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Derivatives and Funding Value Adjustments: A Simple Corporate Finance Approach

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In the aftermath of the GFC, banks have adjusted their books of derivatives for funding costs and have made Funding Valuation Adjustments (FVA). These adjustments are surprising for two reasons. First, they are made on a voluntary basis. They are neither imposed by banking regulation nor suggested by accounting guidelines. Second, there are controversial within the academic community. The issue of whether the valuation of derivatives should account for funding costs has been highly debated in the recent years and remains unsettled. The goal of paper is to suggest a simple corporate finance approach to assess and illustrate the impact of funding costs on the valuation of derivatives and on the value of a dealer bank. In line with the conclusions of Hull and White (2012, 2014) and Andersen, Duffie and Song (2016), among others, it argues that the funding of derivative contracts leaves the bank value unaffected and that derivatives' valuation should not be adjusted for funding costs or benefits. The paper highlights the issues of wealth transfers between the shareholders and the creditors, and raises the issues of conflicts of interests between derivatives dealers, creditors, and the bank's shareholders.

1. Introduction

There is an intense debate in the academic literature about whether the value of derivative contracts should be adjusted for funding costs. In a controversial paper, Hull and White (2014) argue that adjustments for funding costs violate fundamental principles in financial economics such as the Fisher-Hirshleifer's separation principle between investment and financing decisions, the law of one price, and the well-known Modigliani-Miller irrelevance Proposition. In contrast, the derivatives quant community differentiates price from value and argues that funding costs are akin manufacturing costs which should be accounted for in the price of derivatives.[1] Their conclusions are not innocuous. Adjustments for funding costs mark the demise of the law of one price, a pillar of financial economics and the foundation of derivatives valuation.[2] They create arbitrage opportunities and break the concept of exit price cherished by accountants. Despite the lack of an official stand by regulators and accounting bodies and a lack of a consensus in the academic community, banks have made billions of dollars of funding adjustments since 2014, with significant differences across banks regarding their calculations.[3] The theoretical and regulatory foundations of these adjustments remain an open question.

Derivative contracts appear on the balance sheet of dealer banks on the asset side as derivative receivables or on the liability side as derivatives payable.[4] Until recently, a shortcoming of the literature on funding and derivatives was its failure to look at funding implications on the balance sheet of dealer banks.[5] Derivative contracts that need funding may require the issuance of new debt or new equity. In contrast, derivative contracts that provide funding may lead to a debt or an equity buy-back unless the cash raised is invested in riskless securities. Issuing, or buying-back, debt or equity generates wealth transfers between the shareholders and the creditors that are well documented in the corporate finance literature. These effects are usually ignored in the derivatives pricing literature that looks at the "standalone" impact of funding on derivatives' valuation, in isolation of any possible impact on the dealer bank's debt and equity values.[6] The recent paper of Andersen, Duffie and Song (2016) addresses this shortcoming. They suggest a full structural model of a dealer's balance sheet to investigate the impact of funding on derivatives valuation. They prove that funding value adjustments are inconsistent with any coherent notion of fair market value, they show that funding value adjustments are the costs to the

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[1] See Gregory (2016) for an introduction to funding value adjustments.

[2] See for example Green (2016) "*…in the context of derivatives it is not clear that the law of one price always applies… The only case where the law of one price might be said to hold is in the case of very liquid exchange-traded derivatives such as futures or exchange-traded options*." (p. 3).

[3] Of course, funding value adjustments could be used by dealer banks to hedge the debit value adjustment (DVA) of their derivatives' books given the lack of almost any other hedging device. It is probably not coincidental that JP Morgan aggregates DVA and FVA adjustments in its accounts. See: JPMorgan Chase & Co./2015 Annual Report, p. 200.

[4] For example, JP Morgan had a total of $ 59.677 bn. in net derivative receivables, $ 52.790 bn. in net derivative payables, and $2,352bn. in total assets, recorded on December 31, 2015. Derivative receivables and payables are netted across the relevant netting sets. See JPMorgan Chase & Co., 2015 Annual Report, p. 212.

[5] There are exceptions. See for example Burgard and Kjaer (2011), among others.

[6] There are exceptions. Issues about wealth transfers are discussed in Albanese and Andersen (2014) and Albanese, Andersen and Iabichino (2015).

shareholders for financing up-front counterparty cash payments and collateral requirements, and they derive the price that makes the shareholders indifferent to a new derivative trade.

The goal of this paper is to examine the issue of funding and derivatives valuation using a simple corporate finance approach. Deliberately free of technical developments, it illustrates the theoretical results obtained by Andersen, Duffie and Song (2016), clarifies the concepts of funding costs and benefits, and analyzes the mechanics of wealth transfers.[7] It looks at a simple unsecured and a secured derivative contract entered between a credit risky bank and a riskless counterparty. It relies on important principles in corporate finance regarding financing decisions and the interaction between financing and investment decisions, to investigate the impact of derivatives' funding on i) the market value of the derivative contract, ii) the market value of the bank, and iii) on the wealth of its shareholders and its creditors. First, in line with Hull and White (2012, 2014), and Andersen Duffie and Song (2016), the paper argues that funding costs and benefits should not be accounted for in the valuation of derivatives. Second, it shows that the derivatives' funding costs or benefits leave the market value of the bank unaffected, as per the Modigliani-Miller (1958) invariance Proposition. However, they generate wealth transfers between the shareholders and the creditors. Derivatives destroy or create value for the shareholders depending on the funding instrument and whether they require or provide funding. Regardless of the funding instrument, shareholders are worse-off with derivatives that require funding and more so when derivatives are funded by equity rather than by debt. The opposite conclusions hold true for derivatives that provide funding. These results are consistent with the pecking order of preferred financing methods. The introduction of a corporate tax changes the magnitude of the wealth transfers but not the fundamental conclusion that the bank's shareholders absorb the (after-tax) funding costs or benefits.

This raises issues about fund transfer pricing (FTP) and more specifically about the price of derivatives that makes shareholders indifferent. Funding costs should be passed to counterparties for the shareholders to be indifferent to derivatives trades. This creates agency problems and conflicts of interests between the derivatives dealers and the shareholders. Derivatives dealers have little incentives to charge counterparties for funding costs, as they run the risk of losing their trades to the competition, in particular to better capitalized dealer banks. Shareholders are likely to end up absorbing the funding costs unless their interests are properly aligned with those of the dealers. The recent funding value adjustments made by the banks that make the shareholders worse-off suggests that derivatives dealers do not necessarily act in the shareholders best interests.

The paper is organized as follows. Section 2 introduces the relevant framework, Section 3 discusses funding costs, Section 4 covers funding benefits, Section 5 deals with the funding of margin requirements. The assumption of perfect markets is relaxed in Section 6 and Section 7 concludes.

[7] See Andersen, Duffie, and Song (2016) for all the relevant technical aspects and formulas.

2. The Framework

The framework assumes competitive capital markets for debt and equity with complete information, and relies on a classic one-period binomial model to investigate the impact of funding on the valuation of derivatives and on the value of a dealer bank. Initially, markets are assumed to be perfect with no taxes and no costs of financial distress.

Consider a credit-risky bank funded by debt and equity. Suppose that the bank has no cash, and the current market value of the bank's assets is \$100. Assume the riskiness (volatility) of the bank's assets is captured by a multiplicative (annual) up- and down-factor equal to $u = 1.20$ and $d = 0.80$, respectively. In this binomial setting, the assets of the bank are worth \$100 at time 0, and increase to either \$120 in the up-state or decrease to \$80 in the down-state in one year's time, referred to as time 1. The credit-risky debt issued by the bank has a face value of \$90 and matures in one year. Given the asset values at time 1 and the face value of the debt, the bank is either in the no-default state when the asset value is \$120 (the up-state), or in the default state when the asset value is equal to \$80 (the down-state).

The bank's balance sheet given in Table 1.A is obtained at time 1 by allocating the asset value first to the creditors and then to the shareholders. As the residual claimants, the shareholders hold a call option on the bank's assets. The option is sold by the creditors who earn a credit spread over the risk-free rate as a compensation for the written option. The credit spread is denoted by CS and is given by:[8]

$$CS = (1 + R_F) \times \left(\frac{p \times L}{1 - p \times L}\right)$$

Its calculation requires two critical parameters, the loss rate L experienced by the creditors when the bank defaults, and the bank's risk-neutral default probability. In the default state, the creditors receive \$80 of the asset value on a face value of \$90.0, thereby experiencing a loss rate equal to $L = \left(1 - \frac{80}{90}\right) = 11.11\%$. In the standard one-period binomial setting, the risk-neutral probability of the down-state, here the default state, is equal to:

$$p = \frac{u - (1 + R_F)}{u - d}$$

where R_F denotes the risk-free rate assumed to be equal to 5.0%. This means that the risk-neutral default probability is equal to 0.375, giving a credit spread equal to:

$$CS = 1.05 \times \frac{0.375 \times 11.11\%}{1 - 0.375 \times 11.11\%} = \mathbf{4.565}\%$$

[8] Consider a one-year zero-coupon credit-risky bond with a face value of \$1.0, a risk-neutral default probability of p and a loss rate of L%. The current market price of the bond can be written as: $P = \frac{p\times(1-L)}{(1+R_F)}$. Alternatively, it can be written as: $P = \frac{1.0}{(1+R_F+CS)}$, where CS is the bond's credit spread. The formula above is obtained by equating: $\frac{1.0}{(1+R_F+CS)} = \frac{p\times(1-L)}{(1+R_F)}$, and solving for CS. See also ADS (2016) p.8, where the credit spread is calculated as: $R \times \frac{E^*(\varphi)}{1-E^*(\varphi)}$, where φ is the proportional loss rate, $E^*(\varphi)$ is the (risk-neutral) expected loss rate and R is equal to 1.0 plus the risk-free rate.

The risk-neutral valuation approach is used to obtain the bank's balance sheet at time 0. This is done by discounting back the expected value of debt and equity from time 1 to time 0, using the risk-neutral probabilities to calculate the expectation, and the risk-free rate to discount the relevant expected cash flows. Table 1.B gives the market values of debt and equity at time 0. They are equal to \$82.143 and \$17.857 respectively.[9] Riskless debt with a face value of \$90.0, would trade in the market for \$85.714. The difference between the value of riskless debt and the value of credit-risky debt with the same face value, denoted by D_F and D, respectively, is a credit derivative, more specifically a put option written by the creditors to the shareholders, worth:[10]

$$D_F - D = \$\frac{90.0}{1.05} - \$\frac{90.0}{1.09565} = \$85.714 - \$82.143 = \$\mathbf{3.571}$$

In the derivatives markets, the credit put option is referred to as a debit value adjustment. Denoted by DVA_{Debt} , it is calculated as the PV of the creditors' expected positive exposure times the expected loss rate:

$$DVA_{Debt} = \$\left(1 - \frac{80}{90}\right) \times \frac{1}{1.05} \times 90.0 \times 0.375 = \$\mathbf{3.571}$$

Table 1.C gives the banks' balance sheet at time 0 gross and net of DVA. The liability side can be decomposed as:

$$A = E + D = E + (D_F - DVA_{Debt}) = \$17.857 + \$82.143 = \$17.857 + (\$85.714 - \$3.571) = \$100$$

where A, E, and D denote the market value of the assets, the equity and the debt, respectively.

Assume now that the credit-risky bank enters a derivative contract, such as a forward, a swap or an option contract with a riskless counterparty.[11] The size of the trade is assumed to be small enough to have no impact on the bank's default probability. Denote by (B) and (C), the two parties involved in the derivative contract, the bank and the counterparty, respectively. For the sake of simplicity, consider an option contract, either call or put, that requires funding when purchased or provide funding when sold, such as a European option. Its market value, free of counterparty credit risk and funding considerations, is

[9] The credit spread can be obtained by inferring the debt's promised yield from the debt's market value at time 0. Solving for CS in $\$82.1429 = \frac{F}{1+R_F+CS}$, gives a credit spread CS equal to **4.565%.**

[10] Credit-risky debt is a portfolio of riskless debt and a credit put written by the creditors to the shareholders (or equivalently, from the put-call parity, a portfolio that contains the assets and a short call). When the bank defaults, the creditors get the assets from the shareholders. As long as the bank does not default, the creditors receive a spread in excess of the risk-free rate from the shareholders, i.e., the credit spread, as a compensation for the loss they experience when the bank defaults. See Merton (1974).

[11] This is for the sake of simplicity and without loss of generality. Otherwise, assumptions have to be made about the counterparty's credit-riskiness. The arguments are not affected by whether the counterparty is credit risky or not. The goal is to isolate the credit-riskiness of the bank.

denoted by V. The option contract is assumed to have a maturity of one year, and to have a value V equal to \$15.0 at time 0, giving an expected value of \$15.75 at time 1.[12]

Two cases are examined. In the first case, the bank purchases the option contract from the riskless counterparty. The bank has a new asset, a derivative receivable that requires funding. In the second case, the bank sells the option contract to the counterparty. The bank has a new liability, a derivative payable that provides funding. Three issues are discussed in both cases. The first issue is the impact of funding costs or funding benefits on the value of the derivative contract. Should the option value be adjusted for funding costs in case 1 and for funding benefits in case 2, adjustments referred to as FCA in the former case and FBA in the latter case? The second issue is to assess the impact of the derivative contract on the value of the bank from the point of view of all the providers of capital and from the point of view of the shareholders only. A third issue is the relevance of the funding instrument. In case 1, the option premium paid by the bank at time 0 is funded by issuing new debt or new equity. In case 2, the cash received by the bank at time 0 from the option sale is used to retire debt, to buy back equity, or is invested in riskless assets. The third issue is to determine whether the funding instrument matters for the valuation of the derivative contract and for the valuation of the bank. The three issues are discussed both, for unsecured (uncollateralized) and secured (collateralized) options. Additional margin-related funding requirements, referred to as MVA, arise when the option is secured. In the secured case, the concept of funding is enlarged to incorporate the possible impact of margin-related funding costs. Finally, the robustness of the results to the assumption of a zero corporate tax rate is investigated in the last section of the paper.

The standard binomial two-step approach is used in all the cases above to address the relevant issues. The market value of debt and equity is calculated at time 1 in the first step. This is done by allocating the market value of the bank's assets to the creditors and then to the shareholders. Backward induction is used to calculate the market value of debt and equity at time 0 in the second step. This is done by discounting the relevant risk-neutral expected cash flows at the risk-free rate.

3. Funding Costs Adjustments (FCA)

In this section, the bank is assumed to purchase the option contract from the riskless counterparty. The new asset on the bank's balance sheet raises credit and funding issues.

First, consider counterparty credit risk issues. The assumption of a riskless counterparty implies that the value of the option contract, as an asset to the bank, incorporates no counterparty credit risk adjustment for the exposure of the bank to the counterparty, i.e., $CVA(B) = 0$.[13] Likewise, the option contract, as a liability to the counterparty, incorporates no counterparty credit risk for the exposure of the counterparty

[12] Initially, the option payoff at maturity is assumed to be known with certainty. Counterparty credit risk aside, the option behaves like a riskless bond that pays \$15.75 at maturity. The assumption is made for the sake of simplicity. It is relaxed in section 5.

[13] $CVA(B)$ denotes the credit value adjustment made by the bank to account for its credit exposure to the counterparty. By symmetry, it is equal to the debit value adjustment made by the counterparty to account for its own credit risk. It is denoted $DVA(C)$ and satisfies the property $CVA(B) = DVA(C)$. A similar reasoning applies to the credit value adjustment made by the counterparty to account for its credit exposure to the bank. It is denoted by $CVA(B)$ and satisfies the property $CVA(C) = DVA(B)$.

to the bank, i.e., $CVA(C) = 0$. Funding issues aside, there are no adjustments for counterparty credit risk, and the option premium is given by:

$$V_D = V_{ND} - CVA(B) + DVA(B) = V_{ND} = \$15.0 = V \quad \text{(Eq. 1)}$$

where V_{ND} is the fair value of an option contract between two riskless counterparties, and V_D is the value of the same option contract between credit-risky counterparties. As a derivative receivable to the bank, the option is free of credit risk adjustments.

Second, consider funding issues. The bank must fund the purchase of the option contract. Two cases are examined. In the first case, the option premium is funded by issuing new debt. In the second case, the option premium is funded by issuing new equity. In both cases, the option is assumed to be unsecured. The issues are to determine whether the option premium should be adjusted for the funding costs, whether the derivative has an impact on the value of the bank, and whether the funding instrument, i.e., debt or equity, matters for valuation.

3.1 Debt Funding

The bank issues new debt to fund the option premium. Assume that the new debt ranks "*pari-passu"* with the existing debt, now referred to as the legacy debt. The new debt has a cost over the risk-free rate reflected in the credit spread required by the new creditors. The issue is to determine whether the bank should pay less for the option contract by an amount equal to the funding costs, denoted by FCA. Is the fair value of the option given by Eq. 1, or alternatively by Eq. 2 below:

$$V_F = V - FCA = \$15.0 - FCA \quad \text{(Eq. 2)}$$

where the option premium, denoted by V_F, differs from V by the amount of the amount of the funding costs?[14]

Corporate finance is useful to address this question. Start with the newly issued debt. The new creditors purchase the debt only to the extent that the debt is fairly priced, i.e., is a zero NPV investment. This is the case when the credit spread is commensurate with the riskiness of the bank's assets and the bank's capital structure, inclusive of the new asset (the derivative receivable) and the new liability. What about the legacy creditors? In the no-default state, their wealth does not change as they are paid in full. However, in the default state, their wealth increases for two reasons. First, the derivative receivable increases the bank's assets which decreases the debt's loss rate and its credit spread. Second, the "*pari-passu*" assumption does not change the debt's priority. With a non-zero default probability, the derivative contract increases the expected wealth of the legacy creditors, i.e., is a positive NPV investment.[15] What about the shareholders? In the default state, the derivative contract does not make the shareholders better off or worse off as their claim is wiped out. However, in the no-default state, they bear the funding

[14] There exist multiple acronyms for funding costs, such as FCA or FVA (Funding Value Adjustments). The former is used here.
[15] Here, the term "positive (negative) NPV" is used in the sense of value creation (destruction), respectively.

costs of the newly issued debt. The derivative contract makes the shareholders worse off, i.e., is a negative NPV investment.

What are the implications regarding valuation? Start with the fundamental principle that investment projects with a NPV of zero do not create value, and with the Modigliani-Miller irrelevance Proposition that the value of a firm is not affected by financing decisions. It follows that, for the derivative contract to have no impact on the bank value, the increase in the legacy debt value must be exactly offset by an equal decrease in the equity value, i.e., wealth is transferred from the shareholders to the legacy creditors. This holds when the derivative contract is fairly priced, i.e., is zero NPV. Fair pricing means charging V for the option premium, as any other price less than V would create value for the bank at the expense of the counterparty. The value of the derivative contract is given by Eq. 1 with no adjustment for funding costs. Corporate finance argues that the funding costs are borne by the bank's shareholders. This raises the issue of the derivative's price that preserves the shareholders' wealth.

The example is used to illustrate the corporate finance principles discussed above. The bank issues new debt to fund the option premium. Its face value F is calculated in such a way that the debt is a zero NPV investment for the new creditors. At time 1, the bank either defaults or does not default. In the first case, the new creditors receive the full face value F. In the second case, they recover $(1 - L)\%$ of the face value F, with L the loss rate, given by:

$$L = 1 - \left(\frac{80 + 15.75}{90 + F}\right)$$

where the numerator (denominator) is the asset value in the default (no-default) state.[16] To satisfy the zero NPV requirement, the face value F is calculated in such a way that the PV of the future expected debt value at time 1 is equal to the initial investment made by the new creditors at time 0. Suppose this investment is equal to the cash required to purchase the option contract, i.e., assume the bank raises \$15.0 in new debt. The face value F of the new debt is obtained by solving:

$$\$15.0 = PV \times [(1 - p) \times F + p \times (1 - L) \times F] = PV \times F \times [1 - p \times L]$$

Solving for F yields $F = \$16.362$.[17] The face value of the new debt must be equal to \$16.362 to be fairly priced, i.e., to be a zero NPV investment.

What are the implications of the new debt issue for the legacy creditors? The debt is issued to fund a new asset, i.e., the derivative receivable, which increases the asset base. In the default state, the new creditors

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[16] Alternatively, in the default state, the new creditors receive a fraction ρ of the bank's asset value. The assumption that the new debt ranks "*pari-passu*" with the legacy debt gives: $\rho = \frac{F}{F+90}$.

[17] Substituting for L gives: $\$15.0 = \frac{1}{1.05} \times F \times \left[1 - 0.375 \times \frac{95.75}{90+F}\right]$. F is obtained by solving a straightforward quadratic equation. Note that $F = \$15.0 \times (1 + R_F + CS)$. This means that CS can be obtained by solving: $\$15.0 = \frac{\$15.0}{1.05} \times (1 + R_F + CS) \times \left[1 - 0.375 \times \frac{95.75}{90+\$15.0\times(1+R_F+CS)}\right]$. See ADS (2016) p. 37.

share the derivative's payoff with the legacy creditors. The former receive $\rho \times V^{-} = \$14.729$, and the latter get $(1-\rho) \times V^{-} = \$81.021$, a higher claim than in the pre-derivative case, where $\rho = \frac{F}{F+90}$. The legacy creditors experience a lower loss rare, fare better in the default state, and require a lower credit spread. The new asset decreases the loss rate to 9.98% from its pre-derivative value of 11.11%, and the credit spread to 4.081% from its pre-derivative value of 4.565%.[18] This is at the expense of the shareholders who bear the funding costs and fare worse in the no-default state.

Table 2.A and Table 2.B give the market value of debt and equity at time 1 and the balance sheet of the bank at time 0. Five conclusions emerge from Table 2.B.

1. The bank's balance sheet increases by an amount equal to the option premium, \$15.0. The bank has a new asset on the asset side, i.e., a derivative receivable worth \$15.0, and a new liability, the newly issued debt, worth \$15.0.
2. The market value of the equity and of the legacy debt sums up to \$100, i.e., the bank's market value before the derivative transaction, as per the Modigliani-Miller invariance Proposition.
3. The derivative contract is a negative NPV investment for the shareholders. The decrease in the equity value, i.e., the transfer of wealth ΔW from the shareholders to the legacy creditors, is equal to:[19]

$$\Delta W = \Delta E = \$17.4927 - \$17.8571 = -\$\mathbf{0.3644}$$

When the bank does not default, the shareholders receive \$15.75 from the derivative contract but pays \$16.3622 to the new creditors. The difference is \$0.6122. This means that when the bank does not default, the shareholders suffer a loss equal to the PV of the expected difference, i.e., $PV(\$0.6122 \times 0.625) = \$\mathbf{0.3644.}$

4. The derivative contract is a positive NPV investment for the legacy creditors. The market value of debt increases by an amount equal to the wealth transfer from the shareholders to the creditors:

$$\Delta W = \Delta D = \$82.5072 - \$82.1428 = \$\mathbf{0.3644}$$

When the bank defaults, the legacy creditors share part of the option's payoff equal to \$15.75 with the new creditors. The latter get \$14.729 and the former receive the difference, i.e., \$1.021.

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[18] The bank total liabilities at time 1 amount to: $\$90.0 + F = \$106.362$. With total assets worth $V^{-} = \$95.75$ in the default state, the loss rate is now equal to: $\frac{\$95.75}{\$106.362} = \mathbf{9.98}\%.$

[19] See ADS (2016), Proposition 1, Eq. 5, p. 9: "*The marginal value to shareholders of debt financing is equal to:* $\delta E^{*}\left[1_{D^C}\left(Y - u(R+S)\right)\right]$" Here, $\delta = \frac{1}{1.05}$, $u = 15.00$, $S = 4.081\%$, $Y = \$15.75$, $R = 1.05$, 1_{D^C} is an indicator that indicates no-default, and E^{*} denotes a risk-neutral expectation. The risk-neutral survival probability is equal to 0.625, giving a marginal value to the shareholders of: $\frac{1}{1.05} \times 0.625 \times (15.75 - 15 \times 1.09081) = \$\mathbf{0.3644.}$

This means that when the bank defaults, the legacy creditors earn the PV of the expected difference, i.e., $PV(\$1.021 \times 0.375) = \$\mathbf{0.3644}$.[20]

5. The new debt is a zero NPV investment for the new creditors. It is fairly priced and has a fair value of \$15.0. Consider the default state. The new creditors lose to the legacy creditors when the bank defaults. At time 1, the wealth transfer from the former to the latter is equal to $\$(15.75 - 14.729) = \$1.021$. At time 0, the wealth of the new (legacy) creditors decreases (increases) by an expected amount equal to $PV(\$1.021 \times\ 0.375) = \$0.3644$. Consider now the no-default state. In order to break even at time 0, the new creditors must make an expected gain of $\$0.3644$ when the bank does not default, i.e., charge $\$\frac{0.3644}{0.625} \times 1.05 = \$0.6122$ at time 1 to the shareholders. This means that the face value of the new debt must be equal to $F = \$15.75 + \$0.6122 = \$16.362$ to be a zero NPV investment. The new debt acts as a conduit through which the gains to the legacy creditors in the default state are passed on as losses to the shareholders in the no-default state.[21]

Summarizing, the bank raises \$15.0 in new debt with a face value of \$16.362 to fund the purchase of an unsecured option contract. The new debt is a zero NPV investment for the new creditors. The purchase of a new asset funded by debt makes the legacy creditors better off at the expense of the shareholders but preserves the bank's value, i.e., the aggregate wealth of the shareholders and the legacy creditors. The issue left pending is the fair value of the option contract. Is it equal to $V = \$15.0$, the cash amount raised in new debt? Or, is it equal to V_F, where V_F differs from V by the amount of the funding costs? If so, what are the funding costs?

3.1.1 FCA: A First Interpretation

There are multiple interpretations and definitions of what the funding costs are.[22] In the example above, the derivative contract is a negative NPV investment for the shareholders. With the derivative contract, the bank borrows at a credit spread over the risk-free rate and lends at the risk-free rate. This argues in favor of defining funding costs as the PV of the excess funding costs paid by the shareholders. In the example, they are equal to:

$$FCA = PV[15 \times (1 + R_F + CS) - 15 \times (1 + R_F)] = PV[15 \times CS] = \$\frac{1}{1.05} \times 15 \times 0.0408131 = \$\mathbf{0.5830}$$

According to this interpretation, the funding costs are the excess "carrying costs" of the derivative contract. They are borne by the shareholders as long as the bank does not default. As shown by Hull and

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[20] See ADS (2016), p. 40, "$\delta E^*[1_D cuS]$ *is the marginal valuation of the new position to the dealer's legacy creditors.* This gives a marginal value equal to: $\frac{1}{1.05} \times 0.625 \times 15.00 \times 4.081\% = \$\mathbf{0.3644}$.

[21] See the illustration in Exhibit 1.

[22] See ADS (2016) p. 4, "*There appears to be significant variation across dealers in the manner in which dealers compute their FVA metrics.*" See also their footnote 14 p.14.

White (2014), they are equal to the DVA of the newly issued debt, denoted by DVA_N, defined as the PV of the (new) creditors' expected positive exposure times the expected loss rate:

$$DVA_N = \$\left(1 - \frac{14.730}{16.362}\right) \times \frac{1}{1.05} \times 16.362 \times 0.375 = \$\mathbf{0.5830}$$

The insight of Hull and White (2012) is to observe that the funding costs absorbed by the shareholders when the bank does not default have matching benefits. The latter are the gains earned by the legacy creditors when the bank defaults.[23] They are passed on as funding costs to the shareholders by the new creditors. Hull and White argue correctly that derivative contracts should not be adjusted for funding because the funding costs (FCA) are offset by the funding benefits (DVA):[24]

$$V_F = V - FCA + DVA_N = \$15.0 - \$0.5830 + \$0.5830 = V$$

3.1.2 FCA: A Second Interpretation

A second interpretation is to define the funding costs as the expected loss experienced by the shareholders, i.e., the decrease in the equity value at time 0. This loss is equal to the wealth transfer from the shareholders to the bondholders:

$$FCA = \Delta W = |\Delta E| = \Delta D = \$\mathbf{0.3644}$$

It is easy to check that the two interpretations differ by the probability that the bank does not default.[25] The former interpretation captures the (excess) funding costs paid by the shareholders as long as the bank does not default. The latter interpretation captures the expected funding costs, i.e., the funding costs times the probability that the bank does not default:

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[23] Castagna (2014) argues p. 11 that "*…there is no benefit whatsoever for anyone when the bank goes bankrupt, either for the bond or the shareholders,*" and concludes on p. 14 that "*the FVA (and the DVA) could be considered as the present value of a cost born by the shareholders.*" The first statement is correct when considering the aggregate wealth of the shareholders and the legacy creditors. However, the second argument fails to recognize the wealth transfer from the shareholders to the legacy creditors. FVA (FCA) is a funding cost borne by the shareholders and DVA is a funding benefit earned by the legacy creditors.

[24] See HW (2014), p. "*Assume for the moment that the whole credit spread is compensation for default risk. The FVA then equals DVA2 for a derivative (or a derivatives portfolio) because the present value of the expected excess of the bank's funding for the derivative over the risk-free rate equals the FVA—which also equals the compensation the bank is providing to lenders for the possibility that the bank might default and is thus equal to the expected benefit to the bank from defaulting on its funding. Therefore, FVA and DVA2 cancel each other out. (When a derivative requires funding, FVA is a cost and DVA2 is a benefit. When it provides funding, FVA is a benefit and DVA2 is a cost.)*" Here $DVA_2 = DVA$ and $FVA = FCA$.

[25] ADS (2016) define the funding costs as the wealth transfer. They write on p. 14 that "*The quantity Φ is the debt funding value adjustment (FVA), recently introduced by dealers to adjust their reported accounting incomes. The FVA Φ may be interpreted as a transfer of wealth away from dealer's shareholders due to the adverse impact of funding costs.*" Note: $\Phi = \delta\big(\delta E^*(Y)\big)SP^*(D^C)$. This gives a FVA amount equal to: $\Phi = \frac{1}{1.05} \times \left(\frac{1}{1.05} \times 15.75\right) \times 4.081\% \times 0.625 = \$\mathbf{0.3644}$.

$$FCA = \Delta W = |\Delta E| = \Delta D = PV[15 \times CS] \times 0.625 = \$\mathbf{0.3644}$$

The contribution of Andersen, Duffie and Song (2016) is to use a balance sheet approach and to show that the derivative contract has an impact on the equity value and on the (legacy) debt value but not on their sum, i.e., the bank value. The decrease in the equity value of \$0.3644 is exactly offset by an increase in the legacy debt value of \$0.3644. The derivative contract makes the shareholders worse off but leaves the aggregate value of equity and debt unaffected. In short, the incremental impact of the derivative transaction on the bank's (pre-derivative) balance sheet is given by:

$$A + V_F = (E + \Delta E) + (D + \Delta D + ND)$$

where ND is the market value of the new debt. The wealth transfer from the shareholders to the legacy creditors, i.e., $\Delta E = -\Delta D$, implies that:

$$A + V_F = E + (D + ND)$$

The bank raises new debt in an amount equal to the option premium V, i.e., $ND = V = \$15.0$. This implies that, for the bank value to be left unaffected by the derivative transaction, i.e., for:

$$A = E + D$$

the following equality must hold:

$$V_F = V = \$15.0$$

This means that the fair value of the derivative contract on the asset side of the bank's balance sheet must be equal to V.[26]

Two conclusions emerge. First, regardless of the interpretation/definition of funding costs, no funding adjustment should be made to the value of the derivative contract. Second, funding the upfront option premium with new debt has no impact on the sum of the equity and the legacy debt value. The derivative contract does not make the bank's providers of capital either better off or worse off as per the Modigliani-Miller invariance Proposition. It is important to emphasize that the results obtained about the derivative value and the bank value are robust to a change in the priority of the new debt, i.e., whether is it made senior or junior to the existing debt. The sole impact of a change in the "*pari-passu*" assumption will be on the wealth transfers between the shareholders and the legacy creditors.[27]

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[26] Conversely, $V_F = V = \$15.0$, implies that $A = E + D$.

[27] For example, making the new debt junior to the existing debt will increase the market value of the legacy debt at the expense of the shareholders. The wealth transfer will be higher than under the "*pari-passu*" assumption because the legacy creditors come first is in the default state, and recovers more of the option's payoff. Regardless of its seniority, the new debt is always a zero NPV investment for the new creditors. They require a higher credit spread than under the "*pari-passu*" assumption, thereby making the shareholders worse off. Conversely, making the new creditors senior to the existing creditors, or issuing debt with a shorter maturity than the existing debt, eliminates the wealth transfer from the creditors to the shareholders. In the default state, the new creditors receive the full

3.1.3 Fund Transfer Pricing (FTP)

This raises the issue of the derivative's price V^* that preserves the shareholders' wealth.[28] The shareholders are indifferent to the derivatives' trade only to the extent that their loss is passed to the counterparty. Assume that the counterparty is willing to make a "donation" equal to the difference between the fair value V and the price V^* of the derivative contract, what will happen to the bank balance sheet?

Corporate finance provides useful guidance. Compare the donation to the no-donation case. First, the donation reduces the bank's funding requirements, and lowers the face value of the new debt. Second, like in the no-donation case, the new debt remains a zero NPV investment for the new creditors. Third, the derivative transaction is a zero NPV investment for the shareholders as per the objective function. This means that, out of the three parties involved, i.e., the shareholders, the new creditors and the legacy creditors, the derivative contract is a zero NPV investment for the first two parties. Fourth, and as before, the new asset on the bank's balance sheet decreases the loss rate experienced by the legacy creditors which increases the wealth of the legacy creditors. The difference with the no-donation case is that the legacy creditors reap the entire benefits of the donation at the expense of the derivatives' counterparty. This means that the market value of the bank increases by the donation.

The example is used as an illustration. Consider the newly issued debt. Its face value must be calculated in such a way that it satisfies two constraints. First, the new debt must be a zero NPV investment for the new creditors. Second, the new debt must preserve the shareholders' wealth. This is the case when the equity value is left unchanged from its pre-derivative value of $30.0 in the no-default state at time 1. From the identity that the market value of the new debt, the legacy debt and the equity adds up to the asset value, F must be equal to the expected value of the derivative contract at time 1:

$$F = A - (D + E) = \$(120 + 15.75) - (90 + 30) = \$\mathbf{15.75}$$

In the default state, for the legacy debt and the new debt to rank "*pari-passu"* and have the same loss rate given default, the loss rate must be equal to the ratio of the asset value given default divided by the sum of the face values of the legacy debt and the new debt:[29]

$$L = 1 - \frac{80 + 15.75}{90 + 15.75} = 9.456\%$$

option payoff. The asset value left to the legacy creditors remains unchanged from its pre-derivative value. Issuing new debt with a higher seniority could be prohibited by existing covenants.

[28] This is the fund transfer pricing problem (FTP) discussed by Albanese and Andersen (2014). They define FTP on p. 29, as *"the bank's entry price, i.e., the price that the bank would bid to acquire a trade or possibly a collection of trades."*

[29] Note that in this case, unlike the previous case, the loss rate on the derivative receivable is equal to the loss rate on the new (and legacy) debt. This is because the face value of the new debt is equal to the option's payoff.

The loss rate is lower than in the no-donation case because of the decrease in the face value to \$15.75 from \$16.362. This in turn decreases the credit spread to 3.86% from 4.081% in the no donation case.[30] Discounting the face value of the newly issued debt at 8.86% gives a debt value of \$14.468. For the shareholders to be indifferent to the derivative contract, the bank must borrow \$14.468 in new debt to fund an option with a fair value of \$15.00. This means that the counterparty must be willing to make a donation equal to:[31]

$$V - V^* = \$15.00 - \$14.468 = \$\mathbf{0.5319}$$

Table 3.A and Table 3.B give the market value of debt and equity at time 1 and the balance sheet of the bank at time 0. Five conclusions emerge from Table 3.B:

1. The market value of the bank increases by the donation. The derivative contract is a positive NPV investment for the bank, in violation of the Modigliani-Miller Proposition. This is because the bank pays less than the fair value for the option premium. There is a wealth transfer from the counterparty to the dealer bank.
2. The derivative contract is a zero NPV investment for the shareholders as per the objective function. The shareholders break-even when the derivative is priced at \$14.468. For all the option prices between $V^* = 14.468$ and the fair value of \$15.0, the derivative contract is a positive NPV investment for the bank but destroys value for the shareholders. This is the well-known debt overhang problem according to which shareholders do not invest in positive (or zero) NPV projects because the value creation is captured in full or in part by the creditors.
3. The derivative contract is a positive NPV investment for the legacy creditors. The wealth of the legacy creditors increases by the donation itself. This is because the derivative contract is a zero NPV transaction for both the shareholders and the new creditors. When the bank defaults, the legacy creditors share part of the \$15.75 received from the derivative contract with the new creditors. The latter get \$14.261 and the former receive the difference, i.e., \$1.489. This means that when the bank defaults, the legacy creditors earn the PV of the expected difference, i.e., $PV(1.489 \times 0.375) = \$$**0.5319.** The donation makes the legacy creditors better off by a larger amount than in the no donation case.[32]
4. The derivative contract is a zero NPV investment for the new creditors. The new debt is fairly priced and has a fair value of \$14.468. Consider the default state. The new creditors lose to the legacy creditors when the bank defaults. At time 0, the wealth of the new (legacy) creditors

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[30] The credit spread CS can be obtained directly by solving: $\frac{1}{(1+R_F+CS)} = \frac{1}{1.05} \times \left[1 - 0.375 \times \frac{95.75}{105.75}\right]$. This gives $CS = (1 + R_F) \times \frac{p \times L}{1 - p \times L} = 1.05 \times \frac{0.375 \times 9.456\%}{1 - 0.375 \times 9.45\%} = \mathbf{3.86}\%$.

[31] See ADS (2016), p.13 *"In this simple case, from the viewpoint of shareholder value maximization, the dealer's breakeven upfront price v^* for entering the swap is an adjustment of the fair market value v that: (i) removes the DVA term d from v. (ii) substitutes the dealer's unsecured discount rate R + S for the risk-free rate R."* and their Eq. 12, p. 13: $v^* = (v - d) \times \frac{R}{R+CS}$. Here, $v = \$15.0$, $R = 1.05$, $CS = 3.86\%$, giving $\boldsymbol{v}^* = \$\mathbf{14.468}$. Note that in the example above $DVA = d = 0$. Also, the credit spread must account for the donation.

[32] Note also, that they will always prefer a donation that increases their wealth to a collateralization scheme that leaves their wealth unaffected.

decreases (increases) by the present value of the expected amount, $PV(1.489\times\ 0.375)=$ $\$0.5319$. In order to break-even at time 0, relative to a riskless debt instrument with a face value of \$15.75 and a current market price of \$15.00, the new creditors must be willing to pay only $\$15.00-\$0.5319=\$14.468$ for a debt with a face value of \$15.75. The new debt acts as a conduit through which the gains to the legacy creditors in the default state are passed on as losses to the derivative's counterparty.

5. The derivative contract is a negative NPV investment for the counterparty. The willingness of counterparties to make donations depend on their own funding costs. The donation, equal to $\$\left(15.0\times\frac{CS}{1+R_F+CS}\right)=\$0.5319$, is proportional to the bank's credit spread post-derivative transaction equal to 3.86%. Strong counterparties with a credit spread lower than the most highly rated bank (highly capitalized dealers) with low credit spreads, have incentives to post collateral.[33] Weak counterparties have incentives to agree on a donation and to minimize the donation, sell the option contract to the most highly rated dealer banks. This implies that the derivatives' book of the latter will be unbalanced and be tilted in favor of derivatives' receivables.[34]

3.1.4 FCA: A Third Interpretation

This suggests a new definition and third interpretation of funding costs, namely the difference between the derivative's value and its price, with the latter calculated to make the shareholders indifferent. They are equal to the excess funding costs paid by the counterparty:[35]

$$FCA=PV(\$14.468\times0.0386)=\$\frac{1}{1.05}\times14.468\times0.0386=\$\mathbf{0.5319}$$

The funding costs are lower than in the no donation case, \$0.5319 versus \$0.5830, given the decrease in the loss rate from 9.98% to 9.46% and the accompanying decrease in the credit spread from 4.08% to 3.86%. As per the argument of Hull and White (2014), the FCA is equal to the DVA of the newly issued debt, i.e., the benefits enjoyed by the legacy creditors at the expense of the new creditors in the default state:

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[33] Under a one-way CSA, the counterparty must post a collateral amount equal to the fair value of the option premium, i.e., \$15.00. The counterparty will be indifferent when $PV[\$15.0\times CS_C]=\$\left(15.0\times\frac{CS}{1+R_F+CS}\right)=$ $\$0.5319$, when $CS_C=\frac{CS\times(1+R_F)}{1+R_F+CS}$, where CS_C is the counterparty's credit spread. Solving for CS_C gives $CS_C=$ $\mathbf{3.723}\%$.

[34] These conclusions appear in HW (2012, 2014) and ADS (2016).

[35] ADS (2016) write on p.15 that under the assumption of a survival probability close to 1.0 "*the client swap counterparties must be willing to donate" the sum of the DVA and the FVA Φ*" where $\Phi=\delta\big(\delta E^*(Y)\big)SP^*(D^C)$. The assumption of a survival probability close to 1.0 does not hold in the example above. However, it is easy to show that the donation must be equal to $v^*-v=\frac{\Phi}{P^*(D^C)}\times\frac{R}{R+S}\approx\frac{\Phi}{P^*(D^C)}$ when this is not the case.

Indeed, $\Phi=\delta\big(\delta E^*(Y)\big)SP^*(D^C)=\frac{1}{1.05}\times15.0\times3.86\%\times0.625=\$0.3447$, giving $v^*-v=\frac{\Phi}{P^*(D^C)}\times\frac{R}{R+S}=$ $\frac{0.3447}{0.625}\times\frac{1.05}{1.0886}=\$\mathbf{0.5319.}$

$$DVA_N = \$\left(1 - \frac{14.261}{15.75}\right) \times \frac{1}{1.05} \times 15.75 \times 0.375 = \$\mathbf{0.5319}$$

This shows that the difference between the value and the price of the derivative contract is equal to:

$$(V - V^*) = \Delta W = FCA = DVA = \Delta D = \$\mathbf{0.5319}$$

where ΔW is the wealth transfer from the derivative's counterparty to the legacy creditors, i.e., the donation.

Summarizing, for the shareholders to be indifferent to the derivative trade, i.e., for $\Delta E = 0$, the derivative's counterparty must be willing to donate \$0.5319. The bank pays \$14.4681 for a derivative contract worth \$15.00 and books a profit. The bank funds the upfront premium by borrowing \$14.4681 in newly issued debt. The new creditors are fairly compensated and the legacy creditors are better off by the full donation.

Donations raise interesting agency problems and conflicts of interests between the traders and the shareholders. Unlike the shareholders who are indifferent at a price of v^*, the traders may have incentives to trade at any price between v and v^*, i.e., to increase the probability of booking the trade with the counterparty. All else equal, it suggests that the shareholders of low-rated banks with high credit spreads are more likely to be affected by conflicts of interest and be worse off than the shareholders of highly-rated banks.

3.2 Equity Funding

A remaining issue is whether the previous results are affected by the choice of the funding instrument. Suppose now that the upfront option premium paid by the bank to the counterparty is funded with new equity. Does equity funding change the conclusions obtained under debt funding?

Corporate finance provides straightforward answers. Start with the new equity issue. The new shareholders subscribe to the new shares issued only to the extent that their investment has a NPV of zero. The creditors are better off because the derivative receivable increases the asset base. This reduces the loss rate and the credit spread and increases the market value of the debt. The derivative contract is a positive NPV investment for the creditors. This means that the (legacy) shareholders are worse off by an amount equal to the increase in the debt value. The only change is the amount of wealth transferred from the shareholders to the legacy creditors. It is significantly higher than in the previous case because the latter do not share the option's payoff with other creditors in the default state. The derivative contract has no impact on the value of the bank and the funding costs are borne by the (legacy) shareholders.

The example is used as an illustration. Table 4.A and Table 4.B give the market value of debt and equity at time 1 and the bank's balance sheet at time 0 when the bank issues \$15.0 worth of new equity to fund the option premium. Six conclusions emerge from Table 4.B:

1. The bank's balance sheet increases by an amount equal to the option premium, \$15.0. The bank has a new asset on the asset side, i.e., a derivative receivable worth \$15.0 funded by \$15.0 of new equity.

2. The market value of the (legacy) equity and debt sums up to \$100, i.e., the bank's market value before the transaction, as per the Modigliani-Miller invariance Proposition.
3. The derivative contract is a zero NPV investment for the new shareholders. The present value of their expected claim at time 1 is equal to their initial investment of \$15.0 at time 0 (as per the objective function).
4. The derivative contract is a negative NPV investment for the (legacy) shareholders. The decrease in the equity value, i.e., the transfer of wealth ΔW from the (legacy) shareholders to the creditors is equal to:

$$\Delta W = \Delta E = \$14.286 - \$17.857 = -\$\mathbf{3.571}$$

   The (legacy) shareholders lose \$3.571.[36] The wealth transfer is higher than in the previous case. Shareholders have a preference for debt funding over equity funding.[37]

5. The derivative contract is a positive NPV investment for the creditors. Their wealth increases by an amount equal to the decrease in the equity value:

$$\Delta W = \Delta D = \$85.714 - \$82.143 = \$\mathbf{3.571}$$

   This is higher than in the previous case under debt funding because the creditors get the entire option value in the default state. In this particular example, the new asset on the balance makes the debt riskless.

6. A possible donation by the counterparty would have to be significantly higher than in the previous case for the (legacy) shareholders' wealth to be left unaffected.

The marginal impact of the derivative transaction on the bank's (pre-derivative) balance sheet is given by:

$$A + V_F = (E + \Delta E + NE) + (D + \Delta D)$$

where NE is the market value of the newly issued equity. The equality $\Delta E = -\Delta D$ implies that:

$$A + V_F = (E + NE) + D$$

The bank raises new equity in an amount equal to the option premium V, i.e., $NE = V = \$15.0$. This means that, for the Modigliani-Miller invariance Proposition to hold, i.e., $A = E + D$, the fair value of the derivative contract on the asset side of the bank's balance sheet must be equal to V:

$$V_F = V = NE = \$15.0$$

[36] In this particular example, there is no default in the sense that in the bad state of the world, the lenders receive their full payment. See ADS (2016) for the loss incurred by the legacy shareholders in the general case. The wealth transfer would be equal to \$15$\times$ 0.375=\$5.625 under the no-default scenario (as opposed to \$3.57).

[37] This is consistent with ADS (2016) Proposition 2. *"A pecking order financing preferences: Suppose that the firm's probability of default is not zero and that the marginal investment cost is strictly positive. The marginal value to the firm's existing shareholders of financing the investment with existing cash is strictly higher than the marginal value under debt financing, which in turn is strictly higher than the marginal value under equity financing."*

This shows that regardless of the funding instrument, funding has no impact on the valuation of derivatives and on the value of the bank itself.

Three conclusions emerge. First, the value of derivative contracts should not be adjusted for funding costs. Second, the value of the bank is not affected by the funding costs required by derivative receivables. Derivative contracts make the legacy creditors better off at the expense of the shareholders. These two conclusions hold regardless of the instrument used, debt or equity. However, the wealth transfer from the shareholders to the creditors depends on the funding instrument. Shareholders are worse off with equity funding than with debt funding. The availability of cash would solve the funding issue faced by the shareholders.[38] Otherwise, the preservation of the shareholders' wealth requires the derivatives' dealers to pass on the funding costs to their counterparties. Whether the dealers are incentivized to do so remains an open question.

4. Funding Benefits Adjustments (FBA)

Consider now the same one-year European-style option contract entered between the same two counterparties the credit risky-bank and the riskless counterparty, where the bank sells the option to the counterparty. Assume that the option is unsecured and, as a new liability to the bank, the option ranks "*pari passu"* with the existing debt. The derivative contract raises issues about credit risk and funding.

First, consider counterparty credit-risk issues. The previous case involved an asset bought by the bank from a riskless counterparty. The present case deals with an asset bought by a riskless counterparty from a credit-risky bank. Assume the counterparty makes a credit value adjustment for its counterparty credit risk exposure to the bank equal to $CVA(C)$. By symmetry, $CVA(C) = DVA(B)$, where $DVA(B)$ is the debit value adjustment made by the bank to account for its own credit risk. Unlike the counterparty, the bank makes no adjustment for counterparty credit risk given its lack of exposure to the counterparty.[39] Funding issues aside, the value of the derivative contract is given by:

$$\boldsymbol{V_D = V_{ND} - CVA(C) = V_{ND} - DVA(B)} \qquad \text{(Eq. 3)}$$

Eq. 3 states that the credit risk of the bank lowers the option premium.

Second, consider funding issues. On the contract inception date, the bank sells the option and receives cash that must be invested. This raises issues about possible funding benefits. Three cases are examined. In the first two cases, the cash is used to retire debt or equity, respectively. In the third case, the cash is assumed to be invested in riskless securities. The issues are to determine whether the option premium should be adjusted for funding benefits, whether the derivative contract has an impact on the market

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[38] Suppose that the bank has \$15.0 in cash. The bank would use the cash to purchase the option from the counterparty at a fair value of \$15.0. This is a zero NPV investment for the bank that neither creates nor destroys wealth. There is no funding requirement and no wealth transfer. Unlike what happens with debt or equity funding, the creditors are not better off. This is because a new asset worth \$15.00 replaces \$15.0 worth of cash. See ADS (2016) Proposition 2.

[39] The derivative contract is a liability to the bank. This implies that $CVA(B) = DVA(C) = 0$.

value of the bank, and whether retiring debt, equity, or parking cash in riskless assets matters for valuation.

4.1 Debt Buy-back

At time 0, the bank sells the option to the counterparty, books a new liability that ranks "*pari-passu*" with the existing debt, and receives a cash amount that remains to be determined. The cash is used to retire debt that trades at a credit spread over the risk-free rate. The issue is to determine whether the bank is willing to receive a lower option premium as a compensation for the funding benefits provided by the option contract on the contract inception date. Is the fair value of the option given by Eq. 3, or alternatively by Eq. 4 below:

$$\boldsymbol{V_{D,F} = V_{ND} - CVA(C) - FBA = V_{ND} - DVA(B) - FBA} \qquad \text{(Eq. 4)}$$

where $V_{D,F}$ denotes the value of an option that incorporates two adjustments, the first for credit risk and the second for funding benefits, and FBA denotes the funding benefits provide by the derivative contract. Note that both adjustments are driven by the credit risk of the bank.[40] This is raising the issue of the overlap between the credit/debit value adjustment and the funding benefit adjustment.

Corporate finance is useful to address these questions. Observe that the use of cash raised by selling a derivative contract to purchase debt at its fair market value amounts to a debt-for-debt swap, i.e., a new liability replaces part of an existing liability. Given the "*pari-passu*" assumption, the debt-for-debt swap leaves the total liabilities, the loss rate and the credit spread unchanged. What are the implications? First, the counterparty charges for the credit risk of the bank via a CVA adjustment. The derivative payable is like newly issued debt that offers a fair credit spread to the creditors. It is a zero NPV investment for the counterparty. Second, the debt purchase is a zero NPV investment for the tendering creditors, who, otherwise, would not tender. Third, the derivative contract and the ensuing debt buyback, that leave the loss rate and credit spread intact, do not affect the wealth of the remaining creditors, i.e., is a zero NPV transaction. If the new derivative contract and the debt buyback are zero NPV transactions for the derivative's counterparty, the tendering creditors and the non-tendering creditors, so should it be for the shareholders. The option fair value must be given by Eq. 3, as any other value would decrease the wealth of one of the parties involved and would violate the zero NPV outcomes and the Modigliani-Miller invariance Proposition.

The example is used to illustrate the corporate finance principles discussed above. Start with time 1 when the assets of the bank are allocated to the three parties involved, i.e., the creditors, the derivative's counterparty, and the shareholders. In the no-default state, the bank pays the option's payoff equal to \$15.75 to the derivative's counterparty. Given that the total aggregate liabilities are left unchanged to \$90.0, the remaining creditors receive the difference between \$90.0 and \$15.75, i.e., \$74.25. Following the debt retirement, the face value of the debt originally at \$90.0 decreases to \$74.25. The shareholders, as residual claimants, receive the difference between the asset value and the total liabilities, i.e., \$30.0,

[40] If the bank were riskless, $DVA(B) = 0$. Also, $FBA = 0$, as the bank would borrow and lend at "the risk-free" rate.

the same claim as in the pre-derivative case. In the default state, the "*pari-passu*" assumption implies that the derivative's counterparty and the creditors experience the same loss rate of 11.11%, which leaves the credit spread unchanged from its pre-derivative value of 4.565%.[41] Not surprisingly, it is equal to the debt's pre-derivative loss rate. At time 0, what amounts to a debt-for-debt swap has no impact on the bank value.

Table 5.A and Table 5.B give the market value of debt and equity at time 1 and the balance sheet of the bank at time 0. Five conclusions emerge from Table 5.B:

1. The bank's balance sheet is left unchanged from its pre-derivative value. The market values of the equity, the debt and the derivative payable sum up to \$100, i.e., the bank's market value before the transaction, as per the Modigliani-Miller invariance Proposition.
2. The derivative contract is a zero NPV investment for the shareholders. The equity value is left unchanged relative to its pre-derivative value of **\$17.857**.
3. The debt buyback is a zero NPV investment for the tendering creditors. The bank raises \$14.375 through the option sale and retires \$14.375 worth of bonds. The bonds are fairly priced. This is because the debt's loss rate and its credit rating are left unaffected. The transaction transforms part of an old liability (the debt) into a new liability (the derivative payable).
4. The derivative contract is a zero NPV investment for the remaining creditors for the same reasons as above. The market value of the remaining debt is equal to its pre-derivative value less the amount retired, i.e., \$82.143-\$14.375**=\$67.768**.
5. The derivative is fairly priced, i.e., is a zero NPV contract for the counterparty. The only adjustment to the option contract is the CVA adjustment. Given that the bank is credit-risky, the counterparty makes a CVA adjustment booked as a DVA adjustment by the bank. It is equal to the product of the PV of the counterparty's expected positive exposure times its expected loss rate :

$$CVA(C) = DVA(B) = L \times EPE \times PD = \$\left(1 - \frac{80}{90}\right) \times \frac{1}{1.05} \times 15.75 \times 0.375 = \$\mathbf{0.625}$$

At time 0, the bank receives a fair option premium equal to:

$$\boldsymbol{V_D = V_{ND} - CVA(C) = V_{ND} - DVA(B) = \$15.00 - \$0.625 = \$14.375}$$

This validates the option value obtained in Table 5.B.[42] This means that the fair value of the derivative from the point of view of the counterparty is given by Eq. 3.

This shows that, save for the CVA adjustment that captures the bank's credit risk, there is no FBA adjustment in the derivative valuation formula. This is because of two offsetting effects:

[41] $L = \left(1 - \frac{\$80}{\$90}\right) = 11.11\%.$

[42] Note that, like for the valuation of credit-risky debt, the same result is obtained by discounting the option's final payoff at the risky discount rate that captures the bank's credit spread $V_D = \frac{15.75}{1.0956} = \$\mathbf{14.375.}$

i. At time 0, the bank uses the \$14.375 received from the option's sale to buy back \$14.375 worth of debt. Riskless bonds with a face value of \$15.75 a time 1 would trade in the debt markets for a price of \$15.00, compared to \$14.375 for the credit-risky bonds. This means that the bank gets a funding benefit, i.e., saves in interest expenses:[43]

$$FBA = \$15.00 - \$14.375 = \$\mathbf{0.625}$$

ii. However, the debt buyback decreases the DVA of the bank's existing debt by exactly the FBA amount. The aggregate face value of the debt is now \$74.25. This means that the DVA of the remaining debt is equal to:[44]

$$DVA_{Debt} = \$\frac{74.25}{1.05} - \$\frac{74.25}{1.0957} = \$70.714 - \$67.768 = \$\mathbf{2.946}$$

The change in the DVA associated with the debt's retirement is equal to:[45]

$$\Delta DVA_{Debt} = \$2.946 -= \$3.571 = -\$\mathbf{0.6250}$$

Two conclusions emerge.[46] First, FBA and ΔDVA_{Debt} offset one another:

$$(FBA + \Delta DVA_{Debt}) = 0$$

The bank gains \$0.6250 in FBA benefits with the derivative contract but loses \$0.6250 of DVA benefits on its existing debt. This leaves the total DVA unchanged, and explains why there is no need to adjust the value of the derivative contract for funding benefits:[47]

$$V_{D,F} = V_{ND} - CVA(C) - (FBA + \Delta DVA_{Debt}) = V_{ND} - DVA(B) - (FBA + \Delta DVA_{Debt}) = V_D$$

$$= \$15.00 - \$0.625 - (\$0.625 - \$0.625) = \$\mathbf{14.375}$$

[43] Alternatively, FBA can be calculated as the PV of the expected exposure times the expected loss rate: $FBA = \$\left(1 - \frac{80}{90}\right) \times \frac{1}{1.05} \times 15.75 \times 0.375 = \$\mathbf{0.6250}.$ As noticed by Hull and White (2012, 2014), FBA is equal to the derivative's DVA.

[44] Alternatively, the DVA of the bank's remaining debt can be calculated as the PV of the creditors' expected positive exposure times the expected loss rate: $DVA_{Debt} = \left(1 - \frac{80}{90}\right) \times \frac{1}{1.05} \times 74.25 \times 0.375 = \$\mathbf{2.946}.$ Note that riskless debt with a face value of \$74.25 at time 1 is worth \$70.714 at time 0. The DVA on the debt can also be obtained from the difference between the value of the riskless debt and the credit-risky debt, i.e., \$70.714-\$67.768**=\$2.946.**

[45] ΔDVA_{Debt} is referred to as DVA_2 by Hull and White (2012,2014).
[46] This is the conclusion reached by Hull and White (2012).
[47] What is referred as DVA benefit here is the margin over the risk-free rate, i.e., the credit spread, gained by the creditors when the bank does not default. These are costs to the shareholders.

Second, the funding benefits are equal to the credit value adjustment charged by the counterparty to account for the bank's credit risk, itself equal to the debit value adjustment made by the bank to account for its own credit risk:

$$FBA = CVA(C) = DVA(B) = \$\mathbf{0.625}$$

Making a FBA adjustment on the top of the DVA adjustment leads to a double-counting effect.

What are the implications for the bank's balance sheet? Before the derivative transaction, the bank total liabilities are equal to \$82.143. Then, the bank sells the option contract and retires its debt. The option is a new liability accounted for as a derivative payable in the bank's balance sheet that ranks "*pari passu"* with the existing debt. The marginal impact of the derivative transaction on the bank's pre-derivative balance sheet is given by:

$$A \ = (E + \Delta E) + (D + \Delta D - ED) + DP$$

where DP is the market value of the derivative payable, and ED is the market value of the retired debt. When the cash raised is used to retire debt, there are no wealth transfers between the shareholders and the creditors, i.e., $\Delta E = \Delta D = 0$ giving:

$$A = E + (D - ED) + DP$$

The identity $DP = ED = V_D = \$14.375$ that states that the sources of funds, i.e., the cash raised by selling the option, is equal to the uses of funds, i.e., the retired debt, implies that the value of the bank post-derivative is equal to its pre-derivative value as per the Modigliani Miller invariance Proposition:

$$A \ = E + D$$

The option trade has no impact on the value of the bank. The balance sheet of the bank is given with the all the DVA benefits in Table 5.C. It is identical to the bank's balance sheet **before** the derivative transaction as given in Table 1.C.

4.2 Equity Buyback

Assume that the bank sells the same one-year European-style option to the counterparty as in the example above, receives the option premium and uses the cash proceeds to repurchase equity. What is the impact of the share repurchase on the option value and on the bank's balance sheet? Corporate finance provides straightforward answers. The share buyback increases the bank's leverage, the loss rate, the credit spread and decreases the debt value. The option will be fairly priced, i.e., will reflect the bank's new credit spread via the CVA. The derivative contract will be a zero NPV investment for the counterparty, a negative NPV investment for the creditors, and a positive NPV investment for the shareholders at the expense of the creditors. There is a wealth transfer from the creditors to the shareholders that leaves the bank value unaffected as per the Modigliani-Miller irrelevance Proposition. The option value will reflect no additional adjustment beyond the CVA.

The example is used to illustrate the points raised above. Consider time 1, when the assets of the bank are allocated to the three parties involved, i.e., the creditors, the derivative's counterparty, and the shareholders. In the no-default state, the aggregate liabilities are equal to the face value of the debt plus the option payoff. They sum up to $105.75 ($90.0+$15.75), and leave the (remaining) shareholders with a residual claim equal to $120-$105.75=$14.25. In the default state, the creditors and the options' counterparty experience a loss rate equal to 19.622% on their respective claims of $90 and $15.75, a significant increase from its pre-derivative value of 11.11%.[48] The credit spread increases to 10.55% from its pre-derivative value of 4.565%.

Table 6.A and Table 6.B give the market value of debt and equity at time 1 and the balance sheet of the bank at time 0. Four conclusions emerge from Table 6.B.

1. The bank's balance sheet is left unchanged from its pre-derivative value. The market value of the equity, the debt and the derivative payable sum up to $100, i.e., the bank's market value before the transaction, as per the Modigliani-Miller invariance Proposition.
2. The derivative contract is a positive NPV investment for all the tendering and non-tendering shareholders. The bank raises $13.630 by selling the option to the counterparty and buys back $13.630 worth of equity. The market value of equity following the derivative transaction, but before the share buyback, is equal to the sum of the proceeds raised by selling the derivative, i.e., the market value of the repurchased shares, and the market value of the remaining shares, a total of $22.112. The increase in the shareholders' wealth is equal to the difference between the market value of equity after and before the transaction:

$$\Delta E = \$22.112 - \$17.857 = \$\mathbf{4.255}$$

3. The derivative contract is a negative NPV investment for the creditors. There is a wealth transfer from the creditors to the shareholders, i.e., the decrease in the creditors' wealth is equal to the increase in the shareholders' wealth. The decrease in the market value of debt is equal to:

$$\Delta D = \$77.888 - \$82.143 = -\$\mathbf{4.255}$$

4. The derivative contract is a zero NPV investment for the counterparty.[49] The option value is lower under a share buyback than under a debt buyback. This reflects the higher loss rate experienced by the counterparty when the bank defaults. The option is fairly valued and there is no other adjustment than the CVA adjustment. Given that the bank is credit-risky, the CVA charged by the counterparty, the product of the PV of the counterparty's expected positive exposure times the expected loss rate, is now equal to:

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[48] $L = \left(1 - \frac{80}{105.75}\right) = 19.622\%.$

[49] This is the case only to the extent that the counterparty prices in the equity buy-back. A counterparty expecting a debt-buyback rather than a share buy-back will charge a CVA of $0.625 (see previous case) and will end up over-paying for the option($14.375 instead of $13.63).

$$CVA(C) = DVA(B) = L \times EPE \times PD = \$\left(1 - \frac{80}{105.75}\right) \times \frac{1}{1.05} \times 15.75 \times 0.375 = \$\mathbf{1.370}$$

At time 0, the bank receives a fair option premium equal to:

$$\boldsymbol{V_D = V_{ND} - CVA(C) = V_{ND} - DVA(B)} = \$\mathbf{15.00} - \$\mathbf{1.370} = \$\mathbf{13.630}$$

This validates the option value obtained in Table 6.B.[50] This means that the fair value of the derivative from the point of view of the counterparty is given by Eq. 3.

This shows that there are no funding benefits *per se*. Instead, there is an increase in the equity value of \$4.255 matched by a corresponding decrease in the debt value of \$4.255. This has no impact on the derivative value.

Consider a balance sheet approach. Define by DP and EB the market value of the derivative payable and the market value of the repurchased equity, respectively. The marginal impact of the derivative contract on the bank's pre-derivative balance sheet is given by:

$$A = (E - EB + \Delta E) + (D + \Delta D) + DP$$

The identity $DP = EB = V_D$ that states that the sources of funds, i.e., the cash raised by selling the option is equal to the uses of funds, i.e., the repurchased shares, and the equality $\Delta D = -\Delta E$ that states that the wealth creation for the shareholders is equal to the wealth destruction for the creditors, imply that the value of the bank value post-derivative is equal to its value pre-derivative as per the Modigliani Miller invariance Proposition:

$$A = E + D$$

The share buyback makes the shareholders better off at the expense of the creditors. This raises issues about potential conflicts of interest between the shareholders and the creditors, and in particular how the creditors can prevent the shareholders from using the cash raised by selling derivatives to buy back shares.

4.3 No Buyback (Asymmetric FVA)

Finally, suppose that, instead of buying back debt or equity, the bank sells the option and invests the cash proceeds in riskless assets. This is the so-called asymmetric funding case where cash shortfalls are funded by newly issued debt and cash surpluses are invested at the risk-free rate. What is the impact of parking surplus funds created by derivatives trading in safe assets on the value of derivative contracts and on the market value of the bank?

[50] Note that, like the valuation of credit-risky debt, the same result is obtained by discounting the option's final payoff at the risky discount rate that captures the bank's credit spread $V_D = \$\frac{15.75}{1.1555} = \$\mathbf{13.630.}$

Corporate finance provides the following answers. The option contract sold to the riskless counterparty is a liability that ranks "*pari-passu*" with the existing debt. The option is fairly priced by the counterparty who charges a CVA adjustment that reflects the bank's credit risk. In effect, the written option is a liability that behaves like a debt instrument with the bank paying for its credit spread via the CVA adjustment charged by the counterparty. For the counterparty, the option is a zero NPV investment. What about the existing creditors? Their wealth does not change in the no-default case but increases in the default case for two related reasons. First, the cash received from the option sale, parked in riskless assets, increases the asset value of the bank which decreases the creditors' loss rate and the credit spread. Second, the "*pari-passu*" assumption does not change the creditor's priority. With a non-zero probability of default, the creditors are better off as their expected wealth increase. For the Modigliani-Miller irrelevance proposition to hold, wealth creation must be offset by wealth destruction. In the asymmetric funding case, the creditors are better off at the expense of the shareholders. With the derivative payable, the shareholders are "*de-facto*" borrowing at a credit spread (via the CVA adjustment charged by the counterparty) and lending at the risk-free rate. This is a negative NPV transaction for the bank's shareholders. The asymmetric funding case is similar to the symmetric funding case for a derivative receivable funded by new debt. In both cases, there is a transfer of wealth from the shareholders to the creditors.

The example is used to illustrate the points raised above. At time 0, the counterparty calculates the option premium to be a zero NPV investment.[51] Its fair value is equal to \$14.4366. It is less than \$15.0 because of the CVA adjustment. At time 1, the assets of the bank are allocated to the three parties involved, i.e., the creditors, the derivative's counterparty, and the shareholders. Note that the cash proceeds invested in riskless assets generates \$15.158. Start with the no-default state. The assets amount to \$120 plus the FV of the cash received from the option sale parked in riskless assets, a total of \$135.158. The aggregate liabilities are equal to the face value of the debt plus the option payoff. They sum up to \$105.75 (\$90.0+\$15.75). This leaves the shareholders with a residual claim less than its pre-derivative value of \$30.0. In the default state, the creditors and the options' counterparty share on a pro-rata basis, the sum of the asset value and the FV of the cash received at time, i.e., a total amount of \$95.158 with a 85.106%, 14.894% split between the two parties involved, respectively. The increase in the asset base makes the creditors better off. This decreases the loss rate and the credit spread, to 10.02% and 4.098% from their pre-derivative values of 4.565% and 11.11%, respectively.

This analysis is confirmed by the results given in Table 5.D that gives the bank's value at time 0. The following five conclusions emerge:

1. The bank's balance sheet is left unchanged from its pre-derivative value. The market value of debt and equity adds up to \$100, i.e., the bank's market value before the transaction, as per the Modigliani-Miller invariance Proposition.

[51] This requires solving $C = PV[0.625 \times 15.75 + 0.375 \times \rho \times V^{-}]$ where, C is the option value at time 0, V^{-} is the asset value in the default state at time 1, equal to $\$80 + FV(C)$ with $\rho = \frac{80+FV(C)}{90+15.75}$. Note that C differs from \$15.0 by the amount of the CVA. Solving for C gives C= $\$\mathbf{14.4366},$ and, $CVA = \$\mathbf{0.5634.}$

2. The derivative contract is a negative NPV investment for the shareholders. The decrease in the shareholders' wealth is equal to the difference between the market value of equity after and before the derivative's trade:

$$\Delta E = \$17.505 - \$17.857 = -\$\mathbf{0.352}$$

3. The derivative contract is a positive NPV investment for the creditors. There is a wealth transfer from the shareholders to the creditors. The increase in the market value of debt is equal to:

$$\Delta D = \$82.495 - \$82.143 = \$\mathbf{0.352}$$

4. The derivative contract is a zero NPV investment for the counterparty. The option is fairly valued and there is no other adjustment than the CVA adjustment. Given that the bank is credit-risky, the CVA charged by the counterparty, the product of the PV of the counterparty's expected positive exposure times the expected loss rate, is equal to:[52]

$$CVA(C) = DVA(B) = L \times EPE \times PD = \$\left(1 - \frac{95.158}{105.75}\right) \times \frac{1}{1.05} \times 15.75 \times 0.375 = \$\mathbf{0.5634}$$

At time 0, the bank receives a fair option premium equal to:[53]

$$\boldsymbol{V_D = V_{ND} - CVA(C) = V_{ND} - DVA(B)} = \$\mathbf{15.00} - \$\mathbf{0.5634} = \$\mathbf{14.4366}$$

This validates the option value obtained in Table 5.D.[54] This means that the fair value of the derivative from the point of view of the counterparty is given by Eq. 3.

This shows that there are no funding benefits *per se*. Instead, there is a decrease in the equity value of \$0.352 matched by a corresponding increase in the debt value of \$0.352. This has no impact on the derivative value. Shareholders will be willing to enter the trade, only to the extent that the counterparty makes a donation and pays more for the option than its fair value of \$14.4366. The donation must be equal to the CVA, i.e., \$0.5634 for this to be the case, i.e., the counterparty must be willing to pay \$15.00.[55] Consider a balance sheet approach. Define by DP and C the market value of the derivative payable and the cash amount invested in riskless assets, respectively. The marginal impact of the derivative contract on the bank's pre-derivative balance sheet is given by:

[52] As discussed in the previous section, the wealth transfer and the CVA/DVA differs by the bank's no-default probability: $\Delta W = 0.625 \times CVA(C) = \$0.625 \times 0.5634 = \$\mathbf{0.352}$.

[53] The option value is obtained by solving: $V_D = PV\big(0.625 \times 15.75 + 0.375 \times 15.75 \times (1 - L)\big)$ with $L = \left(\frac{80+FV(V_D)}{90+15.75}\right)$. The numerator of the loss rate gives the asset value in the default state, equal to \$80 plus the future value of the cash received at time 0.

[54] Note that, like the valuation of credit-risky debt, the same result is obtained by discounting the option's final payoff at the risky discount rate that captures the bank's credit spread $V_D = \$\frac{15.75}{1.09098} = \$\mathbf{14.4366}$.

[55] At maturity, the cash invested returns \$15.75. In the no-default state, the total assets are worth \$135.75. The creditors receive \$90.0, the counterparty gets \$15.75 and the shareholders get the pre-derivative value of \$30.0.

$$A + C = (E + \Delta E) + (D + \Delta D) + DP$$

The identity $DP = C = V_D$ that states that the sources of funds, i.e., the cash raised by selling the option, is equal to the uses of funds, i.e., the investment in riskless assets, and the equality $\Delta E = -\Delta D$ that states that the wealth creation for the creditors is equal to the wealth destruction for the shareholders, imply that the value of the bank value post-derivative is equal to its value pre-derivative, as per the Modigliani Miller invariance Proposition:

$$A = E + D$$

The main findings regarding symmetric and asymmetric funding benefits can be summarized as follows. First, the values of derivative contracts are adjusted for counterparty credit risk but not for funding benefits. Second, the value of the bank is not affected by surplus funds generated by derivative payables. This is because the wealth transfers between the shareholders and the creditors offset one another. These two conclusions hold regardless of how the cash proceeds are invested. However, the wealth transfer from the shareholders to the creditors depends on the use of the surplus funds. A share repurchase hurts the creditors. In contrast, an investment in riskless assets hurts the shareholders. A debt buyback preserves the wealth of the shareholders and the creditors. Shareholders prefer a share buyback over a debt buyback, and a debt buyback over riskless investments. Compared to funding costs, funding benefits give the reverse pecking order of preferred financing methods.

5. Margin Adjustments (MVA)

The assumption that the terminal options' payoff is known with certainty is relaxed. Consider as a second example, a European-style call option with a maturity of one year, a value V_{ND} equal to \$9.048 at time 0, an expected value of \$9.50 at time 1, paying either \$15.20 in the up-state or zero in the down-state.[56] As discussed in the previous sections, option values should not be adjusted either for funding costs or funding benefits. The fair value of the option is \$9.048 if purchased by the bank from a riskless counterparty,

[56] Assume the underlying security is a commodity with a current spot price \$104.33. The (annual) volatility of the commodity is captured by the usual up- and down- factors equal to 1.20 and 0.80, respectively, giving a risk-neutral probability of the up-state equal to 0.625 under the assumption of a 5.0% risk-free rate.[56] This means that there is a 62.5% risk-neutral probability that the price of the commodity will increase from \$104.33 at time 0 to $\$104.33 \times 1.20 = \$125.20$ at time 1. Assume the strike of the call is \$110. In the up-state, the call is exercised and has a terminal payoff of \$15.20. There is a 37.5% risk-neutral probability that the price of the commodity will decrease from \$104.33 at time 0 to $\$104.33 \times 0.80 = \$83.47$ at time 1. In the down state, the call is not exercised and has a terminal payoff of \$0. The expected value of the call at time 1 is equal to $\$15.20 \times 0.625 = \$9.50$. With no adjustments for counterparty credit risk and funding costs/benefits, its value at time 0 is equal to $PV(9.50) = \$9.048$. Note that to keep the bank's asset volatility constant, i.e., unaffected by the derivative contract, the volatility of the underlying commodity is assumed to be equal to the volatility of the bank's assets. This means that the risk-neutral probability that the option will be exercised (not exercised) is identical to the risk-neutral probability that the bank will not default (default). The assumption that the volatility of the underlying commodity is, say, higher than the volatility of the bank's asset would result in wealth transfers from the creditors to the shareholders. This is the well-known asset substitution problem that shareholders benefit from more risky projects at the expense of the creditors. In addition, the returns on the underlying asset are assumed to be uncorrelated with the returns on the bank's assets.

regardless of how the bank funds the option premium. The fair value of the option is equal to \$8.671 if sold to the same counterparty. The difference between the two values of \$9.048 and \$8.671 is the CVA charged by the counterparty to account for the bank's credit risk.[57]

Assume that the credit-risky bank buys the option contract from the riskless counterparty and hedges its market risk by entering an offsetting option contract with another dealer bank, referred to as the "hedge dealer." Inter-dealer trades typically impose margin requirements, more specifically a variation margin (VM) and an initial margin (IM).[58] Assume, as is typically the case, that the hedge dealer requires the bank to post both an initial margin (IM) and a variation margin (VM). The bank ends up with two derivatives in its book, an unsecured derivative receivable with the riskless counterparty and a secured derivative payable with the hedge dealer. Margins must be funded. This raises the issue of whether derivative values should be adjusted for margin-related funding costs, adjustments known as margin value adjustments (MVA). The second example is used to challenge the relevance of MVA adjustment and to discuss the impact of margin-related funding costs on the value of derivative contracts and on the value of the bank.

5.1 Variation Margin (VM)

This section assumes that there are no initial margins and the collateralization scheme is designed to make the derivative contract riskless from the point of view of the hedge dealer. Two cases are examined. Case 1 looks at the single option entered between the bank and the hedge dealer. Case 2 looks at a portfolio composed of two options, the option contract between the bank and the counterparty and the offsetting option between the bank and the hedge dealer.

5.1.1 Case 1: A Single Option

The bank sells the secured option contract to the hedge dealer. The perfect collateralization scheme drives the credit value adjustment (CVA) made by the hedge dealer to zero and gives the secured option a fair value \$9.048. Both parties should agree on a fair value of \$9.048 and, as a zero NPV trade, the option contract should have no impact on the value of the bank. The relevant question from a corporate finance point of view is whether the collateralization scheme generates wealth transfers between the shareholders and the creditors.

The margin process works as follows. At time 0, the bank receives the option premium but immediately posts the amount received as cash collateral to the hedge dealer (or to a third party).[59] To make the collateralization scheme riskless from the point of view of the hedge dealer, the collateral is assumed to be refreshed and exchanged an instant before time 1, once the option value is known but before the realization of the bank's default or no-default state. At time 1, the option is in-the-money or out-of-the

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[57] $CVA(C) = DVA(B) = L \times EPE \times PD = \$\left(1 - \frac{80}{90}\right) \times \frac{1}{1.05} \times 9.50 \times 0.375 = \$\mathbf{0.3770}$.

[58] The variation margin is assumed to be equal to the present value of the transaction. The margin posted earns the risk-free rate.

[59] No cash exchanges hands at time 0. The bank is starved from cash, thereby solving the conflicts of interests between the different parties involved.

money. In the former case, the bank pays to the hedge dealer the difference between the terminal option value and the future value of the cash collateral posted at time 0. The call value is equal to \$15.20 when it is in-the-money. The bank pays \$5.70=\$15.20-\$9.50 in variation margin to the hedge dealer, where \$9.50 is the future value of the cash collateral posted at time 0, i.e., $\$9.50 = FV(\$9.048)$. In the latter case, the hedge dealer returns the \$9.50 worth of collateral to the bank.[60] The expected value of the margin-related CFs is equal to zero, $\$(-5.70 \times 0.625 + 9.50 \times 0.375) = \$0$, both in the default and in the no-default states.[61] Then, the collateral paid or received is subtracted from, or added to, the asset value, respectively. The total asset value is then allocated to the creditors and to the shareholders. The collateralization scheme gives priority to the hedge dealer over the bank's creditors. However, this has no impact on the debt's loss rate and on its market value.[62] In the default state, the assets left to the creditors vary as a function of the option's terminal values. The creditors end up receiving the same expected CF as in the pre-derivative case, namely $\$(74.30 \times 0.625 + 89.50 \times 0.375) = \$80$.[63] They neither gain nor lose.

The relevant cash flows and the bank's balance sheet at time 1 are given in Table 7A in each of the four scenarios obtained by crossing the two option values, i.e., in-the-money versus out-of-the-money, by the two asset values obtained for the bank in the default and the no-default states, respectively. Table 7.B gives the expected option, debt and equity values in the no-default and the default states obtained at time 1. They are calculated by multiplying the relevant CFs by the risk-neutral probabilities that the option will be exercised or not. The comparison of Table 7.B and Table 1.A shows that the market values of debt and equity post-derivative at time 1 are identical to their pre-derivative values. This implies that the debt and equity values are equal to their pre-derivative values at time 0. This is confirmed by the results reported in Table 7.C. The derivative contract has no impact on the market value of the bank and leaves the wealth of both the creditors and the shareholders unaffected. The only impact of the collateralization scheme is the higher option premium received by the bank \$9.048 instead of \$8.671 in the unsecured case.

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[60] This implicitly assumes that the hedge dealer is default-free.

[61] Consider the default state. The asset value is equal to \$80 excluding the derivative contract. The option introduces uncertainty in the asset value at maturity depending on whether it is in-the-money or out-of-the-money. In the default state, the hedge dealer comes first before the creditors and receives\$5.70 when the option is in-the-money and pays \$9.50 when the option is out-of-the-money. The expected value of the margin-related CFs is equal to zero, i.e., the hedge dealer expects to receive 0 at time 1. This implies that the expected asset value to be distributed to the creditors is equal to \$80.

[62] A wealth transfer from the creditors to the shareholders would be observed, otherwise.

[63] This is a one-period model. In a multiple-period setting, additional variation margins will be posted or received depending on whether the option contract is in-the-money or out-of-the money in the future. In the former (latter) case, the variation margin will be positive (negative) and additional margin will be posted (received). In the symmetric funding case, debt is either issued (or bough-back) to satisfy positive (negative) margin requirements. This implies that the margin-related future expected CFs is zero. In the asymmetric funding case, cash shortfalls are covered by issuing new debt at a spread over the risk-free rate but cash surpluses are re-invested at the risk-free rate. This will generate additional funding costs that will be borne by the shareholders.

5.1.2 Case 2: A Portfolio of Options

Consider now the option contracts between the bank and the counterparty and between the bank and the hedge dealer. Assume that the bank requires the counterparty to post a variation margin and is required by the hedge dealer to post a variation margin as well. Further, assume that the margin process makes the options riskless for the two parties exposed to counterparty credit risk, i.e., the bank and the hedge dealer, i.e., assume that both options are secured. The collateralization scheme offers an important benefit to the bank. It pays the option premium to the counterparty, i.e., $9.048, but receives the same amount in collateral. No cash exchanges hands at time 0 between the bank and the counterparty, and there is no need for the bank to issue new debt to fund the option premium.

For the sake of comparison, Tables 8.A, 8.B and 8.C present the balance sheet of the bank with both option contracts in the 1) no collateralization case, 2) the partial collateralization case, and 3) the full collateralization case, respectively. The most interesting results are summarized below:

1. No collateralization case (Table 8.A): This assumes that both the derivative receivable and the derivative payable are unsecured. The funding of the unsecured derivative receivable triggers a wealth transfer from the shareholders to the legacy creditors. Shareholders are worse off. The cash received from the unsecured derivative payable is used to buy-back debt. The debt-for-debt swap is a zero NPV transaction. Both derivative contracts are fairly priced. The only adjustment is the CVA charged by the hedge dealer to account for its credit exposure to the bank. There are no funding valuation adjustments.

2. Partial collateralization case (Table 8.B): This assumes that the derivative receivable (payable) is unsecured (secured). The only difference with the previous case is the lack of a CVA adjustment made to the derivative payable. There are no funding adjustments and both options have the same value.

3. Full collateralization case (Table 8.C): This assumes that both options are secured. The collateralization of the derivative receivable solves the bank's funding problem. There is no newly issued debt and no wealth transfer from the shareholders to the creditors. The post-derivative market values of debt and equity are equal to their pre-derivative values. Both derivative contracts have the same value and there are no funding valuation adjustments.

In the three cases above, the Modigliani-Miller irrelevance Proposition holds. There is no value creation for the bank even if the derivative receivable destroys value for the shareholders in the first two cases.

5.2 Initial Margin (IM)

The examples suggest that, for the option contracts discussed above, the variation margins do not create additional funding costs or benefits. At time 0, the option premium paid (received) is offset by the collateral received (posted). This is not the case for the initial margin which must be posted in cash or in assets which cannot be re-hypothecated. The initial margin must be funded. This raises the issue of whether there should be an adjustment for the initial-margin related funding costs, (MVA), as is done by the industry.

Consider the option sold by the bank to the hedge dealer. In the secured case with no initial margin, the fair value of the option is given by:

$$V_F = V \qquad \text{(Eq. 5)}$$

Consider the secured case with the bank posting an initial margin to a third party such as a custodian. Should the option value be calculated as per Eq. 5 above or as per Eq.6 below:

$$V_F = V + MVA \qquad \text{(Eq. 6)}$$

where in Eq. 6, the bank requires a higher premium from the hedge dealer as a compensation for bearing the financing costs of the initial margin.

The corporate finance principles discussed above suggest that the option fair value is given by Eq. 5. This is because the financing costs of the initial margin do not differ from the funding costs discussed in Section 3, i.e., *FCA*. Issuing new debt (equity) to fund the initial margin is a zero NPV investment for the new creditors (shareholders). The cash proceeds are kept in cash, or are invested in riskless securities and held by a third party. This makes the legacy creditors better off as they recover a fraction of the securities held by the custodian in the default state.[64] This means that the shareholders are worse off as they bear the financing costs of the initial margin in the no-default state. A derivative contract subject to an initial margin is a negative NPV investment for the shareholders. This raises the issue of the derivative's price that makes the shareholders indifferent.

The second example is used to illustrate the impact of the initial margin on the value of the derivative contract and on the value of the bank. Assume that the bank buys the unsecured option from the counterparty and hedges its derivative position by entering an offsetting contract with the hedge dealer. Assume the hedge dealer requires the bank to post on the contract inception date, in addition to the variation margin, an initial margin of $5.88 in cash that earns the risk-free rate.[65] Finally, assume that the bank issues new debt to fund both the unsecured option and the initial margin that ranks "*pari-passu*" with the existing debt. The results discussed in Section 3 remain unchanged except that the wealth of the legacy creditors increases at the expense of the shareholders by an incremental amount related to the funding of the initial margin. The shareholders bear the entire financing costs of the initial margin in the no default state. As always, the new debt is issued at a credit spread that reflects the riskiness of the

[64] Consider the default state. If the option is properly secured, the variation margin should be sufficient to cover the loss to the hedge dealer when the option is in-the-money. Assume it is insufficient. Then, in the worst case, the initial margin could be entirely transferred to the hedge dealer with no gains to the legacy creditors. This still leaves the case when the bank is in the default state and the derivative is out-of-the-money. In this case, the legacy creditors receive a fraction of the (future value of) the initial margin. The expected gain to the legacy creditors is positive under a non-zero joint probability that the bank is in the default state and the option is out-of-the money.

[65] This is used as an illustration. This makes the option riskless. See BCBS (2015) for "real-world" estimates. In the standardized framework, initial margins can take any value between 1% to 15% of the notional amount depending on the asset class the derivative belongs to and its duration.

bank's assets and the capital structure, and is a zero NPV investment for the new creditors. Both options are fairly valued at \$9.048.

Table 9.A and Table 9.B give the market values of the legacy debt, the new debt and the equity at time 1 and the balance sheet of the bank at time 0. The bank issues new debt with a face value F equal to \$16.285 to satisfy all the funding requirements where F is calculated to make the debt be a zero NPV investment for the new creditors. In the default state, they receive \$14.659 and suffer a loss rate of 9.98%, along with the legacy creditors. This gives a credit spread of 4.083%. The comparison of Tables 9.B and 8.B shows the incremental impact of the initial margin on the market value of the legacy debt and equity. The debt (equity) value is higher (lower) in Table 9.B than in Table 8.B by an amount related to the funding of the initial margin.

The wealth transfer from the shareholders to the legacy creditors is given by the change in its post- and pre-derivative value:

$$\Delta W = |\Delta E| = |\$17.494 - \$17.857| = \$\mathbf{0.363}$$

It is equal to the change in the market value of the legacy debt:

$$\Delta W = \Delta D = \$82.506 - \$82.143 = \$\mathbf{0.363}$$

The wealth transfer originates from two sources. The first source is the funding of the derivative receivable. From Section 3, the funding cost adjustment is equal to:

$$FCA = |\Delta E| = \Delta W_1 = PV[\$9.048 \times 4.083\%] \times 0.625 = \$\mathbf{0.2199}$$

It is equal to the DVA of the newly issued debt, DVA_N. The second source is the funding of the initial margin, MVA. The margin value adjustment is defined as the discounted expected initial margin times the funding cost of posting the initial margin, times the no-default probability:[66]

$$MVA = \Delta W_2 = PV[\$5.88 \times 4.083\%] \times 0.625 = \$\mathbf{0.1429}$$

Summarizing:

$$\Delta W = |\Delta E| = \Delta D = \Delta W_1 + \Delta W_2 = FCA + MVA = \$0.2199 + \$0.1429 = \$\mathbf{0.363}$$

For the sake of completeness, Table 9.C gives the balance sheet of the bank when both options are secured. The collateralization of the derivative receivable decreases the debt funding requirement. This increases the loss rate and the credit spread to 4.38% from 4.083% in the unsecured case. The wealth transfer is lower and originates solely from the financing costs of the initial margin. The change in the post- and pre-derivative value is equal to:

$$\Delta W = |\Delta E| = \$17.704 - \$17.857 = \$\mathbf{0.1533}$$

[66] See Gregory (2016), p. 364.

This is equal to the MVA:[67]

$$MVA = \Delta W = PV[\$5.88 \times 4.38\%] \times 0.625 = \$\mathbf{0.1533}$$

This shows that MVA, like its cousin FCA, should not be accounted for in the valuation of derivatives and does not affect the market value of the bank, as per the Modigliani-Miller irrelevance Proposition.

However, the financing of the initial margin hurts the banks' shareholders. This raises the issue of the derivative's price that preserves the shareholders' wealth. Following the arguments developed in Section 3.1.3, it is straightforward to show that the counterparty, here the hedge dealer, would have to agree on a donation of $0.2293 for the shareholders to be indifferent to the option contract.[68] The bank would receive $9.2773 for a derivative worth $9.048 and book a profit. The bank funds the initial margin by borrowing $5.652 in newly issued debt. The new creditors are fairly compensated and the legacy creditors are better off by the full donation as displayed in Table 9.D. However, the new regulatory requirements that force derivative dealers to post an initial margin makes the donation extremely unlikely. This means that the financing of initial margins are likely to be borne by the shareholders in the future.[69]

6. Derivatives Funding and Interest Tax Shields

The analysis so far assumed perfect markets. The assumption of no taxes, more specifically no interest tax shields, is now relaxed. This is in line with a recent strand of literature that investigates the impact of taxes on the valuation of derivatives. A tax value adjustment (TVA) has been proposed recently to capture the effect of taxes on profits and losses generated by derivatives that cannot be perfectly hedged.[70] More specifically, the goal of this section is to examine the impact of tax shields arising from the funding of derivatives. It assumes that i) interest expenses are tax deductible and ii) a dollar of interest expenses gives an interest tax shield equal to $\$1.0 \times T_C$, where T_C is the dealer's bank marginal tax rate.

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[67] This is consistent with ADS (2016). Thwy show on p. 19 that the funding cost adjustment for the payment of the initial margin is equal to $\Lambda = \delta \times P^*(D^C) \times S \times I$, where I is the initial margin. Here, $\Lambda = \mathrm{MVA} = \$\frac{1}{1.05} \times 0.625 \times 4.083\% \times 5.88 = \$\mathbf{0.1533}$.

[68] For ΔE to be equal to 0, the face value of the newly issued debt must be equal to $FV(\$5.88) = \$6.175$. The new creditors receive \$6.175 in the no default state and $\$5.533 = \$86.175 \times \rho$ in the default state, with $\rho = \frac{\$6.175}{\$96.175}$. This gives a loss rate of $L = \left(1 - \frac{86.175}{96.175}\right) = \mathbf{10.398}\%$ and a credit spread equal to $CS = \mathbf{4.26}\%$. The new debt has a market value of \$5.6516 at time 0. The donation is equal to $PV[I \times CS] = \frac{1}{1.05} \times 5.6516 \times 4.26\% = \$\mathbf{0.2293}$. This amount is equal to the difference between the market value of the new debt without and with the donation: $\$5.8809 - \$5.6516 = \$\mathbf{0.2293}$. The legacy debt increase by an amount equal to \$82.372-\$82.143**=\$0.229**. This is less than $\frac{\$0.1533}{0.625} = \$0.2453$ in the no donation case because the donation reduces the funding needs and decreases the bank's funding requirements.

[69] Consider a derivative contract entered between a bank and a corporate client hedged with an offsetting contract entered between the bank and a hedge dealer. This pair of transactions requires the bank to post two initial margins. The bank's shareholders are likely to be hurt unless the bank passes the financing costs of the two initial margins to the corporate client.

[70] See Kenyon and Green (2015).

The pre-derivate value of the bank including tax shields is given in Table 10.A. The one-year zero-coupon bond is assumed to be issued at a price of \$82.143. This is an original issue discount (OID) of \$7.857 relative to its face value of \$90.0.[71] The bank is assumed to receive an interest tax shield of either $\$7.857 \times T_C$ in the no-default state and \$0 in the default state at time 1. The PV of the expected tax shield at time 0, denoted by $PVITS$, is equal to $PV[\$7.857 \times T_C] \times 0.625$. Compared to the no tax shield case, shareholders are better off by an amount equal to $PVITS$. With a tax rate of 40.0%, the market value of equity increases by \$1.871.

6.1 Derivative Receivables

Assume that the bank purchases the option contract worth \$15.0 from the riskless counterparty and funds the option premium by issuing \$15.0 worth of new debt. As discussed in Section 3, the new debt is a zero-coupon bond with a face value F equal to \$16.362, where F is calculated to make the bond a zero NPV investment for the new creditors. This gives an OID of \$1.362 and an interest tax shield of $\$1.362 \times T_C$ in the no-default state at time 1. At time 0, the funding of the derivative contract increases the market value of the bank and the market value of equity by an incremental amount $\Delta PVITS$ equal to $PV[\$1.362 \times T_C] \times 0.625$. The introduction of an interest tax shield does not fundamentally alter the wealth transfer effects between the legacy creditors and the shareholders. However, it introduces a new party, i.e., the tax authorities, and decreases the magnitude of the losses experienced by the shareholders. The reason is that part of the funding costs is now absorbed by the government. As shown in Table 10.B, the derivative receivable makes the legacy creditors better off by an amount equal to:

$$\Delta W = \Delta D = \$82.5072 - \$82.1428 = \$\mathbf{0.3644}$$

The wealth creation earned by the legacy creditors is the same as in the no interest tax shield case. However, the wealth of the shareholders changes by an amount equal to:

$$\Delta E = -\Delta D + \Delta PVITS = -\$0.3644 + PV[\$1.362 \times T_C] \times 0.625$$

Compared to Table 2.B, the change in the equity value is lower than in the no tax shield case. The change depends on the marginal tax rate and may switch from negative to positive for sufficiently high marginal tax rates.[72] It is straightforward to show that the marginal tax rate that preserves the shareholders' wealth, i.e., that gives $\Delta E = 0$, is equal to:[73]

$$T_C = \frac{CS}{R_F + CS} = 44.94\%$$

[71] Under the US tax code, OID is amortized over the life of the bond and the amortized amount is deducted as interest paid by the issuer.

[72] The analysis also applies to the funding of the initial margin (IM) discussed in Section 5.

[73] $\Delta W = PV[15 \times CS] \times 0.625$ and $\Delta PVITS = PV[15 \times (R_F + CS)] \times 0.625$. Solving for T_C by equating $\Delta W = \Delta PVITS$ gives the desired result.

The rationale is that interest tax shield depends on the interest rate paid, i.e., the sum of the risk-free rate and the credit spread, while the wealth transfer depends only of the credit spread. The breakeven marginal tax rate decreases with an increase in the risk-free rate and a decrease in the credit spread.

What are the implications? First, there is no need to adjust derivatives for tax effects, i.e., to make a TVA adjustment. The derivatives' funding costs are borne by the shareholders and the government. Second, the donations made by counterparties to preserve the shareholders' wealth are now lower, i.e., the FTP derivative price v^* is higher. Third, to minimize donations, counterparties are better off entering derivatives with dealer banks that face the highest marginal tax rates.

6.2 Derivative Payables

Assume that the bank sells an option contract worth \$15.0 to the riskless counterparty and uses the cash proceeds to retire debt. As discussed in Section 4.1, the derivative's trade and the debt retirement amount to a debt-for debt swap that generates no wealth transfer and preserves the market value of the equity. Does this conclusion still hold when interest tax shields are introduced?

Section 4.1 shows that the dealer bank receives \$14.375 from the option sale and retires \$14.375 worth of debt value at time 0, equivalently \$15.75 worth of par value. The impact of the debt retirement is to reduce the interest tax shield by an incremental amount equal to $\$1.375 \times T_C$. This means that the introduction of an interest tax shield decreases the shareholders' wealth by an amount equal to $PV[\$1.375 \times T_C] \times 0.625$, relative to its pre-derivative value:

$$\Delta E = -PV[\$1.375 \times T_C] \times 0.625$$

This is illustrated by Table 10.C that gives the market value of the bank under a tax rate of 40.%. There are two implications. First, unlike the no tax shield case, the derivative payable makes the shareholders worse off, unless the counterparty is willing to make a donation, i.e., is willing to pay more upfront. Second, to minimize the donation, counterparties have incentives to transact with the dealer banks that have the lowest marginal tax rates.

Assume now that, the cash raised through the option sale is invested in riskless securities instead of used to retire debt. Section 4.3 reached the conclusion that the parking of cash in riskless instruments makes the creditors better off at the expense of the shareholders. Consider the impact of interest tax shields. As shown by Table 5.D, the dealer bank receives \$14.437 through the option sale and invests the proceeds in cash, earning 5.0% in the process, i.e., \$0.7218 in interest at time 1. This means that the shareholders are penalized by a negative interest tax shield equal of $\$0.728 \times T_C$ at time 1. Under the assumption that the government foregoes the tax receipt on interest income in the default state, the negative interest tax shield decreases the shareholders' wealth by an incremental $PV[\$0.728 \times T_C] \times 0.625$ at time 0. Counterparties must be willing to make even bigger donations than in the no interest tax shield case. The same two conclusions as above apply.

The deductibility of interest expenses for tax purposes decreases the losses experienced by shareholders for derivative contracts that require funding. This is because the losses are absorbed by the shareholders and the government rather than just by the shareholders. In contrast, interest tax shields make the shareholders worse off for the derivative contracts that provide funding because of either foregone interest tax shields or negative interest tax shields. There is no rationale for adjusting derivative values for tax effects. The after-tax funding costs and benefits are absorbed by the shareholders. For both derivative payables and receivables, counterparties must be willing to make donations to preserve the shareholders' wealth. Counterparties have incentives to transact with dealer banks that have the highest (lowest) marginal tax rates for derivative receivables (payables), respectively.

7. Conclusion

The impact of financing decisions and the interaction between investment and financing decisions have been studied extensively in the corporate finance literature. A fundamental principle of corporate finance theory is the irrelevance of financing decisions. Another principle is that financing decisions can distort investment decisions and generate transfers of wealth between shareholders and creditors. These two fundamental corporate finance principles provide a useful framework to investigate the impact of funding costs and benefits on the value of derivative contracts.

Derivative contracts may impose funding requirements on dealer banks. A first example is a long option contract (an asset). A second example is uncollateralized contract, currently in-the-money (an asset) hedged with an offsetting collateralized derivative contract, currently out-of-the money (a liability).[74] In both examples, the contracts are assets that require funding. Two conclusions emerge from a structural analysis of the bank's balance sheet. First, regardless of the funding instrument, debt or equity, the funding of the derivative contract is a zero NPV transaction to the bank. This implies that derivative contracts should not be adjusted for funding costs. Second, regardless of the funding instrument, there is a transfer of wealth from the shareholders to the legacy creditors, which is more significant with equity than with debt funding. Shareholders should object to derivative transactions unless the funding costs are passed on to the counterparties. This raises agency issues and conflicts of interests between the shareholders and the derivatives dealers. The recent FVA adjustments made by the banks suggest that shareholders end up absorbing the funding costs.

Derivative contracts may provide funding benefits to dealer banks. A first example is a written option (a contingent liability). A second example is an uncollateralized contract, currently out-of-the money (a liability), hedged with an offsetting collateralized derivative contract, currently in-the-money (an asset).[75]

[74] This would be the case for, say, a swap not subject to a CSA agreement between a corporate and bank (B) hedged with an offsetting swap subject to a CSA agreement between bank (B) and bank (C). From the perspective of bank (B), the swap with the corporate is an asset while the swap with bank (C) is a liability. Bank B receives no collateral from the corporate but must post collateral to bank (C). Bank (B) must fund the shortfall.

[75] This would be the case for, say, a swap not subject to a CSA agreement between a corporate and a bank (B) hedged with an offsetting swap subject to a CSA agreement between bank (B) and bank (C). From the perspective of bank (B), the swap with the corporate is a liability while the swap with bank (C) is an asset. Bank B receives collateral from bank (C) but does not have to post collateral to the corporate counterparty.

In both examples, the contracts are liabilities that generate cash and provide funding. Two conclusions emerge from a structural analysis of the dealer bank's balance sheet. First, the use of the cash proceeds to retire debt, i.e., a debt-for-debt swap, is a zero NPV transaction to the dealer bank. Second, the use of the cash proceeds to buy back equity, i.e., an equity for debt swap, is a zero NPV transaction to the bank. However, a share buy-back transfers wealth from the creditors to the shareholders which destroys (increases) the wealth of the former (latter). A balance sheet approach shows that the funding benefits provided by derivative contracts are illusory and that their values should not be adjusted for funding benefits. Financing decisions transfer wealth but do not create wealth.

The Modigliani-Miller irrelevance Proposition holds only under many assumptions, such as perfect markets, i.e., no taxes, no costs of financial distress…. Market imperfections change some of the results discussed in the paper. For example, allowing for interest tax shields has an impact on the change in the shareholders' wealth. Derivatives that require funding increase interest tax shields, and reduce the decrease in the shareholders' wealth. Conversely, derivatives that provide funding decrease interest tax shields when cash is used to retire debt, or generate negative interest tax shields when cash is invested in riskless securities. This decreases the shareholder's wealth. Another market imperfection is the costs of financial distress. Issuing new debt to fund derivatives may increase the costs of financial distress and decrease the bank's value. These two market imperfections have an impact on the magnitude of the change in the equity and in the debt values but not on the mechanics of wealth transfer effects. The finance profession and the industry are split on the issue of funding and derivatives valuation. The conclusion that the valuation of derivatives should be adjusted for funding is inconsistent with both the perfect- and the imperfect-market versions of the Modigliani-Miller Proposition. The issue of whether market imperfections (other than taxes and financial distress) justify the current practice of making funding value adjustments is an open question.

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Table 1.A Bank Value at Time 1 - Pre-Derivative Trade			
State	**ASSETS**	**DEBT**	**EQUITY**
No Default	120	Min(120,90)=90	Max(0,120-90)=30
Default	80	Min(80,90)=80	Max(0, 80-90)= 0

Notes:

1. The loss rate is equal to $L = \left(1 - \frac{80}{90}\right) = \mathbf{11.11}\%$
2. The credit spread is equal to $CS = (1 + R_F) \times \left(\frac{p \times L}{1 - p \times L}\right) = 1.05 \times \frac{0.375 \times 11.11\%}{1 - 0.375 \times 11.11\%} = \mathbf{4.565}\%$.
3. Equity is a call option with a strike equal to the face value of the debt $90.0.
4. Debt is a portfolio composed of the assets and a short call. Alternatively debt is a portfolio composed of a riskless bond with a face value of $90.0 and a short put with a strike $90.0. In the default state, the shareholders exercise the put against the creditors. The latter receive assets worth $80 instead of $90. The put value is equal to: $PV(0.375 \times (90 - 80)) = PV(3.75) = \$\mathbf{3.571}$.

Table 1.B Bank Value at Time 0 - Pre-Derivative Trade			
Assets		**Liabilities**	
Assets	100.00	Equity	17.857
		Debt	82.143
Total Assets	**100.00**	**Total Liabilities**	**100.000**

Notes:

1. Equity Value: $PV(30 \times 0.625) = \$\mathbf{17.857}$
2. Debt Value:
   2.1 Value: $PV(90 \times 0.625 + 80 \times 0.375) = \$\mathbf{82.143}$
   2.2 Credit Spread: $82.143 = \frac{90}{1 + 5\% + CS}$. Solving for CS, gives $CS = \mathbf{4.565}\%$

Table 1.C Bank Value at Time 0 - Pre-Derivative Trade					
Assets		**Liabilities**			
Assets	100.00		**BOOK VALUE**	**DVA**	**MARKET VALUE**
		Equity	17.857	0	17.857
		Debt	85.714	3.571	82.143
Total Assets	**100.00**	**Total Liabilities**	**103.571**	**3.571**	**100.00**

Notes:

1. The debt DVA is equal to the market value of the put option sold by the shareholders to the creditors calculated in Table 1.A.

Table 2.A: Derivative Receivable Bank Value at Time 1 - Post Derivative Trade Derivative Contract Funded by New Debt				
State	**TOTAL ASSETS**	**NEW DEBT**	**LEGACY DEBT**	**EQUITY**
No Default (1)	120+15.75=135.75	16.362	90.00	29.388
Default (2)	80+15.75=95.75	14.730	81.02	0

Notes:

(1) **No Default**:

1.1: The new creditors receive the full face value with $F = \$\mathbf{16.362}$

1.2: The legacy creditors receive the full face value of their claims equal to **$90.0**

1.3: The shareholders receive the residual, i.e., difference between the asset value and the debt values: **$29.388**.

(2) **Default**:

2.1: The loss rate is equal to $L = \left(1 - \frac{95.75}{106.362}\right) = \mathbf{9.98}\%$

2.2: The credit spread is equal to $CS = (1 + R_F) \times \left(\frac{p \times L}{1 - p \times L}\right) = 1.05 \times \frac{0.375 \times 9.98\%}{1 - 0.375 \times 9.98\%} = \mathbf{4.081}\%$.

2.3 The new creditors receive $\rho\%$ of the asset value, with $\rho = \frac{16.362}{90 + 16.362} = \mathbf{15.383}\%$

2.4: The legacy creditors receive $(1 - \rho)\%$ of the asset value with $(1 - \rho) = \mathbf{84.617}\%$

2.5: Equity is wiped out.

Table 2.B: Derivative Receivable Bank Value at Time 0 - Post Derivative Trade Derivative Contract Funded by New Debt			
Assets		**Liabilities**	
Assets	100.00	Equity	17.493
Derivative Receivable	15.00	Legacy Debt	82.507
		New Debt	15.000
Total Assets	**115.00**	**Total Liabilities**	**115.00**

Notes:

1. Equity Value: $PV(29.388 \times 0.625) = \$\mathbf{17.493}$
2. Legacy Debt:
   2.1 Value: $PV(90 \times 0.625 + 81.02 \times 0.375) = \$\mathbf{82.507}$
   2.2 Credit Spread: $\$82.507 = \frac{90}{1 + 5\% + CS}$. Solving for CS, gives $CS = \mathbf{4.081}\%$
3. New Debt:
   3.1 Value: $PV(16.362195 \times 0.625 + 14.729662 \times 0.375) = \$\mathbf{15.00}$
   3.2 Credit Spread: $\$15.0 = \frac{16.362}{1 + 5.0\% + CS}$. Solving for CS, gives $CS = \mathbf{4.081}\%$

State	Table 3.A: Derivative Receivable Bank Value at Time 1 - Post Derivate Trade Derivative Contract Funded by New Debt with Donation from Counterparty			
	ASSETS	**NEW DEBT**	**LEGACY DEBT**	**EQUITY**
No Default (1)	120+15.75=135.75	15.75	90.00	30
Default (2)	80+15.75=95.75	14.261	81.489	0

Notes:

(1) **No Default**:

1.1: The new lenders receive the full face value with $\boldsymbol{F} = \$\mathbf{15.75}$.

1.2: The legacy bondholders receive the full face value of their claims equal to **$90.00**

1.3: The shareholders receive the residual, i.e., difference between the asset value and the debt values **$30**.

(2) **Default**:

2.1: The loss rate is equal to: $L = 1 - \frac{80+15.75}{90+15.75} = \mathbf{9.456}\%$

2.2 The credit spread is equal to $CS = (1 + R_F) \times \left(\frac{p \times L}{1 - p \times L}\right) = 1.05 \times \frac{0.375 \times 9.456\%}{1 - 0.375 \times 9.456\%} = \mathbf{3.86}\%$

2.3: The new lenders recover $(1 - L)\%$ of their claim's face value of \$15.75, an amount equal to: **$14.261**

2.4: The legacy bondholders recover $(1 - L)\%$ of their claim's face value of \$90.0, an amount equal to: **$81.489**

2.5: Equity is wiped out.

Table 3.B: Derivative Receivable Bank Value at Time 0 - Post Derivative Trade Derivative Contract Funded by New Debt with Donation from Counterparty			
Assets		**Liabilities**	
Assets	100.00	Equity	17.857
Derivative Receivable	15.00	Legacy Debt	82.675
		New Debt	14.468
Total Assets	**115.00**	**Total Liabilities**	**115.00**

Notes:

1. Equity value: $PV(30 \times 0.625) = \$\mathbf{17.857}$
2. Legacy debt:
   2.1 Value: $PV(90 \times 0.625 + 81.489 \times 0.375) = \$\mathbf{82.675}$
   2.2 Credit Spread: $82.675 = \frac{90}{1+5\%+CS}$. Solving for CS gives $CS = \mathbf{3.86}\%$
3. New Debt:
   3.1 Value: $PV(15.75 \times 0.625 + 14.261 \times 0.375) = \$$**14.468**
   3.2 Credit Spread: $14.468 = \frac{15.75}{1+5\%+CS}$. Solving for CS gives $CS = \mathbf{3.86}\%$

Table 4.A: Derivative Receivable Bank Value at Time 1 - Post-Derivative Trade Derivative Contract Funded by New Equity			
State	**ASSETS**	**DEBT**	**EQUITY**
No Default	120+15.75=135.75	90.00	45.75
Default	80+15.75=95.75	90.00	5.75
Note: In this particular example, there is no default as the lenders are paid in full in the “default” state. The debt becomes riskless.			

Table 4.B: Derivative Receivable Bank Value at Time 0 - Post-Derivative Trade Derivative Contract Funded by New Equity			
Assets		**Liabilities**	
Assets	100.00	Equity Old	14.286
Derivative Receivable	15.00	Equity New Equity	15.000
		Debt	85.714
Total Assets	**115.00**	**Total Liabilities**	**115.000**

Notes:

1. Equity Value**:**
   1.1 Aggregate equity value: $PV(45.75 \times 0.625 + 5.75 \times 0.375) = \$\mathbf{29.286}$
   1.2 New Equity Value: **$15.00**
   1.3 Old Equity Value: **$14.286**
2. Debt value: $PV(90 \times 0.625 + 90 \times 0.375) = \$\mathbf{85.714}$

<table>
<tr><th rowspan="3">State</th><th colspan="4">Table 5.A: Derivative Payable
Bank Value at Time 1 - Post Derivative Trade
Debt Buyback</th></tr>
<tr><th>ASSETS</th><th>DEBT</th><th>DERIVATIVE PAYABLE</th><th>EQUITY</th></tr>
<tr><td>No Default (1)</td><td>120</td><td>74.25</td><td>15.75</td><td>30</td></tr>
<tr><td>Default (2)</td><td>80</td><td>66.00</td><td>14.00</td><td>0</td></tr>
</table>

Notes:

(1) **No Default**: The original aggregate face value of the debt is \$90.0. At time 0, the bank uses the proceeds received by selling the option to the counterparty to buy back debt. This leaves the total liabilities unchanged. At maturity, the total liabilities, i.e., the sum of the debt and the option, add up to \$90.0 if the bank does not default, with a split of \$74.25 and \$15.75 for the debt and the option, respectively.

(2) **Default**:

2.1 The bank's debt and the derivative have the same priority. This means that in case of bankruptcy, the lenders will receive \$74.25/\$90=82.50% of the remaining assets while the counterparty of the derivative contract receives \$15.75/\$90= 17.50%, where \$90.0 is the sum of the bank's liabilities.

2.2 The loss rate is the same for the debt and the option's counterparty and is equal to $\left(1-\frac{80}{90}\right)=\mathbf{11.11}\%$.

2.3 The credit spread is equal to $CS=(1+R_F)\times\left(\frac{p\times L}{1-p\times L}\right)=1.05\times\frac{0.375\times 11.11\%}{1-0.375\times 11.11\%}=\mathbf{4.565}\%$

<table>
<tr><th colspan="3">Table 5.B: Derivative Payable
Bank Value at Time 0 - Post Derivative Trade
Debt Buyback</th></tr>
<tr><th>Assets</th><th colspan="2">Liabilities</th></tr>
<tr><td rowspan="3"></td><td>Equity</td><td>17.857</td></tr>
<tr><td>Debt</td><td>67.768</td></tr>
<tr><td>Derivative Payable</td><td>14.375</td></tr>
<tr><td>100</td><td>Total Liabilities</td><td>100.000</td></tr>
</table>

Notes:

1. Equity Value: $PV(\$30\times 0.625)=\$\mathbf{17.857}$
2. Debt:
   2.2 Value: $PV(\$74.25\times 0.625+\$66.00\times 0.375)=\$\mathbf{67.7678}$
   2.3 Credit spread: $67.768=\frac{74.25}{1+5\%+CS}$. Solving for CS gives $\boldsymbol{CS}=\mathbf{4.565}\%$
3. Derivative Payable: $PV(\$15.75\times 0.625+\$14.00\times 0.375)=\$\mathbf{14.375}$
4. The pre- buyback debt value is \$82.143. The option premium received equal to \$14.375 is used to buy-back debt. After the buy-back, the market value of debt is equal to \$82.143-\$14.375**=\$67.768**

<table>
<tr><th colspan="6">Table 5.C: Derivative Payable
Bank Value at Time 0 - Post Derivative Trade
Debt Buyback</th></tr>
<tr><th colspan="2">Assets</th><th colspan="4">Liabilities</th></tr>
<tr><td rowspan="4">Assets</td><td rowspan="4">100.00</td><td></td><td>BOOK VALUE</td><td>DVA</td><td>MARKET VALUE</td></tr>
<tr><td>Equity</td><td>17.857</td><td>0</td><td>17.857</td></tr>
<tr><td>Debt</td><td>70.714</td><td>2.946</td><td>67.768</td></tr>
<tr><td>Derivative Payable</td><td>15.0000</td><td>0.625</td><td>14.375</td></tr>
<tr><td>Total Assets</td><td>100.00</td><td>Total Liabilities</td><td>103.571</td><td>3.571</td><td>100.00</td></tr>
</table>

Table 5.D: Derivative Payable Bank Value at Time 0 - Post Derivative Trade Premium Reinvested at Risk-Free Rate (AFVA)			
Assets		**Liabilities**	
Assets	100.00	Equity	17.505
Cash	14.437	Debt	82.495
		Derivative Payable	14.437
Total Assets	**114.437**	**Total Liabilities**	**114.437**

Notes: The market value of debt and equity sums to $100, its pre-derivative value**.**

1. Equity Value: $PV(\$29.4082 \times 0.625) = \$\mathbf{17.505}$
2. Debt:
   2.2 Value: $PV(\$90.0 \times 0.625 + \$80.9859 \times 0.375) = \$\mathbf{82.495}$
   2.3 Credit spread: $82.495 = \frac{90.00}{1+5\%+CS}$. Solving for CS gives $\boldsymbol{CS = 4.098}\%$
3. Derivative Payable: $PV(\$15.75 \times 0.625 + \$14.173 \times 0.375) = \$\mathbf{14.437}$
4. The option premium received equal to $14.437 is invested at the risk-free rate.

State	Table 6.A: Derivative Payable Bank Value at Time 1 - Post Derivative Trade Equity Buyback			
	ASSETS	**DEBT**	**DERIVATIVE PAYABLE**	**EQUITY**
No Default (1)	120	90.00	15.75	14.25
Default (2)	80	68.085	11.915	0

Notes:

(1) **No Default**: The face value of the debt is \$90.0 and the option payoff is \$15.75. At maturity, the total liabilities, i.e., the sum of the debt and the derivative payable, adds up to \$90 +\$15.75=\$105.75, leaving the difference between assets and liabilities, i.e., \$14.25 to the shareholders.

(2) Default:

2.1 The bank's debt and the derivative have the same priority. The total liabilities amount to **\$105.75.**

2.2 The loss rate is the same for the debt and the option's counterparty. It is equal to $L = \left(1 - \frac{80}{105.75}\right) = \mathbf{19.622}\%$**.**

2.3 The credit spread is equal to $CS = (1 + R_F) \times \left(\frac{p \times L}{1 - p \times L}\right) = 1.05 \times \frac{0.375 \times 19.622\%}{1 - 0.375 \times 19.622\%} = \mathbf{10.55}\%$

2.4 The creditors receive $\$90 \times (1 - L) = \$\mathbf{68.085}$

2.5 The option's counterparty receives $\$15.75 \times (1 - L) = \$\mathbf{11.915}$.

Table 6.B: Derivative Payable Bank Value at Time 0 - Post Derivative Trade Equity Buyback		
Assets	**Liabilities**	
	Equity	8.482
	Debt	77.888
	Derivative Payable	13.630
100	**Total Liabilities**	**100.000**

Notes:

1. Equity Value: $PV(\$14.25 \times 0.625) = \$\mathbf{8.482}$
2. Debt:
   2.1 Value: $PV(\$90 \times 0.625 + \$68.085 \times 0.375) = \$\mathbf{77.888}$
   2.2 Credit spread: $77.888 = \frac{90.0}{1 + 5\% + CS}$. Solving for CS gives $\boldsymbol{CS} = \mathbf{10.55}\%$
3. Derivative Payable: $PV(\$15.75 \times 0.625 + \$11.915 \times 0.375) = \$\mathbf{13.630}$

Table 7.A: Derivative Payable Bank Value at Time 1 - Post Derivative Trade Option is Collateralized						
State	**ASSET VALUE**	**OPTION VALUE**	**NET COLLATERAL**	**TOTAL ASSETS**	**DEBT**	**EQUITY**
No-Default	120	15.20	-5.70	114.30	90.00	24.30
	120	0	+9.50	129.50	90.00	39.50
Default	80	15.20	-5.70	74.30	74.30	0
	80	0	+9.50	89.50	89.50	0

Notes:

1. The collateral is assumed to be refreshed an instant before time 1 before the bank defaults or does not default.
2. When the option is in-the-money, the bank pays to the hedge dealer the difference between the option value at time 1, \$15.20 less the future value of the cash collateral already posted at time 0, \$9.50. The net collateral paid (variation margin) by the bank to the hedge dealer is equal to **\$5.70.**
3. When the option is out-of-the money, the hedge dealer returns back the future value of the cash collateral received at time 0. The net collateral received (variation margin) by the bank from the hedge dealer is **\$9.50**.

Table 7.B: Derivative Payable Bank Value at Time 1 – Post Derivative Trade Option is Collateralized						
State	**ASSET VALUE**	**OPTION VALUE**	**NET COLLATERAL**	**TOTAL ASSETS**	**DEBT**	**EQUITY**
No-Default	120	9.50	0	120	90	30
Default	80	9.50	0	80	80	0

Notes:

1. Option Value (No default and default): $PV(15.20 \times 0.625) = \$\mathbf{9.50}$
2. Net Collateral (No default and default): $PV(-5.70 \times 0.625 + 9.50 \times 0.375) = \$\mathbf{0}$
3. Total Assets (No default): $PV(114.30 \times 0.625 + 129.50 \times 0.375) = \$\mathbf{120.00}$
4. Total Assets (Default): $PV(74.30 \times 0.625 + 89.50 \times 0.375) = \$\mathbf{80.00}$
5. Debt value (Default): $PV(74.30 \times 0.625 + 89.50 \times 0.375) = \$\mathbf{80.00}$
6. Equity Value (No default): $PV(24.30 \times 0.625 + 39.50 \times 0.375) = \$\mathbf{30.00}$

Table 7.C: Derivative Payable Bank Value at Time 0 - Post-Derivative Trade Option is Collateralized			
Assets		**Liabilities**	
Assets	100.00	Equity	17.857
		Debt	82.143
Collateral	9.048	Derivative Payable	9.048
Total Assets	**109.048**	**Total Liabilities**	**109.048**

Notes:

1. Equity Value: $PV(30 \times 0.625) = \$\mathbf{17.857}$
2. Debt value: $PV(90 \times 0.625 + 80 \times 0.375) = \$\mathbf{82.143}$
3. Derivative Payable: $PV(9.50 \times 0.625 + 9.50 \times 0.375) = \$\mathbf{9.048}$

Table 8.A: Derivative Receivable and Payable Bank Value at Time 0 - Post-Derivative Trades Option Payable is not Collateralized – Option Receivable is not Collateralized			
Assets		**Liabilities**	
Assets	100.00	Equity	17.628
		Legacy Debt	73.677
Derivative Receivable (1)	9.048	New Debt (2)	9.048
		Derivative Payable (3)	8.695
Total Assets	**109.048**	**Total Liabilities**	**109.048**

Notes: Sum of Equity, Legacy debt and Derivative Payable (=Repurchased Debt) adds up to **$100,** with wealth transfer from shareholders to legacy creditors

(1) Option contract between the bank and the counterparty
(2) New Debt Issued to fund the purchase of the option contract with counterparty
(3) Option contract between the bank and the hedge dealer

Table 8.B: Derivative Receivable and Payable Bank Value at Time 0 - Post-Derivative Trades Option Payable is Collateralized – Option Receivable is not Collateralized			
Assets		**Liabilities**	
Assets	100.00	Equity	17.628
		Legacy Debt	82.372
Derivative receivable (1)	9.048	New Debt (3)	9.048
Collateral (2)	9.048	Derivative Payable (4)	9.048
Total Assets	**118.096**	**Total Liabilities**	**118.096**

Notes: Sum of Equity and Legacy debt adds up to **$100,** with wealth transfer from shareholders to legacy creditors

(1) Option contract between the bank and the counterparty
(2) Collateral posted to hedge dealer against derivative payable
(3) New Debt Issued to fund the purchase of the option contract with counterparty
(4) Option contract between the bank and the hedge dealer

Table 8.C: Derivative Receivable and Payable Bank Value at Time 0 - Post-Derivative Trades Both Options are Collateralized			
Assets		**Liabilities**	
Assets	100.00	Equity	17.857
		Legacy Debt	82.143
Derivative Receivable (1)	9.048	Collateral (3)	9.048
Collateral (2)	9.048	Derivative Payable (4)	9.048
Total Assets	**118.096**	**Total Liabilities**	**118.096**

Notes: Sum of Equity and Legacy debt adds up to **$100** with **no** wealth transfer from shareholders to legacy creditors

(1) Option contract between the bank and the counterparty
(2) Collateral posted to hedge dealer against derivative payable
(3) Collateral received from counterparty against derivative receivable
(4) Option contract between the bank and the hedge dealer

Table 9.A: Derivative Receivable and Derivative Payable with Initial Margin Bank Value at Time 1 - Post Derivative Trades Option Payable is Collateralized and Option Receivable is not Collateralized										
		CASH INFLOWS			OUTFLOWS					
State	ASSET VALUE	DERIVATIVE RECEIVABLE (1)	DERIVATIVE PAYABLE (2)	INITIAL MARGIN (3)	DERIVATIVE PAYABLE (4)	NET ASSETS (5)	NEW DEBT (6)	LEGACY DEBT (7)	EQUITY (8)
No-Default	120	+15.20	0	+6.175	-5.70	135.675	16.285	90.0	29.3904
	120	0	+9.50	+6.175	0	135.675	16.285	90.0	29.3904
Default	80	+15.20	0	+6.175	-5.70	95.675	14.659	81.016	0
	80	0	+9.50	+6.175	0	95.675	14.659	81.016	0

Notes:

(1) Bank receives from (riskless) counterparty the option's terminal value when it is in-the-money **$15.20** and $0, otherwise

(2) Bank receives from hedge dealer the (future value of the) variation margin deposited at time 0 when the (secured) option is out-of-the-money, i.e., $FV(9.048) = \$\mathbf{9.50}$

(3) Bank receives the (future value of the) initial margin from third party $FV(5.88) = \$\mathbf{6.175}$

(4) Bank pays to the hedge dealer the difference between the option terminal value of $15.20 and the (future value of the) variation margin deposited at time 0 ($15.20-$9.50**=$5.70**). Hedge dealer has priority over all the creditors.

(5) Net asset=asset value + cash inflows – cash outflows. Net assets are allocated to the new creditors and the legacy creditors (who have the same priority), and then to the shareholders in the no-default state

(6) New debt raised at time 0 to fund the option contract purchased from counterparty and to fund the initial margin. The face value of the new debt is **$16.285**. It is calculated by solving: $(9.048 + 5.88) = PV[0.625 \times F + 0.375 \times \rho \times 95.675]$ where $\rho = \frac{F}{F+90}$. This gives $\rho = \mathbf{15.322}\%$, Loss rate $L = \frac{14.659}{16.285} = \mathbf{9.98}\%$, credit spread $cs = \mathbf{4.083}\%$

(7) Legacy creditors receive $90 in the no-default state. They get $(1-\rho) = \mathbf{84.678}\%$ of the assets in the default state.

(8) Equity gets the residual in the no-default state.

Table 9.B: Derivative Receivable and Payable with Initial Margin Bank Value at Time 0 - Post-Derivative Trades Option Payable is Collateralized – Option Receivable is not Collateralized			
Assets		**Liabilities**	
Assets	100.00	Equity	17.494
		Legacy Debt	82.506
Collateral: (1)		New Debt (3)	
Variation Margin	9.048	Option Premium	9.048
Initial Margin	5.880	Initial Margin	5.880
Derivative Receivable (2)	9.048	Derivative Payable (4)	9.048
Total Assets	**123.976**	**Total Liabilities**	**123.976**

Notes: Sum of Equity and Legacy debt adds up to **$100,** with wealth transfer from shareholders to legacy creditors

(1) Collateral posted to hedge dealer against derivative payable (VM) and initial margin (IM) posted to third party

(2) Option contract between the bank and the counterparty

(3) New Debt Issued to fund the purchase of the option contract with counterparty and the initial margin. Face value of new debt issued is equal to **$16.285**, $L = \mathbf{9.98}\%$, $CS = \mathbf{4.083}\%$, same as legacy debt

(4) Option contract between the bank and the hedge dealer

Table 9.C: Derivative Receivable and Payable with Initial Margin
Bank Value at Time 0 - Post-Derivative Trades
Option Payable and Option Receivable are both Collateralized

Assets		**Liabilities**	
Assets	100.00	Equity	17.704
		Legacy Debt	82.296
Collateral: (1)		New Debt (3)	5.880
Variation Margin	9.048	Collateral (4)	
Initial Margin	5.880	Variation Margin	9.048
Derivative Receivable (2)	9.048	Derivative Payable (5)	9.048
Total Assets	**123.976**	**Total Liabilities**	**123.976**

Notes: Sum of Equity and Legacy debt adds up to **$100,** with wealth transfer from shareholders to legacy creditors

(1) Collateral posted to hedge dealer against derivative payable (VM) and initial margin (IM) posted to third party
(2) Option contract between the bank and the counterparty
(3) New Debt issued to fund the initial margin. Face value of new debt issued is equal to **$6.432**, $L = \mathbf{10.636}\%$, $CS = \mathbf{4.38}\%$
(4) Collateral received from counterparty
(5) Option contract between the bank and the hedge dealer

Table 9.D: Derivative Receivable and Payable with Initial Margin and Donation
Bank Value at Time 0 - Post-Derivative Trades
Option Payable and Option Receivable are both Collateralized

Assets		**Liabilities**	
Assets	100.00	Equity	17.857
		Legacy Debt	82.372
Collateral: (1)		New Debt (3)	5.652
Variation Margin	9.277	Collateral (4)	
Initial Margin	5.880	Variation Margin	9.048
Derivative Receivable (2)	9.048	Derivative Payable (5)	9.277
Total Assets	**124.205**	**Total Liabilities**	**124.205**

Notes: Sum of Equity and Legacy debt adds up to **$100,** with wealth transfer from shareholders to legacy creditors

(1) Collateral posted to hedge dealer against derivative payable (VM) and initial margin (IM) posted to third party
(2) Option contract between the bank and the counterparty
(3) New Debt issued to fund the initial margin. Face value of new debt issued is equal to **$6.175**, $L = \mathbf{10.3977}\%$, $CS = \mathbf{4.26}\%$
(4) Collateral received from counterparty
(5) Option contract between the bank and the hedge dealer

Table 10.A Bank Value at Time 0 - Pre-Derivative Trade Interest Expenses are Tax Deductible			
Assets		**Liabilities**	
Assets	100.00	Equity	19.728
PVITS	1.871	Debt	82.143
Total Assets	**101.871**	**Total Liabilities**	**101.871**

Notes: Assumes 40.0% marginal tax rate

1. $PV[\$(90.0 - 82.143) \times T_C] \times 0.625 = \$1.871$
2. Equity Value pre-interest tax shield =$17.857 (See Table 1.B)
3. Increase in equity value post- and pre-interest tax shield: $\Delta E = \$19.728 - \$17.857 = PVITS = \$1.871$

Table 10.B: Derivative Receivable Bank Value at Time 0 - Post Derivative Trade Derivative Contract Funded by New Debt Interest Expenses are Tax Deductible			
Assets		**Liabilities**	
Assets	100.00	Equity	19.688
PVITS	2.195	Legacy Debt	82.507
Derivative Receivable	15.00	New Debt	15.000
Total Assets	**117.195**	**Total Liabilities**	**117.195**

Notes: Assumes 40.0% marginal tax rate

1. Face value of newly issued debt: $16.362 (See Table 2.A)
2. Interest tax shield on newly issued debt: $\$(16.362 - 15.0) \times T_C = \$1.362 \times T_C$
3. PV of expected interest tax shield on newly issued debt: $\Delta PVITS = PV[\$1.362 \times T_C] \times 0.625 = \$0.3243$
4. PVITS post derivative equal PVITS pre-derivative plus $\Delta PVITS$= $1.871+$0.3243=$2.1953
5. Change in debt value: $\Delta D = \$82.507 - \$82.143 = \$0.3644$
6. Change in equity value $\Delta E = -\Delta D + \Delta PVITS = -\$0.3644 + \$0.3243 = -\$0.0401$
7. Equity value= Equity value pre-derivative + $\Delta E = \$19.728 - \$0.0401 = \$19.688$

Table 10.C: Derivative Payable Bank Value at Time 0 - Post Derivative Trade Option Premium Received Used to Retire Debt Interest Expenses are Tax Deductible			
Assets		**Liabilities**	
Assets	100.00	Equity	19.401
PVITS	1.544	Debt	67.768
		Derivative Payable	14.375
Total Assets	**101.544**	**Total Liabilities**	**101.544**

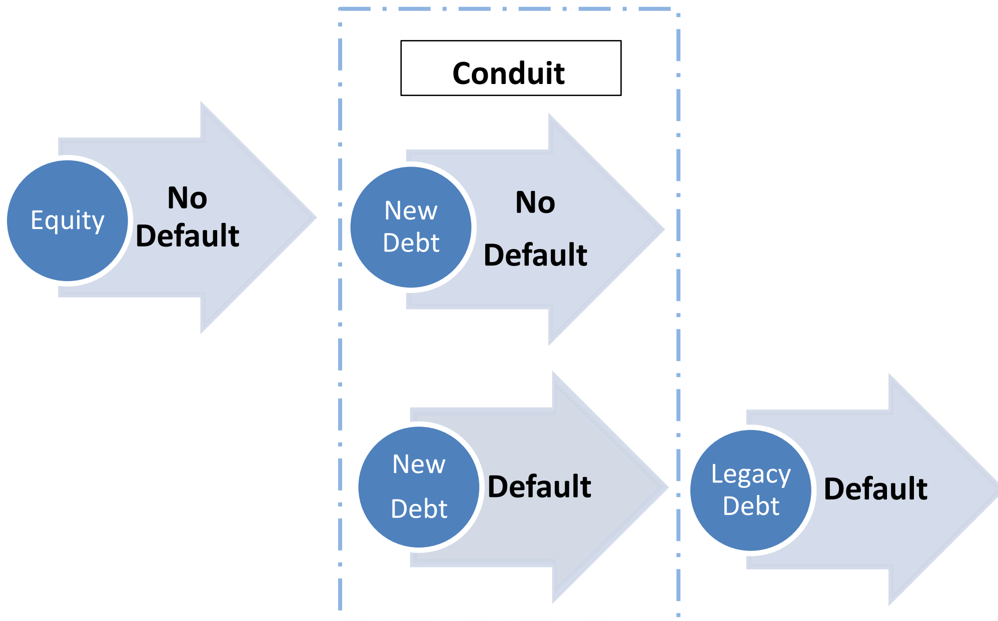
Notes: Assumes 40.0% marginal tax rate

1. Debt retired: $82.143-$67.768=$14.375. (See Table 5.B)
2. Value of the derivative payable: $14.375 (See Table 5.B)
3. Foregone Interest tax shield: $\$(15.750 - 14.375) \times T_C = \$1.375 \times T_C$
4. PV of expected (foregone) interest tax shield on retired debt: $\Delta PVITS = PV[\$1.375 \times T_C] \times 0.625 = \$0.3274$
5. PVITS post derivative equal PVITS pre-derivative less $\Delta PVITS$= $1.871-$0.3274=$1.5436
6. Change in equity value $\Delta E = -\Delta PVITS$
7. Equity value= Equity value pre-derivative +$\Delta E = \$19.728 - \$0.3274 = \$19.401$

Exhibit 1: Wealth Transfers in the No Donation Case

No Default Case: Excess CF Received by New Creditors (Wealth Transfer from Shareholders)

- $CF = \$15.0 \times CS = \$15.0 \times 4.081\% = \$0.6122$
- $PV(CF) = (1 + R_F)^{-1} \times CF = \$(1.05)^{-1} \times 0.6122 = \$0.5830$
- $PV[E(CF)] = (1 - p) \times PV(CF) = \$0.625 \times 0.5830 = \$\mathbf{0.3644}$



Default Case: Excess CF Paid by New Creditors (Wealth Transfer to Legacy Creditors)

- $CF = (F \times (1 - L) - 15.75) = \$(16.362 \times 9.977\% - 15.75) = \$1.021$
- $PV[E(CF)] = p \times PV(CF) = \$0.375 \times (1.05)^{-1} \times 1.021 = \mathbf{0.3644}$

No Default: Excess CF **Paid** by Shareholders **FCA**	**Default**: Excess CF **Received** by Legacy Creditors **DVA**

- $PV(CF) = \$0.5830$
- $PV[E(CF)] = \$\mathbf{0.3644}$
- $\Delta E = \$\mathbf{0.3644}$

- $PV(CF) = \$0.9714$
- $PV[E(CF)] = \$\mathbf{0.3644}$
- $\Delta D = \$\mathbf{0.3644}$