On Purely Financial Synergies:

Implications for Mergers and Structured Finance

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Objectives of Paper

- The previous papers have developed and calibrated models of *default risk*, *bond pricing* and *correlations*
  - Essential information for managing portfolios
- This paper starts with a model of default risk, bond pricing, and correlation, but calibrates it to study different questions
  - The Optimal *Capital Structure* of A Firm
  - The Optimal *Scope* of a Firm

    …Essential information for managing firms

    …Useful information for managing portfolios

    shows effect of mergers, spinoffs, structured finance on debt values

Capital Structure and Firm Scope

- ***Capital Structure*** addresses *how best to finance a given firm.*
- ***Firm Scope*** addresses *prior* question: *What should a firm be? – i.e., how best to group activities into firm(s).*
  - **Capital Structure** typically assumes *scope is given.*
  - **Optimal Scope** typically focuses on *operational synergies* (e.g. economies of scale), and *ignores capital structure*
- We want to examine decisions jointly. Scope decisions include *mergers*, *spin-offs*, *JVs*, *structured finance*

Optimal Scope: How Should Activities be Grouped into Firms?

- ***"Activity"***: indivisible asset(s) producing cash flows
  - Cash flows may be negative (following 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:***
  - Incorporate and lever activities *separately*, or *jointly*?

Financial vs. Operating Synergies

- ***Operating Synergies*** result from activities' cash flows being ***non-additive*** (super- or sub-additive)
  - Economies of scale, market power, agency costs, etc.
  - We focus on case with ***no*** operational synergies: cash flows are exactly **additive**!
    - Any operational synergies would be ***additional to*** financial synergies
    - Probably describes most structured finance deals.
- ***Financial Synergies*** arise from value of leveraging merged activities vs. separate activities
  - Tax savings but default costs from leverage
  - Purely financial synergies often claimed for structured finance

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 (95 cites)
  - Concludes that *financial synergies are always positive* ➔ *purely financial synergies can't explain structured finance!*
  - But overlooked potential *benefit of separate capital structures*
- ***Sarig*** *(1985):* Considers unlevered firms
  - If activity cash flows can be negative, *loss of separate limited liability shelters* will result in *fall in value* with mergers
  - Cross-subsidization of losses in a merger (RJR?) (1 cite)

Note that none of these papers uses models of debt value, optimal capital structure. This paper does.

Structured Finance: A Decision about Scope

- Structured Finance includes ***Asset Securitization***, ***Project Finance.*** Choice to use is choice of ***scope***.
- Structured finance has grown rapidly (see table below)
- Yet finance theory has yet to explain adequately!

	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

Asset Securitization, Briefly

- ***Key aspects:***
  - Originating firm has a set of activities (assets) whose cash flow is low risk and requires little further management (e.g. loan payments).
  - Assets sold by originating or sponsor firm to a *special purpose vehicle* or *special purpose entity* (***SPV/SPE***)—typically a trust.
  - SPV issues debt securities (often tranched) and residual or "equity" tranche, uses funds to pay originating firm. In most cases, originating firm retains no equity.
  - SPV is "bankruptcy remote" from originator.
  - Securitization is much like a spin-off.
- ***Possible Explanations of Why Securitization?***
  - *Regulatory* (reduce capital requirements). But non-bank use, too.
  - *Lower default costs* (Gorton & Souleles 2005). Importance?
  - *Greater leverage* given volatility and default cost differences. --reason given by many in business, but is it right?? M-M?

Preview of Conclusions

- Financial synergies to merger can be positive or negative.
  Two Sources of Synergies:
  - ***Sarig 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 Sarig 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 Simple Model of Optimal Capital Structure

- Two periods, $t = 0$ and $t = T$; risk neutral investors
- Random operational cash flow $\boldsymbol{X}$ at time T, *mean Mu*
- Activity value at $t = 0$ is $X_0 = \frac{1}{(1+r_T)} \int_{-\infty}^{\infty} X \, dF(X) = Mu / (1+r_T)$
- If single-activity no-debt firm with *limited liability*, value is

$$H_0 = \frac{1}{(1+r_T)} \int_{0}^{\infty} X \, dF(X),$$

- Note value of limited liability: $L_0 = H_0 - X_0$

$$= -\frac{1}{(1+r_T)} \int_{-\infty}^{0} X \, dF(X) \geq 0.$$

- $L_0 = 0$ with lognormal $\boldsymbol{X}$

Simple Model (2)

- After-tax Value of ***Unlevered Firm*** is

$$V_0 = \frac{1}{(1+r_T)} \int_0^{\infty} (1-\tau) X \, dF(X) \; = \; (1-\tau) H_0$$

- Zero Coupon ***Debt*** (similar to Merton (1974) model):
  - Principal ***P***, Market Value $D_0(P)$, Interest paid $I = P - D_0$
  - Interest I is tax deductible; no tax rebate if loss ($X < I$)
  - If default, lose fraction α of cash flow value ***X***

- Define
  - X^z = value of ***X*** at which ***tax is zero*** ($X^z = I$)
  - X^d = value of ***X*** triggering ***default*** (note $X^d > X^z$)

$$X^d = P + \frac{\tau}{(1-\tau)} D_0(P)$$

Simple Model (3)

- ***Value of Debt***:

$$D_0(P) = \frac{P\int_{X^d}^{\infty} dF(X) + (1-\alpha)\int_{0}^{X^d} X\, dF(X) - \tau\int_{X^Z}^{X^d}(X - X^Z)dF(X)}{1 + r_T}$$

- ***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 *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 firm value

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

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

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

- Appendix A of paper derives *closed form expressions* for D_0, E_0, TS, DC, *and* v_0 *(as functions of P)* when ***X*** is *Normally distributed*.
- We then numerically optimize $v_0(P)$ to find optimal P^*.
  - Excel's Solver does easily

Base case parameters (calibrated for BBB-rated firm)

Riskfree rate r = **5%**; Avg. Debt duration T = **5 yrs.**;
S&S (2004) ➔ $\sigma = 22\%$; 49% recovery rate (E&G) ➔ $\alpha = 23\%$;
8.2% optimal leverage advantage (G) ➔ effective tax rate $\tau = 20\%$.

TABLE 2: OPTIMAL CAPITAL STRUCTURE

Default Costs α 23%

	Symbols	Values
Value of Unlevered Firm	V_0	80.05
Optimal Zero-coupon Bond Principal	P^*	57.1
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%
Default Value	X^d	67.7
Breakeven Profit Level	X^Z	14.9
Tax Savings of Leverage (PV)	TS_0	2.32
Expected Default Costs (PV)	DC_0	0.89
Value of Optimal Leveraging	$v_0^* - V_0$	1.42
Capitalized Value of Optimal Leverage	$Z(v_0^* - V_0)/V_0$	8.21%

Mergers and 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, cash flows of *merged firm* will also be normal, with

$$Mu_M = Mu_1 + Mu_2$$
$$\sigma_M(\rho) = (\sigma_1^2 + \sigma_2^2 + 2\rho\sigma_1\sigma_2)^{0.5}$$

- Diversification: lower risk when correlation ρ is low.
- Can use previous formulas to compute v^*_M, the value of the merged firm, compare with $v_1^* + v_2^*$.

Scaled 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.

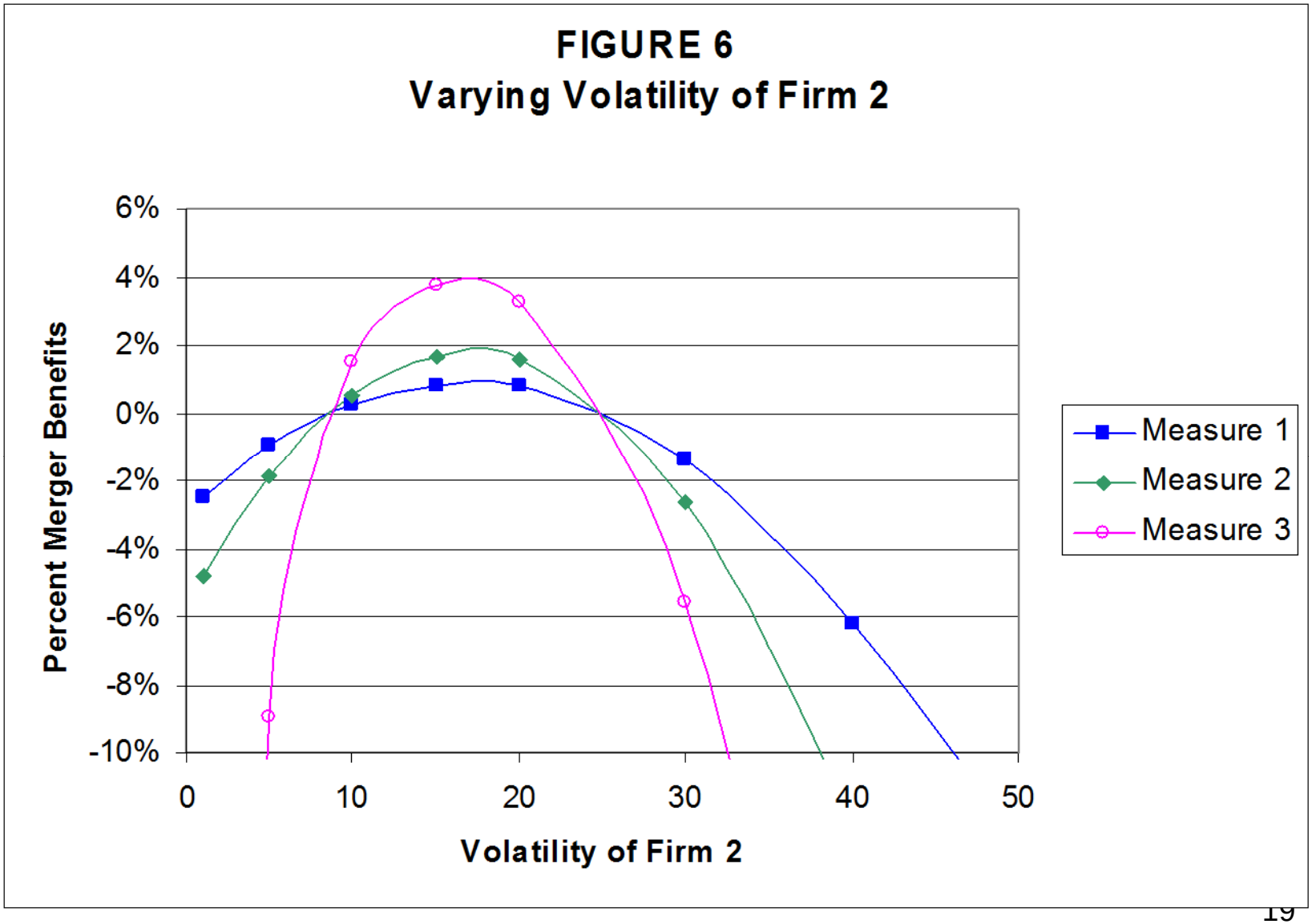
Mergers of Symmetric Firms

- Mergers of symmetric "typical" firms (with $\rho = 0.20$) provide very small purely financial benefits ($\Delta = 0.21$).
  - —Measure 1 = 0.60%, Meas. 2 = 1.2%, Meas. 3 = 2.5%
  - —Insufficient to overcome likely merger fees
  - —Is this disappointing?
- Decomposition of benefits (see Table on p. 23 below)
  - ***Sarig Effect***: $\Delta \boldsymbol{L_0} = L_M - (L_1 + L_2) < 0$ (always negative)
    - In example, -.11, after tax **-.09**
  - ***Leverage Effect***: $\Delta(\boldsymbol{TS - DC}) = TS_M - DC_M - \Sigma_{i=1,2}(TS_i - DC_i)$
    - Leverage Effect Can Have Either Sign (vs. Lewellen)
    - In example, **+.30** ($\Delta \boldsymbol{TS}$ = -.24; $\Delta \boldsymbol{TC}$ = -.54)
    - So net merger benefits = **0.21**, or 0.60%.
  - ***Effect of Different base case volatility***: see Figure 4, p. 24

Mergers of Asymmetric Firms

- Now consider activities that *differ* in characteristics
  - Activity 1 has ***base case parameters***
  - Activity 2 differs only in ***volatility***
  - Figure 6 (next page) shows how results depend on activity 2's volatility
  - Figure 7 (p. 25) shows leverage vs. Sarig effects
- Very different volatilities ➔ keep separate!
- Same for very different default costs ➔ keep separate!
  - Figure 9 in paper

Benefits as Function of Firm 2 Risk



Benefits to Securitization: An Example

- ***Base case***: "Average" firm securitizes 25% of assets that have volatility 4.0%, ρ = 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.

- ***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:
   - ***Sarig Effect*** (always < 0):
     - Loss of limited liability (at high vols.)
   - ***Leverage Effect*** (+ / -) :
     - Negative if separate leverage ratios highly different

2. 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 (Sarig Effect minimal)
   - Firms have similar volatility, default costs (leverages the same)

Opposite cases: Synergies negative, 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): Sarig effect

4. Paper also examines other issues:
   - Optimal size of target firm
   - Effects of mergers on leverage, debt & equity values

Merger of Base Case Firms

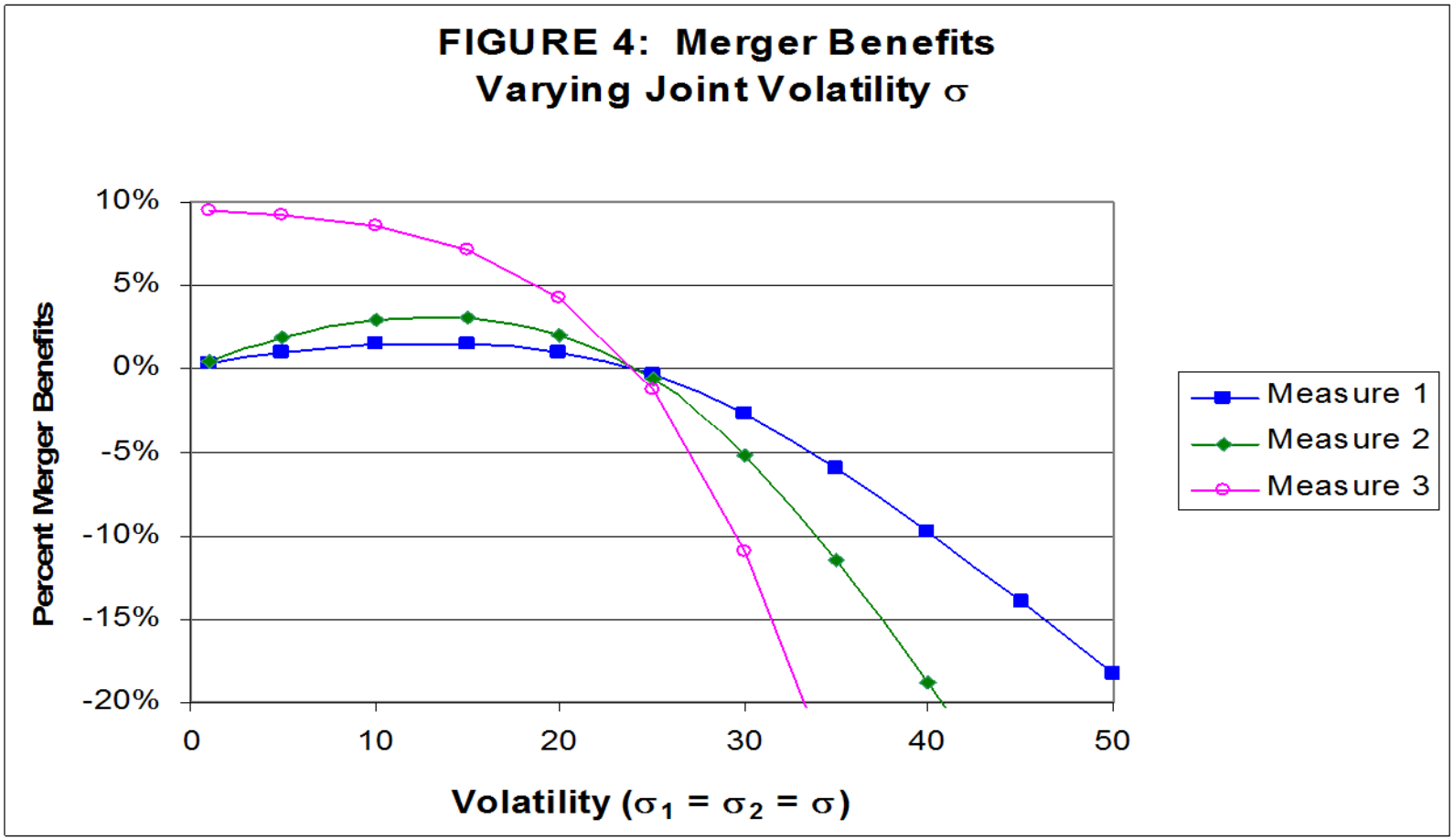
TABLE 3: FINANCIAL EFFECTS OF MERGING FIRMS

	Symbols	Sum of Separate Firm Values	Merged Firm Values	Change	
Value of Limited Firm Liability	L_0	0.115	0.006	-0.11	"Sarig Effect"
Optimal Zero-coupon Bond Principal	P^*	114.27	117.42	3.15	
Default Value	X^d	135.38	139.77	4.38	
Value of Optimal Debt	D_0^*	84.47	89.40	4.94	
Optimal Leverage Ratio	D_0^*/v_0^*	51.84%	54.80%	2.96%	
Annual Yield Spread of Debt (%)	$(P^*/D_0^*)^{1/T} - 1 - r$	1.23%	0.60%	-0.63%	
Recovery Rate	R	49.29%	56.48%	7.19%	
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	Δ TS
Expected Default Costs (PV)	DC	1.79	1.25	-0.54	Δ DC
Net Leverage Benefit	$TS - DC$	2.85	3.14	0.30	

SUMMARY OF BENEFITS

Change in Unlevered Firm Value	ΔV_0	-0.09
Benefit to Leverage	$\Delta TS - \Delta DC$	0.30
Net Benefit of Merger Δ =	$\Delta V_0 + \Delta TS - \Delta DC$	0.21
Measure 1	$Z\,\Delta / (V_{01} + V_{02})$	0.60%
Measure 2	$Z\,\Delta / v_2^*$	1.18%
Measure 3	$Z\,\Delta / E_2^*$	2.45%

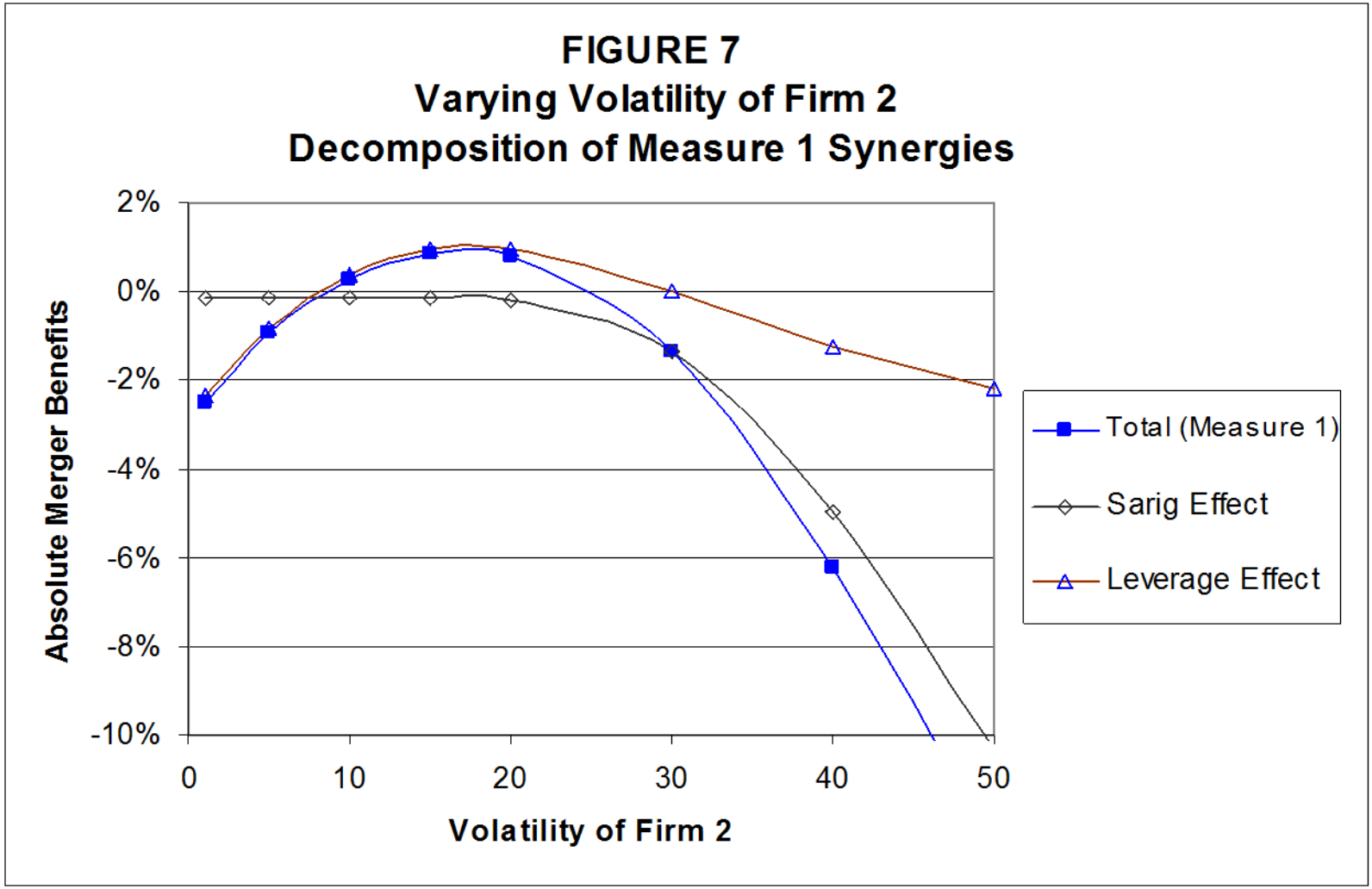
Merger Benefits Varying Joint Volatility



- When volatility very low, little change in total leverage (~100%)
- When volatility medium, leverage effect helps (Lewellen)
- When volatility high, loss of separate limited liability (Sarig)

Decomposition of Merger Benefits

and Counter-Example to Lewellen



Asset Securitization Example

TABLE 5: ASSET SECURITIZATION EXAMPLE

	Symbols	Firm Before Securitization	After Securitization: SPE	After Securitization: Firm	Change	
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	$-\Delta V_0$
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	10.57	
Value of Optimal Debt	D_0^*	42.24	17.18	31.85	6.80	
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%		
Optimal Levered Firm Value	$v_0^* = D_0^* + E_0^*$	81.47	20.72	61.35	0.61	$-\Delta$
Tax Savings of Leverage (PV)	TS	2.32	0.75	2.11	0.54	$-\Delta TS$
Expected Default Costs (PV)	DC	1.01	0.03	0.89	-0.14	$-\Delta DC$

SUMMARY OF BENEFITS TO ASSET SECURITIZATION

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