The WACC Fallacy

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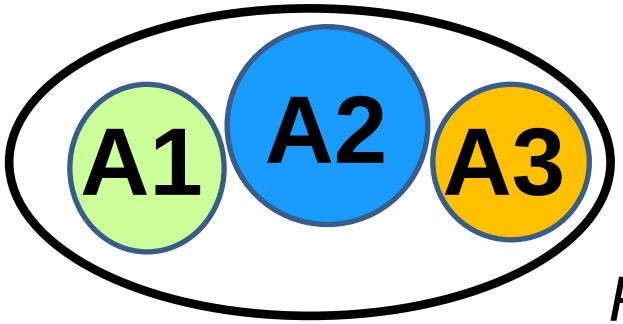
The question

- **Corp Finance 101: Modigliani-Miller**

When computing project NPV, discount rate should depend on the risk of this project, not firm-wide cost of capital.



$$r_A = \frac{A_1}{A} r_{A1} + \frac{A_2}{A} r_{A2} + \frac{A_3}{A} r_{A3}$$

Firm-wide cost of capital

A=A1+A2+A3

The question

- **Survey evidence** (Graham&Harvey, 2001):
  - 75% of CFOs of public companies **always** use NPV in capital budgeting decisions
  - …but, majority relies on **one single** company-wide discount rate.

    → *corporations are **semi-sophisticated***

- **This paper:**
  - Does semi-sophistication distort real investment?
  - How much, if any, value does it destroy?

Example

- Anheuser-Busch Companies (ABC) in 2006:

Budweiser

+

Example:
Anheuser-Busch Companies (ABC)

- **Core Division** (“*beer & liquor*”): 81% of sales; β_A=0.1

  $r_f + \beta_A x(r_m - r_f) = 3\% + 0.1 \times 6\% =$ **3.5%**

- **Non-Core Division** (“fun”): 11% of sales; β_A=0.9

  $3\% + 0.7 \times 6\% =$ **7%**

- If ABC values “*fun*” projects with cost of capital of “*beer & liquor*”

  →NPV of perpetuity is **overestimated by factor 2!**

  →**Investment in “fun” abnormally large**

Empirical strategy (1)

- Show *distortion* in multi-industry firms:

Investment in non-core divisions (fun) sensitive to WACC of core divisions (beer)?

Empirical strategy (2)

- Evaluate the cost of the *distortion*:
- Look at diversifying acquisitions

  – If $\beta_{bidder} < \beta_{target}$: bidder abnormal returns 0.8 % points lower.

  – We find average excess payment of about $16M per deal (4% of the average target value).

Literature

- **Theory & Practice of Corporate Finance**
  - Textbooks, Bierman(93); Graham&Harvey(01), Graham,Harvey,Puri(10); Stein (96)
- **Behavioral Corporate Finance**
  - Baker,Ruback,Wurgler(07): irrational investors and rational managers
  - Malmendier&Tate(05,08,11); Landier&Thesmar(09): irrational managers
- **Internal Capital Markets**
  - Stulz&Shin(98); Lamont(97); Rajan,Servaes,Zingales(00); Scharfstein&Stein(00); Ozbas&Scharfstein(10)

Roadmap

(1) Evidence of the fallacy: *look at multi-industry firms*

(2) Value effects of the fallacy: *look at diversifying acquisitions*

Testing for Investment Distortions

- Focus on **non-core divisions** and assume project discounted at

$$WACC_{core} = r_f + \beta_{core} x (r_m - r_f):$$

(1) if $\beta_{core} < \beta_{non\text{-}core}$

→ non-core division invests more

(2) if $\beta_{core} > \beta_{non\text{-}core}$

→ non-core division invests less

→ **Testable prediction:**

$$CapX_{non\text{-}core} \nearrow (\beta_{non\text{-}core} - \beta_{core})$$

Data

- **Firm-level data**
  - Compustat for financials
  - CRSP for stock returns
  - Execucomp for CEO ownership
- **Division-level data**
  - Compustat segment: 1987-2007
  - Aggregate segments @ ff48 level
  - Call each bundle of segments a “division”
    - get sales, capx and assets
    - average Tobin’s q of standalones in the ff48 industry
  - Conglomerate = # of “divisions” > 1
  - “Core division” = division with highest sales

Data (contd.)

- Two steps to calculate an industry-level cost of capital for each ff48-year:

(1) Equity beta (β_E):

- Regress vw industry portfolio returns on vw CRSP index for rolling windows of 60 months

(2) Asset beta (β_A) :

- Unlever: $\beta_A = \beta_E \times E/(E+D)$
- Use aggregate industry capital structure

FF48	Industry	Description	β^E	$\frac{E}{D+E}$	β^A
1	Agric	Agriculture	0.77	0.68	0.53
2	Food	Food Products	0.64	0.61	0.38
3	Soda	Candy & Soda	0.76	0.50	0.38
4	Beer	Beer & Liquor	0.60	0.76	0.44
5	Smoke	Tobacco Products	0.77	0.58	0.44
6	Toys	Recreation	1.48	0.56	0.82
7	Fun	Entertainment	1.14	0.60	0.69
8	Books	Printing and Publishing	0.91	0.62	0.56
9	Hshld	Consumer Goods	0.90	0.66	0.58
10	Clths	Apparel	1.04	0.68	0.70
11	Hlth	Healthcare	0.92	0.55	0.49
12	MedEq	Medical Equipment	0.90	0.79	0.70
13	Drugs	Pharmaceutical Products	0.84	0.84	0.71
14	Chems	Chemicals	0.93	0.54	0.49
15	Rubbr	Rubber and Plastic Products	1.10	0.54	0.61
16	Txtls	Textiles	0.93	0.45	0.42
17	BldMt	Construction Materials	0.97	0.57	0.55
18	Cnstr	Construction	1.19	0.40	0.48
19	Steel	Steel Works Etc	1.16	0.49	0.57
20	FabPr	Fabricated Products	0.96	0.50	0.49
21	Mach	Machinery	1.20	0.55	0.66
22	ElcEq	Electrical Equipment	1.28	0.49	0.63
23	Autos	Automobiles and Trucks	1.05	0.30	0.31
24	Aero	Aircraft	0.95	0.53	0.50
25	Ships	Shipbuilding, Railroad Equipment	0.79	0.48	0.34
26	Guns	Defense	0.68	0.50	0.32
27	Gold	Precious Metals	0.55	0.83	0.44
28	Mines	Non-Metallic and Industrial Metal Mining	0.93	0.69	0.65
29	Coal	Coal	0.84	0.46	0.40
30	Oil	Petroleum and Natural Gas	0.64	0.63	0.40
31	Util	Utilities	0.42	0.38	0.16
32	Telcm	Communication	1.02	0.54	0.55

Firms with operations in only one FF48 industry

Standalone Firms

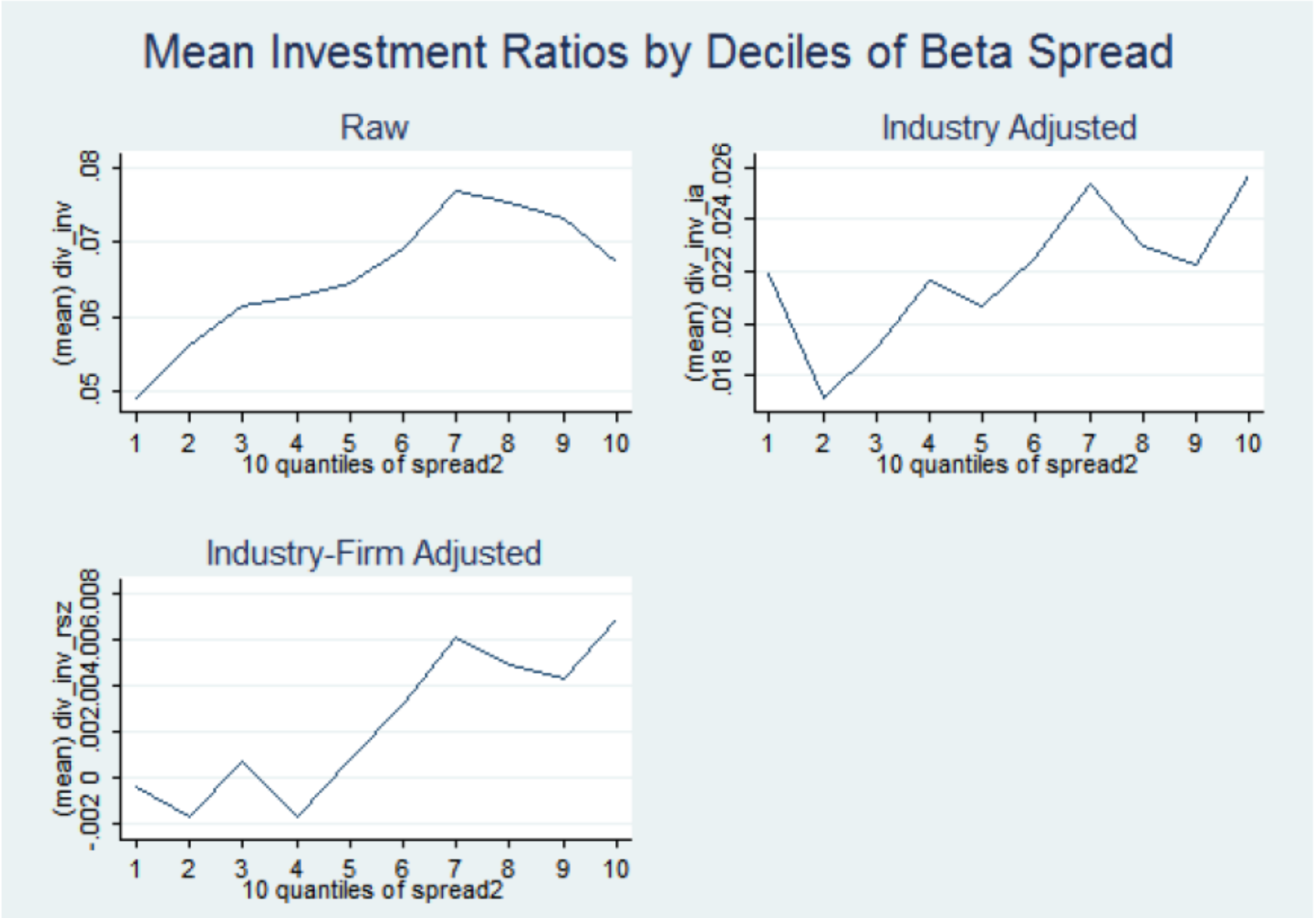
	Mean	Median	SD	P25	P75	N
Firm Cash Flow$_t$	0.029	0.063	0.169	-0.015	0.120	107796
Firm Size$_t$	4.300	4.277	2.456	2.631	5.939	122161
Firm Age$_t$	2.042	2.079	0.983	1.386	2.773	119127
Firm Investment$_{t+1}$	0.065	0.038	0.078	0.013	0.086	103730
Leverage$_t$	0.188	0.092	0.239	0.000	0.302	121064
Sales$_t$	3.937	4.104	2.658	2.345	5.749	122219
Sales Growth$_t$	0.126	0.086	0.367	-0.042	0.263	105363
$Q_{FIRM,t}$	1.879	1.417	1.271	1.037	2.265	93591
$\beta^A_{AVERAGE,t}$	0.631	0.600	0.339	0.390	0.830	115605

Firms with operations in more than one FF48 industry

Conglomerate Firms

	Mean	Median	SD	P25	P75	N
Firm Cash Flow$_t$	0.061	0.075	0.105	0.036	0.113	16150
Firm Size$_t$	5.928	6.008	2.435	4.140	7.721	16507
Firm Age$_t$	2.792	3.045	0.933	2.197	3.526	16408
Firm Investment$_{t+1}$	0.060	0.047	0.054	0.025	0.078	16217
Leverage$_t$	0.229	0.201	0.198	0.074	0.328	16466
Number of Divisions$_t$	2.557	2.000	0.867	2.000	3.000	16507
Sales$_t$	5.833	6.041	2.413	4.204	7.569	16507
Sales Growth$_t$	0.102	0.072	0.260	-0.016	0.178	15714
Firm Focus$_t$	0.733	0.743	0.173	0.594	0.884	16418
$Q_{FIRM,t}$	1.486	1.222	0.844	1.007	1.648	14002
$SD(Q_{i,t})/Q_{FIRM,t}$	0.174	0.128	0.158	0.063	0.232	13911
$\beta^A_{AVERAGE,t}$	0.550	0.537	0.236	0.394	0.675	16507
$SD(\beta^A_{i,t})$	0.202	0.171	0.152	0.095	0.269	16507

Mean Division Investment Sorted by $\beta - \beta_{core}$



Main Result (Table V)

	(1)	(2)	(3)	(4)
$\beta^A_{DIV,t} - \beta^A_{CORE,t}$	0.0181***	0.0157***	0.0155***	
	(8.13)	(6.71)	(6.53)	
$\beta^A_{DIV,t}$				0.0150***
				(4.74)
$\beta^A_{CORE,t}$				-0.0162***
$Q_{DIV,t}$		0.0073***	0.0074***	0.0077***
		(3.07)	(3.09)	(3.06)
$Q_{CORE,t}$		-0.0015	-0.0015	-0.0013
		(-0.61)	(-0.63)	(-0.52)
Firm Cash Flow$_t$		0.0915***	0.0889***	0.0889***
		(11.28)	(10.93)	(10.93)
Divison Size$_t$		0.0015**	0.0020***	0.0020***
		(2.42)	(2.95)	(2.99)
Firm Size$_t$		-0.0005	-0.0007	-0.0008
		(-0.79)	(-1.03)	(-1.09)
Firm Age$_t$		-0.0015	-0.0015	-0.0015
		(-1.49)	(-1.47)	(-1.47)
Firm Focus$_t$			0.0086	0.0085
			(1.60)	(1.59)

Robustness

- Core-wacc, vs. average-wacc
- Control for sales-gr, diversity
- Industry fixed-effects
- Vertical integration
  - Control for firm-wide investment
  - Interact with « vertical relatedness » to core

Robustness Checks (Table VI)

	(1)	(2)	(3)	(4)	(5)	(6)
$\beta^A_{CORE,t}$		-0.0212***	-0.0170***	-0.0184***	-0.0171***	-0.0088***
		(-3.76)	(-4.87)	(-5.25)	(-5.20)	(-2.74)
$\beta^A_{AVERAGE,t}$	-0.0154***	0.0074				
	(-3.42)	(0.99)				
$\beta^A_{DIV,t}$	0.0195***	0.0149***	0.0141***	0.0126***	0.0156***	
	(5.73)	(4.05)	(4.15)	(3.68)	(4.95)	
$Q_{DIV,t} - Q_{FIRM,t}$			-0.0073***			
			(-5.38)			
$SD(Q_{i,t})/Q_{FIRM,t}$				-0.0267***		
				(-4.85)		
Raw Investment Core Division$_t$					0.0893***	0.0799***
					(6.74)	(6.73)
Observations	22840	22840	18955	18860	22006	22017
R^2	0.034	0.035	0.043	0.041	0.045	0.151
Year Fixed Effects	YES	YES	YES	YES	YES	NO
Division Industry*Year Fixed Effects	NO	NO	NO	NO	NO	YES

+ usual controls….

Industry Adjusted Investment (Table A.II)

	(1)	(2)	(3)	(4)
$\beta^A_{DIV,t} - \beta^A_{CORE,t}$	0.0051**	0.0070***	0.0067***	
	(2.31)	(3.03)	(2.83)	
$\beta^A_{DIV,t}$				0.0067**
				(2.14)
$\beta^A_{CORE,t}$				-0.0067**
				(-2.12)
$Q_{DIV,t}$		-0.0052**	-0.0050**	-0.0050*
		(-2.12)	(-2.02)	(-1.89)
$Q_{CORE,t}$		-0.0011	-0.0011	-0.0011
		(-0.46)	(-0.46)	(-0.45)
Firm Cash I		0.0844***	0.0818***	0.0818***
		(10.28)	(9.92)	(9.92)
Observations	23808	22674	22288	22288
R^2	0.004	0.017	0.018	0.018

Strong effect also when non-core investment in excess of median investment of standaliones in the same industry is used.

+ usual controls….

What about vertical integration?

- Assume a firm has a core “toys” (ff48=6) and a non-core “trucks” (ff48=40)
  - it uses the trucks to transport toys
- If $WACC_{toys}$ ↘ $CapX_{toys}$ ↗
  - the firm might expand toy production capacity to cater to investor sentiment.
- To ship the toys, the firm would also need more trucks: $WACC_{toys}$ ↘ $CapX_{trucks}$ ↗
  - non-core division investment responsive to the $WACC_{core}$ for reasons other than the WACC Fallacy

Vertical integration (Table VII)

	(1)	(2)	(3)	(4)
$\beta^A_{DIV,t} - \beta^A_{CORE,t}$	0.0163***	0.0150***	0.0143***	0.0138***
	(6.75)	(3.80)	(3.60)	(3.48)
Medium $V_{DIV,t} \times (\beta^A_{DIV,t} - \beta^A_{CORE,t})$		-0.0077	-0.0058	-0.0055
		(-1.51)	(-1.12)	(-1.05)
High $V_{DIV,t} \times (\beta^A_{DIV,t} - \beta^A_{CORE,t})$		0.0082	0.0076	0.0096
		(1.42)	(1.27)	(1.55)
$Q_{DIV,t}$	0.0084***	0.0079***	0.0082***	0.0097***
	(3.47)	(3.26)	(3.38)	(2.79)
Medium $V_{DIV,t} \times Q_{DIV,t}$				-0.0009
				(-0.17)
High $V_{DIV,t} \times Q_{DIV,t}$				-0.0044
				(-0.78)
$Q_{CORE,t}$	-0.0022	-0.0016	-0.0044	-0.0048
	(-0.91)	(-0.67)	(-1.45)	(-1.59)
Medium $V_{DIV,t} \times Q_{CORE,t}$			0.0099**	0.0101**
			(2.21)	(2.18)
High $V_{DIV,t} \times Q_{CORE,t}$			-0.0008	0.0011
			(-0.16)	(0.21)
+ usual controls….				
Observations	21932	21932	21932	21932
R^2	0.044	0.048	0.048	0.048

Beta spread sensitivity does not depend on vertical relatedness.

$V_{DIV,t}$ measures the flow of goods and services between the core and non-core division's industries (Measure of vertical relatedness)

Bounded rationality

- Key idea: heuristics used when « not too costly »

→if the cost of “wacc fallacy” is high, the investment sensitivity to $\beta - \beta_{core}$ should be lower.

What causes the WACC Fallacy?

- Run the following regression

$$Capx_{non\text{-}core} = b.\{Z \times (WACC_{non\text{-}core} - WACC_{core})\}$$

- Z = net benefit of taking the right WACC
- Bounded rationality hypothesis: b<0
  - if the cost of taking the wrong discount rate is high, the spread sensitivity should be lower.

Bounded Rationality? (Table VIII)

	(1)	(2)	(3)	(4)
$\beta^A_{DIV,t} - \beta^A_{CORE,t}$	0.0264***	0.0182***	0.0302***	0.0295*
	(5.52)	(4.64)	(3.23)	(1.82)
(1992-1996) $\times$ $(\beta^A_{DIV,t} - \beta^A_{CORE,t})$	-0.0038			
	(-0.71)			
(1997-2001) $\times$ $(\beta^A_{DIV,t} - \beta^A_{CORE,t})$	-0.0112*			
	(-1.84)			
(2002-2007) $\times$ $(\beta^A_{DIV,t} - \beta^A_{CORE,t})$	-0.0196***			
	(-3.45)			
Med Relative Importance$_t$ $\times$ $(\beta^A_{DIV,t} - \beta^A_{CORE,t})$		0.0011		
		(0.22)		
High Relative Importance$_t$ $\times$ $(\beta^A_{DIV,t} - \beta^A_{CORE,t})$		-0.0094*		
		(-1.88)		
Med $SD(\beta^A_{i,t})$ $\times$ $(\beta^A_{DIV,t} - \beta^A_{CORE,t})$			-0.0017	
			(-0.17)	
High $SD(\beta^A_{i,t})$ $\times$ $(\beta^A_{DIV,t} - \beta^A_{CORE,t})$			-0.0185*	
			(-1.95)	
High CEO Share Ownership$_t$				0.0007
				(0.19)
High CEO Share Ownership$_t$ $\times$ $(\beta^A_{DIV,t} - \beta^A_{CORE,t})$				-0.0243***
				(-2.96)
Observations	22289	22288	22288	5434
R^2	0.038	0.037	0.038	0.038

+ usual controls & main effects….

Bounded rationality: results

- Investment sensitivity to beta spread stronger when:
  - *Division small relative to Core*
  - *Firm's divisions are homogeneous (in beta)*
  - *Earlier years (t<1996)*
  - *Lower CEO ownership*

Value Effect

- Diversifying acquisition: bidder buys an asset belonging to a different ff48 industry.
- Four reasons for diversifying acquisitions:

(1) Easily observable investment projects

(2) The cost of capital of the investment project can be computed: WACC of the target

(3) Reasonable estimate of project NPV: Stock price reaction of the bidder upon announcement

(4) Large enough so that impact of the project on the value of the acquirer is detectable in a credible way

Value Effect: Prediction

- Assume $WACC_{bidder} < WACC_{target}$
  - Bidder uses a low WACC to value the target
  - Bidder more likely to **overpay** and stock market should react **less** favorably.

→ **Testable predictions:**

1. ***$WACC_{bidder} < WACC_{target}$ more frequent?***
2. ***Bidder announcement return lower if $WACC_{bidder} < WACC_{target}$***

Data

- 6,206 diversifying acquisitions from SDC (1988-2007)
  - Eventually successful deals
  - >1% of bidder's equity value,
  - Deal value >$1m

  → **Mostly small private or subsidiary targets (Average Deal Size: $200M)**

Sample characteristics

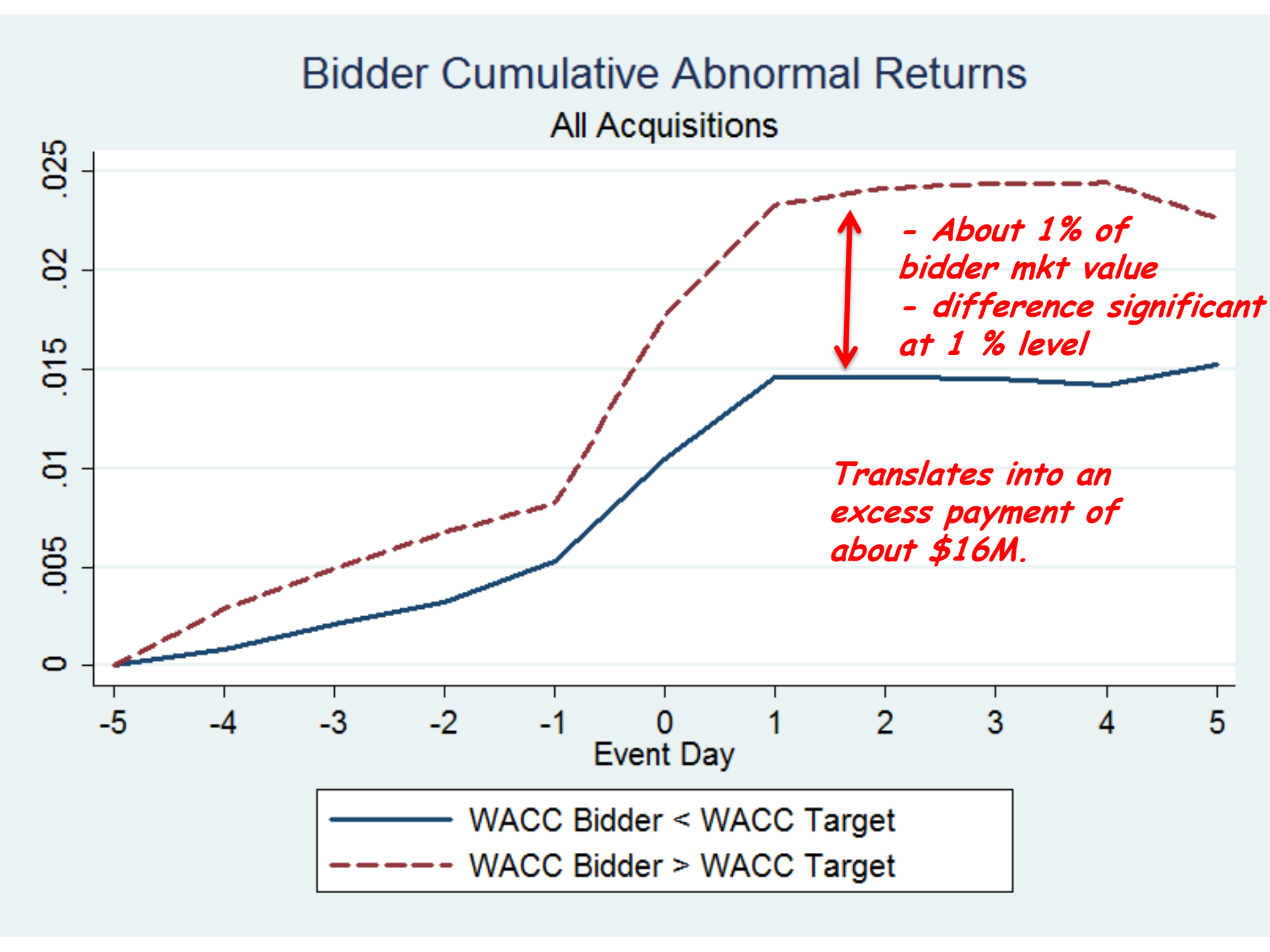
Panel A: Deal Characteristics

	All Deals (N=6,115)	Public (N=687)	Private (N=3,334)
$(\beta^{A}_{BIDDER,t} - \beta^{A}_{TARGET,t} > 0)$	0.41	0.48	0.41
	(0.49)	(0.50)	(0.49)
$(Q_{BIDDER,t} - Q_{TARGET,t} > 0)$	0.49	0.50	0.49
	(0.50)	(0.50)	(0.50)
$V_{TARGET,t}$	186.15	864.61	65.73
	(1082.05)	(3033.24)	(211.98)
$E_{BIDDER,t-1}$	1905.68	6764.01	1090.06
	(7708.39)	(17664.76)	(5094.96)
$V_{TARGET,t}/E_{BIDDER,t-1}$	0.25	0.37	0.21
	(0.57)	(0.65)	(0.48)

First prediction

Panel B: Bidder and Target Characteristics

	All Deals (N=6,115)		
	Bidder	Target	Diff
$\beta^A_{i,t}$	0.592	0.640	-0.048***
	(0.401)	(0.342)	(0.405)
$Q_{i,t}$	1.487	1.487	-0.001
	(0.390)	(0.388)	(0.420)


Bidder Cumulative Abnormal Returns
All Acquisitions
0
.005
.01
.015
.02
.025
-5
-4
-3
-2
-1
0
1
2
3
4
5
Event Day
- About 1% of bidder mkt value
- difference significant at 1 % level
Translates into an excess payment of about $16M.
WACC Bidder < WACC Target
WACC Bidder > WACC Target

Conclusion

- Evidence that firms use a single WACC
  - distorts internal capital market allocation
  - Bounded rationality
- Evidence that this behavior reduces gains from asset acquisitions
  - Bidder announcement returns about 0.8 % points lower (excess payment due to valuation mistakes)