Heterogeneous impact of firm diversification on firms performance: perspective from capital structure and trade-off theory

October 4, 2018

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Abstract: Whether the firm will perform better after firm diversification, and what characteristics make firms benefit more from firm diversification? I investigated the firm performance in acquisition along with two factors, leverage deviation and DifNome. Leverage deviation comes from theory that suggests firms have their optimize leverage ratio and adjust their capital structure to it. In my study firms with larger magnitude of leverage deviation will benefit more from acquisition. The second factor DifNome is obtained from dynamic trade-off theory. I use Nome to approximate parameters in the model, and it characterizes how the firm changes its tax benefit (TB) and bankruptcy cost (BC) with increasing debt. When debt increases, bankruptcy cost increases and tax benefit first increases and then decrease, and the rates of these changes are determined by Nome. Firms with higher Nome increases bankruptcy cost faster and tax benefit slower as the debt increases. Conjecture is that if a firm acquires a target firm with a large difference of Nome then the firm could benefit more from the acquisition by adjusting the stress of debt on both segments thus has better performance. This prediction is partially supported by empirical tests.

1 Introduction

Many studies in finance analyze the diversification impact on a firm's performance. Existing view on firm diversification is that diversified firms reduce the risk of cash flows and thus could bear more debt. As a result, the firm's value should be relative better than standalones. In empirical findings, however, there is not much support for this view. Berger and Ofek (1995) observed diversified firms have diversification discount in firm excess value. Theory and empirical studies suggest that firms could either benefit or be hurt from diversification. In this paper I proposed two firm characteristics that could affect firm performance during diversification and explore that firms with what characteristic could benefit more from it.

The characteristics are derived from the aspect of capital structures and trade-off theory, using merge and acquisition as event of firm diversification. The first factor is deviation from the target leverage. According to theory, firms have target capital structure that are determined by balancing the benefits and cost of financing. In practice, however, observed firm leverage often deviate from the ideal target capital structure. There are many studies about the speed of capital structure adjustment. One way that affect the leverage deviation is the merger and acquisition. Managers of firms which need to adjust their leverage could actively pursue value enhancing acquisitions to rebalance their capital structure, and the adjustment of leverage deviation could be incorporate in the process of firm diversification, for example, current leverage deviation could affect the bidder's choice of financing acquisitions and in return the method of payment could affect the capital structure following the acquisition (Harford et al. 2009). If the deal is paid with cash, firms might reduce the agency costs of free cash flow and face less immediate tax obligation. Cash payments are often realized by issuing new debt, and thus affect the capital structure. There is also study (Harford et al. 2014) that investigates the effect of the bond market and firm investment on capital structure. Thus I conjecture the leverage deviation before the acquisition could be one characteristic that affect firm performance and investigate how firms with different leverage deviation perform differently to the acquisition. In the test of direction of leverage deviation, there is no significant difference in performance for firms that are over-leveraged and under-leveraged. Possible explanation is that over-levered firms are facing more bankruptcy cost and under-levered firms have more agency problems. In the test of magnitude of leverage deviation, I found firms with larger magnitude leverage deviations tend to perform better than firms with smaller magnitude leverage deviation. This indicates that firms which already have large leverage deviation could benefit more in adjusting their capital structure to a better (optimized) level.

The second factor I examine in this paper is the difference of Nome between acquirer and target firm. I define Nome to be the ratio of mean and variance ($\frac{\mu}{\sigma^2}$) of a firm cash flow. DifNome, is the difference of target firm Nome and acquirer Nome. Nome is used to approximate the parameters in dynamic trade-off theory model. The model assumes a firm's cash flow is stochastic and follows distribution with parameters μ and σ^2. The ratio of μ and σ^2 (Nome) is observed from the parameter in solution of the firm's value as a function of firm's debt. i.e. Tax benefit (TB) and bankruptcy cost (BC) can be viewed as functions of coupon C for given realized cash flow. Nome is in parameters of the function. Nome characterizes the increasing rate of tax benefit and bankruptcy cost with increasing debt. Trade-off theory suggests firms reach optimal leverage by balancing benefit and costs from tax and bankruptcy. As firm increases its debt, tax benefit and bankruptcy cost will increase correspondingly. A firm with high Nome will increase the bankruptcy cost much faster and tax benefit slower. A firm with lower Nome will, however, increase its tax benefit relatively faster and bankruptcy cost slower and thus could bear relatively more debt. Take C_x and C_y to be the coupon of acquirer and target firm, the coupon of merged firm is $C_x + C_y$. The mechanism of combining the two firms (acquisition) is that if the difference of Nome is large for two firms, the merged firm could have room to adjust the distribution of debt on two segments ($C'_x + C'_y = C_x + C_y$ with C'_x and C'_y be flexible) and thus firms performance will be different in the acquisition by acquiring a firm with much different Nome. The result of my second test confirmed this conjecture from one direction, that is, let DifNome =target Nome - acquirer Nome, then deals where DifNome is large will have better increase in firm excess value along the years after the acquisition. However, there are two phenomena need to be explained. First is the result is significant only when DifNome = target Nome - acquirer Nome, and the sign of coefficient is reversed when I let difference to be acquirer Nome - target Nome. When taking the magnitude DifNome =abs(target Nome - acquirer Nome) there is no result from the test. Whether high Nome target or high Nome acquirer plays the important role in acquisition is still mysterious to me. Second is that I found the asymmetry in over-leverage and under-leveraged firm for testing the DifNome. I ran the same tests on full sample, subsample of over-leveraged firms and under-leveraged firms. The result overall is significant. But the under-leveraged subsample the result is not significant. Possible reasons could be: 1. under-leveraged firms subsample is not large enough or 2. managers of over-leveraged firm face more bankruptcy risk and thus seek for value-enhancing acquisition more actively. The second explanation brings endogeneity issue in the test. Nevertheless, this paper presents this phenomenon and leaves the reason to be explored.

This paper is related to studies on the performance of diversified firms. Berger and Ofek (1995) found that there is a discount in diversified firms compared to standalone firms. Graham, Lemmon and Wolf (2002) found that the discount is endogenous and is not caused by diversification. Lang, Ofek and Stulz (1995) showed there is a negative relation between leverage and future growth at the firm level for diversified firms. Custodio (2014) addressed that q based measure is biased and corrected the bias.

This paper is also related to literature of capital structure, leverage deficit and its acquisition choices. Kayhan and Titman (2007) examined how cash flows affect debt ratios and focused on leverage deficit, which is the difference between the observed debt ratio and target ratio. Harford, Klasa and Walcott (2009) provided evidence between leverage deviation and acquisition choice in large acquisitions. Uysal (2011) found that capital structure could affect managers' decision of acquisition and investment.

This paper is also related to dynamic trade-off theory literatures. I extend Leland (1994) model to two dimensional case to illustrate the diversified firm. I use the EBIT approach aligned with Goldstein, Ju and Leland (2001) to be more close with those in practice.. Although a closed form solution cannot be provided, I observe the Nome and Difnome factors from the model for empirical tests.

The paper is arranged as follows: In section 2 I will show the empirical methodology and hypotheses. Section 3 I will show the sample selection and how to calculate the measures. Section 4 talks about the summary statistics and empirical result. Section 5 will be discussion. Appendix A briefly goes through Leland's dynamic trade-off model. In Appendix B I analyze two dimensional case and conditions for solution.

2 Methodology and Hypothesis

2.1 Overall Trend

In the first test, I regress on the overall trend of acquisition from one year before the acquisition to five years after the event. Define YRDIFF = fiscal year - acquisition effective year, then YRDIFF $\in [-1, 5]$. I use firm excess value to proxy the firm performance. Then I regress the firm performance on the time trend, with control variables:

$$Firm\ excess\ value = \alpha_0 + \alpha_1 \cdot YRDIFF + \alpha_2 \cdot control\ variables.$$

2.2 Leverage Deviation

For leverage deviation, I did two tests. First test is to test if there is asymmetry of over-leveraged and under-leveraged firm. I define over-leveraged dummy to be 1 if a firm's observed leverage is greater than the target leverage and to be 0 if a firm's observed leverage is below the target leverage. Define interaction of over-leverage to be the product of over-leverage dummy and YRDIFF.

To test the hypothesis:

Hypothesis 1 *Over-leveraged firms performance change during the acquisition is not different from under-leveraged firms.*

I regress:

$$\begin{aligned} Firm\ excess\ value &= \alpha_0 + \alpha_1 \cdot YRDIFF + \alpha_2 \cdot over\ leverage\ dummy \\ &+ \alpha_3 \cdot interaction\ of\ over\ leverage + \alpha_4 \cdot\ control\ variables. \end{aligned}$$

The second test is to test if the magnitude of leverage deviation will affect the firm performance during the years of acquisition. I ranked the absolute value of leverage deviation to be high, medium and low. Define the magnitude leverage deviation dummy to be 1 if it is high and 0 if it is low. Define the interaction of magnitude leverage deviation to be the product of dummy and YRDIFF.

To test the hypothesis:

Hypothesis 2 *Firms with higher magnitude of leverage deviation could benefit more from diversification than firms with lower magnitude of leverage deviation.*

I regress:

$$\begin{aligned} Firm\ excess\ value &= \alpha_0 + \alpha_1 \cdot YRDIFF + \alpha_2 \cdot magnitude\ leverage\ deviation\ dummy \\ &+ \alpha_3 \cdot interaction\ of\ magnitude\ leverage\ deviation + \alpha_4 \cdot control\ variables. \end{aligned}$$

2.3 DifNome

DifNome is defined as the difference between acquirer Nome and target Nome. Let DifNome = target Nome - acquirer Nome. After acquisition, the firm could adjust the pressure of debt on different segments and thus be able to bear more debt. High DifNome acquisition firms are supposed to perform much differently from those with low DifNome deals. I rank

DifNome into high, medium and low, and define DifNome dummy to be 1 if DifNome is high and to be 0 if DifNome is low. Define interaction of DifNome to be the product DifNome dummy and YRDIFF.

To test the hypothesis:

Hypothesis 3 *Firms from acquisitions with higher DifNome performs differently from the acquisitions with lower DifNome during acquisition.*

I regress :

$$Firm\ excess\ value = \alpha_0 + \alpha_1 \cdot YRDIFF + \alpha_2 \cdot DifNome\ dummy$$
$$+\alpha_3 \cdot interaction\ of\ DifNome + \alpha_4 \cdot control\ variables.$$

This test is ran on the full sample, subsample of over-leveraged firms, and subsample of under-leveraged firms.

3 Sample selection and measures

3.1 Sample Firms

I obtain deals from the SDC Plantinum database. The initial sample contains all merger and acquisition transactions in the U.S targets over the period 1988 to 2017. The final sample includes 1345 deals (acquirer and target combination), 869 acquirers. The transactions meet the following criteria: the deal status must be completed or unconditional, the acquirer must own more than 50% of the sales after the transaction, and the data of sample firms must be available from Compustat. The firm sales must be greater than $20 million, no business segments in the financial sector (SIC code 6000 to 6999), agriculture (SIC code lower than 1000), government (SIC 9000), or other noneconomic activities (SIC 8600 and 8800), unclassified services (SIC 8900). Acquirer and target must have different SIC code (unrelated takeover). All observation years are selected from one year before the takeover effective year and five years after the effective year (YRDIFF = fyear-year effective $\in [-1, 5]$). All sample data must be available on COMPUTSTAT. Firm excess value are calculated from COMPUSTAT Segments data. The final sample contains 4923 observations where the firm excess values are available. The subsample where leverage deviation is available contains 2552 observations. The subsample where DifNome is available contains 384 observations.

3.2 Firm Excess Value

Firm excess value is defined as the logarithm of the ratio of the firm's observed q to its imputed q, defined as the assets-weighted (or sales-weighted) average of the hypothetical q of the firm's business segments. q, also referred to as Tobin's q, is the standard empirical measure, defined as the ratio of the market value of assets to the book value of the assets. The market value of assets is defined as the book value of assets minus the book value of equity plus the market value of equity. The hypothetical q is the median(or average, I use average here) q of standalones in the same industry-year. The industry match is done at the four-digit SIC code level when there are five or more standalones. Otherwise, it is done at the highest level where at least five standalones are available. The firm excess value calculated from assets-weighted average is EVAT and from sales-weighted average is EVSALES. Calculation follows Custodio (2014).

3.3 Leverage Deviation

Leverage deviation is constructed as follows. First, I predict the target leverage using (Kayhan and Titman 2007)

$$
\begin{aligned}
L_t = \alpha_0 + \beta_1 M/B_{t-1} + \beta_2 PPE_{t-1} + \beta_4 R\&D_{t-1} + \beta_5 (R\&Ddummy)_{t-1} \\
+\beta_6 SE_{t-1} + \beta_7 SIZE_{t-1} + \beta_8 Industry\ dummy + \epsilon_t
\end{aligned}
$$

The regression is estimated using a Tobit specification where the predicted value of the leverage ratio is restricted to be between 0 and 1. Then I define the leverage deviation to be the observed leverage minus predicted target leverage. If the leverage deviation is positive, the dummy over-leverage is set to be 1. If the leverage deviation is negative, the dummy over-leverage is set to be 0. Also I define abs-leverage deviation to be the absolute value of leverage deviation. In the difference in difference test about leverage deviation, I first test if over-leverage will affect the change of firm performance along the acquisition and then test about the large vs small of abs-leverage deviation on acquisition.

3.4 Nome

The parameters a, b (see Appendix B) in the model affect the changing rate of bankruptcy cost and tax benefit and thus affect the optimized capital structure and firm excess value. I use $\frac{\mu}{\sigma^2}$ to approximate the actual value of a, b and call it Nome. The cash flows (EBIT) follows distribution with parameters μ, σ^2. I obtain μ and σ^2 of EBIT from COMPUSTAT

Fundamental Quarterly data. Using yearly average to calculate μ and 5 year variance as σ^2. Nome is calculated for acquirer firm and target firm for each takeover. And DifNome =Target Nome - Acquirer Nome is calculated at one year before (-1 year) the year of takeover. DifNome is supposed to capture how much a firm could potentially benefit from the diversification to optimize the total tax benefit and bankruptcy cost. DifNome characterizes how merged firms could adjust the pressure of debt on two segments and thus optimized their debt. Prediction is that during the acquisition event, firms performance will be different for high DifNome deals than low DifNome deals.

3.5 Control Variables

Following Claudia, control variables are profitability, defined as the ratio of EBIT to sales; investment, defined as ratio of Capex to sales. I use logarithm of sale to be firm size. In addition, to control the tax and bankruptcy effects, I add the effective tax and zscore. All control variables are related to firm characteristic so they are lagged one year. EVAT, EVSALES, profitability, investment, effective tax rate, and zscores are all winsorized at 1% and 99%.

4 Results

4.1 Trend of excess value over time in full sample

Insert Table 1 here

In the sample there is generally a trend of slightly decrease in firms' performance about the action of acquisition. The four columns correspond to four specifications: excess value calculated from assets weighted average q (EVAT) with industry fixed effect (use Fama French 38 industries), excess value calculated from sales weighted average q (EVSALES) with industry fixed effect, EVAT with firm fixed effect and EVSALES with firm fixed effect. Control variables about firm characteristic in profitability, firm size, investment are lagged one year. Also I controlled the effective tax rate and zscore for both tax and bankruptcy. There is little influence of these variables on the firm performance. There is slight decrease but not significant in firm performance after the diversification.

4.2 Tests of leverage deviation

Insert Table 2 here Table of over-leverage dummy diff-in-diff regression

In the diff-in-diff test of direction of leverage deviation, I first investigate if the effect of over-leverage and under-leverage would be different. The over-leverage dummy is set to be 1 if leverage deviation is positive and 0 if leverage deviation is negative. Interaction term is the product of YRDIFF and over-leverage dummy. The four columns are EVAT with industry fixed effect, EVSALES with industry fixed effect, EVAT with firm fixed effect, EVSALES with firm fixed effect. The overall trend is still slightly negative and there is no significant difference between the over-leveraged and under-leveraged firms.

Insert Table 3 here Table of abs-leverage deviation diff-in-diff regression

Then I test the magnitude of leverage deviation. I take the absolute value of leverage deviation and investigate how much the deviation would affect the firm performance in acquisition. The dummy for absolute-leverage deviation is set to be 1 if it is in the top 33% percentile of the sample, representing large deviation in magnitude. The dummy is set to be 0 if abs-leverage deviation is in the lowesr 33% percentile, representing low leverage deviation. Interaction term is the product of YRDIFF and the abs-leverage deviation dummy. From the result, both EVAT and EVSALES reflect that firms with large abs-leverage deviation will increase their firm excess value more during an takeover event, with industry fixed effect. With more strict control of firm fixed effect, coefficient of EVSALES is still significantly positive. This result confirmed my hypothesis that firms with higher leverage deviation could benefit more from a diversification event, and the reason could be the takeover procedure provides the opportunity for managers to manipulate the method of payments and thus improve the leverage of firm to its target (optimal) level.

4.3 Test of DifNome

Insert Table 4 here Table of DifNome diff-in-diff regression (subsample)
Insert Table 5 here Table of DifNome diff-in-diff regression (subsample)
Insert Table 6 here Table of DifNome diff-in-diff regression

In the diff-in-diff test of DifNome, I define DifNome = Target Nome - Acquirer Nome. And set the dummy of DifNome to be 1 if DifNome is in the top 33% percentile of the sample, representing the high DifNome firms. Set the dummy of DifNome to be 0 if DifNome is in the lowest 33% of the sample, representing low DifNome firms. The interaction is the product of YRDIFF and DifNome Dummy. The four columns represent dependent variables EVAT, EVSALES with industry and firm fixed effect.

Table 6 is the test on subsample of over-leveraged firms. Table 7 is the test on subsample of under-leveraged firms. Table 8 is the test on the full sample where DifNome is available. For the interaction term, EVSALES of high DifNome firms increases significantly more than the increase of EVSALES of low DifNome firms for over-leveraged firms and the full sample. This phenomenon is not significant in under-leveraged firm. In under-leveraged firms sample, the DifNome dummy effect alone was omitted in firm fixed effect due to insufficiency of observations. The asymmetry phenomenon may be caused by insufficiency of observations, may be caused by other reasons need to be explored.

Remark: Same tests were run by having DifNome= abs(target Nome - acquirer Nome) and there is no significant result to show. Same tests when DifNome= acquirer Nome - target Nome have similar result and same coefficients with negative sign. This suggest that the effect of DifNome has direction and are not symmetric between the target firm and acquirer firm. Possible reason could be that acquirer and target play different roles in an acquisition.

5 Discussion

In this paper I how firms with different characteristics perform differently after acquisition. Instead of studying the overall impact of diversification is good or bad for a firm, I divide firms according to different characteristics and test the impact separately using diff-in-diff tests. In this paper I propose two factors that may affect the performance of firms during the event of acquisition and demonstrate their effect in empirical tests.

The first characteristic is the leverage deviation before the acquisition. Empirical results support my conjecture that demonstrated that firms with large leverage deviation will perform better and benefit more from the firm diversification. However, a potential causality issue could be that firms which already suffer a large leverage deviation will actively have more acquisition deals because they could benefit from the diversification. In addition, this paper only explore through capital structure, but it will certainly be reasonable to put manager behavior and agency problems into the same procedure. This concerns can also affect the firm performance after merger and acquisition.

As for the second factor, it is derived from the dynamic trade-off modeling and its solution. I propose this novel factor observed from the conditions in the solution, and my tests results partly confirm my hypothesis, that is, acquisitions with larger difference of Nome in target and acquirer firms will have better performance after the deal. The model has a lot of simplification. In assumption I assumed unrelated firms have independent cash flows, but in reality the correlation may not be zero. I assume the acquirer and target firms belong to industries from their primary SIC code, but in fact they may already be diversified firm and are affected by a third industry. In addition, a gap between the model and empirical tests is that the underlying mechanism and economic explanation of the Nome factor. In practice, how diversified firms work to adjust the debt pressure and tax benefit, how why firms with relatively high/low $\frac{\mu}{\sigma^2}$ in their cash flows exhibit such difference of the rate of change in tax benefit and bankruptcy cost. These questions are remained to be explained.

Table 1: Regression of trend. YRDIFF =fyear - year of acquisition effective date. YRDIFF is restricted from -1 to 5. Four columns represents EVAT/EVSALES with industry/firm fixed effect.

	evat-i.fixed	evsales-i.fixed	evat-f.fixed	evsales-f.fixed
	(1)	(2)	(3)	(4)
YRDIFF	-.006	-.01**	-.003	-.007
	(.005)	(.005)	(.006)	(.006)
lagprofitability	.21	.19	.17	.10
	(.17)	(.16)	(.23)	(.22)
LAGSIZE	.006	-.01	-.05	-.06
	(.02)	(.02)	(.04)	(.04)
laginvestment	10.10	1.21	-19.87	-12.01
	(32.37)	(30.62)	(37.11)	(36.31)
lagefftax	-.06	-.05	-.06	-.04
	(.04)	(.04)	(.04)	(.04)
lagzscore	.0000817	.0000502	.000053	.0000218
	(.0000928)	(.0000956)	(.0001)	(.0001)
Const.	-.13	-.08	.42	.50*
	(.14)	(.15)	(.27)	(.28)
Obs.	4923	4923	4923	4923
R^2	0.01	0.02	.005	.01

Table 2: Test for over-leverage dummy. Over-leverage dummy is indicator of whether leverage deviation is positive. Interaction term is the product of over-leverage dummy and YRDIFF. Four columns represents EVAT/EVSALES with industry/firm fixed effect.

	evat-i.fixed	evsales-i.fixed	evat-f.fixed	evsales-f.fixed
	(1)	(2)	(3)	(4)
YRDIFF	-.01	-.01*	-.005	-.007
	(.01)	(.008)	(.01)	(.008)
1.over-leverage dummy	-.18***	-.17***	-.17***	-.17***
	(.04)	(.04)	(.04)	(.04)
interact	.01	.01	.01	.02
	(.01)	(.01)	(.01)	(.01)
lagprofitability	.15	.22	.20	.28
	(.27)	(.26)	(.34)	(.33)
LAGSIZE	.004	-.02	-.08*	-.10**
	(.02)	(.02)	(.04)	(.04)
laginvestment	-.16	-2.53	-1.56	-1.97
	(46.36)	(47.73)	(51.21)	(51.99)
lagefftax	-.05	-.02	-.05	-.003
	(.06)	(.05)	(.06)	(.05)
lagzscore	.0000551	3.01e-07	.000044	-.0000144
	(.0001)	(.0001)	(.0001)	(.0001)
Const.	.07	.08	.73**	.80***
	(.16)	(.18)	(.31)	(.30)
Obs.	2552	2552	2552	2552
R^2	.03	.03	.03	.03

Table 3: Test of magnitude of leverage deviation. Abs-leverage deviation dummy is 1 if abs-leverage deviation is in the top 33% percent of sample and is 0 if abs-leverage deviation is in the bottom 33% percentage of sample. Interaction term is the product of abs-leverage deviation dummy and YRDIFF. Four columns represents EVAT/EVSALES with industry/firm fixed effect.

	evat-i.fixed	evsales-i.fixed	evat-f.fixed	evsales-f.fixed
	(1)	(2)	(3)	(4)
YRDIFF	-.02*	-.03**	-.02	-.02*
	(.01)	(.01)	(.01)	(.01)
1.abs-leverage deviation dummy	.007	.01	.02	.02
	(.05)	(.05)	(.05)	(.05)
interact	.03*	.03*	.03	.02*
	(.02)	(.01)	(.02)	(.01)
lagprofitability	.10	.13	-.06	-.04
	(.35)	(.34)	(.49)	(.46)
LAGSIZE	.04	.02	-.06	-.08*
	(.02)	(.02)	(.05)	(.04)
laginvestment	21.81	22.52	29.51	32.32
	(54.23)	(55.96)	(63.36)	(64.74)
lagefftax	-.11*	-.10*	-.10	-.08
	(.06)	(.06)	(.06)	(.06)
lagzscore	1.83e-06	-.0000511	-.0000424	-.0000882
	(.0001)	(.0001)	(.0001)	(.0001)
Const.	.02	.02	.52	.63**
	(.19)	(.22)	(.33)	(.32)
Obs.	1657	1657	1657	1657
R^2	.02	.02	.01	.02

Table 4: Test of DifNome dummy on the subsample of over-leveraged firms. Dif Dummy is calculated from ranking the full sample DifNome. It is set to be 1 if DifNome is in the top 33% percent of sample and is 0 if DifNome is in the bottom 33% percent of the sample. Interaction term is the product of Dif Dummy and YRDIFF. Four columns represents EVAT/EVSALES with industry/firm fixed effect.

	evatover-i.fixed	evsales-i.fixed	evat-f.fixed	evsales-f.fixed
	(1)	(2)	(3)	(4)
YRDIFF	-.10**	-.13***	-.10**	-.13***
	(.04)	(.04)	(.05)	(.04)
2.difnome3	-.24	-.34**	-.35***	-.39***
	(.16)	(.15)	(.10)	(.09)
interactdif3	.09**	.11**	.09*	.10**
	(.04)	(.04)	(.04)	(.04)
lagprofitability	.09	-.49	-.24	-.27
	(.98)	(.90)	(.99)	(1.03)
LAGSIZE	-.06	-.01	-.004	.07
	(.10)	(.08)	(.15)	(.15)
laginvestment	-29.21	-30.08	5.03	2.84
	(85.37)	(88.04)	(86.21)	(84.11)
lagefftax	.04	.03	.07	.05
	(.14)	(.13)	(.15)	(.14)
lagzscore	-.001*	-.0008	-.001*	-.001
	(.0006)	(.0006)	(.0008)	(.0008)
Const.	.35	.26	.36	-.25
	(.69)	(.59)	(1.21)	(1.16)
Obs.	203	203	203	203
R^2	.09	.09	.08	.09

Table 5: Test of DifNome dummy on the subsample of under-leveraged firms. Dif Dummy is calculated from ranking the full sample DifNome. It is set to be 1 if DifNome is in the top 33% percent of sample and is 0 if DifNome is in the bottom 33% percent of the sample. Interaction term is the product of Dif Dummy and YRDIFF. Four columns represents EVAT/EVSALES with industry/firm fixed effect. The firm fixed effect of 1.dif dummy is omitted due to insufficiency of observations.

	evatunder-i.fixed	evsales-i.fixed	evat-f.fixed	evsales-f.fixed
	(1)	(2)	(3)	(4)
YRDIFF	-.09	-.10	-.06	-.12
	(.10)	(.09)	(.16)	(.15)
2.difnome3	-.05	.09	(omitted)	(omitted)
	(.24)	(.16)		
interactdif3	.11	.09	.12	.12
	(.11)	(.09)	(.13)	(.11)
lagprofitability	2.07	.54	-1.98	-.16
	(2.59)	(2.11)	(3.04)	(2.16)
LAGSIZE	-.19*	-.09	-.58	-.16
	(.10)	(.10)	(.54)	(.54)
laginvestment	-3299.93	-4276.64	-145.50	-2225.34
	(4215.95)	(2902.35)	(4539.12)	(2395.91)
lagefftax	-.45	-.23	-1.07	-.25
	(.65)	(.42)	(.89)	(.58)
lagzscore	.0002	.0005	-.0003	-.000062
	(.0004)	(.0004)	(.0004)	(.0002)
Const.	.78	(omitted)	6.05	1.68
	(1.55)		(4.59)	(4.58)
Obs.	83	83	83	83
R^2	.13	.14	.22	.17

Table 6: Test of DifNome dummy on the full sample where DifNome is available. Dif Dummy is calculated from ranking the full sample DifNome. It is set to be 1 if DifNome is in the top 33% percent of sample and is 0 if DifNome is in the bottom 33% percent of the sample. Interaction term is the product of Dif Dummy and YRDIFF. Four columns represents EVAT/EVSALES with industry/firm fixed effect.

	evatfull-i.fixed	evsales-i.fixed	evat-f.fixed	evsales-f.fixed
	(1)	(2)	(3)	(4)
YRDIFF	-.11**	-.11***	-.12**	-.13***
	(.05)	(.04)	(.05)	(.05)
2.difnome3	-.21	-.27**	-.40***	-.42***
	(.17)	(.13)	(.12)	(.10)
interactdif3	.13**	.11***	.14**	.12***
	(.05)	(.04)	(.05)	(.04)
lagprofitability	.04	-.55	-.67	-.56
	(.90)	(.70)	(.99)	(.84)
LAGSIZE	-.08	-.03	-.06	.09
	(.07)	(.06)	(.15)	(.13)
laginvestment	-48.00	-35.22	-12.58	3.26
	(75.38)	(73.91)	(79.09)	(66.18)
lagefftax	-.12	.01	-.10	.03
	(.16)	(.12)	(.18)	(.13)
lagzscore	-.0002	-.0002*	-.0002	-.0002
	(.0002)	(.0001)	(.0002)	(.0002)
Const.	.51	.33	1.06	-.34
	(.54)	(.45)	(1.20)	(1.02)
Obs.	286	286	286	286
R^2	.1	.09	.1	.09

A

Appendix A

This is from lecture notes of FIN 782. A one-dimension Leland's model is set up as follows:

• Let x denote the operating cash flow of the firm (pre-tax).

• Assume that operating cash flow follows a random process governed by the Geometric Brownian Motion (under the risk-neutral measure)

$$\frac{dx}{x} = \mu dt + \sigma dW$$

• dW increment of Wiener process.

• T is the corporate tax (linear).

• r is the risk free rate, $r > \mu$.

• C is the coupon on consol bond.

The unlevered firm is worth $\frac{(1-T)x}{r-\mu}$, using Gordon-growth formula. When default occurs, α proportion of value is lost in bankruptcy costs, and lenders recover $\frac{(1-T)(1-\alpha)x}{r-\mu}$. Let $E(x)$ be the value of equity and $D(x)$ be the value of debt.

The objective of firm is to maximize

$$\max_C E(x;C) + D(x;C)$$

By Ito's calculus, if $V(x)$ is time-independent claim pays $mx + k$ dividend or coupon, then it must satisfy

$$rV(x) = mx + k + \mu x V_x(x) + \frac{1}{2}\sigma^2 x^2 V_{xx}(x)$$

Debt pays coupon C, thus $m = 0, k = C$. Let X_D be the bankruptcy threshold, and firm value stay bounded if $x \to \infty$, then the solution of the equations are

$$D(x) = \frac{C}{r} + \left(\frac{(1-T)(1-\alpha)X_D}{r-\mu} - \frac{C}{r}\right)\left(\frac{x}{X_D}\right)^a$$

where $a = \frac{1}{2} - \frac{\mu}{\sigma^2} - \frac{\sqrt{\mu^2+(2r-\mu)\sigma^2+0.25\sigma^4}}{\sigma^2} < 0$.

For Equity, it gets dividends $(1-T)(x-C)$. It worth 0 at default and worth $(1-T)(\frac{x}{r-\mu} - \frac{C}{r})$ as $x \to \infty$. Boundary conditions gives:

$$E(x) = (1-T)\left(\frac{x}{r-\mu} - \frac{C}{r}\right) - (1-T)\left(\frac{X_D}{r-\mu} - \frac{C}{r}\right)\left(\frac{x}{X_D}\right)^a$$

for the same a defined above.

The bankruptcy threshold is chosen by the "smoothing-pasting" condition

$$\frac{dE(x)}{dx}\mid_{x=X_D}=0$$

Thus $X_D = \frac{a}{a-1}\frac{C(r-\mu)}{r}$.

The bankruptcy cost (BC) at default is

$$BC(x) = \frac{\alpha(1-T)X_D}{r-\mu}\left(\frac{x}{X_D}\right)^a = \frac{\alpha(1-T)x^a}{r-\mu}\left(\frac{(a-1)r}{a(r-\mu)}\right)^{1-a}\cdot C^{1-a}$$

and the tax benefits (TB) at default is

$$TB(x) = T\frac{C}{r}\left(1-\left(\frac{x}{X_D}\right)^a\right) = \frac{TC}{r} - \frac{Tx^a}{r}\left(\frac{(a-1)r}{a(r-\mu)}\right)^a\cdot C^{1-a}$$

To find optimal coupon C, maximize

$$\max_C \frac{(1-T)x}{r-\mu} + T\frac{C}{r}\left(1-\left(\frac{x}{X_D}\right)^a\right) - \frac{\alpha(1-T)X_D}{r-\mu}\left(\frac{x}{X_D}\right)^a.$$

Firm value $V(x)$ is thus

$$(1-T)\frac{x}{r-\mu} + TB(x;C) - BC(x;C),$$

it is

$$V(x) = \underbrace{(1-T)\frac{x}{r-\mu}}_{\text{unlevered firm value}} + \underbrace{\frac{TC}{r} - \frac{TC}{r}\left(\frac{x}{X_D}\right)^a}_{\text{Tax Benefit}} - \underbrace{\frac{\alpha(1-T)X_D}{r-\mu}\left(\frac{x}{X_D}\right)^a}_{\text{Bankruptcy Cost}}$$

In $BC(x)$ and $TB(x)$, the parameter $1-a$ is approximated by Nome. For given cash flow x, BC and TB can be viewed as functions of C. If coupon C is increased, BC will increase, and TB will first increase and then decrease. With different value of Nome, the increase rate of BC and TB at different rates are different, and thus lead to different optimal debt level.

B Two-dimensional case, diversified firm

Now consider a diversified firm. I will illustrate with two segments in a firm. Similar to one dimension case, let x, y be the cash flows of two segments, respectively. I assume two segments belongs to different industries (unrelated) and the cash flows are independent from each other.

- Let x, y be the operating cash flows of two segments of the firm (pre-tax).
- Assume that x, y follow a random process governed by Geometric Brownian Motion:

$$\begin{aligned}
&\frac{dx}{x} = \mu_x dt + \sigma_x dW_x \\
&\frac{dy}{y} = \mu_y dt + \sigma_y dW_y \\
&dW_x dW_y = 0 (independence)
\end{aligned}$$

- T is the corporate tax (linear).
- r is the risk free rate, $r > \mu_x, r > \mu_y$.
- C is the coupon on consol bond.

The unlevered firm is worth $\frac{(1-T)x}{r-\mu_x} + \frac{(1-T)y}{r-\mu_y}$ by Gordon-growth formula. When the firm defaults, α proportion of value is lost in bankruptcy costs, and lenders recover $\frac{(1-T)(1-\alpha)x}{r-\mu_x} + \frac{(1-T)(1-\alpha)y}{r-\mu_y}$. Let $E(x, y)$ be the value of equity and $D(x, y)$ be the value of debt.

As for bankruptcy threshold, I use X_D and Y_D. If any segment cash flow is below the threshold, the firm enters technical bankruptcy.
The objective of firm is to maximize

$$\max_C E(x, y; C) + D(x, y; C)$$

By Ito's calculus, if $V(x, y; C)$ is time-independent claim pays $m(x + y) + k$ dividends or coupon, then it must satisfy

$$\begin{aligned}
dV = \quad & V_x dx + V_y dy + \frac{1}{2} V_{xx} dx^2 + E_{xy} dx dy + \frac{1}{2} V_{yy} dy^2 \\
= \quad & V_x (x\mu_x dt + x\sigma_x dW_x) + V_y (y\mu_y dt + y\sigma_y dW_y) + \frac{1}{2} V_{xx} (x\mu_x dt + x\sigma_x dW_x)^2 \\
+ \quad & V_{xy} (x\mu_x dt + x\sigma_x dW_x)(y\mu_y dt + y\sigma_y dW_y) + \frac{1}{2} V_{yy} (y\mu_y dt + y\sigma_y dW_y)^2 \\
E[dV] = \quad & \left(\mu_x x V_x + \mu_y y V_y + \frac{1}{2} \sigma_x^2 x^2 V_{xx} + \frac{1}{2} \sigma_y^2 y^2 V_{yy} \right) dt
\end{aligned}$$

Thus we obtain the differential equation to solve:

$$rV = m(x+y) + k + \mu_x x V_x + \mu_y y V_y + \frac{1}{2}\sigma_x^2 x^2 V_{xx} + \frac{1}{2}\sigma_y^2 y^2 V_{yy} \tag{B.1}$$

To solve $D(x, y)$ for

$$rD = m(x+y) + k + \mu_x x D_x + \mu_y y D_y + \frac{1}{2}\sigma_x^2 x^2 D_{xx} + \frac{1}{2}\sigma_y^2 y^2 D_{yy} \tag{B.2}$$

Here, $m = 0, k = C$. Consider separation of variables $D(x, y) = D_1(x) + D_2(y)$. Then $(B.2)$ can be written as

$$rD_1 = c_1 + \mu_x x D_{1x} + \frac{1}{2}\sigma_x^2 x^2 D_{2xx}$$

and

$$rD_2 = c_2 + \mu_y y D_{2y} + \frac{1}{2}\sigma_y^2 y^2 D_{2yy}$$

$c_1 + c_2 = C$. $D(x, y)$ needs to stay bounded, $D(x, y) = \frac{C}{r}$ as $x, y \to \infty$. The solution is

$$D_1(x) = \frac{c_1}{r} + Ax^a$$

where $a = \frac{1}{2} - \frac{\mu_x}{\sigma_x^2} - \frac{\sqrt{\mu_x^2 + (2r - \mu_x)\sigma_x^2 + 0.25\sigma_x^4}}{\sigma_x^2}$, and

$$D_2(y) = \frac{c_2}{r} + By^b$$

where $b = \frac{1}{2} - \frac{\mu_y}{\sigma_y^2} - \frac{\sqrt{\mu_y^2 + (2r - \mu_y)\sigma_y^2 + 0.25\sigma_y^4}}{\sigma_y^2}$. Thus

$$D(x, y) = \frac{C}{r} + Ax^a + By^b$$

It will be tricky to calculate $D(X_D, y)$ where $y > Y_D$ and $D(x, Y_D)$ where $x > X_D$ because for technical bankruptcy, there is still room for renegotiation and thus the debt value is unclear. However, consider when $x = X_D$ and $y = Y_D$, the firm must default. Solution must satisfy the condition given by this case. When firm defaults at $x = X_D$ and $y = Y_D$, bondholders get $(1-T)(1-\alpha)\left(\frac{x}{r-\mu_x} + \frac{y}{r-\mu_y}\right)$. Let $c_1 + c_2 = C$, and match the coefficients, then

$$D_1(X_D) = \frac{c_1}{r} + AX_D^a = \frac{(1-T)(1-\alpha)X_D}{r - \mu_x}$$

and

$$D_2(Y_D) = \frac{c_2}{r} + BY_D^b = \frac{(1-T)(1-\alpha)Y_D}{r - \mu_y}$$

So

$$A = \frac{1}{X_D^a}\left(\frac{(1-T)(1-\alpha)X_D}{r - \mu_x} - \frac{c_1}{r}\right)$$

and

$$B = \frac{1}{Y_D^b}\left(\frac{(1-T)(1-\alpha)Y_D}{r-\mu_y} - \frac{c_2}{r}\right)$$

Thus

$$D(x,y) = \frac{C}{r} + \left(\frac{(1-T)(1-\alpha)X_D}{r-\mu_x} - \frac{c_1}{r}\right)\left(\frac{x}{X_D}\right)^a + \left(\frac{(1-T)(1-\alpha)Y_D}{r-\mu_y} - \frac{c_2}{r}\right)\left(\frac{y}{Y_D}\right)^b.$$

Equity $E(x,y)$ satisfies

$$rE = m(x+y) + k + \mu_x x E_x + \mu_y y E_y + \frac{1}{2}\sigma_x^2 x^2 E_{xx} + \frac{1}{2}\sigma_y^2 y^2 E_{yy} \tag{B.3}$$

To solve $E(x,y)$, consider separation of variables $E(x,y) = E_1(x) + E_2(y)$. Then $(B.3)$ can be written as

$$rE_1 = mx + k + \mu_x x E_{1x} + \frac{1}{2}\sigma_x^2 x^2 E_{2xx}$$

and

$$rE_2 = my + k + \mu_y y E_{2y} + \frac{1}{2}\sigma_y^2 y^2 E_{2yy}$$

Equity gets dividends $(1-T)(X+Y-C)$, at default it is worthless and at infinity it is $(1-T)(\frac{x}{r-\mu_x} + \frac{y}{r-\mu_y} - \frac{C}{r})$. Thus

$$E_1(x) = (1-T)(\frac{x}{r-\mu_x} - \frac{c_1}{r}) + A'x^a$$

where $a = \frac{1}{2} - \frac{\mu_x}{\sigma_x^2} - \frac{\sqrt{\mu_x^2 + (2r-\mu_x)\sigma_x^2 + 0.25\sigma_x^4}}{\sigma_x^2}$, and

$$E_2(y) = (1-T)(\frac{y}{r-\mu_y} - \frac{c_2}{r}) + B'y^b$$

where $b = \frac{1}{2} - \frac{\mu_y}{\sigma_y^2} - \frac{\sqrt{\mu_y^2 + (2r-\mu_y)\sigma_y^2 + 0.25\sigma_y^4}}{\sigma_y^2}$.

For similar reason, I only consider $E(X_D, Y_D)$ as default to calculate A' and B'. The solution must satisfy

$$E(x,y) = (1-T)(\frac{x}{r-\mu_x} + \frac{y}{r-\mu_y} - \frac{C}{r}) - (1-T)\left(\frac{X_D}{r-\mu_x} - \frac{c_1}{r}\right)\left(\frac{x}{X_D}\right)^a - (1-T)\left(\frac{Y_D}{r-\mu_y} - \frac{c_2}{r}\right)\left(\frac{y}{Y_D}\right)^b$$

Again, consider the "smooth-pasting" condition at bankruptcy.

$$\frac{\partial E}{\partial x}\mid_{x=X_D} = \frac{\partial E}{\partial y}\mid_{y=Y_D} = 0$$

This gives

$$X_D = \frac{a}{a-1}\frac{c_1(r-\mu_x)}{r}, Y_D = \frac{b}{b-1}\frac{c_2(r-\mu_y)}{r}.$$

The bankruptcy cost is thus

$$BC(x,y) = \frac{\alpha(1-T)X_D}{r-\mu_x}\left(\frac{x}{X_D}\right)^a + \frac{\alpha(1-T)Y_D}{r-\mu_y}\left(\frac{y}{Y_D}\right)^b$$

$$= \frac{\alpha(1-T)x^a}{r-\mu_x}\left(\frac{(a-1)r}{a(r-\mu_x)}\right)^{1-a} \cdot c_1^{1-a} + \frac{\alpha(1-T)y^b}{r-\mu_y}\left(\frac{(b-1)r}{b(r-\mu_y)}\right)^{1-a} \cdot c_2^{1-b}$$

and tax benefits is thus

$$TB(x,y) = \frac{Tc_1}{r}\left(1-\left(\frac{x}{X_D}\right)^a\right) + \frac{Tc_2}{r}\left(1-\left(\frac{y}{Y_D}\right)^b\right)$$

$$= \frac{TC}{r} - \frac{Tx^a}{r}\left(\frac{(a-1)r}{a(r-\mu_x)}\right)^a \cdot c_1^{1-a} - \frac{Ty^b}{r}\left(\frac{(b-1)r}{b(r-\mu_y)}\right)^b \cdot c_2^{1-b}$$

The value of firm $V(x,y) = E(x,y) + D(x,y)$ can be calculated directly or through

$$(1-T)(\frac{x}{r-\mu_x} + \frac{y}{r-\mu_y}) + TB(x,y) - BC(x,y),$$

it is

$$\underbrace{(1-T)(\frac{x}{r-\mu_x} + \frac{y}{r-\mu_y})}_{\text{unlevered firm value}} + \left(\underbrace{\frac{TC}{r} - \frac{Tc_1}{r}\left(\frac{x}{X_D}\right)^a - \frac{Tc_2}{r}\left(\frac{y}{Y_D}\right)^b}_{\text{Tax Benefit}}\right) \tag{B.4}$$

$$-\left(\underbrace{\frac{\alpha(1-T)X_D}{r-\mu_x}\left(\frac{x}{X_D}\right)^a + \frac{\alpha(1-T)Y_D}{r-\mu_y}\left(\frac{y}{Y_D}\right)^b}_{\text{Bankruptcy Cost}}\right) \tag{B.5}$$

Suppose c_1 and c_2 are the coupon of two firms before acquisition, after acquisition, the new coupon will be $C = c_1 + c_2$. The advantage of diversification is that firms could adjust c_1, c_2 to c_1', c_2', as long as $c_1' + c_2' = C$. Nome factors for two firms are represented by $1-a$ and $1-b$. $1-a$ and $1-b$ determine how fast that TB and BC increases as the firms increase their coupon c_1 and c_2. If DifNome is large, then firms could react differently by adjusting the values of c_1' and c_2' as long as $c_1' + c_2' = C$. If C is fixed, then the firm would suffer less BC and have more TB. If the trade-off of TB or BC is fixed, firms would be able to increase their debt differently from standalone due to this adjustment. To conclude, by acquiring a target firm with larger difference in Nome, firm performance will be affect by this difference.

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