Received September 2011
Revised March 2012
Accepted June 2012

The operating leverage impact on systematic risk within a context of choice

An analysis of the US trucking industry

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Abstract

Purpose – Strategic cost structure choices determine how firms divide operating costs between fixed and variable components, and therefore have important implications for financial performance. The purpose of this paper is to examine the effect of operating leverage on equity Betas when managers have discretion over firms' cost structures.

Design/methodology/approach – Using panel data for publicly listed trucking firms over years 1994-2006, market model Betas are regressed on controls and alternatively measured proxies for operating leverage: degree of operating leverage, assets in place and percentage of company employed drivers.

Findings – Results of this study generally show positively significant coefficients on all three operating leverage variables.

Originality/value – Operating characteristics of many industries require that firms make substantial investments in long-lived assets that result in high fixed costs (e.g. depreciation), and for these firms cost structure is exogenously or technologically constrained leaving managers with little discretion. In contrast to these types of firms, the authors examine the effect of operating leverage (OL) on Betas when managers have discretion over firms' cost structures. Trucking firms are a particularly interesting industry group for analyzing the impact of operating OL choices on Beta because distinct strategic cost structure choices are available to the management of trucking firms that result in various degrees of OL throughout the industry.

Keywords Beta, Cost structure, Operating leverage, Risk management, United States of America

Paper type Research paper

1. Introduction

Strategic cost structure choices determine how firms divide operating costs between fixed and variable components, and therefore have important implications for financial performance. Operating characteristics of many industries require that firms make

The authors thank Dr Reinhold Lamb and Dr Bobby E. Waldrup, University of North Florida, for their help with the article.

Managerial Finance
Vol. 38 No. 12, 2012
pp. 1184-1202

0307-4358
DOI 10.1108/03074351211271283

substantial investments in long-lived fixed assets that result in high fixed costs (e.g. depreciation), and for these firms cost structure is exogenously or technologically constrained leaving managers with little discretion. For example, auto manufacturers and railroads are industries that have few options when it comes to choosing whether or not they employ a large proportion of fixed assets. However, management's choice of cost structure in trucking firms is less influenced by exogenous factors.

A larger proportion of fixed assets imply greater operating leverage (OL) and, *ceteris paribus*, greater variability in earnings when sales increase or decrease. At any given sales level, the degree of operating leverage (DOL) is a measure of the expected change in net operating income from any percentage change in sales (Garrison *et al.*, 2012, p. 202). Also, OL may affect a firm's financial performance and economic value because it impacts the expected returns of investors in the firm that are embodied in its cost of capital. Therefore, from a manager's perspective, the a priori choice of cost structure is an especially important decision if systematic risk increases with OL because a manager's choice of OL will likely affect the firm's cost of capital. Indeed, a manager's decision to invest in fixed assets and increase the firm's OL may have the unintended consequence of increasing the cost of capital when the firm tries to raise equity for expansion. Prior studies have examined the risk-return implications of differing cost structures across a broad cross-section of capital intensive industry groups and generally found a positive association between the firm's *Beta* and OL (Gahlon and Gentry, 1982; Mandelker and Rhee, 1984; Zhang, 2005).

In a previous empirical study of trucking firms, MacArthur *et al.* (2008), provides preliminary evidence of a positive relation between firms' cost structures and stock *Betas*. In particular they document a positive relation between the magnitude of the firm's invested assets and stock *Beta*. This study extends their prior analysis by among other things including and comparing the effect of three uniquely measured OL variables, Assets-in-Place, DOL and the percentage of company employed drivers on *Beta*. A subjective accounts analysis is also included in this study that provides a comprehensive comparison of the respective cost structures of two prominent trucking firms with different cost structures and *Betas*. That is in conjunction with their estimated systematic risks; cost structure is analyzed for each firm by identifying variable and fixed costs to estimate contribution margins with supporting cost-volume-profit calculations.

The trucking industry provides a sample uniquely suited for testing whether OL is a good predictor of *Beta* because trucking firms may choose to employ a high level of long-term assets in the form of owning tractors and trailers and mainly hiring salaried drivers and sales agents (J.B. Hunt Transport Services, Inc. (Hunt); Hunt, 2009), whereas other trucking firms may choose a much more variable cost structure by contracting with independent truck and tractor owner-operators, warehouse capacity owners[1], and independent sales agents (Landstar Systems, Inc. (Landstar); Landstar, 2009; MacArthur, 2006). Both Hunt and Landstar predominantly operate in the full-truckload (FTL) segment of the trucking industry. Many trucking firms provide both FTL and less-than-loadful (LTL) services to varying degrees (Zingales, 1998).

In essence, trucking firm managers can choose between a relatively high fixed/low variable cost (high OL) and a relatively low fixed/high variable cost (low OL) operating structure. Hence, managers of trucking firms are able to select the firm's cost structure more easily than in many other industries. Although called trucking firms in this article, companies like Hunt and Landstar have gradually expanded the scope of their business beyond the traditional trucking business to provide other surface transportation services. For example, Hunt (2009, p. 16) states that it had furthered the "strategy of transitioning our economic model from that of a primarily asset-based truckload carrier to an asset-light transportation company". Using a sample of US publicly-owned trucking firms during the years 1994-2006, this paper reports the results of a study that investigates whether a trucking firm's OL is a good predictor of its stock return's systematic risk after controlling for variables that prior studies have shown to be important predictors of a firm's *Beta*.

The remainder of the paper is organized as follows. Section 2 presents an example of a relatively high fixed/low variable cost structure trucking firm (Hunt) and relatively low fixed/high variable cost trucking firm (Landstar) that extends the MacArthur (2006) analysis to estimated contribution format income statements in order to conduct typical cost-volume-profit calculations for the two companies. Sections 3 and 4 review prior literature and discuss sample data and research methodology. Section 5 reports the empirical results and Section 6 presents the summary, conclusions, and limitations of the study.

2. Cost structure examples

The consolidated statement of earnings for 2006 through 2008 in US dollars and percentages of operating revenue are shown for Hunt in Tables I and II, respectively, and for Landstar in Tables III and IV, respectively, in order to illustrate the different cost structure of a predominantly high fixed/low variable cost structure trucking firm (Hunt)

Table I.
J.B. Hunt Transport Services, Inc. and subsidiaries consolidated statements of earnings years ended December 31, 2008, 2007 and 2006 (dollars in thousands)

	2008	2007	2006
Operating revenues, excluding fuel surcharge revenues	$3,001,531	3,009,819	2,897,816
Fuel surcharge revenues	730,412	480,080	430,171
Total operating revenues	3,731,943	3,489,899	3,327,987
Operating expenses			
Rents and purchased transportation	1,479,234	1,235,390	1,124,734
Salaries, wages and employee benefits	859,588	888,594	892,066
Fuel and fuel taxes	520,647	463,538	447,309
Depreciation and amortization[a]	202,288	205,133	183,604
Operating supplies and expenses	158,202	155,893	145,794
Insurance and claims	60,772	69,655	71,582
General and administrative expenses, net of asset dispositions	41,363	48,211	33,232
Operating taxes and licenses	32,162	33,540	34,447
Communication and utilities	19,269	21,156	22,566
Total operating expenses	3,373,525	3,121,110	2,955,334
Operating income	358,418	368,789	372,653
Interest income	890	1,011	978
Interest expense	35,337	43,523	16,137
Equity in loss of affiliated company	1,735	1,230	3,181
Earnings before income taxes	322,236	325,047	354,313
Income taxes	121,643	111,913	134,361
Net earnings	$200,593	213,134	219,952

Note: [a]Based on information on page 17, "and amortization" was added
Source: Hunt (2009, p. 36)

	2008	2007	2006
Operating revenues	100.0	100.0	100.0
Operating expenses			
Rents and purchased transportation	39.6	35.3	33.8
Salaries, wages and employee benefits	23.0	25.4	26.8
Fuel and fuel taxes	14.0	13.3	13.4
Depreciation and amortization	5.4	5.9	5.5
Operating supplies and expenses	4.2	4.5	4.4
Insurance and claims	1.6	2.0	2.2
General and administrative expenses, net of asset dispositions	1.1	1.4	1.0
Operating taxes and licenses	0.9	1.0	1.0
Communication and utilities	0.6	0.6	0.7
Total operating expenses	90.4	89.4	88.8
Operating income	9.6	10.6	11.2
Net interest expense	0.9	1.3	0.5
Equity in loss of affiliated company	0.0	0.0	0.1
Earnings before income taxes	8.7	9.3	10.6
Income taxes	3.3	3.2	4.0
Net earnings	5.4	6.1	6.6

Source: Hunt (2009, p. 17)

Table II. J.B. Hunt Transport Services, Inc. and subsidiaries consolidated statements of earnings as percentages of operating revenue years ended December 31, 2008, 2007 and 2006

	2008	2007	2006
Revenue	$2,643,069	2,487,227	2,513,756
Investment income	3,339	5,347	4,250
Costs and expenses			
Purchased transportation	2,033,384	1,884,207	1,890,755
Commissions to agents	203,058	200,630	199,775
Other operating costs	28,033	28,997	45,700
Insurance and claims	36,374	49,832	39,522
Selling, general and administrative	137,758	125,177	134,239
Depreciation and amortization	20,960	19,088	16,796
Total costs and expenses	2,459,567	2,307,931	2,326,787
Operating income	186,841	184,693	191,219
Interest and debt expense	7,351	6,685	6,821
Income before income taxes	179,490	178,008	184,398
Income taxes	68,560	68,355	71,313
Net income	$110,930	106,653	113,085

Source: Landstar (2009, p. 33)

Table III. Landstar Systems, Inc. and subsidiary consolidated statement of income years ended December 31, 2008, 2007 and 2006 (dollars in thousands)

and a low fixed/high variable cost trucking firm (Landstar). The revenue amounts in Tables I and III shows that both Hunt and Landstar are large firms with more than $3 and $2.6 billion in revenues in 2008, respectively. The relatively higher fixed costs of Hunt as compared to Landstar are evident from a comparison of the percentages in the common-sized consolidated financial data shown in Tables II and IV. For example, as a percentage of operating revenues, Hunt has 23 percent salaries, wages, and employee benefits in 2008 (Table II), which are assumed to be mainly fixed costs, versus no such

Table IV.
Landstar Systems, Inc. and subsidiary selected consolidated financial data as percentages of operating revenue years ended December 31, 2008, 2007 and 2006

	2008	2007	2006
Revenue	100.0	100.0	100.0
Investment income	0.1	0.2	0.2
Costs and expenses			
Purchased transportation	76.9	75.8	75.2
Commissions to agents	7.7	8.1	8.0
Other operating costs	1.0	1.1	1.8
Insurance and claims	1.4	2.0	1.6
Selling, general and administrative	5.2	5.0	5.3
Depreciation and amortization	0.8	0.8	0.7
Total costs and expenses	93.0	92.8	92.6
Operating income	7.1	7.4	7.6
Interest and debt expense	0.3	0.3	0.3
Income before income taxes	6.8	7.1	7.3
Income taxes	2.6	2.6	2.6
Net income	4.2	4.4	4.5

Source: Landstar (2009, p. 24)

category in Landstar that suggests relatively insignificant percentages of fixed labor expenses in Landstar's other categories. Instead, in 2008, Landstar has 7.7 percent agent's commission variable expenses and 76.9 percent purchased transportation variable expenses (Table IV) versus zero agent's commission variable expenses and 39.6 percent rents and purchased transportation variable expenses reported for Hunt (Table II)[1]. Another significant difference is the 5.4 percent depreciation and amortization fixed expense reported for Hunt (Table II) versus the 0.8 percent reported for Landstar (Table IV) in 2008. The results shown in Tables I through IV for the two earlier years, 2006 and 2007, mirror the results in 2008.

2.1 Operating leverage and other cost-volume-profit calculations

Using the subjective accounts analysis method to identify variable and fixed costs, Table V shows a contribution format income statement for Hunt and Landstar for 2008 using the numbers shown in Tables I and III. The different cost structures of Hunt (high fixed/low variable costs) and Landstar (low fixed/high variable costs) are well illustrated in the estimated contribution format income statements and supporting cost-volume-profit calculations shown in Table V.

As expected, Hunt has a higher estimated DOL (4.39) than Landstar (2.04). Hunt's estimated contribution margin ratio (0.42) is higher than Landstar's (0.14). Both ratios indicate the higher return potential of Hunt when operating revenues are increasing (and higher loss potential when sales are decreasing). Compared with Landstar, Hunt has a higher estimated break-even point in operating revenue dollars ($2,893,910,000 versus $1,393,514,000) and lower estimated margin-of-safety in absolute sales dollars ($838,033,000 versus $1,252,894,000) and in relative percentage terms (22.5 percent versus 47.3 percent), which indicate a more risky cost structure for Hunt.

Table VI shows that during the 1994-2006 period, Hunt's estimated average *Beta* is 1.452 versus 0.432 for Landstar[2]. Also, the greater variability in the monthly returns of Hunt (JBHT) versus Landstar (LSTR) and the CRSP value-weighted index is clearly shown in the graph in Figure 1. Although there is greater variation in Hunt's stock price,

Hunt/Landstar descriptions (where different)		Hunt		Landstar
Operating revenues (OR)[a]		3,731,943		2,646,408
Variable costs				
Rents and purchased transportation (PT)/PT	1,479,234		2,033,384	
Commissions to agents	–		203,058	
Fuel and fuel taxes	520,647		–	
Operating supplies and expenses/operating costs	158,202		28,033	
Total variable costs		2,158,083		2,264,475
Contribution margin (CM)		1,573,860		381,933
Fixed costs				
Salaries, wages and employee benefits	859,588		–	
Depreciation and amortization	202,288		20,960	
Insurance and claims	60,772		36,374	
G&A expenses, net of asset dispositions/SG&A	41,363		137,758	
Operating taxes and licenses	32,162		–	
Communication and utilities	19,269		–	
Total fixed costs (TFC)		1,215,442		195,092
Operating income (OI)		358,418		186,841
Degree of operating leverage (CM ÷ OI)		4.39		2.04
CM ratio (CM ÷ OR)		0.42		0.14
Break-even point in sales (BE) $s (TFC ÷ CM ratio)		2,893,910		1,393,514
Margin-of-safety in OR $s (MOS) (OR − BE $s)		838,033		1,252,894
MOS in percents (MOS ÷ OR) × 100		22.5		47.3

Source: Adapted from Hunt (2009, p. 36) and Landstar (2009, p. 33); the author/s classified the costs as variable or fixed; [a]Landstar (2009, p. 33) does not use the term "operating revenues" but shows "revenue" and "investment income" separately and not added together (Tables III and IV)

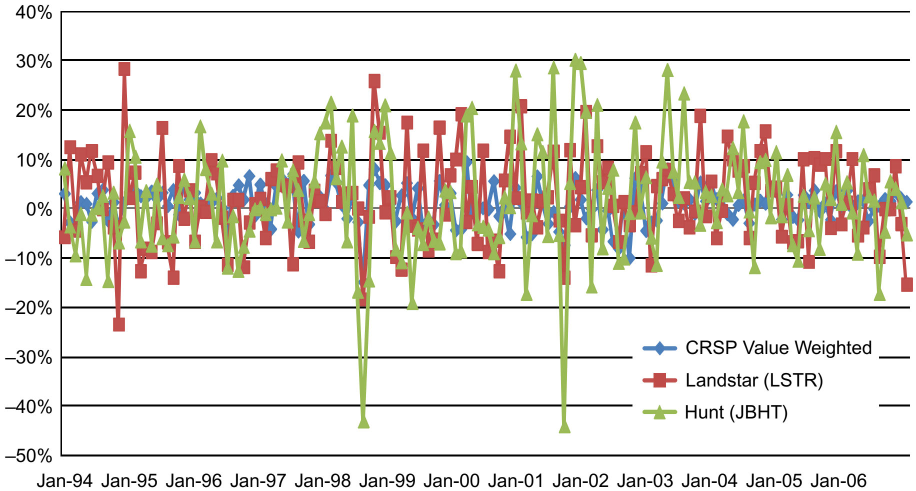
Table V. J.B. Hunt Transport Services, Inc. and subsidiaries (Hunt) and Landstar Systems, Inc. and subsidiary (Landstar) estimated 2008 consolidated contribution margin statements of earnings (dollars in thousands)

	Landstar (LSTR)	Hunt (JBHT)	CRSP value weighted
Beta	0.432	1.452	1.00
SD (%)	8.82	11.57	3.72
Mean return (%)	2.08	1.62	0.98

Notes: Returns are calculated from month-end adjusted closing prices provided from CRSP; although theoretically similar, these results differ from the average Betas reported from out test sample (Table VII); the above findings are from the 1994 to 2006 period; since the detrending approach used in our main tests to estimate DOL and DFL requires five continuous years of data, the sample period for our main tests is 1998-2006

Table VI. *Beta*, standard deviation, and mean monthly returns for J.B. Hunt Transport Services, Inc. and subsidiaries (JBHT), Landstar Systems, Inc. and subsidiary (LSTR), and CRSP value weighted index for 1994-2006

raw returns are in fact lower than Landstar's, i.e. 1.62 percent versus 2.08 percent. In addition, Landstar's mean monthly returns exceed those of the CRSP value-weighted index. These differences reflect Landstar's superior operating performance over the same period. The untabulated mean (median) return on assets for Landstar for this period is 11.97 (12.81) percent with a standard deviation of 3.82[3]. The mean (median) return on assets for Hunt is 6.88 (5.81) percent with a standard deviation of 3.59. Similarly, the mean (median) return on equity for Landstar is 31.97 (33.77) percent with a standard deviation of 13.17[4]. The mean (median) return on equity for Hunt is 11.49 (8.78) percent with a standard deviation of 8.27. Apparently, Landstar was able to earn and sustain higher returns on invested capital with a less risky cost structure and lower *Beta*.



Note: Returns are the month end buy and hold returns with dividends reinvested from CRSP)

Figure 1.
J.B. Hunt Transport Services Inc. and subsidiaries (JBHT) and Landstar Systems, Inc. and subsidary (LSTR) variability in monthly returns 1994-2006

3. Literature

Beginning with the seminal work of Ball and Brown (1968), numerous studies have documented the relevance of accounting earnings on stock returns (e.g. Lev and Ohlson, 1989; Lev, 1989; Nichols and Wahlen, 2004). This early stream of research also produced findings regarding the relation between earnings volatility and systematic equity risk. For example, Beaver *et al.* (1970), Rosenberg and McKibben (1973), Bildersee (1975) and Myers (1977) document that earnings variability is strongly associated with systematic market risk. Kormendi and Lipe (1987) provide evidence that earnings quality is a function of its persistence. Hunt *et al.* (2000) show an inverse relation between earnings volatility and a firm's market value of equity.

In accord with these studies, other prior theoretical analyses show that higher OL is likely to result in greater earnings variability with the impact being greater systematic risk in the firm's stock price and a higher *Beta* (Gahlon, 1981; Gahlon and Gentry, 1982; Chung, 1989). In one of the first empirical studies on OL and systematic risk, Lev (1974) theorizes that within homogenous industries, firms with a higher DOL (i.e. lower variable costs and higher fixed costs) have greater systematic risk. Since published financial reports do not generally separate costs between their variable and fixed components, estimating their relative levels is an important aspect of cost structure research. Using data from three capital intensive industries: electric utility, steel, and oil, Lev estimates average variable cost per unit as the coefficient obtained from a time series regression of total costs on the volume of sales. Two risk measures, the standard deviation of monthly returns over the preceding ten year period (overall risk) and the estimated market model *Beta* from the same period are regressed for each industry on the variable cost estimate. Results show a negative relation between both risk measures and average variable costs.

In a subsequent study, Mandelker and Rhee (1984) use a similar two-stage approach to analyze 255 manufacturing firms across ten industries. In the first stage, DOL is estimated for each company as the coefficient from a time series regression of the natural log of earnings before interest and taxes on the log of sales. Similar to Lev (1974), the authors use sales to proxy for output. The market model *Beta* is then regressed on the firm specific coefficient for DOL. Results show that DOL explains a high percentage of the variation in *Beta*. They also show that financial leverage increases with *Beta*. In addition, the authors document a negative relation between operating and financial leverage and present a "risk trade-off hypothesis" to explain that managers attempt to reduce overall market risk (*Beta*) by selecting lower (higher) levels of OL in concert with higher (lower) levels of financial leverage.

In a follow-up study to Mandelker and Rhee (1984) and Hufman (1989) use a similar sample of manufacturing firms and also finds a similar positive relation between systematic risk and DOL but only when utilities are excluded. Hufmann conjectures that this result may be due to the lack of discretion that utility managers have over their DOL.

Hung and Lui (2005) examine Taiwan's two listed airlines and find a significant relation between changes in *Beta* values and the business cycle, DOL, and the degree of financial leverage. Unlike US companies, Taiwanese firms are required to include DOL in their published financial reports. Hence, their study provides direct, albeit anecdotal, evidence of a positive *Beta* – DOL relation.

Medeiros *et al.* (2006), assume that OL follows a random walk and assert that since earnings are correlated with returns, firms with greater yearly changes in OL will exhibit greater volatility in returns. Following Mandelker and Rhee (1984) they estimate DOL as the coefficient from a time series regression of the natural log of earnings before interest and taxes on the log of net operating revenues. Based on results showing that unexpected returns increase with changes in OL, the authors conclude that OL is a determinant of systematic risk.

More recently, Garcia-Feijoo and Jorgensen (2010) employ a variation of Mandelker and Rhee (1984) to document a positive association between DOL and the book-to-market ratio. They argue that the additional risk associated with a higher DOL explains the value premium associated with high book-to-market firms. The following Section describes the sample and methodology used in this research.

4. Sample and methodology

4.1 Sample and variables

The data for this study comes from Compustat, the System for Electronic Document Analysis (SEDAR) and EDGAR (Electronic Data and Retrieval Service US SEC) and includes panel data on all publicly listed trucking firms (4-digit SIC codes 4213) for the years 1994-2006. Information on trucking employees, i.e. percentage of company drivers, was hand-collected from financial statement footnotes. DOL is measured for each trucking company as the estimate obtained from a regression of the natural logs of earnings on sales over the firm's years of observations as in prior research (Mandelker and Rhee, 1984; Gahlon and Gentry 1986; Huffman, 1989; Griffin and Dugan, 2003; Medeiros *et al.*, 2006). In spite of its widespread use, one criticism of this methodology is the assumption that DOL is constant over the firm's time series of years. However, DOL coefficients are not constant but change from period to period in response to sales level changes and cost structure changes. To account for potential changes in firms' DOL over time, we modify the Mandelker and Rhee (1984) methodology and detrend our DOL estimates by running regressions over five-year overlapping intervals in a manner prescribed by Garcia-Feijoo and Jorgensen (2010). Because we are interested in the relation between DOL and *Beta* for each year, we are required to obtain an estimate for each firm at the end of each year. Hence, similar to Garcia-Feijoo and Jorgensen (2010) our approach requires that firms have at least five years of continuous sales and income data. After deleting companies with insufficient data our sample includes 23 different trucking firms with between two and nine periods of five continuous years of DOL data each. We further describe this detrending approach in the methodology section.

Accounting standards foster conservative financial reporting and prior research documents an asymmetric relation between the information content of positive and negative earnings. For example, prior studies document that earnings response coefficients are higher for positive earnings than those for negative (Basu, 1997). To control for the potentially differing effect of sales on negative and positive earnings and in accordance with O'Brien and Vanderheiden (1987) and others we exclude firm years with negative earnings resulting in a sample size of 141 firm year observations. Finally, to reduce the effect of extreme values on estimates we winsorize data at the top and bottom 1 percent.

4.2 Operating leverage variables

As explained above, higher OL magnifies the effect of sales volume changes and results in higher earnings variability. Firms with high earnings variability are likely to have higher stock price variability and a higher *Beta*. To more comprehensively explore the effect of trucking management's cost structure choices on *Beta*, in addition to degree of operating leverage (DOL), this study also uses the following two proxy variables for OL: Assets-in-Place (*AP*), and the percentage of company employed drivers (*COMPDRV*). The three OL measures overlap only to a limited degree, as measured by the univariate correlations that are discussed later in this section. The three OL measures also complement each other to some extent as explained below.

*Degree of operating leverage (*DOL*).* Similar to prior studies (Mandelker and Rhee, 1984; Medeiros *et al.*, 2006), the *DOL* variable is estimated for each firm across the years in the sample as the coefficient obtained from a regression of the natural log of earnings before interest and taxes on the natural log of net sales. That is:

$$lnEBIT_{it} = \gamma_0 + \gamma_i lnSALES_{\mathrm{it}} + \varepsilon_{\mathrm{it}}, \quad (1)$$

where:

EBIT = earnings before interest and taxes.

SALES = net sales.

γ_{i} = the estimated regression coefficient for *DOL*.

DOL is the usual *ex ante* measure of the impact of OL on the risk-return potential of capital structure choice. *Ceteris paribus*, *DOL* in this study is the estimated multiplier of the percentage increase (decrease) in percentage net operating revenue to determine the percentage increase (decrease) in the net operating income.

As previously discussed, one characteristic of *DOL* that can be problematic for this study is that it is not a static number. *Ceteris paribus*, *DOL* becomes smaller the further away a firm is operating from its break-even point. It is possible for a low fixed/high variable cost structure firm to have a higher *DOL* than a high fixed/low variable cost structure firm if the first firm is operating significantly closer to its break-even point than the second firm. To mitigate the potential effect of non-stationary DOL estimates on results, a detrending procedure is employed similar to Garcia-Feijoo and Jorgensen (2010). In particular, DOL estimates are obtained from regressions run at five-year overlapping periods (i.e. 1994-1998, 1995-1999, etc.). Using this methodology, the average *DOL* estimates for Hunt and Landstar over the 1998-2006 period are, respectively, 2.67 and 2.28 (Appendix) which further illustrates the already discussed increased risk from the higher proportion of fixed to variable costs of Hunt's versus Landstar's cost structure.

Assets-in-Place (AP). The Assets-in-Place (AP) variable is measured as the natural log of the firm's net property, plant, and equipment (PPE). This proxy is intended to capture the effect of higher investment in fixed assets on the firm's cost structure. Higher PPE specifically captures higher OL from company-owned assets such as tractors and trailers and warehouse facilities. This OL measure also proxies for other aspects of operating risk such as a higher break-even point and smaller margin-of-safety associated with increased fixed costs.

For example, in fiscal year 2008, Hunt (2009, p. 35) had a PPE less accumulated depreciation ($1,386,530,000) to total assets ($1,793,453,000) ratio of 0.773 compared with Landstar (2009, p. 32) that had a much smaller operating property less accumulated depreciation and amortization ($124,178,000) to total assets ($663,530,000) ratio of 0.187. Not surprisingly, Hunt also had more business risk as measured by a higher estimated break-even point and lower estimated margin-of-safety in dollar and percentage terms than Landstar in 2008 (Table V).

*Percentage of company employed drivers (*COMPDRV*)*. There have been several articles that have focused on a trucking firm's decision to hire owner-operators rather than company drivers (Williamson, 1985; Grossman and Hart, 1986; Nickerson and Silverman, 2003). Although owner-operators tend to cost less per mile, a larger proportion of trucking, about 70 percent of all miles traveled, is undertaken by company drivers in company-owned trucks (Nickerson and Silverman, 2003). The percentage of company drivers (*COMPDRV*) is used to measure the firm's cost structure choice of whether to employ full time salaried drivers and purchase firm-owned trucks or contract out the services of independent truckers who are responsible for their own vehicles. Companies with a higher percentage of company drivers should have a higher *Beta* because firms hiring a greater (lesser) proportion of independent truck owner-operators (as opposed to employing full-time employees to drive company-owned trucks to transport goods) will be able to adjust trucking capacity and costs more (less) rapidly to meet expanding or contracting market conditions and have lower (higher) OL thus reducing (increasing) variations in earnings.

*4.3 Dependent variable (*Beta*)*

Daves *et al.* (2000) provide evidence that relative to other estimation intervals, using daily returns provide a smaller standard error of the estimated *Beta*. In addition, their results show estimation periods of less than three years are more precise when using daily returns. Using daily returns from The Center for Research in Security Prices (CRSP) and the CRSP value-weighted index as our benchmark portfolio the following market model is used to estimate the yearly *Beta* for each of our firms:

$$R_{it} = \alpha_i + B_i R_{mt} + \varepsilon_{it} \qquad (2)$$

Where R_{it} is the day t return for firm i, B_i is the end of fiscal year *Beta* for firm i, R_{mt} is the daily value-weighted market return and ε_{it} is the error term.

4.4 Control variables

*Total assets (*lnTA*).* This variable is included because previous literature provides evidence that firm size affects *Beta* (Binder, 1992). For example, Olibie and Rezaee (2007) shows that *Beta* is negatively related to total assets. To control for the potential size effect on *Beta* this study uses an operational valuation, which is calculated as the natural log of the firm's end of fiscal year total assets (*lnTA*)[5].

*Number of shareholders (*lnSHOLD*).* Since absolute changes in supply relative to demand and vice versa may be greater when there are fewer shareholders, such changes will have a greater impact on stock price volatility when issues are thinly held. Hasbrouck and Seppi (2001) show that liquidity partially explains the variations in signed and absolute returns. Brooks *et al.* (2005) provide evidence that suggests *Beta* may be higher for thinly traded issues. Because there is a large variation in both the number of shareholders and shares outstanding across our sample of trucking firms, this study includes the natural log of the number of shareholders (*lnSHOLD*) as an independent predictor of *Beta*.

*Market-to-book value (*MB*).* A significant determinant of a firm's value is its expected growth and firms with greater perceived opportunities for growth carry higher market to book multiples. Chung and Charoenwong (1991) investigate the effect of growth opportunities on *Beta* and argue that higher growth expectations affect price variability. Hong and Sarkar (2007) extend this study and show empirically that market-to-book ratio is an important determinant of *Beta*. In particular, they document that *Beta* increases with the market-to-book ratio. In accordance with these findings, this study includes market-to-book ratio *(MB)* measured as the end of fiscal year market value of equity divided by the end of fiscal year book value.

*Degree of financial leverage (*DFL*).* Greater financial leverage intensifies the effect that changes in sales have on earnings. Numerous studies examine the effect of financial leverage on systematic risk. For example, Faff *et al.* (2002) use a time series approach to confirm prior studies (Hamada, 1972; Conine, 1980; Bhandari, 1988), which suggest the need to control for financial leverage when estimating *Beta*. Dunn (2001) shows that financial leverage increases the systematic risk of the firm. In accordance with these and other studies (Lev, 1974; Mandelker and Rhee, 1984; Medeiros *et al.*, 2006), this study uses the degree of financial leverage (*DFL*) to control for the effect of debt level on *Beta*. *DFL* is calculated as the coefficient for each firm obtained from a time series regression of the natural log of earnings before extraordinary items on the natural log of earnings before interest and taxes. That is:

$$lnNI_{it} = \delta_0 + \delta_i lnEBIT_{it} + \varepsilon_{\mathrm{it}}, \tag{3}$$

where:

NI = net income before extraordinary items.

$EBIT$ = earnings before interest and taxes.

δ_{i} = the estimated regression coefficient for *DFL*.

Consistent with our approach for estimating DOL, we also detrend our DFL estimates using overlapping five-year regressions. Similar to Garcia-Feijoo and Jorgensen (2010), we exclude negative DFL estimates[6].

The descriptive statistics for our sample are listed in Table VII.

The dependent variable in the statistical model *Beta* varies from −0.460 to 1.961 with a mean (median) value of 0.835 (0.800) for trucking firms in the sample (Table VII)[7]. Hence, relative to other industries, trucking firms on average report lower systematic risk.

Variable	Maximum	Minimum	Mean	Median	SD
BETA	1.961	−0.460	0.835	0.800	0.553
Control variables					
lnTA	8.152	4.083	6.156	6.09	0.866
InSHOLD	9.821	3.989	7.123	7.404	1.631
MB	9.277	0.260	2.129	1.718	1.631
DFL	2.154	0.250	1.180	1.150	0.481
Operating leverage variables					
DOL	6.474	−2.249	1.322	1.129	1.640
AP	7.691	3.851	5.620	5.522	0.911
COMPDRV	100	12.362	85.119	92.573	21.659

Notes: Variable definitions: *BETA* is the market model coefficient; *lnTA* is the natural log of total assets; *lnSHOLD* is the natural log of the number of shareholders; *MB* is the market value of equity divided by stockholder's equity; *DFL* is the degree of financial leverage; *DOL* is the degree of operating leverage; *AP* is the natural log of net property, plant, and equipment; *COMPDRV* is the percentage of company employed drivers

Table VII. Descriptive statistics

The independent variables include controls associated with *Beta* and three variables intended to proxy as measures of OL. The control variables are: the natural log of total assets (l*nTA*), the natural log of the number of shareholders (*lnSHOLD)*, the market-to-book ratio *(MB)*, and the degree of financial leverage (*DFL)*. As shown in Table VII, the maximum firm year log value for our size control variable, *lnTA*, is 8.15 (YRC Worldwide, 2009). The minimum value is 4.08 (OTR Express). The mean (median) *lnTA* value for our sample of firms is 6.16 (6.09). The number of shareholders range from a minimum of 54 (*lnSHOLD* 3.99) to a maximum of 18,312 (*lnSHOLD* 9.82) and the mean (median) number of shareholders is 1,240 (1,642). The mean *MB* is 2.13. The average *DFL* coefficient is 1.18. Mandelker and Rhee (1984) document an average *DFL* of 0.98 over the industries and years of their study. Garcia-Feijoo and Jorgensen (2010) report a mean *DFL* estimate of 1.23.

OL variables hypothesized to be under the control of trucking managers are: the degree of operating leverage (*DOL)*, Assets-in-Place (*AP*), and the percentage of drivers that are full-time employees of the trucking firm (*COMPDRV)*. The mean (median) *DOL* of the trucking firms included in this study is 1.32 (1.13) and tests show that *DOL* estimates are approximately normally distributed with skewness of 0.954 and kurtosis 1.932. The maximum value for *DOL* is 6.47 (YRC Worldwide, 2009). As shown in the Appendix, the average time series *DOL* (*Beta*) for YRC is 4.06 (1.15). The minimum *DOL* estimate is −2.25 (Covenant Transportation). Covenant's average time series *DOL* (*Beta*) estimate is 0.179 (0.83) (Appendix). Regarding variable *AP*, YRC (OTR) reports the largest (smallest) average net property, plant and equipment over the years of this study. OTR's average *Beta* is 0.315 (Appendix). The mean percentage of company employed drivers (*COMPDRV*) is 85 percent with a maximum and minimum of 100 and 12.36 percent, respectively.

4.5 Variable correlations

Table VIII provides univariate correlations for *Beta*, control variables, and OL variables of interest.

The dependant variable, *Beta*, is positively correlated with control variables: log of total assets (*lnTA*), number of shareholders (*InSHOLD*), and market-to-book (*MB)*. *Beta* also has a positive relation with a firm's degree of operating leverage (*DOL*),

	BETA	lnTA	lnSHOLD	MB	DFL	DOL	AP	COMPDRV
BETA	1	0.616	0.137	0.314	0.002	0.288	0.522	0.107
		(0.000)	(0.085)	(0.000)	(0.983)	(0.001)	(0.000)	(0.238)
lnTA		1	0.481	0.186	−0.059	0.319	0.899	0.140
			(0.000)	(0.028)	(0.488)	(0.000)	(0.000)	(0.121)
lnSHOLD			1	−0.352	−0.048	0.011	0.653	0.442
				(0.000)	(0.571)	(0.899)	(0.000)	(0.000)
MB				1	−0.050	0.205	−0.123	−0.610
					(0.552)	(0.015)	(0.146)	(0.000)
DFL					1	−0.026	−0.051	−0.054
						(0.761)	(0.549)	(0.563)
DOL						1	0.211	−0.043
							(0.012)	(0.640)
AP							1	0.459
								(0.000)
COMPDRV								1

Note: Significance (*p*: two-tailed) is shown in parentheses under coefficients; variables are defined in Table VII

Table VIII. Variable correlations

and level of Assets-in-Place (*AP*). In addition, *DOL* is positively correlated with *lnTA*, and market-to-book (*MB*). Also, firms with higher percentages of company employed drivers (*COMPDRV*) have more shareholders (*InSHOLD*), greater *AP,* and lower *MB*. Finally, *AP* is positively correlated with *lnTA*, *InSHOLD,* and *DOL*. These results provide preliminary evidence of an association between trucking firms' *Betas* and operating leverage and support the notion that the three OL proxy variables are complementary to an extent, with each variable capturing a different aspect of the risk-return trade-off that result from cost structure choice.

4.6 Model selection

To test the effect of a firm's cost structure on its equity risk, market model *Betas* are regressed on control and cost structure variables. An important assumption of regression analysis is that observations are independent from one another. If observations are not independent, the standard error of the estimate could be affected (usually reduced) making inferences regarding significance tests invalid. Since panel data is used in the tests, it is possible that observations contain intra-firm correlations. To mitigate the effect of these correlations, the tests used in this study provide findings using robust standard errors clustered by company. This approach assumes that clusters are small and the number of clusters is large, which is a reasonable supposition for the sample of trucking firms used in this study. The number of firm clusters in this study is 23. The general model is depicted as follows:

$$BETA_{it} = \alpha_1 lnTA_{it} + \alpha_2 lnSHOLD_{it} + \alpha_3 MB_{it} + \alpha_4 DFL_{it} + \alpha_5 OL_{it} + \varepsilon_{\mathrm{it}}, \qquad (4)$$

where OL represents three measures of OL: degree of operating leverage (DOL), Assets-in-Place (AP), and percentage of company drivers (COMPDRV). The following section reports the results of the empirical tests.

5. Empirical results

5.1 Control variables

Table IX provides results for our main tests.

Regarding control variables *lnSHOLD* is negative (positive) when *AP* is included (excluded). As noted above, Table VIII shows that *lnSHOLD* and *AP* are positively correlated (0.653, $p = 0.000$). Hence, the inclusion of OL variable *AP* appears to subsume the effect that number of shareholders has on *Beta*. In accordance with prior findings, market-to-book (*MB*) is also positively related to *Beta*. Hence, trucking firms with higher growth expectations tend to experience greater returns variability. Although all of the degree of financial leverage (*DFL*) coefficients are positive none are significant. Financial leverage does not seem to have any significant impact on stock variability in the trucking industry.

5.2 Operating leverage variables

To better explore how the three different measures of OL are related to a firm's *Beta*, this study reports the results using each specification of OL as well as combinations thereof in the seven models shown in Table IX. Models 1, 2, and 3, provide findings for each of our OL measures: *DOL, AP,* and *COMPDRV*. Models 4, 5, and 6 provide results for alternative combinations of these variables. Finally, Model 7 includes all OL variables. The results provide evidence that a trucking firm's choice of OL affects its *Beta*. For all models, the *DOL* coefficient is positive. Similar results are reported for *AP* and *COMPDRV*. In particular, Models 1, 2, and 3 show that the alternatively reported coefficients for each of the OLs are

Dependent variable: $BETA_{it} = \alpha_1 lnTA_{it} + \alpha_2 lnSHOLD_{it} + \alpha_3 MB_{it} + \alpha_4 DFL_{it} + \alpha_5 OL_{it} + \varepsilon_{it}$

($n = 141$ clusters = 23)	Model 1 Coefficient (p-value)	Model 2 Coefficient (p-value)	Model 3 Coefficient (p-value)	Model 4 Coefficient (p-value)	Model 5 Coefficient (p-value)	Model 6 Coefficient (p-value)	Model 7 Coefficient (p-value)
Control variables							
$lnTA_{it}$	0.015	−0.002	0.010	0.004	−0.004	0.026	0.004
	(0.364)	(0.904)	(0.594)	(0.804)	(0.803)	(0.173)	(0.820)
$lnSHOLD_{it}$	0.093	−0.067	0.062	−0.062	−0.055	0.056	−0.051
	(0.001)	(0.033)	(0.050)	(0.051)	(0.098)	(0.071)	(0.130)
MB_{it}	0.117	0.114	0.207	0.105	0.138	0.182	0.132
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
DFL_{it}	0.035	0.052	0.059	0.049	0.058	0.054	0.055
	(0.694)	(0.488)	(0.508)	(0.510)	(0.458)	(0.534)	(0.474)
Operating leverage variables							
DOL_{it}	0.078			0.031		0.075	0.033
	(0.002)			(0.100)		(0.003)	(0.099)
AP_{it}		0.422		0.404	0.376		0.352
		(0.000)		(0.000)	(0.000)		(0.000)
$COMPDRV_{it}$			0.011		0.004	0.011	0.004
			(0.000)		(0.085)	(0.000)	(0.063)
R^2	0.220	0.420	0.235	0.442	0.421	0.275	0.425
$F(p)$	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Significance (p) is shown in parentheses under coefficients and (p) is estimated using clustered robust standard errors; tests for variables: DOL_{it}, AP_{it} and $COMPDRV_{it}$ are one-tailed; variables are defined in Table VII

Table IX. Results for effects of operating leverage on *Beta* with controls (clustered robust standard errors) positive and significant. Further, *AP* and *COMPDRV* remain significant across Models 4, 5, and 6 which report results in combinations with other OL variables. Although DOL is positively significant when reported alone in Model 1 (0.078, $p = 0.002$) and in Model 6 when reported with *COMPDRV* (0.075, $p = 0.003$), its significance is marginal when *AP* is included (Models 4 and 7). As noted earlier, *AP* and *DOL* are positively correlated. Hence, *AP* may be capturing at least in part the effect of *DOL* on *Beta*.

As noted above the stand alone estimate for *COMPDRV* is positive and significant in Model 2 (0.011, $p = 0.000$) but similar to *DOL* its significance decreases when reported with AP in Models 5 (0.004, $p = 0.085$) and 7 (0.004, $p = 0.063$). Nevertheless, all OL measures are positive and generally significant in all models including when reported together in Model 7.

Although there is no clear consensus in the literature about which are the best measures of OL, the results of this study provide overall support for the assertion that a trucking manager's cost structure decisions are important and have an effect on the firm's systematic risk. In particular, strategic management decisions regarding the firm's DOL, AP and relative proportion of owner-operators and company drivers affect the trucking firm's *Beta*.

6. Summary, conclusions and limitations

This paper provides new evidence about the market's risk assessment of different cost structure strategies in the trucking industry where managers can choose between alternative fixed-variable operating cost structure schemes. Using a panel data set of trucking firms, this study examines the relation between a trucking firm's cost structure and its stock's systematic risk (*Beta*). Using alternative measures of OL along with control variables, the empirical results show positive and significant associations between *Beta* and OL that are consistent with the preliminary results reported in MacArthur *et al.* (2008). These findings provide further evidence that when managers choose cost structures with higher OL, systematic risk increases.

Since changes in equity *Beta* imply changes in the firm's cost of capital, managers should consider the impact of cost structure decisions on their firm's stock price variability. Indeed, achieving and sustaining high operating margins with less risky cost structures that reduce firms' costs of capital has value enhancing implications. Albeit anecdotal, our comparative analysis of Hunt and Landstar is an illustrative case in point. As stated above relative to J. B Hunt, Landstar has chosen a less risky high variable cost structure across all OL proxies (*DOL*, *AP*, and *COMPDRV*) resulting in a correspondingly lower *Beta* (Table VI and Figure 1). Yet Landstar has earned higher returns reflecting their (unreported) superior operating margins.

One limitation of this study is that the results may not be generalizable across all industries since managers do not always have discretion over OL levels; for example, technological constraints in some capital intensive industries compel firms to adhere to an inflexible high fixed cost structure. The results suggest that managers should nevertheless identify and be aware of the market risk effects of "discretionary" fixed costs. For example, the findings strongly suggest that a trucking firm manager's choice between employee driven and owner-operated trucks significantly impacts the firm's equity *Beta*. Hence, within the context of the firm's industry and in conjunction with other operational factors, managers should consciously consider the impact of cost structure choices on the firm's systematic risk.

Notes

1. "The transportation logistics segment offers its customers, through its independent commission sales agent network, national warehousing services without owning or leasing facilities or hiring employees to work at warehouses" (Landstar, 2009, p. 5). "In general, Warehouse Capacity Owners are paid a fixed percentage of the gross revenue for storage and services provided through their warehouse" (Landstar, 2009, p. 7).
2. *Beta* is calculated by regressing each firm's month-end buy and hold returns with dividends reinvested on the corresponding monthly returns of the CRSP value weighted index. A further discussion of the methodology for estimating *Beta* in our primary tests is provided in the methodology section.
3. Data for return on assets is obtained from Compustat and computed as the sum of the fiscal year net income and interest expense divided by total assets.
4. Data for return on equity is obtained from Compustat and computed as the end of fiscal year net income divided by stockholder's equity.
5. In accordance with Compustat assets are measured in units of one million.
6. Including negative DFL estimates does not change the direction or significance of our operating leverage variables of interest.
7. According to Value Line, the (simple) average *Beta* for SIC 4213 trucking firms over the 1999-2006 period is 0.86 (http://pages.stern.nyu.edu/~adamodar/New_Home_Page/data.html).

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(The Appendix follows overleaf.)

Appendix

Table AI.
Average *Beta*, degree of operating leverage, net property plant and equipment, and percentage of company drivers over the years used for sample firms

Company	Years	Average Beta	Average DOL	Average net PPE (millions)	Average percentage of co. drivers
Allied Holdings Inc.	1998-2000	0.473	0.347	282.573	88.406
American Freightways Corp.	1998-1999	0.545	0.996	543.85	100.000
Arkansas Best Corp.	2001-2006	1.312	3.167	374.384	100.000
Arnold Industries Inc.	1998-2000	0.430	0.535	232.462	85.560
Boyd Bros Transportation	1999-2003	0.112	1.419	58.852	62.757
Covenant Transportation	1999-2006	0.830	0.179	239.452	94.607
Heartland Express Inc.	2000-2006	1.100	1.2843	164.500	90.056
Hunt (JB) Transport SVCS	1998-2006	1.120	2.665	940.720	95.657
Kenan Transport Co.	1998-2000	0.030	0.521	61.487	100.000
Knight Transportation Inc	1999-2006	1.010	0.988	234.224	90.297
Landstar System Inc.	1998-2006	0.856	2.277	75.188	18.111
M.S. Carriers Inc.	1998-2000	0.613	1.174	452.085	82.571
Marten Transport Ltd	1998-1999 2005-2006	0.810	2.024	217.322	76.390
Old Dominion Freight	1998-2006	0.823	1.450	306.003	100.000
OTR Express Inc.	1998-1999	0.315	1.160	50.807	88.625
P.A.M. Transportation SVC	1999-2006	0.633	0.557	152.627	94.144
Swift Transportation Co.	1998-2006	1.126	0.806	992.089	81.064
Transport Corp. America	1999-2002	0.468	−0.032	184.633	60.308
US Xpress Entp Inc.	2001-2006	1.028	0.371	251.326	87.049
USA Truck Inc.	1998-2006	0.518	0.636	159.780	98.057
USF Corp.	1998-2004	0.960	1.277	661.154	87.029
Werner Enterpr. Inc.	1998-2006	0.966	0.772	749.364	90.392
YRC Worldwide	2000-2006	1.153	4.060	1120.042	100.000