



MASTER THESIS FINANCE

The Role of Operating Leverage in Asset Pricing

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August 15, 2012



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Abstract

This master thesis examines the association between operating leverage and expected return, operating leverage and systematic risk and between operating leverage and book-to-market ratio through an empirical approach. Financial leverage, as an interactive term of operating leverage, is also included as a main test variable throughout the research. The sample used in the empirical test is based on all North American firms excluding financial and utility firms with a time window of 24 years (1988-2011). The empirical findings of this thesis lend direct evidence for the financial theories on the role of operating leverage and financial leverage in asset pricing.

Keywords: operating leverage, financial leverage, expected return, systematic risk, book-to-market ratio, value premium.

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Defense date:	August 31, 2012

^{*} I am thankful for the guidance and help from my supervisor Drs. J. Grazell of Department of Finance at Tilburg University. Special thanks to Steven Mueller, student at University of Aberdeen, for the helpful comments and support in the construction of this master thesis.

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1. Introduction

The well-established Capital Asset Pricing Model (CAPM) provides an explanation of the cross-sectional variation of equilibrium asset returns. It predicts that the only asset specific explanation for the differences in asset returns is beta, or, systematic risk (Sharpe, 1964; Lintner, 1965; Black, 1972). Several empirical contradictions (Banz, 1981; Basu, 1983; Rosenberg, Reid, and Lanstein, 1985; Bhandari, 1988; Chan, Hamao, and Lakonishok, 1991, Lakonishok, Shleifer, and Vishny, 1994) seem to undermine the ground of CAPM, and the value effect (book-to-market ratio, BE/ME) and size effect (market equity, ME) are deemed as the most prominent amongst the others. Consequently Fama and French (1992) introduce two additional risk factors (HML, SMB) to the single factor (the market) asset pricing model, which gives us the well-known Fama-French three factor model.

Despite the CAPM and Fama-French three factor model's success in theory and empirical tests, some essential questions are left open. For example, the CAPM does not answer the question where the systematic risk a firm faces comes from, and the Fama-French three factor model does not give an explicit explanation to the real risk (or the economic sources of the value premium) behind the two risk factors (MHL, SMB) it proposes. On the one hand, some researchers (e.g. Lakonishok et al. (1994), La Porta (1996), Daniel et al. (1998)) argue that the premiums for the value, size and momentum effects are due to suboptimal behavior biases (investor irrationality). On the other hand, a number of studies (Fama and French (1993), Liew and Vassalou (2000), Berk et al. (1999), Carlson et al. (2004), Petkova and Zhang (2005)) try to use additional risk that is not captured by systematic risk to explain the premiums.

While there are a number of interesting financial/accounting variables that are considered relevant in the study of stock returns (to list a few, leverage, P/E ratio, dividend payout ratio, book-to-market ratio), this paper focuses on a firm specific variable which is closely related to the firm investment decisions: operating leverage.

Firms face trade-off between fixed and variable operating costs. Operating leverage refers to the operating cost structure (fixed costs versus variable costs) a firm chooses for its business (Corporate Finance 9th ed., Ross, Westerfield, Jaffe). In general, a firm chooses an operating cost

structure with high fixed costs and low variable costs is said to have a high operating leverage; on the contrary, a firm that adopts an operating cost structure with low fixed costs and high variable costs is said to have a low operating leverage. Outsourcing is a good example of the decision on operating cost structure a firm takes. A firm can outsource the production department to an external supplier, and bear higher variable costs but lower fixed costs. Alternatively, it may as well purchase the property and machinery for production, which incurs a high level of fixed costs but lower variable costs in turn. Operating leverage, i.e. the trade-off between fixed and variable costs a firm chooses, is an important capital investment decision made by the management of the company.

Firms generate variable revenues. Fixed operating costs however, by definition, have to be paid in a fixed amount under any circumstances (however low or high the sales is). This leaves the firm with the possibility of greater losses or gains. In other words, the sensitivity of profit to the sales of a firm is amplified by the level of fixed costs it chose for its operating cost structure. This is much clearer with a simple numerical example:

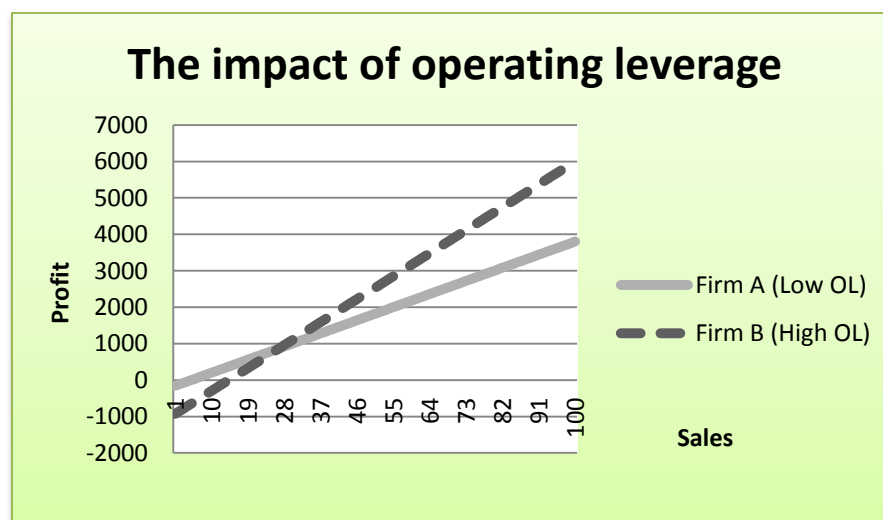
Firm A (low operating leverage) and Firm B (high operating leverage) produce identical products but have different cost structures, as shown in the following table:

Costs and price	Firm A	Firm B
	<i>(Low OL)</i>	<i>(High OL)</i>
Fixed cost	200	1000
Variable cost	80	50
Unit selling price	120	120

Assuming the sales volume of the two firms is the same under different economic states, the profit patterns of the two firms are significantly different due to the operating leverage they choose:

Economic states	Sales volume	Firm A profit	Firm B profit
Bad	10	200	-300
Medium	30	1000	1100
Good	100	3800	6000

As shown clearly in the graph below, by taking on extra operating leverage, firm B experiences higher cyclicality than firm A does when economic condition varies (i.e. during different business cycles) - it earns more in booming periods and loses more in recessions.



Financial leverage refers to the extent to which firms rely on debt capital (Corporate Finance 9th ed., Ross, Westerfield, Jaffe). Similar to operating leverage, financial leverage is the trade-off between fixed and variable financial costs a firm faces. A firm that adopts debt in its capital structure has to make fixed interest payments regardless of the profits it makes. Therefore, financial leverage can also work as a gear in generating revenues as operating leverage does.

It has been broadly accepted that operating leverage as well as financial leverage magnifies the sales risk faced by a firm and therefore leads to higher systematic risk and expected return (Lev (1974), Hill and Stone (1980), Gahlon (1980), Gahlon and Gentry (1982), Mandelker and Rhee (1984), Chung (1987)). Nonetheless, as Novy-Marx (2007) suggests, the role operating leverage plays in generating the cross-sectional variation of expected returns is likely to be under-biased

by two reasons. The first is a measurement problem as operating leverage is largely considered unobservable due to the lack of direct measures available from the observable accounting or market data. The second comes from the partial equilibrium models generally used in theory.

In this paper, the role of operating leverage in asset pricing is examined empirically in the following dimensions. First, the relation between expected return and operating leverage is reexamined. Second, the channel through which operating leverage explains the cross-sectional variation in expected return is discussed by empirical evidence, in specific, the relation between operating leverage and systematic risk as well as between operating leverage and the value and size premiums. Third, the association between operating leverage and financial leverage and a comparison of the impact they have on the expected rate of returns are also examined by empirical methods.

2. Literature review

2.1. The studies on real determinants of systematic risk

Following the establishment of Capital Asset Pricing Model (CAPM), a considerable number of studies have been conducted both theoretically and empirically to identify the real determinants of systematic risk¹.

Hamada (1972) is broadly deemed as the pioneer in the research category of real determinants of systematic risk. He links CAPM with the Modigliani and Miller (1963) proposition and reports in his empirical research that financial leverage accounts for approximately 21 to 24 percent of the cross-sectional variation in observed systematic risk. Rubinstein (1973) shows the association between systematic risk and operating leverage of a company through the application of the mean-variance analysis in the modern portfolio theory. Lev (1974) decomposes the total operating cost into variable and fixed components and finds empirical evidence for a negative association between systematic risk and the variable cost component². However, a few researchers (e.g. Chung (1989), Toms, Salama and Nguyen (2005)) cast doubt on Lev's empirical approach, pointing out that the decomposition of operating cost may suffer from measurement problems.

By repetitive substitutions, Mandelker and Rhee (1984) analytically derive that systematic risk can be decomposed into three independent elements: DOL (degree of operating leverage), DFL (degree of financial leverage) and the intrinsic business risk³. They investigate the combined effects of operating leverage and financial leverage on systematic risk. Their empirical findings report that, at portfolio level, approximately 40 percent of the cross-sectional variation in

¹ The studies include Hamada (1972) and Rubinstein (1973), Lev (1974), Hill and Stone (1980), Gahlon (1980), Gahlon and Gentry (1982), Mandelker and Rhee (1984), Chung (1987), Mensah (1992), Toms, Salama and Nguyen (2005) etc.

² The variable cost component is used as a measure of the operating leverage of the firm by Lev (1974). The higher the variable cost component is, the lower the operating leverage is.

³ The intrinsic risk defined by Mandelker and Rhee (1984) is the covariability of the market portfolio return and the product of the following two terms: the net profit margin one period before, and the return on common equity of the firm in the current period.

systematic risk can be attributed to DOL and DFL. However, they fail to introduce the intrinsic business risk into their empirical model.

Chung's (1989) study further enhances the Mandelker and Rhee (1984) model by adding demand beta as a measure of the intrinsic business risk. In the empirical test of his model, the coefficients of DOL and demand beta both are positive and significant, while the coefficient of DFL is positive but not significant. Approximately 20 percent of the cross-sectional variation in systematic risk is explained by the model. When using the instrumental variable technique, the significance of all three important independent variables improves dramatically, and the effect of DFL becomes significant. When the portfolio approach is adopted, the explanatory power of the model improves significantly from 20 percent to 54 percent.

Studies that examine the joint effect of operating leverage and financial leverage on systematic risk tend to conclude that the operating leverage effect is more significant than the financial leverage effect on systematic risk (Gahlon and Gentry (1982), Mandelker and Rhee (1984), Huffman (1989), Darrat and Mukherjee (1995), Li and Henderson (1991), Chung (1989), Lord (1996), Toms, Salama and Nguyen (2005)). In this thesis, the theoretical relationship between systematic risk and operating leverage and financial leverage is tested by empirical methods.

2.2. Studies on the value premiums of stock returns

The explanations for value and size effects have been a heated source of debate among financial researchers in the past decades, with a large number of studies involved in trying to reveal the underlying interpretation to the value premiums of the two effects. Fama and French (1992) suggest that the book-to-market ratio is associated with relative profitability. This means, on average, value firms have relatively high earnings while growth firms earn relatively low earnings. The evidence in Fama and French (1993) suggest that the risk factor HML captures the variation of relative profitability through time. "A high HML indicates that the difference in relative earnings performance is large during the certain period while a low HML means that difference in relative earnings is less significant during the time period. A stock with negative slope on HML has lower expected return as HML increases due to its hedge position against the

common factor in returns related to relative profitability.” Chen and Zhang (1998) show that the value premium of value stocks is a compensation to the additional risk induced by some characteristics of value stocks. Firms with high book-to-market ratio (value firms) typically face higher degree of financial distress, higher financial leverage and substantial uncertainty in future earnings performance. In addition, Chen and Zhang (1998) notice an interesting point of geographical difference in value effects⁴.

In contrast with the traditional view which holds that value effect is due to the priced financial distress risk in value firms, a new and growing literature is trying to explain the systematic risk and expected return evolutions through firm-level investment decisions by theoretical evidence. Berk, Green, and Naik (1999) are among the first in this line of research. Through a dynamic model they develop, the authors show that optimal investment decisions account for a predictable change in firm’s assets-in-place and growth opportunities and thus impacts the systematic risk and expected return of the firm stocks.

In spirit of Berk, Green, and Naik’s (1999) theoretical approach, Carlson, Fisher and Giammarino (2004) construct two dynamic models to relate endogenous firm investment to expected stock returns. They discover an economic role of operating leverage in explaining the value premium effect: when demand drops by some certain reasons, market value of equity declines due to the unfavorable performance of the firm while book value of equity remains basically the same, leading to a higher book-to-market ratio. And operating leverage can further amplify this dynamic by adding to the demand volatilities. They also show the impact of proportional growth opportunities on size effect with their dynamic models and find empirical support for these models.

Also from a perspective of real options, Zhang (2005) demonstrates that assets in place incorporate higher risk compared to growth options of the firm, especially in economic downturns where the risk premiums increase dramatically. This point of view is against the conventional wisdom which holds that growth options are riskier than assets in place due to their leverage feature on existing assets. His argument is based on an effect of “costly reversibility”,

⁴ That the value premium is strong in the mature U.S. markets, less persistent in growth markets in Japan, Hong Kong and Malaysia, and undistinguishable in high-growth markets of Taiwan and Thailand.

which states that cutting is more costly than expanding in capital for firms. He argues that it is more difficult for value firms to disinvest its unproductive capital than for growth firms in bad times, while in good times growth firms have more flexibility to adjust investment to the favorable economic conditions. Thus, value stocks bear higher risk than growth stocks do.

Novy-Marx (2010), for the first time, finds the direct empirical evidence for the “operating leverage hypothesis⁵” underlying most theoretical models of value premium. His empirical findings suggest that operating leverage, especially market operating leverage (the difference between book and market operating leverage is discussed later in the “operating leverage measurement” part), plays an important role in the value premium of the stock returns. He sorts stocks into quintile portfolios based on operating leverage and finds significant cross-sectional variation in expected returns and the HML loadings generated by Fama-French three factor model across the operating leverage quintiles. He also reaches a conclusion that there is no significant association between operating leverage and the book-to-market ratio by noticing that the sorting on operating leverage does not generate noticeable variation in the portfolios’ book-to-market ratios. This result contradicts with Garcia-Feijoo and Jorgensen’s (2010) empirical findings of a positive relation between the degree of operating leverage (DOL) and book-to-market ratio. This empirical contradiction is possibly due to the different operating leverage measures the two studies used⁶. In addition, Novy-Marx (2010) develops an equilibrium model which predicts that the value premium is largely an intra-industry phenomena and the relationship between expected returns and industry book-to-market is weak and non-monotonic. This prediction of the model is supported by the empirical results in his research.

Gulen, Xing and Zhang (2008) show a strong countercyclical variation pattern in expected value premium of stock returns through a Markov switching framework. They document that growth firms typically display stronger flexibility than value firms in adjusting to unfavorable economic

⁵ As in Navy-Marx (2007), “under the operating leverage hypothesis, high book-to-market firms earn higher returns because they are relatively more exposed to assets-in-place, and assets-in-place are riskier than growth options.”

⁶ Novy-Marx uses an operating leverage measure defined as annual operating costs divided by book assets or market assets (this definition of operating leverage is rarely used in the previous literatures), while Garcia-Feijoo and Jorgensen’s (2010) use the conventional operating leverage measure: degree of operating leverage (DOL), generated through time-series regressions.

conditions⁷ using a variety of flexibility proxies such as operating and financial leverage, the ratio of fixed assets to total assets and the frequency of disinvestment. They demonstrate that expected excess returns of value stocks are more severely affected than growth stocks in economic recessions, while in economic booms both stocks, value and growth, load insignificantly on economic condition measures. Their study sheds light on the cross-sectional expected returns from a perspective of the time-varying expected value premium.

From an accounting point of view, Penman, Richardson and Tuna (2007) raise an interesting point that the book-to-market ratio (or B/P ratio, as in their paper) is intrinsically an accounting phenomenon, which is determined solely by the accounting method accountants use to measure the book value rather than the risk of the equity. They decompose the book-to-market ratio into two components: an enterprise book-to-price component and a leverage component. The former, as measured by book value of net operating assets⁸ divided by its market value, is a reflection of firm operating activities and therefore serves as a proxy for operating risk. The latter, as measured by book value of net debt⁹ divided by market value of equity, is a commonly used measure of financing leverage and therefore reflects financial risk. This decomposition of book-to-market ratio is consistent with the argument that book-to-market ratio absorbs the leverage effect in the model explaining the expected return of stocks. Their empirical results confirm that the enterprise book-to-price component (as proxy for operating risk) is positively associated to expected returns. However, a negative association¹⁰ between the leverage component (reflects financing risk) and expected return is detected in the empirical approach which constitutes an anomaly against the conventional theory that financial risk is supposed to be compensated by higher expected returns. But as noticed by the authors, it is possible that this empirical finding is sample-specific.

⁷ In Gulen, Xing and Zhang (2008), unfavorable economic conditions are measured by high short-term interest rate and high default spread.

⁸ According to the accounting method the authors used, the firm assets are divided into “operating asset” and “financial asset” and accordingly the firm liabilities are divided into “operating liability” and “financial liability”. Net operating asset (NOA) is defined by the difference between operating asset and operating liability.

⁹ The net debt here is defined by the difference between financial liability and financial asset.

¹⁰ The negative association is significant after controlling for several variables including size, estimated beta, returns volatility, momentum and default risk and is therefore deemed robust.

Contrary to the conventional view of a positive relation between expected return and operating leverage in most of the standard corporate finance textbooks, Guthrie (2010) shows that a negative association between the two can be found when the real option to abandon the unprofitable project exists (which he argues is very common the case in reality). In his analysis he decomposes the firm's assets into first asset (abandonment option¹¹ free) and the abandonment option. Accordingly the expected rate of return is decomposed into two components: (1) expected return on first asset (relatively high) and (2) expected return on real option (lower than the risk free rate). And the expected rate of return is a weighted average of the two components. Guthrie demonstrates that as operating leverage increases, the first term (return on first asset) increases as in traditional finance theories, while the weight allocated to the second term (return on real option) also increases due to the increased level of risk. Because the second term provides a lower return compared with the first term, the effect of operating leverage on total expected return is mixed. Guthrie proves through a specific example that the second effect may dominate the first effect under certain circumstances and thus lead to an inverse relation between expected rate of return and operating leverage.

2.3. Measures of leverage

2.3.1. Definitions of leverage measures

The measurement of operating leverage has been a technical problem that plagues the researchers in this category of studies. This is due to the fact that fixed and variable costs are concepts in management accounting (internal accounting) rather than financial accounting (external accounting). This leads to substantial technical difficulties in accurately separating the variable and fixed costs from a firm's cost structure. And accordingly, operating leverage is unobservable from the firm's financial reports. In previous studies, researchers tried to use different proxies of operating leverage to investigate the relationship between operating leverage and systematic risk or expected stock returns. For instance, Lev (1974) uses unit variable as a proxy for operating leverage and demonstrates empirically the positive association between

¹¹ The abandonment option offers the owner of the firm the option to permanently abandon the project when the output price falls below a threshold that is chosen to maximize the value of the firm.

operating leverage and systematic risk. Percival (1974) derives analytically that contribution margin is a component in the covariance between stock returns and the market return and thus concludes that systematic risk is amplified by operating leverage through a form of contribution margin. Gahlon (1980) criticizes these studies by pointing out that these operating leverage measures (i.e. unit variable cost and contribution margin) do not take into account the level of fixed costs incurred by the firm and thus are inappropriate measures of operating leverage. He analytically demonstrates through two models, for single-product and multiproduct firms respectively, that the effect of operating leverage on firm's systematic risk is fully captured by the measure of degree of operating leverage (DOL).

Degree of operating leverage is widely used in finance literature and theories. As a quantitative measure of operating risk, degree of operating leverage has two definitions.

$$\text{Degree of operating leverage (DOL)} = \frac{\% \Delta \text{EBIT}}{\% \Delta Q} \quad (1)$$

The first definition of DOL contains an elasticity concept: the ratio of percentage change in operating income (EBIT) to percentage change in units sold (Q). We can rewrite the equation as following:

$$\text{DOL} = \frac{\% \Delta \text{EBIT}}{\% \Delta Q} = \frac{\Delta \text{EBIT} / \text{EBIT}}{\Delta Q / Q} = \frac{\Delta \text{EBIT}}{\Delta Q} \times \frac{Q}{\text{EBIT}}$$

If we denote P as price per unit (assumed that price does not change within the certain period), V as variable operating cost per unit and F as fixed operating cost, $Q(P-V)$ is known as the contribution margin (units sold times the difference between unit price and unit variable cost). We can denote operating income as $(P-V)Q-F$ (sales less variable operating cost less fixed operating cost). When units sold changes by ΔQ , operating income changes by $(P-V) \Delta Q$. The above equation can be rewritten as following:

$$\text{DOL} = \frac{\Delta \text{EBIT}}{\Delta Q} \times \frac{Q}{\text{EBIT}} = \frac{(P-V) \Delta Q}{\Delta Q} \times \frac{Q}{(P-V)Q-F} = \frac{Q(P-V)}{Q(P-V)-F} \quad (2)$$

This gives us the second definition of DOL: the ratio of contribution margin to operating income.

Similarly, we can define degree of financial leverage (DFL), the quantitative measure of financial risk, as in the following equation (3) and (4):

$$\text{Degree of financial leverage (DFL)} = \frac{\% \Delta \text{NI}}{\% \Delta \text{EBIT}} \quad (3)$$

In the first definition, DFL is the ratio of percentage change in net income (NI) to percentage change in operating income (EBIT). The second definition of DFL is as following:

$$\text{Degree of financial leverage (DFL)} = \frac{\text{EBIT}}{\text{EBIT} - \text{Interest}} \quad (4)$$

The intuition of this second definition of DFL is straightforward: the higher the fixed financial cost (interest expenses), the higher financial risk the firm faces.

The firm's total leverage is a combination of operating leverage and financial leverage. In accordance with the two definitions of DOL and DFL, the degree of total leverage is defined in the following two ways:

$$\text{Degree of total leverage (DTL)} = \text{DOL} \times \text{DFL} = \frac{\% \Delta \text{EBIT}}{\% \Delta Q} \times \frac{\% \Delta \text{NI}}{\% \Delta \text{EBIT}} = \frac{\% \Delta \text{NI}}{\% \Delta Q} \quad (5)$$

$$\text{Degree of total leverage (DTL)} = \frac{Q(P - V)}{Q(P - V) - F} \times \frac{\text{EBIT}}{\text{EBIT} - \text{Interest}} = \frac{Q(P - V)}{\text{EBIT} - \text{Interest}} \quad (6)$$

The first definition of total leverage can be interpreted as the percentage of change in net income when units sold change by 1 percent. In the second definition, degree of total leverage equals to the proportion of contribution margin in earnings before tax.

Novy-Marx (2010) argues that the operating leverage depends not on the level of the costs and revenues of the firm as commonly assumed, but on the capitalized values of all future costs and revenues of the firm. Accordingly, in his empirical research he uses the concepts of “book operating leverage” that is defined as the ratio between annual operating costs and book value of assets. This measure used by Novy-Marx has rarely been adopted by previous studies and little theoretical evidence can be found to support this approach, therefore the traditional and widely used DOL and DFL are adopted as the main variables throughout the empirical approach.

2.3.2. Estimation of DOL and DFL

A broadly used approach in empirical researches to estimate the degree of operating leverage and degree of financial leverage is time-series regression. For degree of operating leverage (DOL), this approach regresses the earnings before interest and tax (EBIT) on the sales (Q) in a time-series dimension. Accordingly, degree of financial leverage (DFL) is estimated by time-series regression of net income (NI) against earnings before interest and tax (EBIT). The variables (both dependent and independent) take the form of natural logarithm in the time-series regressions.

This logarithm form better captures the (first) definition of DOL and DFL but in the same time incorporates a problem with negative earnings (that the natural logarithm of a negative number does not exist). Researchers used a variety of methods to deal with the issue of negative numbers. For example, in Mandelker and Rhee (1984) a different estimation approach¹² is activated if negative earnings are observed. Chung (1989) adopts the approach Mandelker and Rhee (1984) use for negative observations for his whole sample in order to avoid estimation biases caused by different treatments between positive and negative observations. Garcia-Feijoo and Jorgensen's (2010) used a special transformation technique to obtain the main variables in natural logarithm form.

O'Brien and Vanderheiden (1987) argue that the DOL estimated by the time-series regression as suggested in Mandelker and Rhee (1984) would bias towards a value of one when sales and EBIT grow on average at the same rate. To avoid this estimation bias, they suggest a two-stage time-series regression technique which includes a detrending procedure before the time-series regression estimation for DOL. Dugan and Shriver (1992) compare these two estimation methods of DOL through an empirical approach and show that the O'Brien and Vanderheiden's estimation technique produces DOL estimates with less values of below one and the DOL estimate is more consistent with the ex-ante theory¹³. This approach is adopted by Garcia-Feijoo and Jorgensen's (2010) in their empirical research about operating leverage. However, as noticed

¹² For DOL, in case of negative observations for EBIT or sales, they first run a regression of earnings before interest and tax on sales (same regression variable but without natural logarithm format). Then the DOL is estimated by the coefficient of sales in the above time series regression divided by the 20-year average value of EBIT times the 20-year average value of sales.

¹³ Lord (1998), "According to ex-ante theory, these measures (measures of operating leverage) should be greater than one for firms operating above the breakeven point."

by Lord (1998), the DOL estimate from the detrending approach of O'Brien and Vanderheiden (1987) is also problematic: it tends to produce more volatile series of DOL estimates than the Mandelker and Rhee approach.

Another approach for the measure of DOL is the point-to-point method, which estimates the DOL as the ratio of changes in earnings to changes in sales ($\frac{\% \Delta EBIT}{\% \Delta Q}$). Following this method, Ferri and Jones (1979) define the degree of operating leverage in their empirical study as: $DOL = \frac{E_t - E_{t-1}}{E_{t-1}} / \frac{S_t - S_{t-1}}{S_{t-1}}$ where E_t is the earnings before interest and taxes in year t and S_t represents the sales in year t . They also include two alternative measures of operating leverage which are based on the accounting data: 1) FA/TA, value of fixed assets to value of total assets; $\mu(FA) / \mu(TA)$, the average value of fixed assets to the average value of total assets in the preceding years (in their analysis they use the average value of the preceding four years). Gulen, Xing and Zhang (2008) measure the operating leverage by the ratio of the percentage change in operating income before depreciation to the percentage change in sales in their empirical approach.

3. Hypothesis, Data and Methodology

3.1. Hypothesis

The main purpose of this thesis is to provide aggregate direct empirical proof for the previous theoretical studies on operating leverage and dynamics of expected returns where straightforward empirical evidence is almost always missing. In addition, the interaction effect of operating leverage and financial leverage indicates a necessity to include financial leverage in the empirical research of operating leverage to avoid the endogenous problems. Thus, the hypotheses to be tested by empirical methods in this thesis are as below:

H1: Expected stock return is positively associated with operating leverage.

H2: Systematic risk is positively associated with operating leverage.

H3: Book-to-market ratio is positively associated with operating leverage.

H4: Size is positively associated with financial leverage.

H5: Operating leverage plays a more important role in asset pricing than financing leverage (in terms of their impact on expected return and systematic risk).

3.2. Sample selection

The sample used in this empirical research is based on all North American firms (except for financial and utility firms) that have available data record both on Center for Research in Security Prices (CRSP) and Compustat for no less than five years during the time window of 1988-2011¹⁴. Firms from financial industry (SIC code: 6000-6900) and utility industry (SIC code: 4000-4900) are excluded from the sample as the financial industry has its special capital structure (high leverage, low equity) amongst the others and the utility industry typically has

¹⁴ The first four years, 1988-1991, are included for the aim of time-series regression estimation of certain variables; the empirical researches of the hypotheses are actually based on the 20-year research period of 1992-2011.

more predictable revenue growths compared to other industries (Jegadeesh, N. and Livnat, J. (2006)).

The monthly security data is obtained from Center for Research in Security Prices (CRSP) tape and annual financial statement data is obtained from the CRSP/Compustat Merged database. Security data includes monthly return (RET), stock price (PRC), number of shares outstanding (SHROUT) and market value-weighted return including distributions (VWRETD). Annual financial statement data includes earnings before interest and taxes (EBIT), sales (SALE), cost of goods sold (COGS), selling, general and administrative expense (XSGA), interest and related expense (XINT), net income (NI), total assets (AT), property, total net plant and equipment (PPENT), total common/ordinary equity (CEQ), debt in current liabilities (DLC) and total long term debt (DLTT).

3.3. Variable definition

3.3.1. DOL and DFL

The Mandelker and Rhee (1984) time-series regression approach is adopted for the estimation of DOL and DFL, which are used as the main explanatory variables in the research. One shortcoming of the M&R (1984) is that the DOL and DFL derived from their approach are time invariant, which is obviously against the fact that the operating leverage and financial leverage of the firm may change from time to time. Therefore, I follow the empirical approach of Garcia-Feijoo and Jorgensen's (2010) who estimate the annually time-varying DOL and DFL by running the time-series regressions at five-year overlapping intervals at firm-level:

$$\ln EBIT_{it} = \gamma_{0i} + \gamma_{1i} \ln Sales_{it} + u_{it} \quad (7)$$

$$\ln NI_{it} = \lambda_{0i} + \lambda_{1i} \ln EBIT_{it} + v_{it} \quad (8)$$

Where the regression coefficients $\widehat{\gamma}_{1i}$ and $\widehat{\lambda}_{1i}$ are the estimations of DOL and DFL for company i respectively. u_{it} and v_{it} are error terms. The time period for these regressions runs from 1992 to 2011¹⁵ (20 years in total).

The transformation technique used by Garcia-Feijoo and Jorgensen's (2010) to deal with negative values in estimation of DOL and DFL is adopted here. The transformation is as following:

$$\begin{cases} Y = \ln(1+X) , & \text{if } X \geq 0 \\ Y = -\ln(1-X) , & \text{if } X < 0 \end{cases}$$

Where X stands for EBIT, Sales or Net Income and Y is the value of the natural logarithm of the three variables after the transformation.¹⁶

In addition, the degree of total leverage (DTL) is used as a measure of combining effect of operating leverage and financial leverage, which is calculated as the product of DOL and DFL estimated from the time-series regressions above.

3.3.2. Alternative variables of operating and financial leverage

Alternative proxies for operating leverage and financial leverage are also included in the empirical approach in order to make comparisons to previous studies (e.g. Novy-Marx (2010), Garcia-Feijoo and Jorgensen (2010)) with their empirical results as well as a robustness check of the empirical results. These alternative leverage measures are defined as following:

Book operating leverage and market operating leverage and an alternative measure of book operating leverage as used by as in Novy-Marx (2010):

$$BOL = \frac{\mu(\text{net fixed assets})}{\mu(\text{Book Value of Assets})} \quad (9)$$

¹⁵ For example, the DOL for the year 1992 is estimated by the time-series regression over fiscal years 1988-1992; the DOL for the year 1993 is estimated over fiscal years 1989-1993 so on so forth. Therefore the real time window for the data is from 1988 to 2011.

¹⁶ The adjusted value of LnEBIT, LnSales and LnNI are used hereafter, readers should bear in mind that these are not the natural logarithm of original data but values after the adjustment.

$$MOL = \frac{\mu(\text{net fixed costs})}{\mu(\text{Market Value of Assets})} \quad (10)$$

$$BOLX = \frac{\text{Annual Operating Cost}}{\text{Book Value of Assets}} \quad (11)$$

Where $\mu(\text{net fixed costs})$ stands for the five year average value of book value of net fixed costs (observed from Compustat as the total net property, plant and equipments) and the same applies for book and market value of assets as well as that of debt and equity below. The third definition of operating leverage is used in Novy-Marx (2010).

Book financial leverage, market financial leverage and an alternative definition of degree of financial leverage:

$$BFL = \frac{\mu(\text{Book Value of Debt})}{\mu(\text{Book Value of Equity})} \quad (12)$$

$$MFL = \frac{\mu(\text{Book Value of Debt})}{\mu(\text{Market Value of Equity})} \quad (13)$$

$$DFLX = \frac{EBIT}{EBIT - \text{Interest}} \quad (14)$$

3.3.3. Systematic risk - beta

In order to investigate the association between systematic risk and operating leverage, the commonly used market model is adopted for the estimation of beta:

$$R_{it} = \alpha_{it} + \beta_{it}R_{mt} \quad (15)$$

Where R_{it} is the holding period return (with dividends) of company i in month t and R_{mt} is the return on value-weighted market portfolio (including all distributions).

The beta estimated by this approach is equity beta (or levered beta). Another commonly used systematic risk measure is asset beta (or unlevered beta) which, by definition, reflects the systematic risk of the firm regardless of its capital structure (i.e. the systematic risk of the firm as if the firm were 100% financed by equity). Equity beta is more appropriate in the context of this

thesis as equity beta includes the impact of debt in the capital structure and we are interested in the role of financial leverage as one of the determinants of systematic risk.

Similar to DOL and DFL, the estimation of systematic risk is based on the five-year (60 months) overlapping interval regressions.

3.3.4. Return, size and book-to-market ratio

Following the previous literature¹⁷, average monthly return of calendar year t is calculated as equally weighted average of monthly returns from July (year t) to the next June (year $t+1$).

The market capitalization of the firm in year t is calculated as the product of price and number of shares outstanding by the end of June in year t . Price and shares outstanding data are obtained from CRSP monthly stock file.

The book-to-market variable is defined as the book value of common equity at the end of previous fiscal year (year $t-1$) divided by the market capitalization by the end of June in year t if fiscal year end is between January and June, or the market capitalization by the end of December in year $t-1$ if fiscal year end is between July and December.

¹⁷ Fama and French (1996), Garcia-Feijoo and Jorgensen (2010) etc.

Table 1 – Summary variables

Variables	Definitions	Description
Average monthly return ¹	$\sum (12 \text{ RETs}) / 12$	Annually observed
DOL	γ_1 from: $\text{Ln EBIT} = \gamma_0 + \gamma_1 \text{Ln Sales} + u$	5-year overlapping regressions
BOL	$\mu(\text{PPENT}) / \mu(\text{AT})$	5 year average
MOL	$\mu(\text{PPENT}) / \mu(\text{AT} + \text{PRC} * \text{SHROUT} - \text{CEQ})$	5 year average
BOLX	$(\text{COGS} + \text{XSGA}) / \text{AT}$	Annually observed
DFL	λ_1 from: $\text{Ln NI} = \lambda_0 + \lambda_1 \text{Ln EBIT} + v$	5-year overlapping regressions
BFL	$\mu(\text{DLC} + \text{DLTT}) / \mu(\text{CEQ})$	5 year average
MFL	$\mu(\text{DLC} + \text{DLTT}) / \mu(\text{PRC} * \text{SHROUT})$	5 year average
DFLX	$\text{EBIT} / (\text{EBIT} - \text{XINT})$	Annually observed
DTL	$\text{DOL} * \text{DFL}$	Annually calculated
Beta	β_i from: $R_i = \alpha_i + \beta_i R_m$	5-year overlapping regressions
ME ²	$\text{PRC} * \text{SHROUT}$	Annually observed
BE/ME ³	$(\text{CEQ}) / \text{ME}$	Annually observed

¹. The 12 months start from July to the June of next year.

². As explained in the variable definition, PRC and SHROUT are both data in June of each calendar year.

³. As defined above, CEQ is the book value of equity from the end of last fiscal year and ME is the market capitalization by the end of June in year t if fiscal year end is between January and June, or the market capitalization by the end of December in year t-1 if fiscal year end is between July and December.

3.4. Methodology

The main methods used in the empirical test of this thesis are portfolio formation and cross-sectional regressions at both firm and industry level.

3.4.1. Portfolio formation approach

Quintile portfolios are formed at the end of June each year from 1992 to 2010 based on two pairs of variables: book-to-market ratio and size, DOL and DFL.

Book-to-market & Size

Every year, firms are formed into 5×5 quintile portfolios based on their book-to-market ratio and size. Upon construction of the portfolios, the cross-sectional average values of the following variables are calculated for each portfolio: monthly return (equally weighted), DOL, DFL, DTL, BOL, MOL, BFL and MFL. The time-series average values of these variables of each portfolio are then calculated and reported in the empirical results. This portfolio formation approach is similar to what is used in Fama and French (1993) and Garcia-Feijoo and Jorgensen (2010).

DOL & DFL

In order to obtain an initial understanding about the impact of operating leverage and financial leverage on expected return, systematic risk and value and size effects, quintile portfolios are formed on DOL and DFL each year.

Following the construction of portfolios by the end of each June, the portfolio average monthly return is calculated as equally weighted average of the average monthly return all the firms in the portfolio. Portfolio market capitalization (ME) is calculated as the average of market capitalization of each stock in the portfolio by the end of June in year t . Portfolio beta is calculated as value weighted average beta of the stocks in the portfolio. The same portfolio formation and calculation apply to the next year till the June of 2010.

Upon obtaining the time-series data of the 25 portfolios, the average values of all the variables are calculated for each portfolio and reported in the empirical results.

This portfolio formation approach has never been used in the past with this line of research (as far as the author is aware of). In the previous studies where portfolio formation method is used, portfolios are formed either on operating leverage measures or on financial leverage measures, but never at the same time. However as some previous theoretical and empirical studies suggest, a U-shaped relation exist between operating and financial leverage. Therefore, it is sensible to include both DOL and DFL in the portfolio to make sure that when one variable (DOL or DFL) changes, the other (DFL or DOL) remains unchanged.

3.4.2. Cross-sectional regression approach

The cross-sectional regression approach includes two components: individual firm level regressions and industry level regressions.

Individual firm level

The individual firm level cross-sectional regressions aim to examine three theoretical relations regarding operating leverage: first, the expected stock returns and operating leverage; second, the systematic risk of stock and operating leverage; third, the book-to-market ratio and operating leverage. Econometric models to be tested are as following:

Expected return as dependent variable:

$$\begin{aligned} \text{Average montly return}_i \\ = a_0 + a_1 \text{Ln DOL}_i + a_2 \text{Ln DFL}_i + a_3 \text{Ln } \beta_i + a_4 \text{Ln (BE/ME)}_i + a_5 \text{Ln ME}_i + \varepsilon_i \end{aligned} \quad (16)$$

Systematic risk as dependent variable:

$$\text{Ln } \beta_i = b_0 + b_1 \text{Ln DOL}_i + b_2 \text{Ln DFL}_i + b_3 \text{Ln (BE/ME)}_i + b_4 \text{Ln ME}_i + \varphi_i \quad (17)$$

Book-to-market ratio as dependent variable:

$$\text{Ln (BE/ME)}_i = c_0 + c_1 \text{Ln DOL}_i + c_2 \text{Ln DFL}_i + c_3 \text{Ln ME}_i + \psi_i \quad (18)$$

Size as dependent variable:

$$\text{Ln ME}_i = c_0 + c_1 \text{Ln DOL}_i + c_2 \text{Ln DFL}_i + c_3 \text{Ln (BE/ME)}_i + \psi_i \quad (19)$$

By definition, degree of total leverage (DTL) is linearly dependent on DOL and DFL, therefore cannot be added in the same regression with DOL and DFL. As a result, DTL will be tested separately in the cross-sectional regressions as a combined effect of operating leverage and financial leverage.

The time-series average values of the coefficients and t-statistics of the above regressions are reported in the empirical results.

Industry level

The two-digit SIC code is used for defining the industries here. Industry return is calculated as the equally-weighted average of the monthly average returns of all firms belong to the industry each year. The independent variables, DOL, DFL, beta, BE/ME and ME are calculated as the average values of all companies in the industry each year during 1992 and 2010. Panel data method is used in the industry level regression.

Industry expected return as dependent variable:

$$\begin{aligned} & \text{Industry average return}_{it} \\ &= p_0 + p_1 \text{Ln DOL}_{jt} + p_2 \text{Ln DFL}_{jt} + p_3 \text{Ln } \beta_{jt} + p_4 \text{Ln (BE/ME)}_{jt} + p_5 \text{Ln ME}_{jt} + \varepsilon_{jt} \quad (20) \end{aligned}$$

Cross-sectional regression at industry level can also be seen as a special case of portfolio grouping approach in which portfolios are formed based on industry categories.

4. Empirical results

4.1. Sample description

The summary statistics of the sample used for this empirical research is presented in Table 2. The full sample constitutes of 20,094 observations in total.

Table 2- Sample description

Market data are collected from CRSP monthly stock file from January 1988 to December 2011. And accounting data are collected from CRSP/COMPUSTAT Merged database for fiscal years 1988-2011.

For the sake of convenience, two market capitalization variables are specified as shares outstanding times price at the end of June and end of December each year (nominated as ME_6 and ME_12 respectively). Average monthly return (year t) is calculated as the equally weighted average of monthly returns from July (year t) to the next June (year t+1). Book-to-market ratio (year t) is defined as the book value of common equity at the end of previous fiscal year (year t-1) divided by the market capitalization by the end of June (ME_6) in year t if fiscal year end is between January and June, or the market capitalization by the end of December (ME_12) in year t-1 if fiscal year end is between July and December. The end-June market capitalization (ME_6) is used as proxy for size in the empirical tests. Beta is estimated by 5-year rolling regression at monthly level, i.e. 60 months for each beta estimate, following the market model:

$$R_{it} = \alpha_{it} + \beta_{it} R_{mt}$$

Main test variable, degree of operating leverage and degree of financial leverage, are estimated by the following rolling regressions at five-year intervals (coefficients of LnSales and LnEBIT respectively):

$$\text{Ln EBIT}_{it} = \gamma_{0it} + \gamma_{1it} \text{LnSales}_{it} + u_{it}$$

$$\text{Ln NI}_{it} = \lambda_{0it} + \lambda_{1it} \text{LnEBIT}_{it} + v_{it}$$

Alternative proxies for operating leverage, BOL, MOL and BOLX are defined as five-year average ratio of net fixed assets to book value of assets, five-year average ratio of net fixed assets to market value of assets and ratio of operating costs to book value of assets.

Similarly alternative proxies for financial leverage, BFL, MFL and DFLX are defined as five-year average ratio of debt to book value of equity, five-year average ratio of debt to market value of equity and ratio of EBIT divided by EBIT less interests.

Companies with less than five year market data on CRSP or accounting data on COMPUSTAT are excluded from the sample. CRSP and COMPUSTAT datasets are then merged by permno, year (fiscal year for COMPUSTAT dataset) and two-digit sic code. The first four year observations of each company are dropped after the estimation of DOL, DFL, BOL, MOL, BFL and MFL. Finally, observations with negative book value

of equity, negative DOL, negative DFL¹⁸ and missing average monthly returns are dropped from the sample. Finally the value of average monthly return, market capitalization (ME), book-to-market ratio (BE/ME), DOL and DFL of the top 0.5% and bottom 0.5% observations were set at the same value as the top and bottom 0.5 percentiles respectively. This is to avoid the influence of outliers and extreme observations to the empirical results and is commonly used in literature (e.g. Fama and French (1992), Garcia-Feijoo and Jorgensen (2010)).

Sample summary statistics

variable	mean	sd	max	min	p25	p50	p75	N
Ret (%)	1.53	4.01	18.90	-9.41	-0.72	1.27	3.34	20,094
ME (mln)	3615	12923.02	122113	2.59	65.69	332.26	1549.34	20,094
BE/ME	1.46	6.18	71.89	0.03	0.30	0.50	0.86	20,094
LnME	5.84	2.23	13.07	-0.93	4.18	5.81	7.35	20,094
LnBE/ME	-0.63	1.07	8.26	-8.92	-1.22	-0.70	-0.15	20,094
Beta	1.10	0.78	6.01	-3.33	0.58	0.99	1.49	20,094
DOL	3.27	4.84	34.96	0.02	0.95	1.58	3.38	20,094
DFL	1.68	2.30	18.74	0.06	0.83	1.02	1.41	20,094
DTL	4.46	6.99	48.81	0.01	0.93	1.83	4.76	20,094
BOL	0.29	0.22	0.91	0.01	0.12	0.24	0.41	20,094
MOL	0.21	0.20	1.07	0.00	0.06	0.15	0.30	20,094
BOLX	1.13	0.75	4.54	0.07	0.62	0.97	1.44	20,094
BFL	0.59	0.85	6.70	0.00	0.10	0.36	0.74	20,094
MFL	0.75	3.33	37.07	0.00	0.04	0.16	0.43	20,094
DFLX	1.17	1.32	11.30	-7.77	1.00	1.07	1.24	20,094

After comparing the summary statistics of the sample used in the empirical research to that of Garcia-Feijoo and Jorgensen's (2010), I find that the statistics of the main variables employed in our research are very similar. The only exception lies in the mean value of book-to-market ratio of the sample, which is probably due to the different definitions of the ratio in the research.

¹⁸ Because negative DOL and DFL values are economically irrational, I delete the observations with negative DOL and DFL values. In Garcia-Feijoo and Jorgensen (2010), the authors measure DOL in absolute value and drop the negative DFL observations. I use their method as a robustness check in the last section of the thesis.

The correlations among test variables are presented in Table 3. Consistent with traditional literature, size (ME) is negatively correlated with average monthly return while beta and book-to-market ratio (BE/ME) are positively correlated with average monthly return. All the proxies for operating leverage (DOL, BOL, MOL and BOLX) are positively correlated with average return, which is in line with our expectation for the role of operating leverage. For financial leverage the correlation with average monthly return is less consistent for each proxy: DFL (degree of financial leverage) shows no correlation with return; BFL (book financial leverage) and DFLX (alternative definition of DFL) show positive correlation with return; and MFL (market financial leverage) shows a negative correlation with return. This is also consistent with our expectation that financial leverage plays a less distinguishable role in expected return of assets.

It is also worthy to notice that DOL is relatively strongly correlated with book-to-market ratio and beta in a positive direction (with both correlation coefficients of 0.14) while DFL is relatively strongly correlated with size in a positive direction (with correlation coefficient of 0.16). These initial results will be demonstrated with more rigorous empirical tests later on.

Table 3 - Correlation coefficients among main test variables

Corr	Ret	LnME	LnBM	Beta	DOL	DFL	DTL	BOL	MOL	BOLX	BFL	MFL	DFLX
Ret	1.00												
LnME	-0.14	1.00											
LnBE/ ME	0.10	-0.42	1.00										
Beta	0.02	0.09	-0.08	1.00									
DOL	0.01	-0.04	0.14	0.14	1.00								
DFL	0.00	0.16	0.04	0.01	-0.09	1.00							
DTL	0.01	0.08	0.12	0.11	0.67	0.47	1.00						
BOL	0.02	0.07	0.06	-0.20	0.02	-0.00	0.02	1.00					
MOL	0.02	-0.16	0.47	-0.21	0.10	0.03	0.10	0.81	1.00				
BOLX	0.01	-0.22	0.05	-0.08	0.03	-0.01	0.02	-0.17	-0.11	1.00			
BFL	0.01	0.03	-0.05	-0.06	0.03	0.18	0.13	0.17	0.19	0.01	1.00		
MFL	-0.01	-0.13	0.55	-0.05	0.04	0.06	0.05	0.04	0.25	-0.03	0.16	1.00	
DFLX	0.01	0.00	0.02	-0.03	-0.03	0.06	0.01	0.03	0.04	0.01	0.10	0.02	1.00

4.2. Empirical results from portfolio formation

Quintile portfolios formed on book-to-market ratio and size

Each year from 1992 to 2010 I form quintile portfolios of individual firms based on book-to-market ratio (BE/ME) and size (ME). After the formation of portfolios, the test variables (average monthly return, DOL, DFL etc.) of the portfolios are calculated by the equally-weighted average of all the firms in each portfolio every year. Then the time-series average values of each variable for the portfolios are calculated and reported as in the following table.

Table 4 - Quintile portfolios formed on book-to-market (BE/ME) and size (ME)

From 1992 to 2010, 5×5 quintile portfolios are formed by the end of June on book-to-market ratio (BE/ME) and size (ME) at firm level every year. The book-to-market ratio of year t is defined as book value of common equity at the end of fiscal year t-1 divided by the market capitalization by the end of June in year t if fiscal year end is between January and June, or the market capitalization by the end of December in year t-1 if fiscal year end is between July and December. And size is proxied by market capitalization at the end of June each year. All test variables are as defined in Table I. Numbers reported in the table are time series average values of the test variables of each portfolio.

ME Quintile	Book-to-Market (BE/ME) Quintile					ALL
	BE/ME-Low	BE/ME -2	BE/ME -3	BE/ME -4	BE/ME -High	
Average Monthly Return						
ME-Small	1.78%	2.13%	1.80%	2.32%	2.60%	2.13%
ME-2	1.18%	1.00%	1.51%	1.67%	1.71%	1.41%
ME-3	0.84%	1.20%	1.33%	1.32%	1.59%	1.26%
ME-4	1.10%	1.20%	1.20%	1.37%	1.41%	1.25%
ME-Big	1.06%	1.00%	1.16%	0.91%	1.58%	1.14%
ALL	1.19%	1.31%	1.40%	1.52%	1.78%	
Average DOL						
ME- Small	2.64	2.48	2.32	2.66	4.02	2.83
ME-2	2.67	2.74	3.21	3.51	5.22	3.47
ME-3	2.77	2.85	3.11	4.07	4.57	3.48
ME-4	2.81	2.69	2.92	4.27	5.80	3.70
ME- Big	1.91	2.22	3.45	5.30	6.75	3.93
ALL	2.56	2.60	3.00	3.96	5.27	

Table 4 - Continued

	Average DFL					
ME- Small	1.00	1.00	0.99	1.07	1.31	1.08
ME-2	1.21	1.11	1.23	1.35	1.67	1.32
ME-3	1.27	1.29	1.69	1.93	2.02	1.64
ME-4	1.42	1.75	2.19	2.51	2.72	2.12
ME- Big	1.68	2.34	2.62	3.50	4.15	2.86
ALL	1.32	1.50	1.75	2.07	2.37	

	Average DTL					
ME- Small	2.55	2.47	2.22	2.65	4.32	2.84
ME-2	2.90	2.84	3.47	3.90	5.89	3.80
ME-3	3.29	3.28	4.30	5.83	6.97	4.74
ME-4	3.50	3.85	4.93	7.46	9.43	5.83
ME- Big	3.20	4.56	7.10	10.38	15.38	8.12
ALL	3.09	3.40	4.40	6.04	8.40	

	Average BOL					
ME- Small	0.22	0.24	0.28	0.26	0.28	0.26
ME-2	0.21	0.23	0.26	0.29	0.32	0.26
ME-3	0.24	0.29	0.31	0.30	0.33	0.29
ME-4	0.29	0.33	0.35	0.35	0.34	0.33
ME- Big	0.28	0.34	0.37	0.40	0.32	0.34
ALL	0.25	0.29	0.31	0.32	0.32	

	Average MOL					
ME- Small	0.10	0.14	0.19	0.22	0.34	0.20
ME-2	0.09	0.13	0.17	0.23	0.38	0.20
ME-3	0.10	0.15	0.20	0.24	0.39	0.22
ME-4	0.11	0.17	0.23	0.28	0.40	0.24
ME- Big	0.10	0.19	0.25	0.33	0.36	0.25
ALL	0.10	0.16	0.21	0.26	0.37	

Table 4 - Continued

	Average BFL					
ME- Small	0.97	0.59	0.53	0.49	0.54	0.62
ME-2	0.58	0.46	0.41	0.47	0.65	0.52
ME-3	0.83	0.45	0.46	0.53	0.68	0.59
ME-4	0.78	0.53	0.56	0.67	0.67	0.64
ME- Big	0.67	0.63	0.71	0.78	0.78	0.71
ALL	0.77	0.53	0.54	0.59	0.66	

	Average MFL					
ME- Small	0.26	0.25	0.31	0.36	3.33	0.90
ME-2	0.14	0.18	0.24	0.35	2.37	0.66
ME-3	0.20	0.17	0.24	0.39	3.50	0.90
ME-4	0.16	0.19	0.28	0.46	4.53	1.13
ME- Big	0.11	0.22	0.35	0.54	1.83	0.61
ALL	0.18	0.20	0.28	0.42	3.11	

Table 4 shows the results of quintile portfolios formed on book-to-market ratio (BE/ME) and size (ME). Unconditionally, value stocks (high BE/ME) consistently outperform growth stocks (low BE/ME) with average monthly return increasing from 1.19% to 1.78% across the book-to-market quintiles and small firms consistently outperform large firms with average monthly return decreasing from 2.13% to 1.14% across the size quintiles. Conditionally, the expected return increases strictly across BE/ME quintiles within the fourth size quintile and decreases strictly across size quintiles within the third BE/ME quintile. This result is exactly as expected and consistent with the conventional knowledge in asset pricing that expected return is higher for value and small firm stocks (value and size effect).

Unconditionally, the average DOL increases monotonically from 2.56 to 5.27 across the book-to-market quintiles and increases monotonically from 2.83 to 3.93 across the size quintiles. The same applies for the two alternative proxies for operating leverage, BOL and MOL. These results indicate a positive association between operating leverage and book-to-market and between operating leverage and size, but the association between operating leverage and book-to-market ratio seems to be stronger as the operating leverage measures increase more significant across the book-to-market quintiles than the size quintiles. And conditionally, DOL increases strictly across

BE/ME quintiles within the second, third and fifth size quintile and across size quintiles within the highest two BE/ME quintiles.

The portfolio formation results of DFL suggest a positive association between DFL and size. The average DFL increases monotonically within all book-to-market quintiles as size increases. And unconditionally it increases monotonically from 1.08 to 2.86 as size increases from the smallest quintile to the largest. The association between size and financial leverage is unobservable by BFL (book financial leverage) and unconditionally observable by MFL (market financial leverage). There also seems to be a positive association between DFL and book-to-market ratio as average DFL increases unconditionally from 1.32 (low BE/ME quintile) to 2.37 (high BE/ME quintile), but this association is less significant than that between DFL and size.

The combined effect of operating leverage and financial leverage, DTL (degree of total leverage), shows a significant positive association with both book-to-market ratio and size. For example, unconditionally, average DTL increases from 2.84 to 8.12 within the size quintiles and from 3.09 to 8.40 within book-to-market quintiles.

In summary, the results from the portfolio formation based on book-to-market ratio and size provide us initial proof for our hypothesis about the positive association between operating leverage and book-to-market ratio. Additionally, a positive association between financial leverage and size is traced in the portfolio formation results too. The positive association between operating leverage and book-to-market ratio suggests firms that adopt a high operating leverage (high fixed cost and low variable cost in the asset structure) tend to have high book-to-market ratio. And as the positive association between financial leverage and size suggests, big firms tend to adopt a high financial leverage (more debt and less equity in the capital structure). These results are also very similar to that of Garcia-Feijoo and Jorgensen's (2010).

Quintile portfolios formed on DOL and DFL

Table 5 shows the results from portfolio formed on operating leverage (DOL) and financial leverage (DFL). But since operating leverage and financial leverage are less dominant than size and book-to-market ratio for their influence on expected return, the empirical results from these

portfolio formations are not as significant as those from the book-to-market and size quintiles. However, there is still some evidence for the role of operating leverage and financial leverage that is worth of our notice.

Table 5 - Quintile portfolios formed on DOL and DFL

From 1992 to 2010, 5×5 quintile portfolios are formed by the end of June based on operating leverage (DOL) and financial leverage (DFL) at firm level every year. DOL and DFL are estimated by the time-series regression as suggested by Mandelker and Rhee (1984) but with 5-year overlapping intervals in order to obtain DOL and DFL for each firm annually. All test variables are as defined in Table 1. Numbers reported in the table are time series average values of the test variables of each portfolio.

DFL Quintile	DOL Quintile					ALL
	DOL-Low	DOL-2	DOL-3	DOL-4	DOL-High	
Average Monthly Return						
DFL-Low	1.31%	1.46%	1.42%	1.77%	1.61%	1.51%
DFL-2	1.43%	1.23%	1.65%	1.68%	1.67%	1.53%
DFL-3	1.48%	1.36%	1.55%	2.10%	1.59%	1.62%
DFL-4	1.28%	1.50%	1.48%	1.61%	1.89%	1.55%
DFL-High	1.41%	1.41%	1.57%	1.43%	1.36%	1.44%
ALL	1.38%	1.39%	1.53%	1.72%	1.62%	
Average Market Capitalization (Ln ME)						
DFL-Low	5.25	5.89	5.64	4.82	5.13	5.35
DFL-2	5.37	6.19	5.73	4.82	4.95	5.41
DFL-3	5.55	6.83	6.31	5.11	5.36	5.83
DFL-4	5.81	6.88	6.33	5.77	5.08	5.97
DFL-High	6.15	6.63	6.51	6.45	6.18	6.38
ALL	5.63	6.48	6.10	5.39	5.34	
Average Book-to-Market Ratio (BE/ME)						
DFL-Low	1.58	1.42	1.18	1.53	1.78	1.50
DFL-2	0.85	1.58	1.56	1.00	1.68	1.34
DFL-3	1.43	1.12	1.12	1.23	1.98	1.38
DFL-4	1.02	1.21	1.13	1.24	1.55	1.23
DFL-High	2.20	1.39	1.06	2.18	1.99	1.76
ALL	1.42	1.35	1.21	1.44	1.80	

Table 5- Continued

	Average Beta					
DFL-Low	0.92	0.93	0.97	1.04	1.22	1.02
DFL-2	1.03	0.97	1.06	1.11	1.21	1.08
DFL-3	1.07	1.06	1.02	1.16	1.41	1.14
DFL-4	1.04	0.98	1.00	1.13	1.26	1.08
DFL-High	1.04	1.00	1.07	1.11	1.20	1.08
ALL	1.02	0.99	1.02	1.11	1.26	

Evidence is a bit less convincing for the positive association between leverage (DOL and DFL) and expected return compared to the results from the portfolio formed on book-to-market and size. Unconditionally, average monthly return increases monotonically from 1.38% to 1.72% in the first four DOL quintiles but drops to 1.62% for the fifth DOL quintile. And for DFL quintiles the average monthly return is hump-shaped as average return increases from 1.51% (first quintile) to 1.62% (third quintile) and then decreases to 1.44% (fifth quintile).

The portfolio formation on DOL and DFL provides further evidence for the positive association between DFL and size. Unconditionally, the average market capitalization increases from 5.35 to 6.38 as DFL increases from the lowest to the highest quintile. And conditioning on the degree of operating leverage, the average market capitalization increases monotonically across the DFL quintiles within the first, third and fourth DOL quintiles.

Even though the results show no monotonic trend of book-to-market ratio as DOL increases, we can see that the high-DOL quintile consistently has higher BE/ME ratio than the second and third DOL quintiles across the DFL quintiles. And there is no evidence for systematic change in book-to-market ratio as DFL increases.

The results show some evidence for a positive association between DOL and beta. Conditioning on the lowest quintile of DFL, average beta increases monotonically from 0.92 to 1.22 across the DOL quintiles. Unconditionally, average beta monotonically increases from 0.99 to 1.26 across the higher four DOL quintiles. The low-DOL quintile is a little inconsistent in this case with a

lower value of 1.02. But it is worthy to notice that the high-DOL quintile has consistently higher average beta value than the other four DOL quintiles across all the DFL quintiles.

Consistent with the results from the quintile portfolios formed on book-to-market ratio and size, the second portfolio formation on DOL and DFL adds evidence for the positive association between size and financial leverage and between operating leverage and beta. Though less convincing, it also provides some support for the positive association between DOL and book-to-market ratio.

In general, the portfolio formation results provide initial support for our hypotheses that operating leverage is positively associated with expected return, book-to-market ratio and beta, while financial leverage is positively associated with size. And the effect on expected return is stronger from operating leverage than from financial leverage.

4.3. Empirical results of firm-level regressions

Every year I run four cross-sectional regressions at firm level of the following dependent variables: average monthly return, beta, book-to-market ratio (BE/ME) and size (ME). The average monthly return of the firm in year t equals the average return from July to the June of next year. Beta is estimated annually by running 5-year rolling regressions of the market model (coefficient of the value-weighted market return). The market capitalization of the firm in year t is calculated as the product of price and number of shares outstanding by the end of June in year t . The book-to-market ratio is defined as the book value of common equity at the end of previous fiscal year (year $t-1$) divided by the market capitalization by the end of June in year t if fiscal year end is between January and June, or the market capitalization by the end of December in year $t-1$ if fiscal year end is between July and December. The time-series average values of the coefficients from the cross-sectional regressions are reported in percentage in Table 6.

Table 6 - Firm level regression results

I separately regress average monthly return, beta, book-to-market ratio (BE/ME) and size (ME) against DOL, DFL, DTL and other control variables each year from 1992 to 2010 at firm level. All variables are as defined in Table 1. The time-series average coefficients of the cross-sectional regressions are reported in percentage in

the following tables. T-statistics (calculated as the time-series average value of the t-statistics from the cross-sectional regressions) are in brackets. Constants are included in all specifications of the regressions but are not reported in the results.

Panel A: Average monthly return as dependent variable

Ind. Var.	Dependent variable: Average monthly return									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
LnDOL	0.06 (0.63)			0.06 (0.62)	0.05 (0.45)	0.03 (0.32)	0.04 (0.42)	0.04 (0.36)		
LnDFL		-0.01 (-0.07)		0.00 (0.06)	-0.03 (-0.05)	-0.01 (-0.05)	0.09 (0.69)	0.08 (0.62)		
LnDTL			0.04 (0.56)						0.05 (0.58)	
LnBeta					0.39 (0.83)					0.54 (1.28)
LnBE/ME						0.25** (2.42)		0.05 (0.62)	0.05 (0.65)	0.04 (0.54)
LnME							-0.22*** (-4.05)	-0.21*** (-3.34)	-0.21*** (-3.32)	-0.22*** (-3.43)

*, **, ***; significant at 10,5,1 percent level respectively.

Panel B: Beta as dependent variable

Ind. Var.	Dependent variable: Beta (LnBeta)				
	(1)	(2)	(3)	(4)	(5)
LnDOL	3.38*** (3.70)		3.45*** (3.78)	3.58*** (3.90)	
LnDFL		1.25 (1.03)	1.76 (1.41)	1.13 (1.01)	
LnDTL					2.84*** (3.68)
LnBE/ME				-2.02* (-1.70)	-2.15* (-1.81)
LnME				1.09* (1.83)	0.91 (1.54)

*, **, ***; significant at 10,5,1 percent level respectively.

Table 6-Continued**Panel C: Book-to-Market as dependent variable**

Ind. Var.	Dependent variable: Book-to-Market (LnBE/ME)				
	(1)	(2)	(3)	(4)	(5)
LnDOL	9.51*** (3.36)		9.80*** (3.45)	8.11*** (3.17)	
LnDFL		2.08 (0.56)	3.39 (0.87)	12.72*** (3.34)	
LnDTL					9.30*** (4.30)
LnME				-21.37*** (-15.54)	-21.10*** (-15.55)

*, **, ***, significant at 10, 5, 1 percent level respectively.

Panel D: Size as dependent variable

Ind. Var.	Dependent variable: Size (LnME)				
	(1)	(2)	(3)	(4)	(5)
LnDOL	-10.44* (-1.89)		-8.10 (-1.48)	0.64 (0.05)	
LnDFL		45.25*** (5.36)	43.94*** (5.18)	46.70*** (6.11)	
LnDTL					14.32*** (3.18)
LnBE/ME				-86.87*** (-15.54)	-87.93*** (-15.55)

*, **, ***, significant at 10, 5, 1 percent level respectively.

4.3.1. Average monthly return

Table 6 Panel A shows the regression results of the average monthly return with 10 specifications. Consistent with the previous literature, book-to-market ratio is positively associated to expected return and size is negatively associated to expected return. Even though no significant evidence is traced for the association between DOL and expected return, the sign of the coefficients of DOL is consistently positive despite different control variables were added

to the regression. For DFL the association with expected return is also insignificant, and the sign changed from negative to positive when size is added into the regression. The possible explanation for this result is that DFL is positively related to size and therefore when size is added to the regression, part of the role of DFL is absorbed by size.

The insignificance of the regressions results for DOL, DFL and DTL are more or less expected due to the “error-in-variable” problem. As independent variable, DOL, DFL and DTL are not directly observable from any available accounting or market data. Instead, they have to be estimated by time-series regression which may lead to an error that involved in the DOL, DFL and DTL estimates we use in the cross-sectional regressions. In addition, as suggested by O’Brien and Vanderheiden (1987), the estimation results for DOL from the simple time-series regression method of Mandelker and Rhee (1984) might be biased by the co-varying growth of EBIT and sales. Garcia-Feijoo and Jorgensen (2010) use a detrending procedure as suggested by O’Brien and Vanderheiden (1987) before the time-series estimation of Mandelker and Rhee (1984) and report positive association between DOL and expected return. They also report in their robustness check that their empirical results are sensitive to this detrending procedure employed in the research.

4.3.2. Systematic risk

In order to testify the association between systematic risk and operating (and financial) leverage, I run regressions of beta against DOL, DFL and DTL, using BE/ME and ME as control variable. The regression results are reported in Table 6 Panel B.

As suggested by the regression results, there is a significant positive association between DOL and systematic risk regardless of the control variables added to the regressions. While the coefficients of DFL are also consistently positive, none of them show statistically significance. These results are consistent with the conventional theory that systematic risk can be amplified by the leverage (operating and financial) the firm takes. In other words, other conditions being equal, firms with high operating leverage and financial leverage would have higher systematic risk. And it also suggests that operating leverage has a stronger effect on systematic risk of the firm compared with financial leverage.

4.3.3. Book-to-market ratio (BE/ME)

From the correlation matrix in sample description as well as portfolio formation results initial evidence was found for the positive association between DOL and book-to-market ratio. But a more rigorous empirical approach is required to draw the solid conclusion about this association. In Table 6 Panel C, I report the results of the cross-sectional regressions of book-to-market ratio against DOL, DFL and DTL. Size (ME) is added as a control variable in some specifications of the regression.

As the regression results in Table 6 Panel C show, DOL is positively associated with book-to-market ratio and this association is statistically significant. For DFL, the coefficients are positive but not statistically significant. Only when size is added as a control variable in the model, DFL becomes significantly associated with book-to-market. As a combined effect of DOL and DFL, DTL is also positively associated with book-to-market ratio. But this association is less strong than that between DOL and book-to-market ratio. These results well matches the operating leverage hypothesis that associates the value premium to the firm level investment decisions (operating leverage). They are also consistent with the empirical results in Garcia-Feijoo and Jorgensen (2010).

4.3.4. Size (ME)

As suggested by the initial results from sample description and portfolio formation, financial leverage is positively associated with size (ME). That is to say, big firms tend to have higher debt ratio than small firms. This result is rather intuitive as big firms generally have more access to debt (more collaterals, higher credit ratings etc.) than small firms.

Table 6 Panel D shows the time-series average of the regression results of size against DOL, DFL and DTL. In some specifications, control variable book-to-market ratio is added to the regression. As the results suggest, DFL is significantly positively associated to size. This association is robust to DOL and the book-to-market ratio as control variables in the regressions. The association between DOL and size is not robust across the different specifications of the regression. When DOL is the only explanatory variable, it seems to be negatively associated with

size. When adding DFL to the regression, the sign remains negative but no longer statistically significant. And when book-to-market ratio is added, its sign changes to positive and is statistically insignificant. The combined effect of operating leverage and financial leverage, DTL, is also significantly positively associated with size.

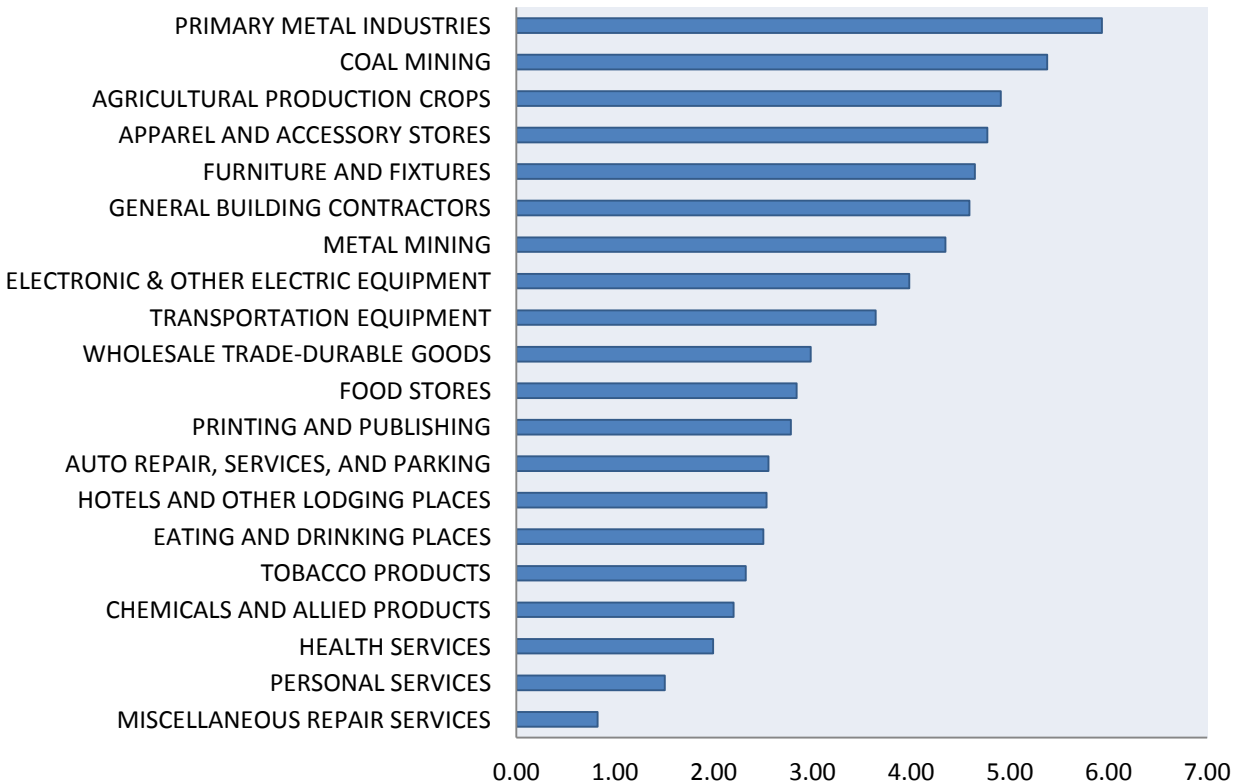
In summary, the empirical evidence from the firm level regressions is consistent with both the initial results from portfolio formation and the theories about operating leverage and financial leverage. The regression results suggest that DOL is positively associated with expected return, and this positive association can be a result of higher systematic risk (higher beta) or higher value premium (higher book-to-market ratio). The association between DFL and expected return is less consistent as that between DOL and expected return. But DFL is positively associated with size which has a strong negative association with expected return.

4.4. Empirical results at industry and division level

The previous empirical methods are all based on data at individual firm level. However, the leverage level chose by a firm is largely dependent on the industry that the firm belongs to. In other words, the industry characteristics might have certain influence on the operating leverage and financial leverage of the firm. For this reason, it is important to pay attention to the empirical results at an industry and division level.

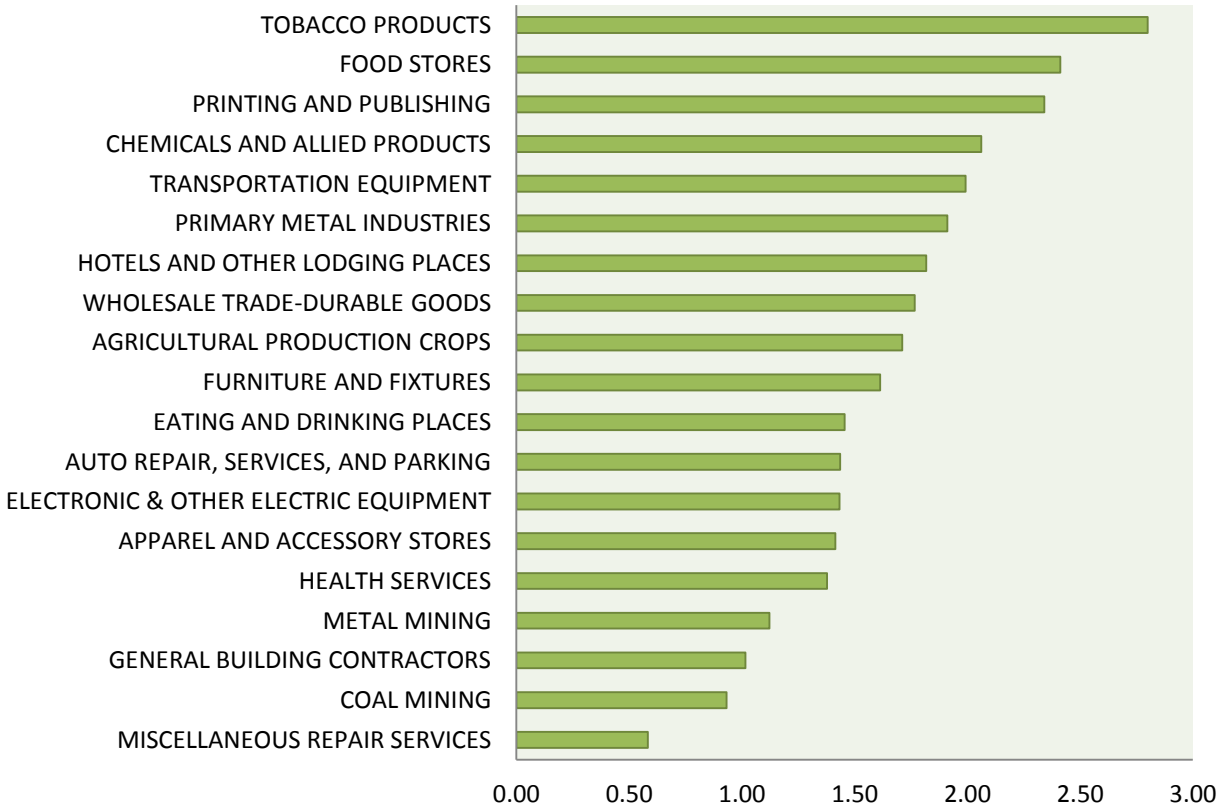
All companies in the sample are divided into 52 industries based on the 2-digit SIC code. DOL, DFL and DTL of each industry are calculated as the equally weighted average of DOL, DFL and DTL of all companies included in the industry during the 19 years (1992-2010). Then 19 representative industries are chosen out of the 52 industries from the sample and their average DOL, DFL and DTL are reported in figures1 to 3.

Figure 1 - Degree of Operating Leverage (DOL) of Different Industries



As can be seen from Figure 1, the degree of operating leverage (DOL) varies significantly across industries. For instance, the industry-level DOL increases from 0.82 for miscellaneous repair service to 5.93 for the primary metal industries. Mining, agriculture and construction industries have relatively high operating leverage. Such results are intuitive as these industries often require a big amount of fixed investment (plants, properties and equipments etc.) in assets. The figure also shows that service industries have relatively low operating leverage than other industries. This result is also easy to be interpreted as the most important investment in service industry is human resource which means a high level of variable costs and relatively low level of fixed costs.

Figure 2 - Degree of Financial Leverage (DFL) of Different Industries



The degree of financial leverage (DFL) of the 19 different industries is shown in Figure 2. Compared with DOL, DFL varies less significantly across industries, with 0.58 for miscellaneous repair services as the lowest and 2.80 for tobacco products as the highest. In addition, food stores, printing and publishing, chemicals and allied products, transportation equipment and primary metal industries tend to have higher financial leverage than other industries. Reasons are less straightforward behind the high financial leverage of these industries and no clear pattern can be easily drawn. But as suggested by the previous empirical results, financial leverage is positively associated with the size. That is, large firms tend to have more debt in their capital structure than small firms because of better access to the debt market. Therefore, compared with operating leverage, financial leverage is influenced more by the firm characteristics than the industry characteristics.

Figure 3 - Degree of Total Leverage (DTL) of Different Industries

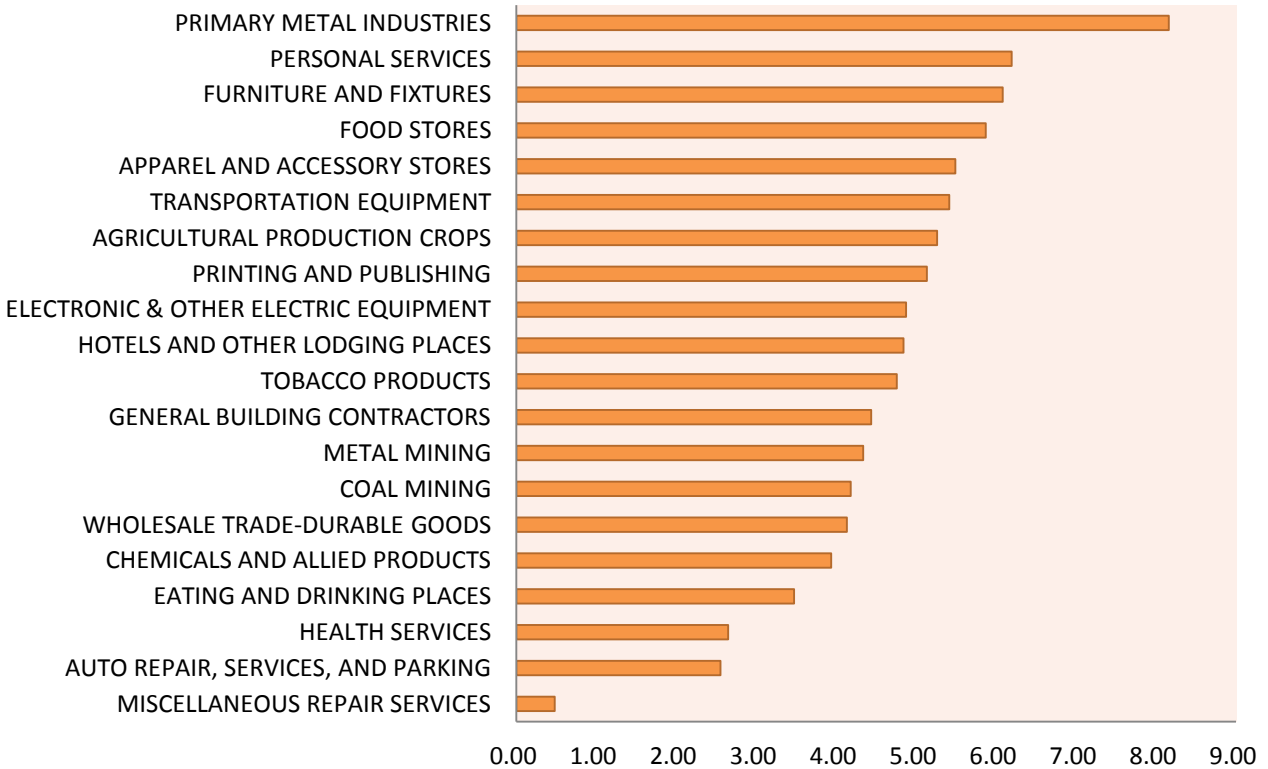
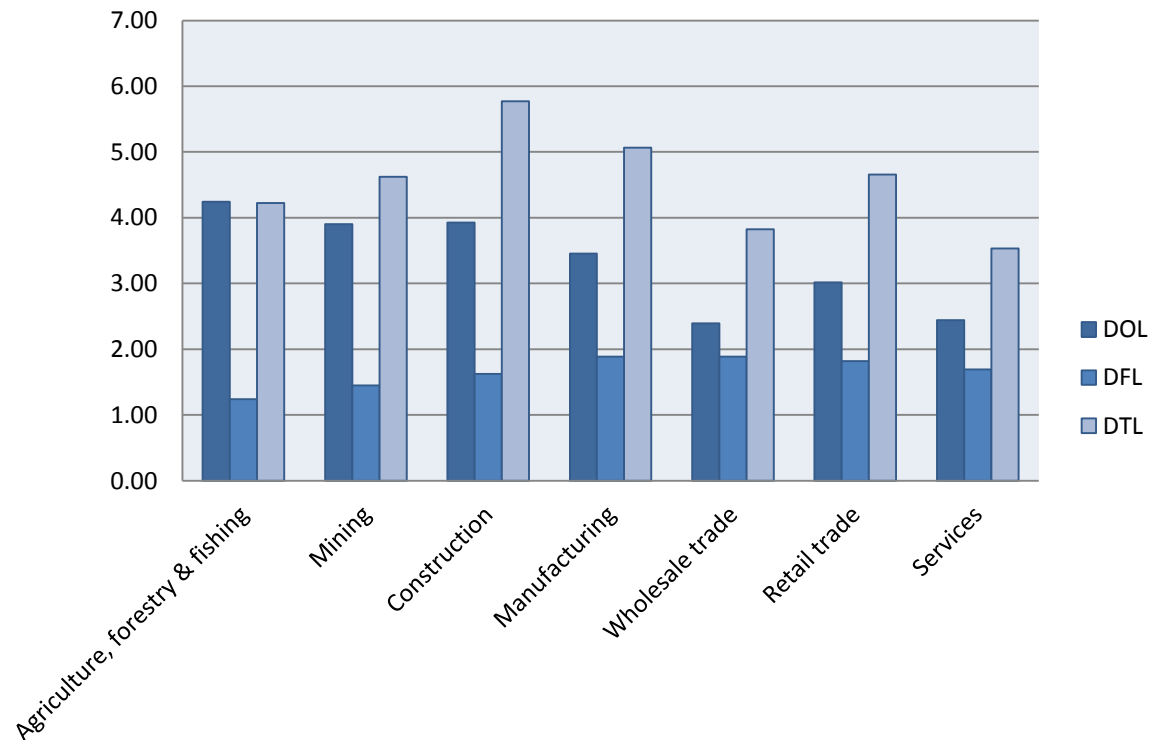


Figure 3 shows the degree of total leverage (DTL) of the 19 industries. By definition, DTL is a combined effect of operating leverage and financial leverage. As suggested in the figure, DTL varies significantly across the industries. Primary metal industry has the highest DTL of 8.16 and miscellaneous repair service has the lowest DTL of only 0.48. Furniture and fixtures, food stores, apparel and accessory stores and transportation equipment have relatively high total leverage than the other industries. Health service and auto repair service have relatively low total leverage among all the industries.

The above results of DOL, DFL and DTL are all from the industry level. However some industries may have some characteristics in common. For this reason, the 52 industries are further grouped into seven divisions. Similarly to the industry level leverage measures, the DOL,

DFL and DTL of each division are calculated as the equally weighted average of DOL, DFL and DTL of all industries it contains during the 19 years (1992-2010).

Figure 4 - DOL DFL & DTL by Divisions



Consistent with our previous findings, the agriculture, forestry and fishing, mining and construction divisions have significantly high degree of operating leverage and the wholesale trade and services divisions have significantly low degree of operating leverage. Financial leverage is high in manufacturing and wholesale trade division and low in construction, mining and agriculture, forestry and fishing. In general the variation in financial leverage is less obvious compared with that of operating leverage. In terms of total leverage, the division of construction has the highest leverage level amongst the seven divisions and the division of service has the lowest. All these results are intuitively understandable as divisions like agriculture, forestry and fishing, mining and construction require a high amount of fixed investment; while for the divisions like service, variable costs accounts more in the total investment. By nature of the

different business, firms involved in construction, manufacturing and wholesale trade tend to be larger in size as a result of scale of economy and firms involved in agriculture and service tend to have smaller size. As the positive association between financial leverage and size suggests, this difference in firm size can explain the variation in capital structure (financial leverage) of the firms.

It is interesting to notice that there seems to be a “trade-off” effect between operating leverage and financial leverage among the divisions. As is clearly shown in the figure, divisions with higher operating leverage tend to have lower financial leverage (i.e. agriculture, forestry and fishing, mining, construction) and the lower operating leverage is accompanied by higher financial leverage in the wholesale trade, retail trade and service divisions. It proves that operating leverage and financial leverage are not independent but interacted. This is also consistent with the negative correlation between DOL and DFL we found in the sample description.

4.5. Empirical results from industry-level regressions

In order to investigate the impact of industry DOL and DFL on the expected return of the industry, I run regressions of industry returns against industry DOL, DFL, DTL, and use industry beta, book-to-market ratio and size as control variables.

Table 7 - Industry level regression results

Industry return is calculated as the equally-weighted average return of the monthly average return of all companies in the industry during the sample period (1992-2010). The independent variables are calculated as the equally-weighted average of all companies in the industry during 1992-2010. The Miscellaneous repair services industry (two digit SIC code: 76) is dropped from sample due to the lack of enough observations¹⁹. T-statistics are in brackets. Constants are included in all specifications of the regression but are reported in the results.

¹⁹ There are only two observations in the miscellaneous repair services industry.

Table 7-Continued

Ind. Var.	Dependent variable: industry return				
	(1)	(2)	(3)	(4)	(5)
DOL	0.17*** (3.08)		0.17*** (2.99)	0.16*** (2.73)	
DFL	-0.07 (-0.57)		-0.07 (-0.57)	-0.08 (-0.63)	
DTL					0.01 (0.27)
Beta		0.5 (1.48)		0.27 (0.85)	0.05 (1.31)
BE/ME		0.01 (0.22)	0.00 (0.08)		0.00 (0.19)
ME		-0.00 (-0.02)	0.00 (0.22)		-0.00 (-0.01)

*, **, ***, significant at 10, 5, 1 percent level respectively.

The results of the industry-level regressions are instructive. In contrast with the firm level regression results, at industry level, operating leverage is significantly positively associated with expected return. The association between DFL and expected return is still insignificant, but the sign is consistently negative regardless of the control variables added to the regressions. Beta, book-to-market ratio and size do not show significant influence on expected return at industry level. These results suggest that value effect is more of an intra-industry effect rather than inter-industry. This is consistent with Norvy Marx's (2010) model which predicts that value premium is an intra-industry phenomenon and the association between industry book-to-market ratio and expected return is weak and non-monotonic. In addition to the book-to-market ratio, beta and size are also insignificant in the industry level regressions of expected return. These results suggest that the traditional asset pricing theories (CAPM and Fama-French three factor model etc.) that apply for individual firms do not have a good explanatory power for the returns at industry level. But operating leverage, on the contrary, plays a significant role in explaining the industry return even though it seems to be less significant in explaining returns at individual firm level.

5. Robustness checks

In this section, robustness checks are performed on the methodology and variable definitions employed in the main empirical research in the previous section.

5.1. Robustness check on methodology

In the empirical approach in the previous section, 5441 observations with negative DOL values are dropped from the sample, which accounts for almost 20% of the observations in the whole sample (28960 observations). Garcia-Feijoo and Jorgensen (2010) use an alternative method to deal with the negative DOL values-the absolute value. I use this method and conduct the regression approach again with the new sample (absolute DOL values) as a robustness check. The results of the regressions are reported in Table 8.

Table 8 – Regression results with absolute DOL values

As an alternative empirical approach to Table 6, DOL is calculated as the absolute value when negative values are observed. All the variables are as defined in Table 1. The time-series average coefficients of the cross-sectional regressions are reported in percentage in the following tables. T-statistics (calculated as the time-series average value of the t-statistics from the cross-sectional regressions) are in brackets. Constants are included in all specifications of the regressions but are not reported in the results.

Panel A: Average monthly return as dependent variable

Ind. Var.	Dependent variable: Average monthly return									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
LnDOL	0.0 (0.60)			0.04 (0.59)	0.03 (0.45)	0.02 (0.30)	0.04 (0.52)	0.03 (0.43)		
LnDFL		-0.02 (-0.05)		-0.02 (-0.01)	-0.04 (-0.17)	-0.03 (-0.11)	0.07 (0.61)	0.05 (0.49)		
LnDTL			0.03 (0.47)						0.04 (0.56)	
LnBeta					0.33 (0.72)					0.51 (1.32)
LnBE/ME						0.25*** (2.66)		0.08 (0.91)	0.08 (0.92)	0.06 (0.76)
LnME							-0.21*** (-4.15)	-0.20*** (-3.32)	-0.19*** (-3.34)	-0.20*** (-3.48)

*, **, ***, significant at 10, 5, 1 percent level respectively.

Table 8-Continued**Panel B: Beta as dependent variable**

Ind. Var.	Dependent variable: Beta (LnBeta)				
	(1)	(2)	(3)	(4)	(5)
LnDOL	2.77*** (3.50)		2.84*** (3.60)	2.94*** (3.73)	
LnDFL		1.09 (0.99)	1.60 (1.43)	0.93 (0.95)	
LnDTL					2.36*** (3.49)
LnBE/ME				-2.10** (-2.03)	-2.22** (-2.14)
LnME				1.25** (2.34)	1.11** (2.13)

*, **, ***, significant at 10, 5, 1 percent level respectively.

Panel C: Book-to-market as dependent variable

Ind. Var.	Dependent variable: Book-to-Market (LnBE/ME)				
	(1)	(2)	(3)	(4)	(5)
LnDOL	8.58*** (3.55)		8.98*** (3.69)	8.46*** (3.83)	
LnDFL		2.86 (0.81)	4.38 (1.21)	13.54*** (3.93)	
LnDTL					9.68*** (5.04)
LnME				-21.29*** (-16.51)	-21.02*** (-16.49)

*, **, ***, significant at 10, 5, 1 percent level respectively.

Table 8-Continued**Panel D: Size as dependent variable**

Ind. Var.	Dependent variable: Size (LnME)				
	(1)	(2)	(3)	(4)	(5)
LnDOL	-5.55 (-1.20)		-2.79 (-0.62)	4.67 (1.04)	
LnDFL		43.93*** (6.00)	43.26*** (5.87)	46.85*** (7.01)	
LnDTL					16.08*** (4.20)
LnBE/ME				-81.08*** (-16.51)	-81.90*** (-16.49)

*, **, ***, significant at 10, 5, 1 percent level respectively.

The regression results in Table 8 are very similar to those reported in Table 6. It suggests that the alternative method for negative DOL values does not influence empirical results from the main approach in the previous section. The only noticeable change is in Panel B, where the negative association between beta and book-to-market ratio and the positive association between beta and size are statistically more significant than in the previous section. The positive association between DOL and beta, DOL and book-to-market ratio and between DFL and size are robust to the change in the empirical method with negative DOL values.

5.2. Robustness check on variable definitions

Degree of operating leverage and degree of financial leverage are the most commonly used measures for operating and financial leverage in the previous studies. Nonetheless, there are some drawbacks in these measures (e.g. DOL and DFL are not observable from the available marketing or accounting data). They are estimated by running time-series regressions, in which errors are inevitably involved. The “point-to-point” approach for the operating and financial leverage measures can complement the DOL and DFL measures to some extent. Therefore, in the second part of the robustness check, part of the former empirical tests is performed again

with alternative measures of operating and financial leverage. The alternative measures of operating leverage include book operating leverage (BOL), market operating leverage (MOL) and an alternative book operating leverage used by Norvy-Marx (2010) (BOLX). The alternative measures of financial leverage include book financial leverage (BFL), market financial leverage (MFL) and an alternative measure of degree of financial leverage (DFLX). The definitions of these variables are available in Table 1.

5.2.1. Portfolio formation

The results of the portfolio formation on BOL and BFL are reported in Table 9. The portfolio formation method is exactly the same as in Table 4 except that portfolios are formed on BOL and BFL instead of DOL and DFL.

Table 9 – Quintile portfolios formed on BOL and BFL

From 1992 to 2010, 5×5 quintile portfolios are formed by the end of June based on BOL and BFL at firm level every year. BOL is defined as five-year average ratio of net fixed assets to book value of assets. BFL is defined as five-year average ratio of debt to book value of equity. All test variables are as defined in Table 1. Numbers reported in the table are time series average values of the test variables of each portfolio.

BFL Quintile	BOL Quintile					ALL
	BOL-Low	BOL-2	BOL-3	BOL-4	BOL-High	
Average Monthly Return						
BFL-Low	1.43%	1.55%	1.51%	1.21%	1.48%	1.44%
BFL-2	1.81%	1.50%	1.43%	1.60%	1.40%	1.55%
BFL-3	0.96%	1.53%	1.70%	1.61%	1.66%	1.49%
BFL-4	1.64%	1.24%	1.54%	1.57%	1.61%	1.52%
BFL-High	1.43%	1.82%	1.41%	1.48%	1.62%	1.55%
ALL	1.45%	1.53%	1.52%	1.50%	1.55%	
Average Market Capitalization (LnME)						
BFL-Low	4.91	5.49	5.36	5.81	5.26	5.37
BFL-2	5.16	5.46	5.70	5.88	6.13	5.67
BFL-3	5.50	5.65	6.04	6.34	6.12	5.93
BFL-4	5.25	5.94	6.30	6.31	6.32	6.02
BFL-High	5.18	5.85	6.17	6.01	6.01	5.84
ALL	5.20	5.68	5.91	6.07	5.97	

Table 9-Continued

	Average Book-to-Market Ratio (BE/ME)					
BFL-Low	0.59	0.76	1.39	1.25	2.20	1.24
BFL-2	0.69	1.03	1.42	1.74	0.87	1.15
BFL-3	0.82	1.15	1.59	1.21	1.55	1.26
BFL-4	1.19	1.67	2.15	2.17	1.83	1.80
BFL-High	1.03	2.00	2.71	2.46	1.48	1.94
ALL	0.86	1.32	1.85	1.77	1.59	
	Average Beta					
BFL-Low	1.38	1.30	0.94	1.02	0.77	1.08
BFL-2	1.28	1.24	1.10	1.01	0.91	1.11
BFL-3	1.22	1.18	1.12	1.09	0.88	1.10
BFL-4	1.27	1.08	1.05	1.06	0.92	1.08
BFL-High	1.20	1.02	0.92	1.00	0.99	1.03
ALL	1.27	1.16	1.03	1.04	0.89	

Similar to the results of the portfolios formed on DOL and DFL, the BOL and BFL quintiles do not generate significant change in expected returns. This result is not surprising as the association between operating (financial) leverage and expected return is not as strong as that between expected return and book-to-market ratio or size. There is weak evidence of a positive association between BFL and size: unconditionally, market capitalization increases from 5.73 to 6.02 across the first four BFL quintiles as BFL increases, but then decreases to 5.84 for the highest BFL quintile. BOL, on the contrary, seems to be positively associated with size as it increases monotonically within three (second, fourth and fifth) quintiles conditioning on BFL. This can be easily understood with common sense: firms that are bigger in size tend to have more fixed assets and therefore higher book operating leverage. There is no noticeable evidence for the association between systematic risk and BOL or BFL.

5.2.2. Firm level regressions

Similar to the firm level regressions in the previous section, I run cross-sectional regressions every year of the four independent variables (average monthly return, beta, book-to-market ratio and size) against the alternative operating and financial leverage variables: BOL and BFL, MOL

and MFL, BOLX and DFLX. Subsequently the time-series average of regression coefficients are calculated and reported in Table 10 in percentage.

Table 10 – Results of regressions with alternative leverage variables

Alternative operating leverage measures, BOL, MOL and BOLX and alternative financial leverage measures BFL, MFL and DFLX are the main test variables in the cross-sectional regressions. Definitions of variables are available in Table 1. The time-series average coefficients of the cross-sectional regressions are reported in percentage in the following tables. T-statistics (calculated as the time-series average value of the t-statistics from the cross-sectional regressions) are in brackets. Constants are included in all specifications of the regressions but are not reported in the results.

Panel A: BOL & BFL

Dep. Var	Ave. monthly return		LnBeta		LnBE/ME		LnME	
Ind. Var	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
BOL	0.07 (0.25)	0.28 (0.58)	25.49*** (4.79)	27.72*** (5.25)	35.74** (2.33)	59.62*** (4.33)	118.95*** (3.81)	150.63*** (5.34)
BFL	0.05 (0.53)	0.07 (0.68)	-0.77 (-0.51)	-0.51 (-0.31)	-7.71** (-2.12)	-6.53* (-1.95)	6.65 (0.93)	0.39 (0.09)
LnBE/ME		0.06 (0.67)		-0.87 (-0.71)				-87.79*** (-15.66)
LnME		-0.21*** (-3.31)		1.54** (2.68)		-21.36*** (15.66)		

*, **, ***, significant at 10, 5, 1 percent level respectively.

Panel B: MOL & MFL

Dep. Var	Ave. monthly return		LnBeta		LnBE/ME		LnME	
Ind. Var	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
MOL	0.32 (0.74)	-0.31 (-0.32)	31.56*** (5.47)	31.49*** (5.02)	187.95*** (14.73)	170.62*** (14.83)	-93.67** (-2.80)	-128.44*** (-3.70)
MFL	-0.02 (-0.42)	-0.06 (-1.40)	0.20 (0.52)	0.05 (0.20)	15.81*** (19.74)	14.66*** (20.36)	-7.23*** (-3.26)	11.17*** (5.04)
LnBE/ME		0.20 (1.37)		1.18 (0.85)				-117.24*** (-15.79)
LnME		-0.19** (-2.94)		1.24** (2.15)		-16.29*** (15.79)		

*, **, ***, significant at 10, 5, 1 percent level respectively.

Table 10-Continued**Panel C: BOLX & DFLX**

Dep. Var	Ave. monthly return		LnBeta		LnBE/ME		LnME	
Ind. Var	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
BOLX	0.06 (0.48)	-0.07 (-0.28)	2.79* (1.90)	2.15 (1.46)	7.34* (1.66)	-4.93 (-1.22)	-57.30*** (-6.63)	-50.92*** (-6.53)
DFLX	0.03 (0.45)	0.04 (0.52)	-0.50 (-0.57)	-0.40 (-0.48)	2.29 (0.82)	2.56 (1.02)	1.33 (0.27)	3.29*** (5.04)
LnBE/ME		0.06 (0.68)		-1.72 (-1.44)				-84.58*** (-15.21)
LnME		-0.21*** (-3.26)		0.89 (1.54)		-21.18*** (-15.21)		

*, **, *** , significant at 10,5,1 percent level respectively.

No significant evidence for the association between expected return and operating leverage or financial leverage is observed with the alternative measures of leverage. Regression results in Panel A and Panel B lend support for the positive association between beta and operating leverage, whilst no evidence is traced for the association between beta and financial leverage.

Evidence for positive association between book-to-market ratio and operating leverage is observed in Panel A (BOL and BFL) and Panel B (MOL and MFL). In Panel C (BOLX and DFLX) without controlling for size, the coefficient of BOLX is significant at the 10% level.

Evidence is mixed for the association between operating leverage and size. BOL is positively associated with size in the sample while MOL and BOLX are negatively associated with size. These results are intuitive by the definition of the variables. BOL is defined as the ratio of net fixed assets to total assets, and firms that are bigger in size tend to employ more fixed assets. By definition, MOL is the ratio of net fixed assets to the market value of total assets. The market value of total assets is directly associated with market capitalization (market value of equity). Therefore, the negative association between MOL and size is reasonable.

The regression results also add support for the positive association between financial leverage and size. In Panel B (MOL and MFL) and Panel C (BOLX and DFLX), after controlling for book-to-market ratio, the coefficients of the financial leverage measures are significantly positive.

In summary, the empirical results of the robustness checks are consistent with those of the main empirical approach conducted in the previous section and provide further support to the role of operating leverage in asset pricing.

6. Conclusions, limitations and suggestions for future studies

This thesis provides direct empirical evidence for the financial theories about the impact of operating leverage and financial leverage in asset pricing. The empirical results resemble those of Garcia-Feijoo and Jorgensen (2010) in many aspects and, to some extent, can be seen as a complement to their empirical research.

6.1. Conclusions

Evidence for the positive association between firm-level expected return and operating leverage is weak in the sample used by this empirical research. But as discussed in the previous sections, this result is more or less anticipated as some downward biases add to the difficulty for this association to be examined. These downward biases include the non-avoidable “error-in-variable” problem (Mandelker and Rhee (1984), Chung (1987) etc.) and the co-varying growth pattern in EBIT and sales (e.g. O’Berien and Vanderheiden (1987), Garcia-Feijoo and Jorgensen (2010)). However, there is strong evidence for the positive association between DOL and expected return at an industry level.

The positive association between beta and DOL in the sample suggests that operating leverage amplifies the systematic risk faced by the firms. As for financial leverage, the association between DFL and beta is not statistically significant even though the sign is consistently positive in the empirical tests. These results indicate that operating leverage plays a more important role as a determinant of systematic risk than financial leverage (Thompson (1976), Chung (1987), Li and Henderson (1991), Toms, Salama and Nguyen (2005)).

Results of the empirical tests in this research suggest a strong positive association between DOL and book-to-market ratio (consistent with Garcia-Feijoo and Jorgensen’s (2010) empirical findings and contradicts that of Norvy-Marx’s (2010)) and between DFL and size in the sample employed by the empirical research in this thesis. This evidence lends support for the risk-related explanation and undermines the financial distress explanation for the value premium in the expected returns.

6.2. Limitations and suggestions for future studies

As discussed in the previous sections, there is an “error-in-variable” problem involved in the estimations of the main test variables of operating leverage and financial leverage in the empirical approach. To overcome this problem, the technique of instrumental variable or portfolio grouping can be adopted in the empirical approach in further studies.

The accurate measurement of operating and financial leverage has always been a problem in the research topics regarding operating leverage and financial leverage. In this thesis, except for the commonly used degree of operating leverage (DOL) and degree of financial leverage (DFL), three pairs of alternative variables of operating leverage and financial leverage are adopted and work as a robustness check of the main empirical tests with DOL and DFL. In future studies, researchers can try other alternative proxies of operating leverage and financial leverage or develop more accurate approach for estimating the operating and financial leverage of a firm.

Furthermore, the empirical results of the cross-sectional regression at industry level are instructive; however the empirical methods used in this part of the tests are simplified. In future studies in this direction, researchers can apply more advanced empirical methodology for the research of operating leverage at an industry level.

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