

STRUCTURAL MODELS IN CORPORATE FINANCE

LECTURE 3:

Financial Synergies and the Optimal Scope of the Firm: Implications for Mergers and Structured Finance

Hayne Leland
University of California, Berkeley

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Firm Scope and Synergies

- The optimal grouping of activities into firms, or ***optimal firm scope***, has long been an important topic in economics (Baumol and Willig!)
 - Most studies have focused on ***operational synergies***
 - Economies (or dis-economies) of scope in production
 - Pricing power related to scope
 - Contracts and optimal scope of a firm (again, Princeton)
 - Managerial benefits or costs to larger scope
 - Firms that combine activities that have ***zero operational synergies*** are often termed “*conglomerate*” mergers
 - Often explained behaviorally, e.g. managerial empire-building
 - But others have maintained there may be ***purely financial synergies*** that justify combination.

Objectives of This Lecture

- We examine the question of ***purely financial synergies*** in conglomerate mergers
 - Do they exist?
 - Are they always positive (or always negative)?
 - What determines their size?
 - Are their magnitudes likely to be significant?
 - Can they explain activities such as structured finance?
 - Asset securitization
 - Project finance
- Note: financial synergies and operational synergies are not mutually exclusive!

Optimal Scope: ***How Should Activities be Grouped into Firms?***

- ***“Activity”***: indivisible asset(s) producing cash flows
 - Cash flows may be negative (following Scott (1977), Sarig (1985))
 - Ownership can be transferred
- ***“Firm”***
 - Bankruptcy-remote unit that owns one or more activities (corporation or SPE)
 - Issues debt, equity. Debt has senior claim to firm’s cash flows
 - Firm has limited liability (avoids negative cash flows)
- ***“Optimal”***
 - Maximizes total value of activities, including gains to leverage
- ***The Key Problem we address:***
 - Incorporate and lever activities *separately*, or *jointly*?

Intellectual Roots of Financial Synergies

- ***Modigliani-Miller (1958)***: In “pure” world, no taxes etc.:
 - Leverage doesn’t matter: *no financial synergies*
→ No benefits to mergers that have zero operational synergies
- ***Lewellen (1971)***: nonsynergistic mergers, but adds taxes
 - Mergers lower default probability → higher “debt capacity” → greater leverage, tax benefits, value. No formal model
 - Concludes that *financial synergies are always positive* → ***purely financial synergies can’t explain structured finance!***
 - But overlooked potential *benefits of separate capital structures*
- ***Two benefits to separation vs. combination (merger)***:
 - Separate limited liability shelters (Scott 1977, Sarig 1985)
 - Separate capital structures (leverage ratios)
 - Not examined previously—need solvable optimal capital structure model

An Application: Structured Finance

- Structured Finance: A recent financial trend
 - Examples: ***Asset securitization*** and ***Project Finance***
 - *Former* involves low risk cash flows; *latter* involves high risk
 - Enormous business, both in US and internationally
 - But finance theory has found it is difficult to explain

	Agency	Non-Agency	Non-Mtge.	
YEAR	MBS	MBS	ABS	TOTAL
2000	2,491.8	669.3	1,071.8	4,232.9
2001	2,830.2	776.4	1,281.2	4,887.8
2002	3,158.3	862.1	1,543.2	5,563.6
2003	3,488.1	1,046.0	1,693.7	6,227.8
2004	3,547.3	1,490.2	1,839.2	6,876.7

All Numbers in \$ Billion

Source: The Bond Market Association

Structured Finance

- **Key elements of structured finance**

- *Assets (or “activity”) owned by a firm (the “sponsor”) are sold to a **Special Purpose Entity /Vehicle** (SPE/SPV)*
 - Sole purpose of SPE is to collect and disperse activities’ cash flows
 - Activities typically require little management
 - Typically SPE is a trust, sometimes a corporation
 - SPE is “bankruptcy remote” from sponsoring firm
- *The SPE issues securities backed by the assets’ cash flows*
 - Examples: mortgage-backed securities (MBS), asset-backed (ABS)
 - Debt “tranches” with different seniorities, plus “equity” (5% -15%)
- *Funds raised are used to repay sponsor for assets transferred*

The Puzzle of Structured Finance

- **No obvious operational synergies in asset transfers**
- **Possible explanations for structured finance**
 - **Regulatory** (reduce capital requirements). But non-bank use, too.
 - **Purely Financial:**
 - Cheaper financing** **But** more expensive for remaining assets?
Modigliani-Miller suggests that will be the case)
Possibly: greater liquidity (but less for remaining)
 - Greater leverage** (Reason given by many in business, but is total leverage increased? Lewellen says no!)
- **Is there a legitimate “purely financial” explanation?**

This relates back to the question of

“Is There an Optimal *Financial* Scope to the Firm?”

Preview of Conclusions:

- Financial synergies to merger can be *positive or negative*.
Two Sources of Synergies:
 - *“LL” Effect* (always < 0): Loss of separate limited liability
 - *Leverage Effect* (+ or -) : Separation can give higher tax benefits
- Financial synergies are more likely to favor merger when:
 - Correlation of activities is low (better risk diversification)
 - Volatility of individual activities is low (lesser *LL* effect)
 - Firms have similar volatility, default costs (less loss of advantage to firm’s having different leverage ratios)Opposite cases: **separation is better**
- Negative synergies can be of greater magnitude (12-25%)
 - Provides rationale for structured finance, including *asset securitization, project finance*

A Two-Period Model of Capital Structure

$t = \{0, T\}$

- **Value of Debt with Principal P** ($X =$ random value at T , *dist.* $F(X)$)

$$D_0(P) = \frac{P \int_{X^d}^{\infty} dF(X) + (1 - \alpha) \int_0^{X^d} X dF(X) - \tau \int_{X^Z}^{X^d} (X - X^Z) dF(X)}{1 + r_T}$$

where $X^d =$ default level, $X^Z =$ zero tax level, $\tau =$ tax rate, $\alpha =$ default cost

- **Value of Equity:**

$$E_0(P) = \frac{1}{1 + r_T} \left(\int_{X^d}^{\infty} (X - P) dF(X) - \tau \int_{X^d}^{\infty} (X - X^Z) dF(X) \right)$$

- **Value of Firm:**

$$v_0(P) = E_0(P) + D_0(P)$$

$$= V_0 + TS(P) - DC(P)$$

where

- $V_0 =$ value of **unlevered** firm
- $TS(P) =$ expected PV of **tax savings** from leverage
- $DC(P) =$ expected PV of **default costs**
- Note:** $TS(P) - DC(P) =$ **value of leverage.**

Optimal Capital Structure

- Choose $P = P^*$ to maximize total firm value

$$v_0(P) = E_0(P) + D_0(P)$$

- Define
$$v_0^* = E_0(P^*) + D_0(P^*)$$
$$= V_0 + TS(P^*) - DC(P^*)$$

- Assume future value X is normally distributed $N(\text{Mu}, \text{Std})$
- We then numerically optimize $v_0(P)$ to find optimal P^*
 - Excel's Solver does easily
 - Note P^* **also maximizes leverage benefits** $TS(P) - DC(P)$
(since V_0 constant)

An Example (typical firm)

Base case parameters (calibrated for BBB-rated firm)

Normally distributed future cash flows; risk-neutral valuation

Riskfree rate	$r_f = 5\%$ (risk neutrality \rightarrow expected asset return μ)
Horizon	$T = 5$ yrs (average debt duration)
Annual Volatility	$\sigma = 22\%$ (Schaefer & Strebulaev 2004)
Default costs	$\alpha = 23\%$ (implied by Moody's 49% recovery rate)
Tax rate	$\tau = 15\%$

Implications (see also Appendix 2)

- Unlevered firm value $V_0 = 80.05$ (limited liability value = .05)
 - Optimal Leverage $L = 51.82\%$
 - Optimal firm value $v^* = 81.47$
 - Debt interest rate $r = 6.23\%$
 - Tax savings of leverage $TS = 2.32$
 - Expected default costs $DC = 0.89$
- Capitalized leverage benefits = 8.21%**

Mergers and Financial Synergies

- Assume Operational Cash Flows are *Additive*:

$$X_M = X_1 + X_2 \rightarrow X_{0M} = X_{01} + X_{02}.$$

- With separate activity cash flows *normally distributed*, future cash flows of *merged firm* will also be normal, with

$$Mu_M = Mu_1 + Mu_2$$

$$Std_M(\rho) = (Std_1^2 + Std_2^2 + 2\rho Std_1 Std_2)^{0.5}$$

- Diversification: lower merged risk when correlation ρ is low.
- Given Mu_i and Std_i , can compute P_i^* , v_i^* , $i = \{1, 2, M\}$
- Then compare v_M^* vs. $v_1^* + v_2^*$.

Measures of Synergies

- Financial synergies are determined by

$$\Delta = v_M^* - v_1^* - v_2^*$$

Measure 1: $\Delta / (v_1^* + v_2^*)$ (% total value)

Measure 2: Δ / v_2^* (% of target firm value)

Measure 3: Δ / E_2^* (% of target firm equity)

- **Capitalizing T -period benefits to infinite horizon:**
 - Benefits Δ received every T years starting at $t = 0$ have value $Z \Delta$ where $Z = (1 + r^T) / r^T$. Benefits multiplied by Z in what follows.
- **Benefits can be decomposed into two sources**
 - Loss of separate firms' limited liability ("**LL Effect**"), always < 0 .
 - Gains (or losses) from leverage, the "**Leverage Effect**"
 - Leverage Effect = changes in (tax savings less default costs)

Mergers of Symmetric Firms

- Mergers of symmetric “typical” firms (with $\rho = 0.20$) provide very small purely financial benefits (Appendix 3)
 - Measure 1 = 0.60%, Meas. 2 = 1.2%, Meas. 3 = 2.5%
 - Insufficient to overcome likely merger fees
 - Is this disappointing?
- But mergers of identical firms are not always optimal!
- Separation is desirable ($\Delta < 0$) if
 - Volatilities are high (negative *LL* Effect important)
 - Correlation is high (diversification and Leverage Effect small)
 - Propositions 1 & 2 of paper make this more precise
 - Additionally, if firms have **asymmetric** volatility or default costs

Mergers of Asymmetric Firms

- Now consider activities that *differ* in characteristics
 - Firm 1 has ***base case parameters***
 - Firm 2 differs only in ***volatility***
 - Figure 6 shows how results depend on activity 2's volatility
 - Figure 7 shows Leverage vs. *LL* effects
- Very different volatilities → keep separate!
- Same for very different default costs → keep separate!
 - Figure 9 in paper

Merger Benefits as a Function of Firm 2 Risk

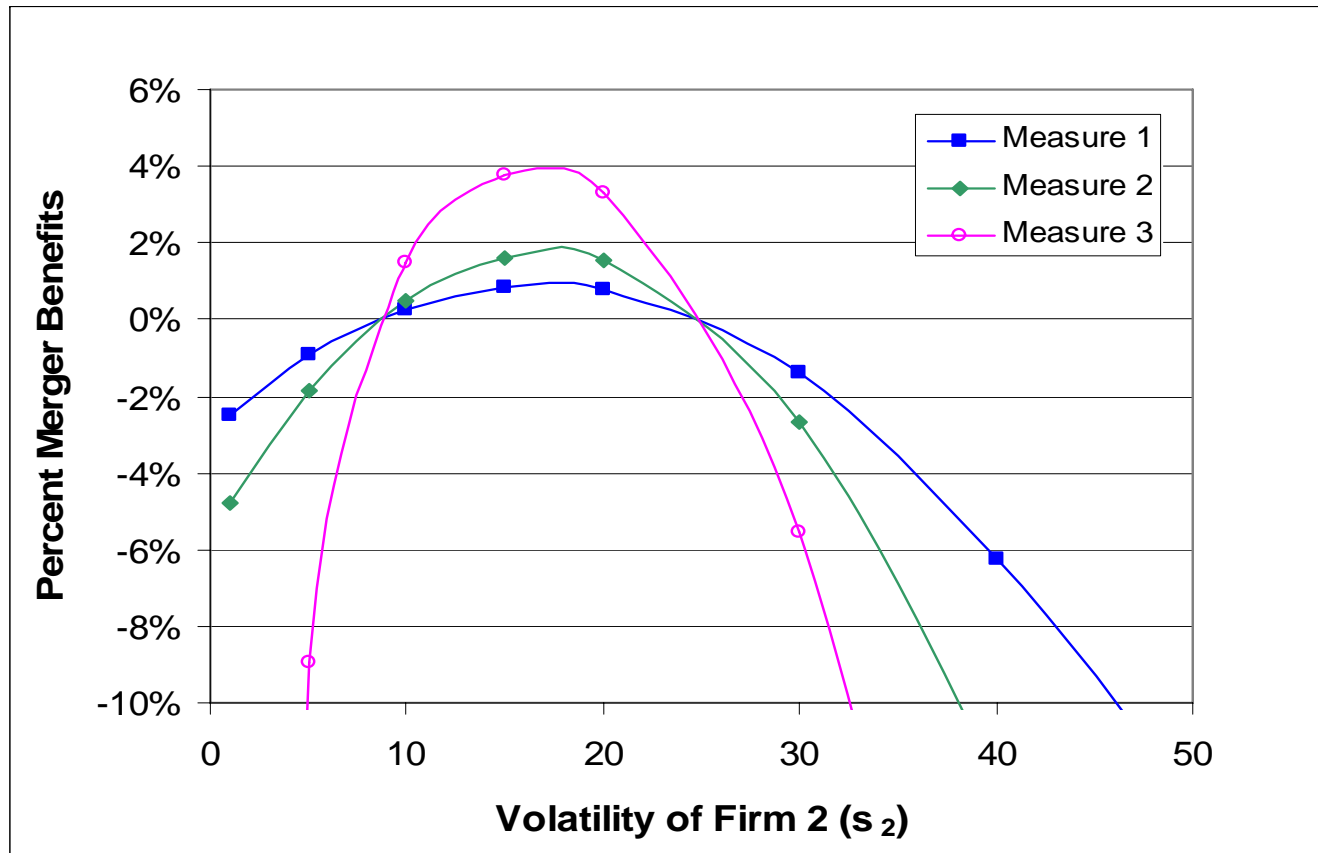


Figure 6. Merger benefits with asymmetric volatility.

The lines plot three different measures of the value of merging two firms of equal asset value, as a function of the annualized volatility of Firm 2. The annualized volatility of Firm 1 is 22%. The assumed debt maturity and time horizon are $T = 5$ years, the risk-free interest rate is $r = 5\%$, the effective corporate tax rate is $\tau = 20\%$, default costs are $\alpha = 75\%$, and the correlation between cash flows is 0.

Decomposition of Merger Benefits and Counter-Example to Lewellen

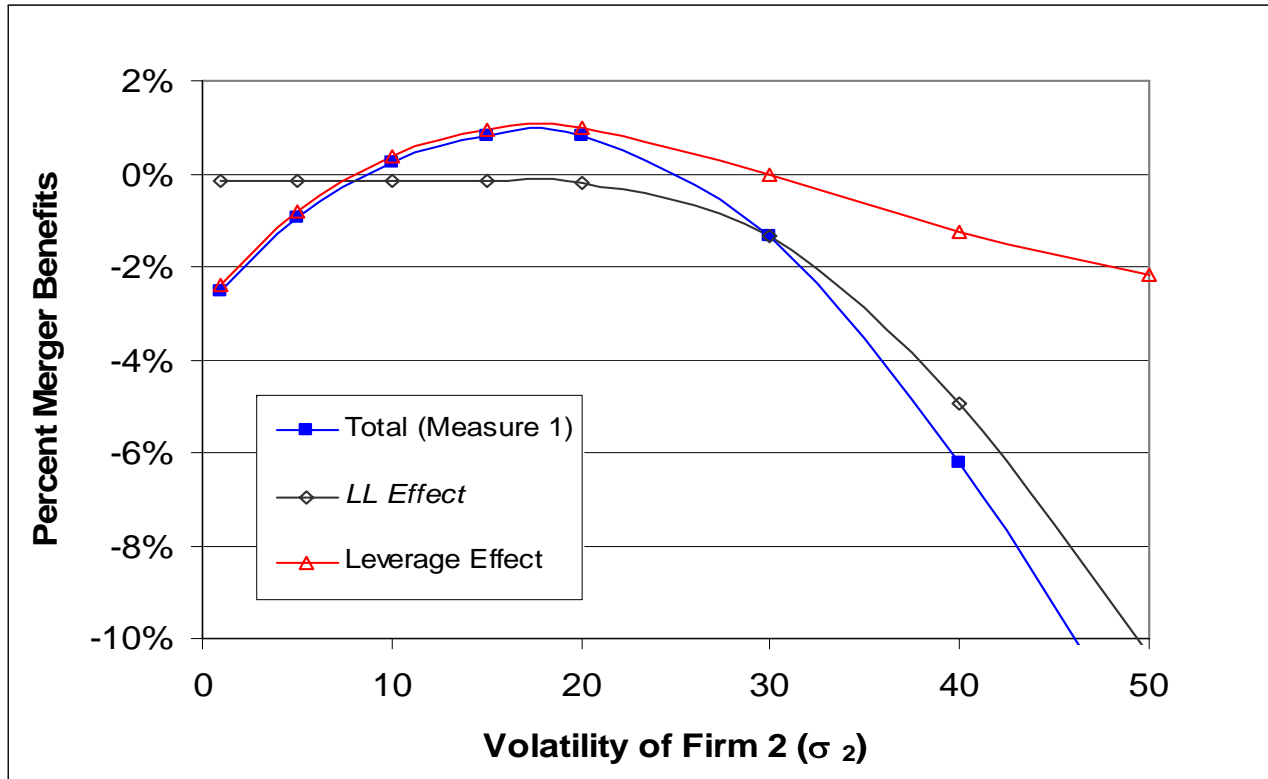


Figure 7. Decomposition of merger benefits with asymmetric volatility.

The lines plot the loss of separate limited liability (*LL*) effect, the Leverage effect, and their combined total effect (Measure 1) from merging two firms of equal asset value as a function of the annualized volatility of Firm 2. It is assumed that the debt maturity and time horizon is 5 years, the risk-free interest rate is 5%, the effective corporate tax rate is 20%, the default costs of both firms is 23%, the annualized volatility of Firm 1 is 22%, and the correlation of cash flows is 0.20. The assumed debt maturity and time horizon are $T = 5$ years, the risk-free interest rate is $r = 5\%$, the effective corporate tax rate is $\tau = 20\%$, default costs are $\alpha = 23\%$, and the correlation between cash flows is 0.20. Note that Measure 1 values here are identical to Measure 1 values in Figure 6.

Benefits to Securitization: An Example

- **Base case:** “Average” firm securitizes 25% of assets that have volatility 4.0%, $\rho = 0.50$ with other assets whose vol. = 28.6%.
Leverage ratio: Before, 52%. After, 83% / 51%.
Yield spread: Before, 123 bp. After, 4 bp. / 251 bp.
 - See Appendix 4
- **Benefits:** 13.6% of assets securitized (costs ~ 6%?).
2/3rd from leverage effect,
1/3rd from Sarig effect.
- **Now Lower SPV Default Costs:** to 5%
Leverage rises from 83% to 88%
But benefits rise only from 13.6% to 14.4%.
... Contrary to Gorton & Souleles (2005),
Lower default costs don't seem to be major source of benefits

Conclusions

1. Financial synergies can be positive or negative.
Two sources of synergies:
 - **LL Effect** (always < 0):
 - Loss of separate limited liability (more important at high vols.)
 - **Leverage Effect** (+ / -):
 - Negative if separate leverage ratios highly different
 - Financial synergies are more likely to be positive (i.e. favor merger) when:
 - Correlation of activities is low (diversification)
 - Volatility of individual activities is low (*LL Effect* minimal)
 - Firms have similar volatility, default costs (leverages the same)
- Opposite cases: Synergies are negative and separation is preferred**

Conclusions (p. 2)

3. Negative synergies can be of greater magnitude (12-25%)
 - Provides rationale for *asset securitization*, *project finance*, when volatilities of structured assets differ from firm's other activities
 - Primary explanation is different:
 - Asset Securitization (low risk)***: Leverage effect
 - Project Finance (high risk)***: LL effect
4. Paper also examines other issues:
 - ***Optimal size*** of target firm
 - Effects of mergers on leverage
 - Differential benefits to debt & equity holders (if debt noncallable)

Empirical Implications

- Empirical studies that predict merger likelihoods should include financial variables (variances, correlations, default costs)
- Predications (as before)
 - Mergers more likely (ceteris paribus) if low volatilities and correlations, high default costs
 - Spinoffs more likely in opposite cases

Appendix 1

Table I
Base-case Parameters

This table shows the parameter values chosen for the base case.

Variable	Symbols	Values
Annual Risk-free Rate	r	5.00%
Time Period/Debt Maturity (yrs)	T	5.00
T-period Risk-free Rate	$r_T = (1 + r)^T - 1$	27.63%
Capitalization Factor	$Z = (1 + r_T)/r_T$	4.62
<u>Unlevered Firm Variables</u>		
Expected Future Operational Cash Flow at T	Mu	127.63
Expected Operational Cash Flow Value (PV)	$X_0 = Mu / (1+r)^T$	100.00
Cash Flow Volatility at T	Std	49.19
Annualized Operational Cash Flow Volatility	$Std/(X_0 T^{0.5})$	22%
Tax Rate	τ	20%
Value of Unlevered Firm w/Limited Liability	V_0	80.05
Value of Limited Liability (after tax)	$(1 - \tau)L_0$	0.05

Appendix 2

Table II
Optimal Capital Structure

This table shows the optimal leverage for the firm and the resulting gains to leverage given the base-case parameters and a default cost $\alpha = 23\%$ (consistent with a recovery rate on debt of 49.3%). The annual volatility of the firm is $\sigma = 22\%$, the time horizon is $T = 5$ years, the risk-free interest rate is $r = 5\%$, and the tax rate is $\tau = 20\%$.

Variable	Symbols	Values
Default Costs	α	23%
Optimal Zero-coupon Bond Principal	P^*	57.1
Default Value	X^d	67.7
Breakeven Profit Level	X^Z	14.9
Value of Optimal Debt	D_0^*	42.2
Value of Optimal Equity	E_0^*	39.2
Optimal Levered Firm Value	$v_0^* = D_0^* + E_0^*$	81.47
Optimal Leverage Ratio	D_0^*/v_0^*	51.8%
Annual Yield Spread of Debt (%)	$(P^*/D_0^*)^{1/T} - 1 - r$	1.23%
Recovery Rate	R	49.3%
Tax Savings of Leverage (PV)	TS_0	2.32
Expected Default Costs (PV)	DC_0	0.89
Value of Optimal Leveraging	$v_0^* - V_0$ (or $TS_0 - DC_0$)	1.42
Capitalized Value of Optimal Leverage	$Z(v_0^* - V_0)/V_0$	8.21%

Appendix 3

Table III
Financial Effects of Merging Identical Firms

This table shows the financial effects of merging two identical firms with base-case parameters when the correlation of cash flows $\rho = 0.20$. It is assumed that the firms are optimally leveraged both before and after merging. The separate firms have annual standard deviation $\sigma_1 = \sigma_2 = 22\%$. The annualized standard deviation of the merged firm is $\sigma_M = 17.04\%$. For all firms, the tax rate $\tau = 20\%$, the default cost fraction $\alpha = 23\%$, and time horizon $T = 5$ year. The annual risk-free rate is $r = 5\%$, resulting in a capitalization factor is $Z = 4.62$.

Variables	Symbols	Sum of Separate Firm Values	Merged Firm Value	Change
Value of Unlevered Firm	V_0	160.09	160.01	-0.09
Optimal Zero-coupon Bond Principal	P^*	114.27	117.42	3.15
Value of Optimal Debt	D_0^*	84.47	89.40	4.94
Value of Optimal Equity	E_0^*	78.47	73.74	-4.73
Optimal Levered Firm Value	$v_0^* = D_0^* + E_0^*$	162.94	163.15	0.21
Tax Savings of Leverage (PV)	TS	4.63	4.39	-0.25 ΔTS
Expected Default Costs (PV)	DC	1.79	1.25	-0.54 ΔDC
Net Leverage Benefit	$TS - DC$	2.85	3.14	0.30

Ratios	Symbols	Separate Firms	Merged
Optimal Leverage Ratio	D_0^*/v_0^*	51.84%	54.80%
Annual Yield Spread of Debt	$(P^*/D_0^*)^{1/T} - 1 - r$	1.23%	0.60%
Recovery Rate	R	49.29%	56.48%

SUMMARY OF BENEFITS			
Source	Symbols	Values	Effect
Change in Unlevered Firm Value	ΔV_0	-0.09	LL Effect
Benefit to Leverage	$\Delta TS - \Delta DC$	0.30	Leverage Effect
Net Benefit of Merger Δ	$\Delta V_0 + \Delta TS - \Delta DC$	0.21	Total Benefits
	$Z \Delta / (V_{01} + V_{02})$	0.60%	Measure 1
	$Z \Delta / v_2^*$	1.18%	Measure 2
	$Z \Delta / E_2^*$	2.45%	Measure 3

Appendix 4

Table IV
Asset Securitization Example

The table details an optimally leveraged firm before and after it has securitized a fraction (25%) of low-risk assets. Before securitization, the firm consists of two (merged) activities: The assets subsequently securitized, whose parameters are listed in the column "SPE," and other assets, whose parameters are listed in the column "Firm." The correlation of the activities' cash flows is assumed to be 0.50. Parameters associated with the combination of these activities are listed in the column "Firm Before Securitization." Financial synergies are given by Δ . Since these synergies are negative, separation ("securitization") is desirable. The benefits to securitization can be decomposed into the increase in value due to separate limited liability shelters ($-\Delta V_0$), plus the increase in total tax savings due to optimal leverage ($-\Delta TS$) less the increase in expected default costs ($-\Delta DC$).

	Symbols	Firm Before Securitization	After Securitization		Change
			SPE	Firm	
Value of Operational Cash Flows	X_0	100	25	75	0
Value of Unlevered Firm	V_0	80.05	20.00	60.26	0.21 $-\Delta V_0$
Pre-Tax Value of Limited Firm Liability	L_0	0.06	0.000	0.33	0.27
Annual Volatility (as % of X_0)	σ	22.0%	4.0%	28.6%	
Optimal Zero-coupon Bond Principal	P^*	57.13	21.96	45.74	10.56
Value of Optimal Debt	D_0^*	42.23	17.18	31.85	6.79
Value of Equity	E_0^*	39.23	3.54	29.51	-6.18
Optimal Levered Firm Value	$v_0^* = D_0^* + E_0^*$	81.47	20.72	61.35	0.61 $-\Delta$
Optimal Leverage Ratio	D_0^*/v_0^*	51.8%	82.9%	51.9%	
Annual Yield Spread of Debt (%)	$(P^*/D_0^*)^{1/T} - 1 - r$	1.23%	0.04%	2.51%	
Recovery Rate	R	49.3%	70.6%	41.7%	
Tax Savings of Leverage (PV)	TS	2.32	0.75	2.11	0.54 $-\Delta TS$
Expected Default Costs (PV)	DC	0.89	0.03	1.01	-0.14 $-\Delta DC$

SUMMARY OF BENEFITS TO ASSET SECURITIZATION

(Negative) Merger Benefits	$-\Delta$	0.61
(Negative) Measure 1	$-Z\Delta/(V_{01}+V_{02})$	3.51%
(Negative) Measure 2	$-Z\Delta/v_{02}^*$	13.57%