D/A}^{\infty} dF(x|\theta^*) \quad (17)$$

That is, the marginal dollar of junior debt is worth at least its payoff in the event of no default (and could be higher in the presence of default subsidies). Thus,

$$\left. \frac{\partial G(D, D')}{\partial D'} \right|_{D'=D} \geq - \int_{D/A}^{\infty} t_D(x, A, D) dF(x|\theta^*) > 0 \quad (18)$$

■

To illustrate the ratchet effect, we consider an explicit example. Normalize the asset size to $A = 1$, and let returns have a binary distribution with either a zero payoff (failure) or a positive payoff (success), where the amount and likelihood of the positive payoff is subject to some degree of discretion. Specifically, we assume that once any debt is in place, the probability of success p is chosen by equity holders from the interval $[p_0, p_1]$, and the payoff of the assets given success is given by $g(p)$. The expected payoff is thus $m(p) \equiv pg(p)$, which we assume has the following form:¹⁵

$$m(p) = \mu - \frac{(p^* - p)^2}{2\lambda} \quad (19)$$

¹⁵ This particular functional form is for simplicity; the specific choice has no qualitative impact on the key results.

where $p^* \in (p_0, p_1)$ is the first-best risk choice. We restrict parameters so that $m(p_0) - p_0 m'(p_0) \geq 0$, which together with the concavity of m implies that $g(p) = m(p)/p$ is strictly decreasing in p on its domain.¹⁶

Next, we assume all payments to equity holders are taxed at rate τ , whereas payments to debt holders are tax free. Given this specification, and given face value of debt $D \leq g(p_0)$, the value of equity is given by

$$V^E(D) = \max_p (1-\tau) p (g(p) - D) = (1-\tau) \max_p (m(p) - pD) \quad (20)$$

Therefore, we can solve for the equity's optimal risk choice from the first-order condition $m'(p) = D$, which implies

$$p(D) = \max \{ p^* - \lambda D, p_0 \} \quad (21)$$

In other words, the probability of success falls as D increases, as equity holders find it optimal to engage in increased asset substitution. Total firm value is given by

$$\begin{aligned} V^E(D) + V^D(D) &= (1-\tau) (m(p(D)) - p(D)D) + p(D)D \\ &= (1-\tau) m(p(D)) + \tau p(D)D \end{aligned} \quad (22)$$

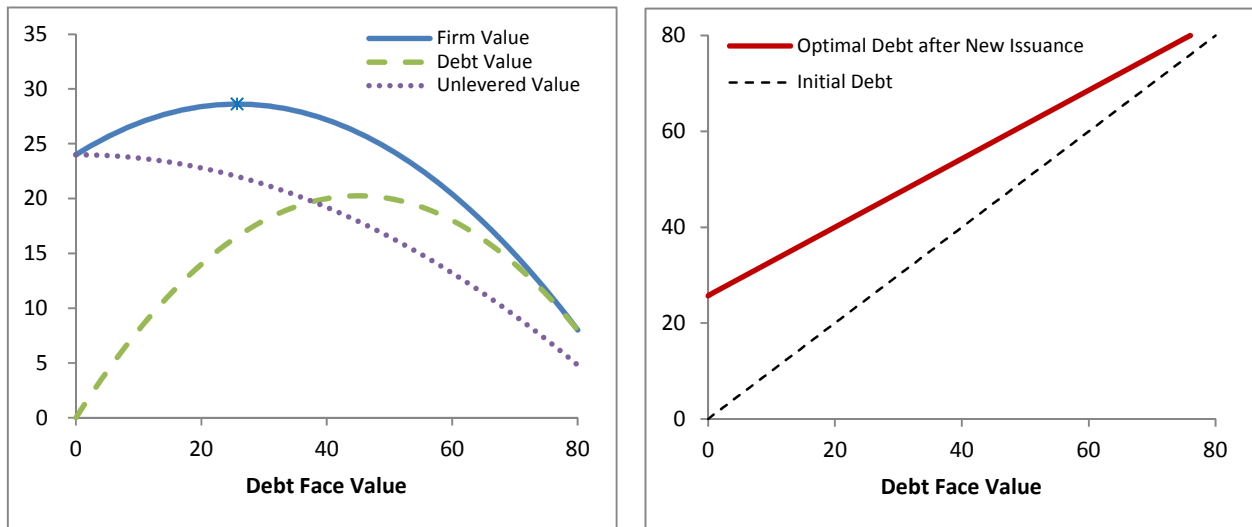
Because of the debt tax shield, total firm value is maximized with a positive level of debt \hat{D} and corresponding second-best risk choice \hat{p} where

$$\hat{p} = \frac{p^*}{(1+\tau)} \quad \text{and} \quad \hat{D} = \frac{\tau p^*}{(1+\tau)\lambda} \quad (23)$$

¹⁶ This assumption is to assure a conflict of interest; projects where $g(p)$ is increasing would never be chosen, as a safer project with a higher payoff would dominate for both equity and debt holders.

Figure 1 below illustrates this example with parameter choice of $\mu = 40$, $p^* = 90\%$, $p_0 = 10\%$, $\lambda = 1\%$, and $\tau = 40\%$. Given these parameters, the maximum payoff $g(p_0)$ is equal to 80. The left panel shows the “unlevered” firm value – that is the value before the debt tax shield – as a function of leverage, given by $(1-\tau)m(p(D))$. This value is maximized at $D = 0$ since this avoids any asset substitution. Because of the debt tax shield, however, total firm value is maximized as shown with $\hat{D} = 25.7$ (and $\hat{p} = 64.3\%$). Note that the total value of the debt, $V^D = p(D)D$ is non-monotonic; for $D > p^*/(2\lambda) = 45$, the asset substitution problem is so severe that the decline in value from issuing an additional dollar of debt more than offsets the addition to the debt’s face value, leading to the familiar credit-rationing result (Stiglitz and Weiss, 1981).

Figure 1: The Ratchet Effect



The right panel in Figure 1 illustrates the ratchet effect result of Proposition 4. For each level of current debt D , we show the optimal new debt choice D' if equity holders can make a one-time issuance of junior debt. Note that for the unlevered firm ($D = 0$), the optimal debt choice is $\hat{D} = 25.7$. But with higher initial debt, the optimal debt choice increases, as equity holders ignore the losses imposed on existing creditors associated with a new issue. Moreover, for any level of leverage, no matter how inefficient for total firm value, equity holders would prefer to issue additional debt. Indeed, given the linear tax specification in our example, the

marginal benefit of an additional \$1 of junior debt is $\tau p(D)$, the tax rate times the market value of the new debt.

3.4 Leverage Ratchet as an *Ex Ante* Cost of Debt

We have shown that leverage ratchet means that shareholders will not voluntarily reduce leverage, even if leverage reduction would increase total firm value. This leads to the question why equity holders would take on debt levels that might lead to the problems created by the leverage ratchet. What level of debt D will shareholders choose initially and what does the leverage ratchet mean for the dynamics of leverage?

Creditors who understand that they can be subsequently harmed by the leverage ratchet can insist on debt covenants aimed at preventing shareholder actions that harm their interests (e.g. caps or restrictions on future debt issuance¹⁷). However, unless these covenants are extremely restrictive, losses due to the leverage ratchet (and other agency costs) will still be a problem. Indeed, absent complete contracts, leaving the firm with some flexibility to adjust leverage in response to changes in the environment is desirable. But debt holders must recognize that shareholders will exercise their discretion in an asymmetric manner – increasing leverage when the opportunity arises, but not reducing leverage even if doing so would be value enhancing.

Specifically, suppose that after the initial choice of capital structure, circumstances change so that the capital structure that maximizes the total value of the firm (taking into account all frictions) involves higher leverage, i.e., additional borrowing. In that case, if covenants did not prevent such a change, shareholders would certainly choose to increase leverage. The debt holders are likely to lose because the default probability will be higher, even though the value of the total firm is increased.

However, because of the leverage ratchet effect, shareholders respond differently if instead of an increase in leverage, changes in the optimal capital structure for the firm involve a *reduction in* leverage. In that case shareholders will resist the change. There is typically little that creditors can do to force a recapitalization plan that reduces leverage. It is therefore possible that

¹⁷ Note that the common restriction that any new debt must be junior to existing creditors is insufficient to prevent the costs associated with the leverage ratchet effect. As the example in Section 3.3 illustrates, even the issuance of junior debt can harm existing creditors by increasing the likelihood of incurring any deadweight costs of bankruptcy, and by exacerbating the distortions due to agency costs such as underinvestment and asset substitution.

creditors would lose and the total value of the firm would decline because of the resistance of shareholders to recapitalization.

The asymmetry in shareholder leverage decisions has implications for the *ex ante* choice of debt. First, the leverage ratchet effect suggests that initial debt will trade for a lower price, as debt holders internalize the possibility of future value-destroying leverage increases combined with shareholder resistance to value-enhancing leverage reductions. This price effect will induce firms to take on less leverage initially.

Starting from this position of lower initial leverage however, the leverage ratchet effect has strong predictions for leverage dynamics. Firms will actively increase leverage but only passively reduce it (via debt maturity or growth in assets). Moreover, we should observe an asymmetric response with regard to shocks that impact optimal leverage, such as changes in tax rates. Increases in the value of the debt tax shield should induce increases in leverage, but reductions in leverage should not cause a similar fall in leverage. Moreover, even temporary increases in the net benefit of leverage should lead to increases in debt which are not subsequently reversed. Thus, our model of the leverage ratchet effect can explain what otherwise might be quite puzzling empirical results.

To see how the leverage ratchet might play out, consider the example in 3.3.1 where there is no commitment at all. We demonstrated above that given any choice of leverage, equity holders would like to increase leverage if given the opportunity to do so on a one time basis. But if equity holders have the flexibility to increase leverage in the future, this will impact the price that creditors will be willing to pay for any current debt issue. This raises the question of what the equilibrium debt choice will be absent any commitment by equity holders not to issue junior debt in the future.

The question of equilibrium when the firm has sequential opportunities to borrow is a delicate one. Bizer and DeMarzo (1992) consider this problem from the perspective of a risk averse borrower and demonstrate the likelihood of inefficient equilibria in which the creditor borrows beyond the level of debt at which the total value of debt is maximized (so that debt forgiveness coupled with restrictions on future borrowing would be optimal for creditors). Bizer and DeMarzo (1994) consider a more general setting in which multiple equilibrium outcomes are

possible; we use a similar methodology here to illustrate a similar result in the specific context of corporate leverage.

In our example above, once the firm has issued debt equal to the maximum possible payoff $D_0 = g(p_0) = 80$, there is no incentive to increase debt further (all tax shields have been exhausted, and new junior debt would be worthless). Thus the debt level D_0 is (trivially) sustainable as an equilibrium even without commitment. Next note that for D sufficiently close to but less than D_0 , equity holders gain by increasing debt to D_0 ; that is, $G(D, D_0) > 0$. This is true until debt level $D_1 < D_0$ such that

$$G(D_1, D_0 = g(p_0)) = 0 \quad (24)$$

Absent commitment then, a debt level of $D \in (D_1, D_0)$ cannot be sustained in equilibrium, as shareholders would gain by increasing leverage to D_0 and the new debt would be priced accordingly since debt will not be further increased. But note that debt level D_1 is sustainable in equilibrium. While shareholders could gain by increasing debt to some level $D > D_1$, new creditors recognize that the firm will continue to increase leverage until $D = D_0$. Thus, any new debt beyond D_1 will be priced accordingly at $p(D_0)$, and at this price (24) implies that shareholders will not strictly gain.

We can repeat this argument and find a set of stable leverage choices $D_n < D_{n-1}$ by recursively solving

$$G(D_n, D_{n-1}) = 0 \quad (25)$$

Together, (24) and (25) define an equilibrium without commitment of the following form: Given current debt D , shareholders increase leverage to the next highest leverage level D_n such that $D_n \geq D > D_{n-1}$, and receive price $p(D_n)$ for the debt. We illustrate the calculation of this equilibrium and the resulting stable debt levels in Figure 2. There we can see the “ratchet” nature of the equilibrium – firm’s never reduce leverage, but “ratchet up” to the next stable leverage level, in this case 35.6, 66.7, or 80. Note that in this case all three stable points are beyond the efficient level of leverage.

Figure 2: Stable Debt Levels

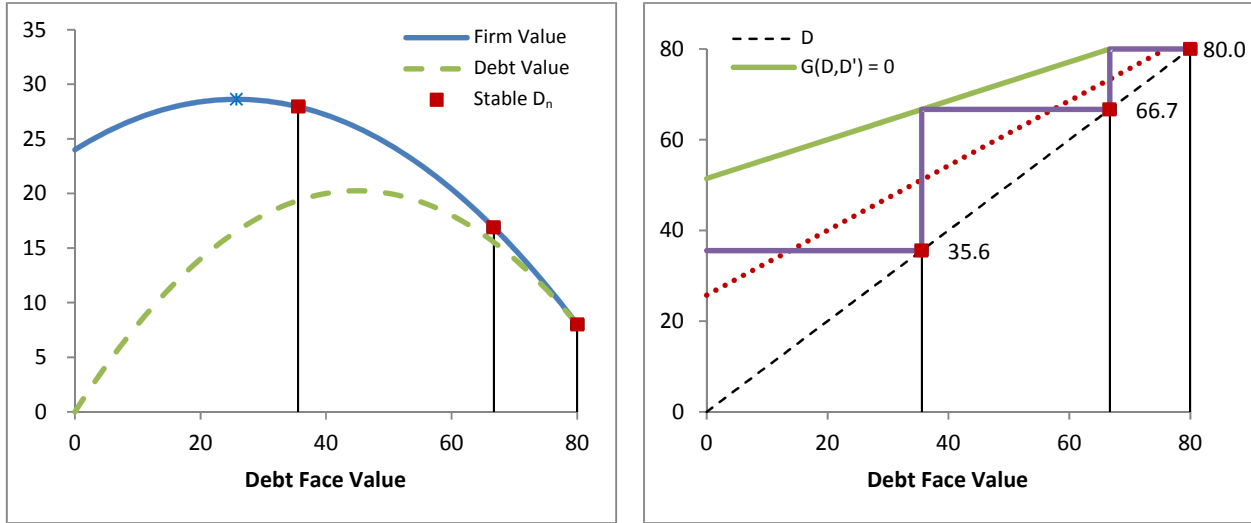
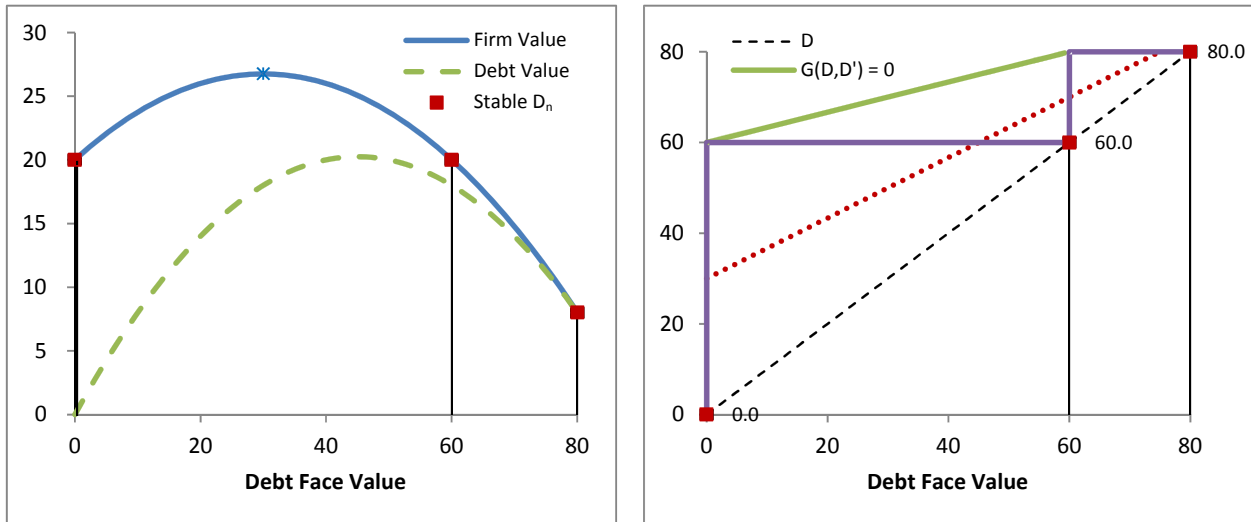


Figure 3 shows the equilibrium calculation with the same parameters but with a tax rate of 50% rather than 40%. Note that the efficient level of leverage increases with the higher tax benefit. However, the lowest stable point is now zero – that is, we might see firms choosing zero leverage despite the increased tax benefit. This outcome is supported as an equilibrium as creditors presume the firm will issue debt with face value of 60 if it begins to issue any leverage at all.

Figure 3: Stable Debt Levels with a Higher Tax Rate



The two figures together also imply the following possibility – suppose that starting from an initial tax rate of 40%, the firm issued debt of 35.6 as per the earlier equilibrium. If tax rates

then unexpectedly changed to 50%, the firm would increase debt to 60 as shown in Figure 3. Finally, if tax rates were to again unexpectedly change back to 40%, the firm would not reduce debt but would increase it yet again to 66.7. In other words, a temporary increase in the tax benefit of leverage would lead to an increase in debt which is not undone when the tax benefit disappears.

Of course, to fully assess the dynamics of leverage we would have to build a fully dynamic model in which tax rates, or other factors affecting shareholder preferences, as well as asset values are changing continuously and the firm can adjust leverage at any time in response to these changes. While such a model is beyond the scope of the current paper, the ratchet effect of leverage that we have documented here is a force that will lead to a gradual upward drift in the firm's leverage.¹⁸ This upward drift may be countered by positive innovations in the firm's asset values (through returns or new positive NPV investments) or through debt maturity.

4. Alternative Ways to Reduce Leverage

Up to this point, we have restricted our attention to the costs and benefits of adjusting leverage by a pure recapitalization in which the firm issues equity and uses the proceeds to repurchase outstanding debt. In such a transaction, the scale of the firm and the assets on its balance sheet are unchanged.

However, a pure recapitalization is not the only method available to reduce leverage. Leverage can also be changed through adjustments to the scale of the firm's assets. Two alternative ways to adjust leverage involve the following transactions:

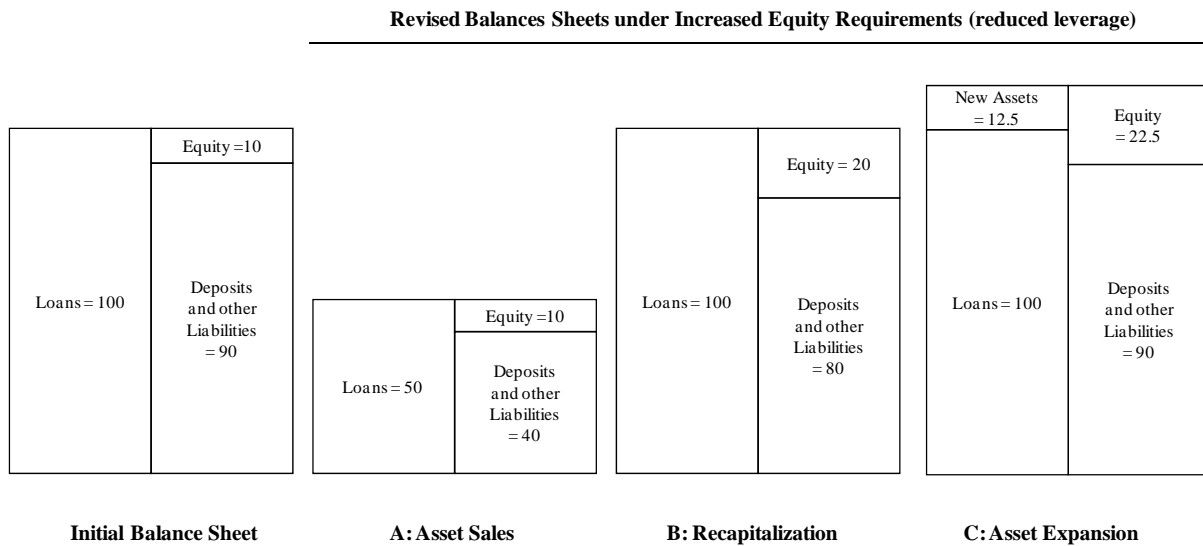
- **Asset Sales** (so-called “deleveraging”): The firm sells assets and uses the proceeds to repurchase debt, thus lowering leverage without issuing new equity.
- **Asset Expansion:** The firm issues equity and uses the proceeds to buy additional assets, thus lowering leverage without repurchasing debt.¹⁹

¹⁸ See DeMarzo and Urosevic (2006) for a similar dynamic related to the selling of shares by a large shareholder in the presence of agency costs. They show that in a continuous time model a similar ratchet effect – identified by Admati Pfleiderer and Zechner (1994) in a static context – leads to a gradual unloading of shares by the large shareholder.

¹⁹ Asset expansion was the subject of the original analysis of debt overhang in Myers (1977). Myers shows that because existing debt holders capture some of the benefit of the new investment via reduced credit risk, shareholders may refuse to undertake a new positive NPV investment project.

In Figure 4 we illustrate how leverage can be reduced using each of the three responses. We assume that the ratio of debt to assets must be reduced from 90% to 80%. As the figure shows, this can be accomplished by selling half of the firm's assets (asset sales), issuing equity equal to 10% of the firm's assets and using the proceeds to buy back debt (recapitalization), or issuing equity equal to 12.5% of the firm's assets and using the proceeds to invest in new assets (asset expansion).

Figure 4: Alternative Responses to Increased Equity Requirements



In Admati et al. (2011) we observed that increased capital requirements do not force banks to reduce bank lending because they do not require that banks shrink. Increased capital requirements can be met either through recapitalization (B) or asset expansion (C), which either leave the size of the bank unchanged or increase it. The analysis below complements Admati et al. (2011) by examining *the incentives of shareholders* in choosing one course of action over the others. Understanding the incentives of shareholders is important in assessing the effects of imposing minimum capital (equity) requirements for banks, and in particular determining whether capital requirements will induce banks to deleverage via asset sales.

4.1 An Irrelevance Result

The different approaches to reducing leverage result in different sizes (assets levels) for the firm. Let D_0 be the current face value of debt and A_0 be the level of assets for the firm, so that $\delta_0 = D_0 / A_0$ is its current debt-asset ratio. Suppose that firm is required to reduce its debt-asset ratio to $\delta_1 < \delta_0$. If the firm can choose any combination of debt and assets (D_1, A_1) satisfying this debt-asset ratio – i.e., such that $D_1 = \delta_1 A_1$ – which combination will shareholders prefer?

If $A_1 \neq A_0$, then assets will be either sold or purchased as part of the leverage reduction. We assume first that the assets are perfectly homogeneous, so that each unit of the assets today will generate a payoff of \tilde{x} in the future. (We comment on the more general case of asset heterogeneity in section 4.2.3 below.) We also assume that the frictions we have considered that are related to taxes and net bankruptcy costs are homogenous with firm size. Letting $\delta = D / A$, we assume that for all (A, D) , we have

$$t(x, A, D) = t(x, 1, \delta) A \quad \text{and} \quad n(xA, D) = n(x, \delta) A. \quad (26)$$

In addition, we assume that if agency costs due to asset substitution exist, they are also homogeneous with respect to firm size. In particular this means that

$$\theta^* \equiv \arg \max_{\theta} V^E(D, A, \theta) = \arg \max_{\theta} V^E\left(\frac{D}{A}, 1, \theta\right) \quad (27)$$

for all (A, D) .²⁰

Using the expressions for the value of debt and equity in Section 3, we see that when the assets and frictions (including those due to asset substitution) are homogeneous, the total value of the firm (equity plus debt) is proportional to its asset holdings and is given by:

²⁰ To keep the focus on how shareholders' preferences across the various modes of leverage reduction are related to changes in firm size, we do not consider the agency costs due to the Myers (1977) underinvestment problem that we discussed above. To consider the role that these underinvestment agency costs would play in the shareholders' choice among the three ways to reduce leverage, we would need to make specific assumptions about how new investment opportunities are related to the size of the firm as given by assets in place.

$$\begin{aligned}
V(A, D) &= \int_{\delta}^{\infty} xA - t(x, A, D) dF(x, \theta^*) + \int_0^{\delta} xA - n(xA, D) dF(x, \theta^*) \\
&= \left[\int_0^{\infty} x dF(x, \theta^*) - \int_{\delta}^{\infty} t(x, 1, \delta) dF(x, \theta^*) - \int_0^{\delta} n(x, \delta) dF(x, \theta^*) \right] A \\
&\equiv v(\delta)A
\end{aligned} \tag{28}$$

where $\theta^* = \arg \max_{\theta} V^E(\delta, 1, \theta)$.

The homogeneity of the firm's assets also implies that the average price of the firm's debt, which we denote by $q(\delta)$, depends only on the leverage ratio $\delta = D/A$:

$$\begin{aligned}
q(\delta) &= q\left(\frac{D}{A}\right) \\
&= \frac{V^D(D, A)}{D} = \int_{D/A}^{\infty} dF(x, \theta^*) + \int_0^{D/A} \frac{xA - n(xA, D)}{D} dF(x, \theta^*) \\
&= \int_{\delta}^{\infty} dF(x, \theta^*) + \frac{1}{\delta} \int_0^{\delta} (xA - n(xA, D)) dF(x, \theta^*)
\end{aligned} \tag{29}$$

Recall from Section 3 that if the firm has a single class of debt outstanding, it will be forced to pay the price $q(\delta_1)$ to repurchase its outstanding debt in the market (as this price is the value of the debt to a bondholder who refuses to tender). Thus, to reduce its debt level to $D_1 \leq D_0$, the firm must spend $q(\delta_1) \times (D_0 - D_1)$ on debt repurchases.

Assume that the price at which the firm will be able to buy or sell assets is p . It follows that to move from initial balance sheet positions (D_0, A_0) to the new balance sheet positions (D_1, A_1) with $D_1 \leq D_0$, the amount of equity the firm must issue is:

$$\text{New Equity Issued} = N = p \times (A_1 - A_0) + q(\delta_1) \times (D_0 - D_1) \tag{30}$$

On the other hand, the total change in the firm's equity value from the transaction is given by:

$$\text{Change in Total Equity Value} = \nabla V^E = V^E(D_1, A_1) - V^E(D_0, A_0) \tag{31}$$

We can therefore determine the effect of the leverage change on existing shareholders by subtracting (30) from (31). Specifically, the gain or loss for new shareholders is given by $\nabla V^E - N$.

We are now in a position to evaluate the effect on existing shareholders from alternative methods of reducing leverage. Recall that in a pure recapitalization, there is no change to the firm's assets ($A_1 = A_0$). With pure asset sales, all reductions in debt are financed by asset sales, so that $N = 0$. In a pure asset expansion, no debt is repurchased so that $D_1 = D_0$.

We can ask whether shareholder losses differ across these or other intermediate scenarios. As one would expect, the answer depends, among other things, on the relation between the price of the assets and their expected rates of return. Recall from (13) that

$$v(\delta_1) = \int_0^\infty x dF(x, \theta^*) - \int_{\delta_1}^\infty t(x, 1, \delta_1) dF(x, \theta^*) - \int_0^{\delta_1} n(x, \delta_1) dF(x, \theta^*), \quad (32)$$

is the expected payoff of the assets net of taxes and of (net) default costs. If $p = v(\delta_1)$ then, conditional on the final debt-asset ratio being equal to δ_1 , buying or selling assets does not affect the value of equity, i.e., from the perspective of shareholders, the Net Present Value (NPV) of asset sales and purchases is zero. If $p < v(\delta_1)$ then the NPV of asset purchases is positive, and if $p > v(\delta_1)$ then the NPV of asset sales is positive. Notice that, in this comparison, the NPV of asset sales and purchases depends on the debt-asset ratio because the debt-asset ratio affects taxes and (net) default costs.

Proposition 5 (An Irrelevance Result): *Assume that $p = v(\delta_1)$, there is only one class of debt, and the firm faces no transactions costs in buying or selling assets or the securities it issues. Then shareholders find pure recapitalization, asset sales, and asset expansion equally undesirable. Specifically, starting from the initial position (D_0, A_0) , shareholder losses are equal to $(q(\delta_1) - q(\delta_0)) \times D_0 + (v(\delta_0) - v(\delta_1)) A_0$ for all (D_1, A_1) with $D_1 = \delta_1 A_1 \leq D_0$.*

Proof: After the change, the total value of equity will be:

$$V^E(A_1, D_1) = v(\delta_1) A_1 - q(\delta_1) D_1. \quad (33)$$

Therefore,

$$\nabla V^E = (\nu(\delta_1)A_1 - q(\delta_1)D_1) - (\nu(\delta_0)A_0 - q(\delta_0)D_0). \quad (34)$$

Thus, the total change in value for existing shareholders is

$$\begin{aligned} \nabla V^E - N &= (\nu(\delta_1)A_1 - q(\delta_1)D_1) - (\nu(\delta_0)A_0 - q(\delta_0)D_0) \\ &\quad - p(A_1 - A_0) - q(\delta_1)(D_0 - D_1) \\ &= (\nu(\delta_1) - p)A_1 - (q(\delta_1) - q(\delta_0))D_0 - (\nu(\delta_0) - p)A_0 \\ &= -(q(\delta_1) - q(\delta_0))D_0 - (\nu(\delta_0) - \nu(\delta_1))A_0. \end{aligned} \quad (35)$$

Since this does not depend on either A_1 or D_1 , it is the same for all changes that lead to a given reduction in the leverage ratio, proving the result. ■

While perhaps surprising at first sight, the intuition for this result is straightforward. If asset and security sales or purchases have zero NPV, they cannot change the total value of the firm. Because debt holders gain from the decline in leverage, the shareholders must lose an equal amount. The gain for debt holders is determined by the change in the average price of the debt, which depends only on the change in the firm's leverage ratio. All of this is captured in the first term in the last line of (20). The second term represents losses on the value of existing assets due to changes in tax benefits, bankruptcy costs or subsidies resulting from the reduction in leverage

In Proposition 5, the asset price p is taken as given. The firm is treated as a price taker in a large market where it has no market power. The proposition should therefore be understood as a characterization of the map from asset prices to the firm's excess demand/supply for assets. At the critical $p = \nu(\delta_1)$, this mapping is characterized by indifference, i.e. all levels of asset purchases or sales are equally desirable. At other values of the asset price, of course, indifference will not hold, and the firm will strictly prefer to buy or to sell assets depending on whether the asset price p is less than or greater than $\nu(\delta_1)$.

4.2 Shareholder Preferences for Different Modes of Leverage Reduction

In many settings, the conditions under which Proposition 5 holds are violated, and shareholders have a preference for one mode of leverage reduction over the others. We discuss in this section some of the major factors that can invalidate the irrelevance result and lead to a firm's managers (acting in the interest of the firm's shareholders) choosing one action over the others.

4.2.1 Cases where the asset's market price and value to the firm diverge

Proposition 5 concerns the case in which $p = v(\delta_1)$. In other words, we assume that the price at which the firm's assets can be bought or sold is precisely equal to the value of the assets to the firm's investors when the leverage ratio is δ_1 . What can we say about shareholder preferences at other prices? In this analysis, we begin by taking the asset price p as parametrically given, without considering whether it is consistent with market equilibrium. This corresponds to the standard approach of analyzing the behavior of price-taking agents by considering their demand and supply choices at *any* parametrically given prices. We will introduce equilibrium considerations once we discuss the parametric analysis.

If $p > v(\delta_1)$, the market price of assets exceeds the value of those assets when held by the firm. If $p < v(\delta_1)$, the firm can increase shareholder value by purchasing assets at the market price and holding them. The change in shareholder value is:

$$\nabla V^E - N = -(q(\delta_1) - q(\delta_0))D_0 - (v(\delta_0) - v(\delta_1))A_0 - \eta(A_1 - A_0), \quad (36)$$

where $\eta = p - v(\delta_1)$. The third term shows that shareholders will prefer reducing leverage through asset sales when $\eta > 0$ and when $\eta < 0$ prefer doing so through asset purchases.

Taking the asset price as given is justified if the individual firm or bank can be thought of as a price taker operating in a large market. However, when we consider what occurs when there is a policy change that affects a large number of firms, e.g., an increase in bank capital requirements, we must recognize that the price-taking assumptions may no longer be justified.

Even though an individual firm acting alone may be justified in taking the market price of assets as given, when all firms change their behavior in response to changes in regulatory requirements, it can be expected that the equilibrium market price will change.

For example, in the case of banking regulation, assume that the initial capital requirements correspond to the debt-asset ratio δ_0 and that, for this debt-asset ratio, the equilibrium asset price is equal to $p_0 = v(\delta_0)$, the price at which banks with the debt-asset ratio δ_0 are just indifferent about their asset holdings. Now suppose capital requirements are tightened, so that leverage must fall to δ_1 , and that, because of a reduction in tax benefits and subsidies net of bankruptcy costs, we have $v(\delta_1) < v(\delta_0)$. Then, at the price $p_0 = v(\delta_0)$, all banks want to respond to the new requirement by selling assets to buy back debt. Unless there are third parties willing to hold assets at this price, the asset price $p_0 = v(\delta_0)$ will no longer clear the market. The new equilibrium price of the asset must be lower. Indeed, if there are no third parties willing to hold the assets, the new equilibrium price must fall to $p_1 = v(\delta_1)$, as we are assuming in Proposition 5.

Throughout our discussion, we have assumed that the leverage regulation involves a debt-asset ratio D/A , which is fixed without regard to prices. In practice, regulations such as bank capital requirements are often based (at least to some extent) on market values, imposing an upper bound on a ratio such as $q(\delta_1)D/p_1A$ or D/p_1A . The first corresponds to a ratio based solely on market values, the second corresponds to a case where assets are marked to market but debt levels are measured at the face value of liabilities. If δ_1 has to be equal to either $q(\delta_1)D/p_1A$ or to D/p_1A , then, because $q(\delta_1) > q(\delta_0)$ and $p_1 < p_0 = v(\delta_0)$, the deleveraging effect is rather larger than it would be if δ_1 had to be equal to D/A . This means that when the leverage ratio is based on market values, rather than quantities, the effect of deleveraging is exacerbated.

4.2.2 The Case of Multiple Classes of Existing Debt

In this section we consider shareholder preferences when not all debt has the same priority. We continue to assume that the assets returns and the frictions are perfectly homogenous with firm size, but we now assume that the firm has multiple classes of *existing* debt with different levels of priority. In this case, if $D_1 < D_0$, it is optimal for the firm to repurchase the most junior debt first, as it will be the least expensive. For simplicity, we will assume that all of the debt that is repurchased is junior to the debt that remains after the transaction. Because a junior debt holder who does not tender will not be paid until after the remaining debt D_1 is fully repaid, the junior debt can be repurchased at the price

$$\begin{aligned}
 q^J(\delta) &= \int_{\delta}^{\infty} dF(x, \theta^*) \\
 &< \int_{\delta}^{\infty} dF(x, \theta^*) + \frac{1}{\delta} \int_0^{\delta} (x - n(x, \delta)) dF(x, \theta^*) = q(\delta).
 \end{aligned} \tag{37}$$

where, as above, $\theta^* = \arg \max_{\theta} V^E(\delta, 1, \theta)$.

The fact that junior debt is cheaper to repurchase breaks the indifference result of Proposition 5. Now, shareholders will be better off the more (junior) debt that is repurchased. In particular, we have the following important result:

Proposition 6 (Multiple Classes of Existing Debt): *Assume $p = v(\delta_1)$. Then*

- i. If the firm can repurchase junior debt, shareholders find asset sales preferable to a pure recapitalization, which in turn is preferable to an asset expansion.*
- ii. In the case of asset expansion, the ability to purchase junior debt makes no difference since no debt is repurchased.*
- iii. In the case of a pure recapitalization the shareholders lose less with the ability to repurchase junior debt than they lose when there is only one debt class, but they still lose.*
- iv. In the case of asset sales, shareholders may gain if the reduction in leverage is sufficiently small.*

Proof: As before we have $\nabla V^E = (v(\delta_1)A_1 - q(\delta_1)D_1) - (v(\delta_0)A_0 - q(\delta_0)D_0)$, but given the lower cost $q^J(\delta_1)$ of repurchasing the junior debt, the total change in value for existing shareholders is:

$$\begin{aligned}
\nabla V^E - N &= (\nu(\delta_1)A_1 - q(\delta_1)D_1) - (\nu(\delta_0)A_0 - q(\delta_0)D_0) \\
&\quad - p(A_1 - A_0) - q^J(\delta_1)(D_0 - D_1) \\
&= (\nu(\delta_1) - p)A_1 - (\nu(\delta_0) - p)A_0 - (q(\delta_1) - q(\delta_0))D_0 \\
&\quad + (q(\delta_1) - q^J(\delta_1))(D_0 - D_1) \\
&= -(q(\delta_1) - q(\delta_0))D_0 - (\nu(\delta_0) - \nu(\delta_1))A_0 + (q(\delta_1) - q^J(\delta_1))(D_0 - D_1)
\end{aligned} \tag{38}$$

Since $q(\delta_1) > q^J(\delta_1)$, the shareholders' loss is lower the more junior debt that is repurchased, i.e., the greater is $(D_0 - D_1)$. Since for a pure asset expansion we have $D_0 = D_1$, the shareholder loss is identical to that in the case of a single debt class. For a pure recapitalization, $(D_0 - D_1) > 0$, and for the case of asset sales $(D_0 - D_1)$ is even larger. This establishes that with the ability to repurchase junior debt shareholders prefer asset sales over recapitalization and recapitalization over expansion. From Proposition 2 we know that shareholders lose in a pure recapitalization even if they are able to repurchase junior debt. To show that shareholders may gain with asset sales if they can repurchase junior debt, we consider the case in which there are no frictions. Since in a pure asset sale the proceeds from the sale are used solely to repurchase junior debt, we know that $N = 0$. This means that

$$p \times (A_0 - A_1) = q^J(\delta_1)(D_0 - D_1) = q^J(\delta_1)(\delta_0 A_0 - \delta_1 A_1) \tag{39}$$

or

$$A_1 = \frac{p - \delta_0 q^J(\delta_1)}{p - \delta_1 q^J(\delta_1)} A_0. \tag{40}$$

From (23) and assuming no frictions we can derive the following:

$$\nabla V^E - N = -A_0 \int_{\delta_1}^{\delta_0} (\delta_0 - x) dF(x, \theta^*) + (A_0 - A_1) \int_0^{\delta_1} x dF(x, \theta^*). \tag{40}$$

Substituting the expression for A_1 in (40) into (40), we find the shareholders will gain in a pure asset sale ($\nabla V^E - N > 0$) if and only if the following inequality is satisfied:

$$\begin{aligned} \frac{q'(\delta_1)}{p - \delta_1 q'(\delta_1)} \int_0^{\delta_1} x \, dF(x, \theta^*) &= \frac{q'(\delta_1)}{v(\delta_1) - \delta_1 q'(\delta_1)} \int_0^{\delta_1} x \, dF(x, \theta^*) \\ &> \frac{1}{\delta_0 - \delta_1} \int_{\delta_1}^{\delta_0} (\delta_0 - x) \, dF(x, \theta^*), \end{aligned} \quad (40)$$

Since $v(\delta) > \delta q'(\delta)$, the left-hand side is strictly positive, while the right-hand side approaches zero for δ_1 sufficiently close to δ_0 . ■

This result explains why shareholders may choose to engage in asset sales or “deleveraging” (as opposed to recapitalization or asset expansion) if a decrease in leverage is imposed by regulation and there are no covenants protecting senior debt holders. While it is well known that an asset sale that is used to fund payouts to equity holders will benefit shareholders at the expense of creditors, our result (iv) above states that equity holders can gain even if the proceeds are used to buy back junior debt. While total leverage declines and junior creditors gain, senior debt holders lose even more (as their claims are backed by a smaller pool of assets). If allowed, shareholders therefore prefer this form of deleveraging over a pure recapitalization or asset expansion.

Note that in our analysis of asset expansion we have assumed that $A_1 = D_0 / \delta_1$ so that $D_1 = \delta_1 A_1 = D_0$. Increasing assets further would necessitate issuing new debt in order to achieve the target leverage ratio δ_1 . If this new debt could be issued at an equal priority to the firm’s existing debt (so that it would command the same average price), asset expansion with $A_1 > D_0 / \delta_1$ will be no more costly than it is with $A_1 = D_0 / \delta_1$. In many cases, however, any new debt would be required to be junior to the existing debt. In this case, it would command a lower price, and additional asset purchases beyond $D_0 \times (1/\delta_1 - 1/\delta_0)$ would impose further losses on shareholders. In other words, we have the following straightforward extension of Myers (1977) debt overhang result:

Proposition 7 (Asset Expansion with Additional Debt): *Assume $p = v(\delta_1)$. If $D_1 = \delta_1 A_1 > D_0$ then:*

- i. *shareholders are indifferent to any choice of A_1 if the new debt is of equal seniority to existing debt;*

- ii. *if new debt must be junior to existing debt, then shareholders are worse off choosing $A_1 > D_0 / \delta_1$; and*
- iii. *if new debt can be senior to existing debt, then choosing $A_1 > D_0 / \delta_1$ makes shareholders better off.*

Proof: By the same logic as the prior result, if $q_1^{initial}$ is the post transaction price of the firm's initial debt, then shareholder losses are given by $(q_1^{initial} - q(\delta_0)) \times D_0$. If new debt is equal priority to existing debt, then $q_1^{initial} = q(\delta_1)$ for any level of A_1 and $D_1 = \delta_1 A_1$. But if new debt is junior to existing debt and $A_1 > D_0 / \delta_1$, then $q_1^{initial} = q\left(\frac{D_0}{A_1}\right) > q(\delta_1)$ and this is increasing in A_1 . Alternatively, if new debt is senior to existing debt, $q_1^{initial}$ will be less than $q(\delta_1)$. ■

This result extends Proposition 5 by showing that that irrelevance to scale continues to hold if new debt is of equal seniority to existing debt. Shareholders would not choose to expand if any of the new debt issued must be junior to existing debt. An interesting case is one where the new debt can be senior to existing debt. This case might be relevant for banks, which rely on significant amounts of short term debt. Short term debt is effectively senior to the bank's long-term debt. Proposition 7 suggests that shareholder losses are *decreasing* in the scale of the firm in this case. This suggests that if new debt can be senior, shareholders might prefer asset expansion beyond even the level of balance sheet C in Figure 4.

4.2.3 The Case of Heterogeneous Assets

Proposition 5 is based on an assumption that the firms' assets are homogeneous, i.e., each asset unit has a return of x so that the total return on all assets is simply xA . When assets are homogeneous in this way, sales and purchases only change the scale of the firm, but not the risk of the debt for any given level of maintained leverage. If assets are heterogeneous, and particularly if they differ in their contribution to the overall risk of the firm's asset base, shareholders will generally have preferences with respect to which assets to sell or purchase. If a firm deleverages through asset sales, shareholders prefer to sell relatively safe assets. In contrast, they will prefer to purchase relatively risky assets if the firm expands. This is just a manifestation

of the asset substitution agency problem that we have discussed above. When the shareholders can engage in asset substitution through asset sales or asset purchases, simple recapitalization, a transaction that leaves the asset base unchanged, is unlikely to be the preferred choice. The choice between deleveraging or asset expansion depends on the costs of selling less risky assets relative to the costs of purchasing more risky assets. The transactions costs associated with assets sales and purchases, especially those arising from asymmetric information, are potentially important in this regard and these are discussed in sections 4.2.4 and 4.2.5 below.

In the context of capital regulation for banks, an attempt is made under Basel II and Basel III to address the problems created by asset substitution and risk shifting. This is done by assigning risk weights to assets and formulating capital requirements in terms of the size of the risk-weighted asset base. If the risk weighting system worked perfectly and completely removed the ability of bank managers and shareholders to engage in asset substitution and risk shifting when assets are sold or purchased, asset heterogeneity would not necessarily undermine the irrelevance result given in Proposition 5. In particular, if risk weighing effectively means that the value of debt depends only on leverage as measured by the risk weighting system, so that $q(\delta_1)$ will be the same no matter what the mode of leverage reduction, then the conditions for proposition 5 to hold are potentially restored even with heterogeneous assets.

In practice risk weighting falls short of removing the ability of banks to increase risk and engage in asset substitution. Indeed, the regulations often involve transparently inappropriate risk weights, e.g., a zero risk weight for sovereign debt or for highly rated securities even when they clearly carry some potentially significant risks. Making matters worse is the fact that in practice the implementation of the risk weighting system relies in part on the banks' own internal risk models and is therefore highly manipulable. This means that there is large scope for bank shareholders to gain in the two modes of leverage reduction that involve changes in assets.

4.2.4 The Effects of Transactions Costs

Proposition 5 is based on the assumption that the firm faces no transactions costs in changing the scale of its assets or in issuing and retiring securities. Not surprisingly the introduction of transactions costs can lead to one alternative being preferred over the others,

since the three ways of changing leverage that we consider involve different pairs of transactions as shown below:

	The firm purchases:	The firm sells:
Asset Sales	Debt	Assets
Recapitalization	Debt	Equity
Asset Expansion	Assets	Equity

Asset expansion will be the preferred alternative if the transactions costs involved in repurchasing debt are particularly large relative to the other transactions, but this is unlikely to be the case. The transactions costs involved in equity issuance and asset sales are likely to be more important. If equity issuance costs are large relative to those in asset transactions, then asset sales, since they involve no equity transactions, will be the preferred alternative. If the transactions costs involved in selling assets are particularly large compared to equity issuance costs (e.g., the firm faces extreme “firesale conditions” in liquidating assets), then recapitalization or asset expansion will be preferred. Without making specific assumptions about the magnitude of the various transactions costs, little more can be said about what approach will be most advantageous for shareholders.

4.2.5 The Effects of Asymmetric Information

A key component of transactions costs in settings such as the ones we are considering is due to the possibility that the firm’s managers have private information about the firm’s assets and growth opportunities. Managers will want to sell assets that the market is overvaluing and similarly will want to issue equity if they perceive the market is overpricing the firm’s shares. The possibility that managers will make strategic choices based on their private information can account for a significant part of the bid/ask spread for transactions involving the firm’s assets and securities. Information asymmetries can be particularly important in asset sales and equity issuance and this explains why transactions costs for these are likely to be larger than those associated with debt buybacks.

Asymmetric information factors that would affect the valuation of the firm’s assets in the asset sales approach clearly also give rise to asymmetric information issues affecting the market

valuation of the firm's equity when the firm issues equity directly (as opposed to a rights offering) to recapitalize or expand its assets.²¹ It is clear that if there is asymmetric information about the value of the assets in place, there must be asymmetric information about the value of the firm's equity. It is not immediately obvious whether this makes it more expensive for the firm's shareholders to sell assets and deleverage or to sell equity and recapitalize. In fact, it can be shown that in some circumstances asymmetric information about asset values makes the shareholders indifferent between the two. This can occur when the firm's assets are homogeneous, the firm is known to have no growth opportunities, and the leverage requirement is based on the ratio $D / p_1 A$, face value of debt relative to the marked-to-market value of assets. If the market is undervaluing the firm's assets and this is the only source of transactions costs facing the shareholders, then shareholders will be indifferent between asset sales and recapitalization as ways to meet the leverage requirement. (See appendix for a precise statement of the result and proof.) Although a greater dollar amount of assets needs to be sold in the asset sales approach than the dollar amount of equity that needs to be issued to effect a recapitalization, the underpricing of equity is larger in percentage terms because of leverage, and this is just sufficient to make the loss due to underpricing equivalent.²²

²¹ Note that in Myers and Majluf (1984) the asymmetric information that makes management reluctant to issue equity relates to the value of assets in place as well as the value of the investment opportunity the equity issuance would finance. The key assumption in the Myers Majluf (1984) analysis is that the firm can only raise equity through an offering of common shares and not, for example, through a rights offering. With symmetric information, as in Proposition 5, it does not make a difference whether new equity is raised through an offering of shares to the market or through a rights offering. With asymmetric information, it does make a difference. In a sale of new shares to the market, the market's assessment of the firm directly impacts the amount of money raised by the firm. In a rights offering, if it succeeds, the market's assessment of the firm does not affect the amount of money raised by the firm, but only the value of shares and therefore the value of the rights. The attitude of existing shareholders to a rights offering then depends on whether they are short-term investors, who are interested in the current share price, or long-term investors à la Myers-Majluf, who are interested in returns and share prices in the future, when the market will have "learnt".

²² One might wonder why the results we obtain for asymmetric information differ from those presented above in 4.2.1, where we assume that the market price for the firms' assets differs by η from the value of the assets when they are held by the firm. Since in section 4.2.1 we assume that there is symmetric information about the value of the assets if they are held by the firm, it follows that when that value differs from the market price, there is uniform agreement that the firm should either be selling assets if $\eta > 0$ and buying assets if $\eta < 0$. Whether the firm should grow or shrink is unambiguous, and this makes the preferred mode of leverage reduction depend on the *amount* of assets sold or bought. With asymmetric information the situation is quite different. When equity is issued, the price is based on the market's perception of the *total* value of the assets and any losses are due the market's undervaluation of that total. As discussed above, the same amount of assets is effectively sold at undervalued prices when equity is issued as when assets are sold directly. This means that while in the analysis of 4.2.1 the losses or gains are based on the amount of assets sold, in the case of asymmetric information the losses are based on the market's valuation of all the assets. It does not matter whether the assets are directly sold or indirectly sold through issuance of equity — the loss is the same. A long-term investor, who is patient enough to wait until the market has

If the firm's assets are heterogeneous, the situation involving asymmetric information becomes more complex. Transactions costs due to asymmetric information are likely to be lowest on the least risky assets. As discussed above, asset substitution considerations indicate that the shareholders will want to sell low-risk assets when deleveraging, but will want to buy high-risk assets in the asset expansion approach to reducing leverage. This means that transactions costs concerns and asset substitution will tend push shareholders toward the deleveraging alternative. With deleveraging, incentives associated with asset substitution and transactions cost minimization are aligned. This is not the case with asset expansion.

Note, however, that deleveraging is not always the preferred alternative from a transactions costs perspective. If most assets are hard to value by outsiders and managers can pick the assets they sell, then the adverse selection effects can be greater with asset sales than they are when equity is sold. This is because equity represents a claim on a portfolio of assets rather than an adversely selected subset. The transactions costs associated with issuing equity can be lower than those involved in selling hard to value assets. This could tip the balance in favor of recapitalization.

Finally, it should be noted that one way that leverage can be reduced that involves almost no transactions costs due to asymmetric information is for the firm to retain earnings and build equity "internally." Adverse selection costs can also be eliminated by raising equity through a rights offering. Shareholder resistance to these ways of reducing leverage is entirely due to debt overhang.

5. The Leverage Ratchet in Banking

Our analysis has important implications for understanding the use of debt by banks and for banking regulation. With debt on the order of ninety-five percent of total assets and sometimes more, banks are the most highly leveraged corporations in the economy. In the years 2007-2009, this high leverage meant that many banks were unable to absorb the losses they suffered, and various chain reactions led to major breakdowns in funding and credit across the globe. Since then, capital requirements for banks have been a key subject of policy debate. Regulators have raised these requirements a bit but regulation still allows banks to fund as much

learnt, would however take a different view if equity was raised through a rights offering; see the preceding footnote. Such an investor would prefer the rights offering to a sale of assets.

as 97 percent of their assets by borrowing. Banks have been successfully lobbying against increases in capital requirements. They claim that increased requirements would limit their ability to lend to the real economy and to promote economic growth.

Our results show that the fact that we see high levels of leverage in banking does not imply that these high levels are desirable. The levels we observe may well be inefficient, even without considering the negative externalities that distress and default of banks can have on the rest of the economy. As we show, high levels of leverage can be the result of the leverage ratchet and can reduce the value of the bank to its investors.

Of course, there always is a sense in which the results of voluntary contracting are efficient in some n^{th} -best version of efficiency that takes account of all incentive constraints, including those that arise from imperfect commitments. If perfect *ex ante* commitments cannot be made or are ineffective, then future behavior is not fully determined by initial contracting. The observed outcomes then depend on subsequent decisions, which may involve conflicts of interest that are not reined in by contracting. If that is the case, the notion that observed outcomes are n^{th} -best efficient relative to the given commitment technologies is not relevant for the policy debate. Regulatory measures that constrain the banks' subsequent decisions might replace or strengthen missing or ineffective covenants in initial contracts, and thus improve on the banks' ability to commit their future behaviors.

Our analysis suggests that the observed high leverage in banking, and particularly the use of short-term debt, can in fact be explained by the lack or ineffectiveness of covenants in contracts and by the consequences of conflicts of interests in subsequent funding decisions. The following effects that we have discussed are immediately relevant:

- Even if the value of the bank could be increased by leverage reduction, shareholders on their own would not generally choose to reduce the firm's leverage and buy back debt, unless they can use some form of collective bargaining to make debt holders give up their share of the benefits. On the contrary, regardless of what the debt level might be, shareholders would want to increase leverage if this enables them to take additional advantage of the differential treatment of debt and equity in corporate taxation.
- Once significant leverage is in place, shareholders have an incentive to increase leverage even if doing so is value destroying, as they no longer internalize the consequences of additional leverage on existing creditors. This incentive is enhanced if new debt can usurp the priority of existing claims. While outright dilution may be ruled out by covenants prohibiting the issue of new debt that is senior or equal in status to incumbent

debt, such covenants can be circumvented if the new debt matures earlier than the incumbent debt. The “maturity rat race” of Brunnermeier and Oehmke (2013) is fully in line with the logic of our analysis. The effect is strengthened if the bank is free to secure the new debt with collateral, which in itself reduces the resources that are available to incumbent debt holders in bankruptcy.

- If regulation forces a bank to decrease its leverage, shareholders will try to impose part of the cost on incumbent senior creditors and the deposit insurance system. Shareholders can do this by selling relatively safe assets and buying back junior debt. The reduction in assets worsens the senior debt holders’ prospects; moreover, the effect is stronger the safer are the assets that are sold. By focusing on junior rather than senior debt, shareholders both minimize the cost of the debt buy back and devalue any remaining claims. In fact, shareholders might gain by this form of deleveraging if the dilution of senior creditors (and the deposit insurance system) is sufficiently large.

All these effects involve shareholders making decisions that take advantage of debt holders. These decisions are *socially inefficient*, and they would not be taken if prior contracting to prohibit them was feasible and enforceable. When the government safety net is present, however, creditors no longer have strong incentives to protect themselves in any way, since many of the risks have been shifted to the government and its taxpayers. As a result, the protections to guard against such inefficiencies will not occur via private contracting and so will only be provided through appropriate regulation.

The effects that we have described are in line with what we observe. For example, when in the fall of 2011, European authorities mandated banks to increase their core equity up to nine percent of risk-weighted assets by June 30, 2012, many banks responded by using cash to buy back hybrid debt, i.e., the most junior kind of debt they had.²³

In the 2000s, we have also observed a dramatic expansion of short-term borrowing through repo contracts, and the enormous repo markets continue to be a source of concern to regulators. Repo borrowing, which legally is not borrowing but a combination of a sale and repurchase, is effectively a way to issue new debt ahead of any incumbent debt, jumping the queue of claimants in default, getting ahead even of depositors because the repo collateral is not available to repay them, let alone other creditors.

Our findings are directly relevant for the policy discussion. To the extent that the high indebtedness of banks, and particularly their high short-term indebtedness, reflects leverage

²³ Pre-Basel III, some of this hybrid debt had been issued to as “Tier 2 Capital”. With the regulators’ shift in focus towards common equity, this role of hybrid debt became less important.

ratchet effects in the absence of prior commitments, efficiency concerns about regulatory interference in private contracting may not be relevant; to the contrary, regulatory rules may improve the basis for private contracting by giving debt holders more confidence that they will not be taken advantage of in the bank's subsequent funding decisions.

Most academic contributions to the policy debate have focused on the economic role of bank debt, in particular, short-term bank debt.²⁴ One line of argument is based on the theory that banks' reliance on funding by short-term debt that must be constantly rolled over is useful, because the need to make sure that refinancing is always available imposes discipline on bank managers. A manager who "misbehaves" must fear that funding will evaporate and the bank will fail.²⁵ Another line of argument is based on the theory that short-term bank debt is useful to debt holders because they cherish the liquidity of their claims, i.e. the ability to turn them into cash whenever they wish, without worrying much about their value.²⁶

Elsewhere, we have provided detailed critical assessments of both lines of argument, noting, in particular, that they are strikingly in conflict with each other.²⁷ Whereas the discipline approach to explaining the prominence of short-term debt in bank funding presumes that debt holders are constantly monitoring to make sure that bank managers do not misbehave, the liquidity approach presumes that debt holders are happy to have an asset about which they do not have to worry. "Information insensitivity" of bank debt, i.e., the fact that, in normal times, the returns debt holders can expect are independent of the bank's returns on its assets, is taken to provide the basis for the liquidity of bank debt. Because bank debt is information insensitive, the story goes, in normal times, nobody has an incentive to invest in information, and therefore nobody must fear being taken advantage of by better informed investors. If debt holders do not invest in information, however, it is difficult to see how they would impose discipline. Hence the

²⁴ Some contributions also refer to asymmetric information and the analysis of Myers and Majluf (1984) as a reason for why banks would respond to increased capital requirements by reducing their lending. As noted in the introduction, however, the Myers-Majluf argument, only shows that the *issuance of new equity* by a sale in the open market can be "expensive". The argument does not explain why banks would resist other forms of raising equity; according to Myers and Majluf (1984), banks should actually prefer raising funds by retaining earnings rather than adding to their borrowing.

²⁵ See Calomiris and Kahn (1991), Dewatripont and Tirole (1994, 2013), Diamond and Rajan (2000, 2001, 2013), French et al (2010, p.).

²⁶ See Diamond and Dybvig (1983), Gorton (2009, 2012), DeAngelo and Stulz (2013).

²⁷ See Admati et al. (2011, Section 5), Admati and Hellwig (2013 a, b, c)

two narratives have strongly conflicting views about the role of information collection and monitoring by short term creditors.

Leaving aside the details and the differences of the two approaches, it is important to see that both are based on the presumption that the financing patterns of banks that we observe must be efficient. In this spirit, French et al. (2010) warn against raising equity requirements for banks on the grounds that tighter equity requirements might reduce benefits from debt as a disciplining device. Appealing to the other approach, DeAngelo and Stulz (2013) claim that higher equity requirements would reduce banks' ability to provide the economy with deposits that people cherish for their liquidity. Their analysis, however, is highly problematic.²⁸

Some, e.g., Gorton (2010, 2012) have suggested that the growth of repo borrowing and lending in the 2000s was due to a very large demand for liquid bank debt. In Gorton's interpretation, overnight repo loans are a modern version of deposits, and the expansion of bank borrowing in the past decade was largely a response to the economy's need for liquidity. The inference is that, even though the repo market is highly fragile and subject to runs, it would be unwise to curb its scope.²⁹

By contrast and consistent with our model, the growth of repo borrowing and lending can also be explained by a combination of a leverage ratchet and maturity rat race in borrowing. In this interpretation, the bankruptcy exemption of repo that was granted in 2005 enabled growth. Whereas the liquidity interpretation presumes that repo growth has been beneficial, our analysis

²⁸ DeAngelo and Stulz (2013) analyze optimal behavior of banks under the presumption that the liquidity benefits from deposits translate into a liquidity premium in the deposit rate. Under their assumptions about technology and preferences however, this presumption is incompatible with competitive equilibrium. DeAngelo and Stulz do not actually discuss market equilibrium, let alone whether equilibrium outcomes are efficient. They also assume away any return uncertainty of the assets in which banks invest depositors' funds. As discussed in Admati et al. (2011) and in Admati and Hellwig (2013a, Chapter 10, 2013b, c), since the returns on banks' assets are uncertain, it is essential to consider that default risk harms the liquidity of deposits and that additional equity that reduces default risk might actually *enhance* the liquidity of deposits. Gorton (2012) does not analyze equity requirements, but suggests that they would not be very useful because banking crises are due only to runs and panics from short-term funding. Short-term debt is taken to be what banks "produce," without taking account of the possibility that banks would take risk with the borrowed money and may become insolvent, and without asking how this possibility impacts creditors or taxpayers.

²⁹ Gorton (2010, 2012) acknowledges the vulnerability to runs and panics but suggests that it would be preferable to deal with this problem in the same way the analogous problem with deposits was dealt with, by deposit insurance, i.e., government-backed guarantees and backstops. As argued in Admati et al (2011) and Admati and Hellwig (2013a, Chapter 10, 2013b,c), the quality of liquidity provision would actually be improved if banks had more equity, because then the banks' short-term debt would be even *more* informationally insensitive and trustworthy.

throws doubt on that presumption. The prominence of repo in the funding of large banks may well be due to commitment failures and is therefore inefficient, even for the banks themselves.³⁰

The case for regulation of an industry usually rests on external effects by which the decisions of a firm affect third parties. In the case of banks, in particular large banks, external effects are indeed very important because the failure of a large bank can cause severe damage to the entire economy. For example, the billions of dollars, euros or pounds that were lost by the creditors in the bankruptcy Lehman Brothers, declared in September, 2008, were dwarfed by the trillions of dollars that were lost by the subsequent disruption of economic activity.

Some people question the appropriateness of regulatory intervention infringing the autonomy of corporate decision making. Because of the large social cost and inefficiencies associated with bank distress or failure, fairness considerations should not be focused on the narrow perspective of those shareholders holding concentrated positions in banks and their managers, who are the only ones losing in the immediate aftermath of leverage reduction in the private markets. Regulators must take into account all impacted parties.

The case for capital regulation of banks rests not only on the substantial external effects that bank borrowing and risk taking exerts on the rest of the financial system and the economy. Capital regulation also protects the banks' creditors, the deposit insurance fund and taxpayers who bear the costs of the inefficiencies that arise when banks are excessively leveraged. In light of our results about the potential inefficiency from a lack of commitment powers, regulatory intervention might actually end up being beneficial for the banks themselves and their immediate counterparties.

In the case of banks, distortions leading to excessive borrowing are exacerbated by prospects of support when things go wrong. Such support was amply provided in 2007-2009; some of which is still being maintained. The rationale behind this support is to prevent collateral damage caused by the default of some institutions; as we have learned, because of the high level of interconnectedness in the financial system, such collateral damage can be very large.³¹ In addition, when banks are distressed, they often cut lending and this can harm the broader

³⁰ Acharya, Schnabl, and Suarez (2013) also suggest that the increase in size of wholesale markets may have been caused by distorted incentives rather than an unbounded "need for liquidity."

³¹ See Admati and Hellwig (2013, Chapter 5).

economy.³² However, the prospect of government support makes creditors more willing to lend to banks; if they expect to be bailed out by the government, they need not be given a premium for default risk.

Our analysis in Section 4 has important implications for how banks adjust to higher equity requirements or recover from crises. As we have shown, there are a number of circumstances under which banks would choose to reduce leverage by selling assets and shrinking. Asset sales might also be the fastest way for banks to reduce leverage. The destabilizing effects of many banks simultaneously deleveraging through asset sales would be greatly reduced if banks were much better capitalized, i.e., “deleveraging multiples” are much lower. This is yet another benefit of higher equity requirements.

Insolvent banks would find it difficult, and possibly impossible, to raise new equity from investors, and they may therefore have to resort to asset sales in order to appear sufficiently capitalized. It is critically important for regulators to recognize hidden insolvencies and intervene in such cases. As seen, for example, in the Savings and Loans crisis in the US in the 1980s, insolvent banks are subject to many distortions and might inflict additional costs on taxpayers.³³

Analyses of how the government should provide supports to the banking system³⁴ take the original capital structure of the bank as given and do not consider regulatory interventions to reduce banks’ leverage when it gets excessive. If banks’ capital structure is inefficient and harmful, however, regulators are in a position to force banks to reduce their leverage in the private markets.

³² See, for example, Bernanke and Lown (1991). Diamond and He (2012) analyze the impact of different maturities of debt on debt overhang in investment. These papers take the capital structure of the banks as exogenous.

³³ Asset sales, and the accompanying shrinkage of bank balance sheets, can be socially beneficial. For example, subsidies associated with high leverage can lead banks to become overly large and complex and encourage them to hold assets that would be uneconomical for them to hold absent the subsidies. If subsidies are reduced with leverage reduction, the allocation of assets in the economy might become more efficient as banks sell assets. An added benefit is that this would make banks smaller and less complex to manage, regulate and unwind. A concern often raised in this context is that the assets sold would be held by entities in the so-called “shadow banking system.” This only highlights the importance of effective enforcement, something essential for any regulation to achieve its objective. See Admati and Hellwig (2013a, Chapter 13). If asset sales are considered undesirable, regulators should avoid giving banks full discretion as to how to reduce their leverage. In the transition to better capitalizations, if policy makers are concerned with a reduction in lending, it again becomes important to reduce the discretion banks have to adjust their leverage. Rather than direct them to achieve a particular *ratio*, regulators should focus on reducing payouts that deplete equity, and possibly mandate specific amounts of new equity for banks to issue. Directing banks in this way would lead banks to have sufficient funds with which to make worthy loans, and prevent inefficient contraction.

³⁴ See, for example, Phillipon and Schnabl (2013), and Bhattacharya and Nyborg (2013).

The leverage ratchet effect suggests that shareholders would resist such regulatory actions, but also that there is a justification for the action because of the collateral damage of default. Moreover, the anticipation of bailouts creates significant moral hazard and encourages even further risk taking and leverage, because these actions increase the value of the implicit government guarantees. Perversely, therefore, bailouts exacerbate the inefficiency of the leverage ratchet, feeding the addiction to leverage that the effect creates.

The forms of support that banks receive from central bank or governments rarely include injections of new common equity. Central banks aim to provide only “liquidity supports” to solvent banks, which amount to lending money to the banks against “good enough” collateral, i.e., assets whose value is at least as high as the loan, but in recent years some of the collateral has been questionable. Governments may also “inject capital” through various forms of preferred equity, which amounts to funding in exchange for promises that are junior to all debt. Whereas such supports provide funds to distressed banks that alleviate their immediate problems and allow them to avoid default, they can have the effect of increasing the banks’ leverage from the perspective of shareholders.

Indeed, allowing distressed or even insolvent (“zombie”) banks to continue operating, and especially supporting them by cheap credit or by preferred shares, does not generally address the distortions associated with their distress.³⁵ Examples of such programs are European Central Bank through the Long Term Refinancing Operation (LTRO), which provided cheap loans to banks, and Troubled Assets Relief Program (TARP) in the US in 2008-2009, which was based on preferred equity. Consistent with our observations, neither the LTRO program nor TARP resulted in significant increases in (business) lending.³⁶

More generally, capital regulation often allows for non-equity claims to be counted as “regulatory capital,” including preferred equity, or so-called “silent participation” claims, and various forms of hybrid securities. Many have argued, in particular, that “bail-inable debt” or various forms of contingent capital or even long-term debt should be counted as a way to satisfy capital regulation on the presumption that they would be able to absorb losses or to relieve the

³⁵ See Admati and Hellwig (2013a, especially Chapter 11).

³⁶ On the LTRO program, see Acharya and Steffen (2013), who refer to the LTRO as “the greatest carry trade ever.” Anecdotal evidence that the program did not improve lending includes such stories as Louise Armitstead, “ECB's LTRO plan flops as banks cut lending,” *Telegraph*, March 28, 2012. Cole (2012) shows that banks receiving capital injections from the TARP failed to increase their small-business lending, and instead decreased their lending by even more than other banks.

banks' distress when necessary (or in a resolution process). However, it is important to recognize that *any* security that has a privileged position relative to common equity gives rise to debt overhang and leverage ratchet effects. It is therefore important that capital regulation focuses on increasing the fraction of common equity used in the funding mix of banks and other financial institutions.

6. Concluding Remarks

In this paper we analyzed an agency cost of debt that stems from subsequent capital structure choices of firms that already have debt in place. This agency cost, which we call the *leverage ratchet effect*, biases the shareholders of leveraged firms towards leverage increases and against leverage decreases.

In the absence of full commitments and complete contracts, the agency costs of debt tend to increase the *ex ante* costs of funding mixes that include significant borrowing. Debt covenants that try to deal with the ratchet effect might forbid all borrowing until the debt is paid, but such constraints, like other covenants reduce the flexibility of the firm subsequently.

Because it represents an additional agency cost of debt, the leverage ratchet effect may help explain why some firms choose very low leverage. It is well known that low leverage gives firms more flexibility to take advantage of investment opportunities without constraints from covenants and helps them avoid the negative effects of subsequent debt overhang. The leverage ratchet effect strengthens this rationale for low leverage by the observation that low leverage helps firms avoid the inefficiencies associated with excessive subsequent leverage. This may contribute to our understanding of the so-called “zero-leverage puzzle.”³⁷

As we discussed, the leverage ratchet effect applies immediately to banks and other financial institutions whose creditors, particularly short-term creditors who may have access to collateral and depositors, do not constrain subsequent leverage increases through contracts. Because high leverage exacerbates the other agency costs of debt such as underinvestment and asset substitution, banks' high leverage is a source of inefficiency, including social inefficiency if there is collateral damage of distress and default. Moral hazard problems associated with explicit and implicit government guarantees exacerbate the problems. Regulation that allows a form of commitment to a more efficient capital structure with lower leverage can therefore play

³⁷ See, for example, Strebulaev and Yang (2013).

an important role. The analysis in this paper reinforces the conclusions of Admati et al (2011) that equity requirements significantly higher than those currently considered would provide large social benefits at little if any social cost.

Appendix

We state here precise conditions under which the current shareholders will be indifferent between asset sales and recapitalization when the market is undervaluing assets in place. We will assume that the market undervalues the firm's assets in the following sense: for each asset unit that the market perceives, the firm actually has $1+v$ units and this difference is perceived by the firm's managers. Thus the market assumes that the realized value of the assets will be $\tilde{x}A$, but managers know that the realized value will be actually be $\tilde{x}(1+v)A$. We will assume that the firm must decrease its leverage from δ_0 to $\delta_1 < \delta_0$ with leverage defined to be the ratio of the *face* value of debt to the *market* value of assets.

Proposition: *Assume that $p = v(\delta_1)$, there is only one class of debt, and the firm faces no transactions costs in buying or selling assets or the securities it issues other than that implied by the market's undervaluation of its assets. Then for all $v \geq 0$, shareholders find pure recapitalization and asset sales equally undesirable.*

Proof:

Let $q(\delta)$ is the market value of a unit of debt (face value is equal to 1) when the (market) leverage is δ and let $e(\delta)pA$ be the *total* market value of equity when the market value of assets is equal pA and the (market) leverage is δ .

In a recapitalization the firm must issue equity sufficient to buy back Δ_D units of debt so that

$$\frac{D - \Delta_D}{pA} = \delta_1, \text{ or } D - \Delta_D = \delta_1 pA \quad (\text{A41})$$

The "true" value of current equity holders' claim after recapitalization will be:

$$\left(1 - \frac{q(\delta_1)\Delta_D}{pA - q(\delta_1)(D - \Delta_D)}\right) e\left(\frac{\delta_1}{1+\nu}\right) p(1+\nu)A \quad (\text{A42})$$

The total value of equity (from the perspective of the informed insiders) is $e(\delta_1^{True})p(1+\nu)A$ where $\delta_1^{True} = \delta_1^{Market} / (1+\nu)$ and $p(1+\nu)A$ is the managers' assessment of the value of the assets. Note that "true" leverage as perceived by the managers is less than the market perceived leverage since the market is undervaluing the assets. The fraction of the total equity claim retained by current shareholders is based on the amount that must be raised through issuing equity to buy back the debt, i.e., $q(\delta_1)\Delta_D$, and the market's valuation of equity after the recapitalization, i.e., $pA - q(\delta_1)(D - \Delta_D)$.

Substituting (A41) into (A42), we have

$$\begin{aligned} \left(1 - \frac{q(\delta_1)\Delta_D}{pA - q(\delta_1)(D - \Delta_D)}\right) e\left(\frac{\delta_1}{1+\nu}\right) p(1+\nu)A &= \left(\frac{pA - q(\delta_1)D}{pA - q(\delta_1)(D - \Delta_D)}\right) e\left(\frac{\delta_1}{1+\nu}\right) p(1+\nu)A \\ &= \left(\frac{pA - q(\delta_1)D}{pA - q(\delta_1)pA\delta_1}\right) e\left(\frac{\delta_1}{1+\nu}\right) p(1+\nu)A \quad (\text{A43}) \\ &= \left(\frac{pA - q(\delta_1)D}{1 - q(\delta_1)\delta_1}\right) e\left(\frac{\delta_1}{1+\nu}\right) (1+\nu) \end{aligned}$$

In reducing leverage through assets sales the amount of debt bought back must solve:

$$\frac{D - \Delta_D}{pA - q(\delta_1)\Delta_D} = \delta_1 \quad \text{or} \quad \Delta_D = \frac{D - pA\delta_1}{1 - q(\delta_1)\delta_1} \quad (\text{A44})$$

Since $A - q(\delta_1)\Delta_D / p$ will be the new level of assets after the deleveraging is completed, the value of the equity claim after the asset sales is:

$$e\left(\frac{\delta_1}{1+\nu}\right) p(1+\nu) \left(A - \frac{q(\delta_1)\Delta_D}{p}\right) \quad (\text{A45})$$

Using (A44), we find that the new level of assets will be:

$$\begin{aligned} \left(A - \frac{q(\delta_1)}{p} \left(\frac{D - pA\delta_1}{1 - q(\delta_1)\delta_1} \right) \right) &= \left(\frac{pA - pAq(\delta_1)\delta_1 - q(\delta_1)D + pAq(\delta_1)\delta_1}{p - pq(\delta_1)\delta_1} \right) \\ &= \left(\frac{pA - q(\delta_1)D_1}{p - pq(\delta_1)\delta_1} \right) \end{aligned} \quad (\text{A46})$$

This means that (A45) becomes

$$\begin{aligned} e\left(\frac{\delta_1}{1+\nu}\right) p(1+\nu) \left(A - \frac{q(\delta_1)\Delta_D}{p} \right) &= e\left(\frac{\delta_1}{1+\nu}\right) p(1+\nu) \left(\frac{pA - q(\delta_1)D_1}{p - pq(\delta_1)\delta_1} \right) \\ &= e\left(\frac{\delta_1}{1+\nu}\right) (1+\nu) \left(\frac{pA - q(\delta_1)D_1}{1 - q(\delta_1)\delta_1} \right) \end{aligned} \quad (\text{A47})$$

Since this is precisely equal to (A43), the shareholders are indifferent between recapitalization and asset sales.

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