Firms' Cost Structure and Stock Return Volatility

Abstract

Purpose: This paper proposes a framework to identify a pattern in the relationship between firms' cost structure (i.e., fixed versus variable) and their volatility in stock returns.

Design/methodology/approach: Our empirical analysis is based on a panel data regression where we use an extended sample period and a time-series regression-based elasticity measure of operating leverage.

Findings: We document significantly higher systematic risk among firms with large fixed costs, a conclusion which confirms theoretical predictions of earlier studies. In new findings, we document high firm-specific risk, and high stock returns volatility among firms with a fixed cost structure.

Originality/value: The paper fills a gap in the literature by examining the effect of cost structure using various operating leverage measures and other control measures for firm characteristics on idiosyncratic risk. Studies that seek to explain firms' systematic risks are numerous; conversely, there are relatively fewer studies on the determinants of firms' specific risks.

JEL Classification: G11

Keywords: Cost Structure; Operating Leverage; Idiosyncratic Risk; Market Risk; Beta; Total Risk; Competition Effects.

1. Introduction

Does a firm's inclination to or persistence in a specific cost structure (viz., fixed or variable) impact the extent of (e.g., systematic and idiosyncratic) risks it faces in a market? Such a question is primordially conventional, yet some irregularities seem to have dominated the extant literature about a theoretically-informed empirical mechanism through which possible directional effects of the choice of cost-type could drive the extent of such risks in firms.

At a fundamental level, while it is well-known that the '*operating leverage hypothesis'* – that is, the extent to which a firm's operating costs are fixed - determines the degree of a firm's exposure to business and economic shocks[1] (see Lev 1974, Mandelker and Rhee 1984, Carlson et al. 2004, Zhang 2005, Cooper 2006 and Garcıa-Feijoo and Jorgensen, 2010), its impact on firms' idiosyncratic volatility is largely under-explored. A primary aim of this paper is to undertake an in-depth study of the relationship between firms' cost structure and their idiosyncratic risk.

A firm's operating cost structure comprises of both fixed and variable costs. Unlike the latter, fixed costs do not often vary with a firm's output level. Therefore, firms with high fixed costs are constrained in their ability to adjust their costs downwards following demand or supply shocks. This lack of flexibility in cost structure introduces uncertainty in the firms' operating profitability and consequently compounds their idiosyncratic volatility. In our work, we conjecture a direct association between firms' fixed cost structure and their idiosyncratic risks.

[1] It is very similar to the role of debt servicing as in Novy-Marx (2011).

Our empirical analysis is based on an extended sample of panel data for US firms, covering over three decades (1981 to 2015).[2] We follow a new measure of operating leverage, i.e., a time-series regression-based elasticity measure. Such a procedure is recommended on the grounds that a firm's cost structure evolves with time. Furthermore, while previous studies focus on stock return beta, we contribute to the literature by also studying the impact of cost structure on firm-specific risk. Studies that seek to explain firms' systematic risks are numerous; conversely, there are relatively fewer studies on the determinants of firms' specific risks. Brown and Kapadia (2007) explain why studies of firm-specific risk are essential: it affects the size of diversified portfolios; certain investors cannot diversify and must bear firm-specific risk; option pricing is based on total risk as opposed to systematic risk alone; managers devote resources to managing such risk; it affects information asymmetry; and, it may be a priced factor. Thus, our paper investigates the determinants of firm-specific risk. Additionally, to provide comparable results to other literature in the field, we explore the determinants of the three major types of risk, i.e., idiosyncratic risk, systematic risk, and total risk.

We follow Kulchania (2016) to define a firm's cost structure as the sensitivity of changes in its operating expenses to changes in its sales revenue. Firms with a flexible cost structure can promptly adjust their operating expenses following changes in sales revenue and, therefore, are less risky. These firms have a higher fraction of their operating costs that is flexible/variable. Conversely, firms with a

[2] The data are collected from the COMPUSTAT database, as explained in Section 3.

fixed cost structure and, thus, have a higher fraction of fixed costs, cannot adjust their costs promptly following changes in their sales revenue. Chen, Harford, and Kamara (2014) find that inflexible/fixed operating costs reduce a firm's ability to pay its debt and increase the likelihood of default.

We relate the measures of cost structure with investors' perceptions of firms' riskiness, i.e., firms' idiosyncratic risk, systematic risk, and total risk, respectively. After controlling for firm characteristics, such as size, growth opportunities, capital structure, profitability, and variability in profit, we find that cost structure is a significant determinant of stock price risk measures. Specifically, firms with fixed cost structures exhibit higher idiosyncratic risk, systematic risk and total risk than firms with flexible cost structures. Considering that firms might self-select a cost structure in an event when there is a noisy signal in the market, the inferences are likely to suffer from endogeneity issues. To mitigate the problem, we employ a multi-pronged approach. First, we use a propensity-score matching approach to find firms with similar observable characteristics but different cost structures. Second, we implement a Heckman self-selection model to control for cost structure self-selection bias. Third, we conduct an instrumental variable analysis. Our findings are consistent and robust to various controls.

Our paper contributes to the literature on the management-performance aspects of firms. We shed important light on firm characteristics that affect their idiosyncratic risks. In a frictionless market, only systematic risk is relevant and priced by investors because investors can diversify firm idiosyncratic risk away.

However, ample empirical evidence suggests that uncertainty, information asymmetry, and holding costs render firms' idiosyncratic risk a relevant source of risk to investors. Merton (1987), Malkiel and Xu (1997, 2001), Ang et al. (2006), Ang et al. (2009) and Fu (2009) present evidence of the importance of idiosyncratic risk in explaining the cross-section of expected stock returns after controlling for important firm characteristics. Consequently, a stream of literature is devoted to exploring firm characteristics that affect their idiosyncratic risk. We contribute to the literature by showing that operating leverage is an essential determinant of idiosyncratic risk, similar to product market competition (Gaspar and Massa, 2006 and Abdoh and Varela, 2017), corporate governance (Ferreira and Laux 2007), earnings quality (Rajgopal and Venkatachalam 2011; Chen, Huang, and Jha 2012), and pension deficits (Chen, 2015).

Our study illustrates the role of operating cost structure in a firm. Lev (1974), Mandelker and Rhee (1984), Carlson et al. (2004), Zhang (2005), Cooper (2006), Garcıa-Feijoo, and Jorgensen (2010) and Jacquier, Titman, and Yalçin (2010) document the relationship between operating leverage and systematic risk. Chen, Harford, and Kamara (2014) find that higher fixed costs (e.g., lower operating leverage) reduce a firm's ability to pay its debt and increase the likelihood of default. Kulchania (2016) documents that firms with higher operating leverage are more capable of committing to a steady dividend payout policy. We add to this stream of literature by showing the impact of operating cost structure on firm idiosyncratic risk.

The rest of the paper proceeds as follows. In Section 2, we develop a theory to lay a foundation to the proposed interlinkage between firms' choice of cost structure and their eventual susceptibility to systematic risks. Various hypotheses are developed to test our empirical construct following a review of the literature. We describe data along with summary statistics in Section 3. A detailed discussion of results (both baseline and selection-bias mitigated) are presented in Section 4. Finally, Section 5 summarizes our findings and contextualizes them to relevant firm-level policy.

2. Background literature to theoretical development and hypotheses

Characterizing the direction and magnitude of impacts of firms' cost structure on stock returns volatility is not straightforward. The extant literature presents mixed conclusions. Using operating leverage as a measure of firms' cost structure (fixed and variable) we have known since at least Rubinstein (1973), Beaver, Kettler, and Scholes (1970), and Mandelker and Rhee (1984) that there is a positive association between operating leverage and both total risk and systematic risk. Nowadays, though finance textbooks do not typically cover in any detail the impact of operating fixed costs on risk, it is well understood that fixed costs increase earnings variability and hence total risk, as well as a firm's exposure to systemic factors. On the other hand, more recent literature has considered the impact of real options (e.g., option to wait or to expand), and of other firm characteristics (e.g., profitability), together with operating leverage, to develop predictions that, depending on the model, might suggest that operating leverage only has a minor impact on risk, that there are nonlinear effects, interactions with other firm characteristics, and time-varying dynamics (e.g., Hackbarth and Johnson, 2015).

We differentiate between two types of firms, as shown in Figure 1, i.e., low- versus high operating leverage firms. Operating leverage is defined as the ability of a firm to change its cost structure, given a change in demand. Measuring a firm's operating leverage involves regressing the firm's total operating costs on the firm's physical output. The coefficient from this regression is shown to vary with a firm's stock return volatility (Lev, 1974). Mandelkar and Rhee (1984) documents that operating leverage contributes to the systematic risk of common stock. However, Huffman (1989), upon replicating and updating the study of Mandelkar and Rhee, finds different results, which suggests that the association between operating leverage and firm risk requires further examination.

Figure 1: The two types of firms based on operating leverage

Type of firm:	Cost characteristics:
Low Operating Leverage	High fixed cost; Inflexible cost structure; Low operational flexibility
High Operating Leverage	Low fixed cost; Flexible cost structure; High operational flexibility

Following Novy-Marx (2011), firm value is expressed as follows: Following Novy-Marx (2011), firm value is expressed as follows:

$$V^i = V_A^i + V_G^i \qquad (1)$$

where i denotes the firm and the subscripts A and G signify assets-in-place and growth options, respectively. V_A^i consists of the capitalized value of the revenues the assets-in-place generate (V_R^i) *minus* the capitalized cost of operating the assets (V_C^i) as follows:

$$V_A^i = V_R^i - V_C^i \qquad (2)$$

Beta (β) represents a firm's exposure to the underlying risk factors as follows:

$$\beta^i = \left(\frac{V_A^i}{V^i}\right)\beta_A^i + \left(\frac{V_G^i}{V^i}\right)\beta_G^i \qquad (3)$$

where, β_A^i is expressed as follows:

$$\beta_A^i = \beta_R^i + \left(\frac{V_C^i}{V_A^i}\right)\left(\beta_R^i - \beta_C^i\right) \qquad (4)$$

That is, the exposure of the assets to the underlying risks is the value-weighted average of the exposures of the capitalized revenues and the capitalized operating costs. Based on this equation, operating leverage significantly impacts the riskiness of the deployed capital under two conditions:

(i) $\frac{V_C^i}{V_A^i} \gg 0$, i.e., the business is highly geared (gearing is defined as the ratio of capitalized operating costs to capitalized operating profits). Such a business has high levels of total operating costs.

(ii) $\beta_R^i \gg \beta_C^i$, i.e., the business has limited operational flexibility. This occurs when fixed costs are a high proportion of the firm's total operating costs.

These two conditions suggest that operating leverage depends on high fixed costs of production (consistent with Zhang, 2005). Gahlon (1981) derives the following equation to show how the degree of operating leverage determines firms' systematic risk:

$$cov(R_i, R_M) = \frac{\left[DOL_i\left(\frac{cov(Q_i,R_M)}{E(Q_i)}\right)\right]R_F}{1-\lambda DOL_i\left(\frac{cov(Q_i,R_M)}{E(Q_i)}\right)} \qquad (5)$$

where $R_i = [C_iQ_i - F_i]/V_i$, C_i is the contribution margin, F_i represents fixed expenses, Q_i represents the number of units with an expected value of $E(Q_i)$ and a standard deviation of $\sigma(Q_i)$, R_M is the return on the market portfolio, R_F denotes the risk-free rate of interest, λ is the price of risk and $DOL_i = \frac{C_iE(Q_i)}{[C_iE(Q_i)-F_i]}$ is firm i's degree of operating leverage. In Equation (7), the only random variables are DOL and $\frac{cov(Q_i,R_M)}{E(Q_i)}$, and, therefore, they are the determinants of firm i's systematic risk. Operating leverage contributes to systematic risk through DOL.

We argue that since DOL affects systematic risk, it also affects the volatility in a firm's share price based on the following relationship:

$$\sigma_i^2 = \beta_i^2\sigma_M^2 + \sigma_{e_i}^2 \qquad (6)$$

where $\beta_i = \frac{cov(R_i,R_M)}{\sigma_M^2} = f\{DOL, \sigma(Q_i)\}$. Thus, we test the hypothesis that a firm's degree of operating leverage (DOL) directly contributes to the volatility observed in its stock price.

While various papers show how DOL affects systematic risk and, consequently, a stock's total risk, the effect of DOL on firm-specific risk, $\sigma_{e_i}^2$, is unspecified. Portfolio theory assumes that such risks lose their significance within the context of well-diversified portfolios. Though, as argued earlier, numerous studies reviewed by Brown and Kapadia (2007) suggest that it is not the case. To the extent that DOL also affects firm-specific risk, then DOL would have a more significant impact on securities like option prices that depend on total volatility as well as the wealth of investors who do not hold well-diversified portfolios (for example, employee stock ownership plans) than what is currently documented based on the relationship between DOL and systematic risk. We propose to test the effect of DOL on firm-specific risk empirically.

Hypothesis (Background) – Both the profitability and cash flows of firms with high fixed costs are sensitive to changes in sales. When business sales are high, these firms tend to report high profits and cash flows since most of their costs are fixed and therefore do not increase with sales. However, when sales are low, such firms cannot reduce their fixed costs to match the fall in sales. Conversely, firms with high variable costs can save on these costs and adjust their total costs quickly to falling sales. Therefore, a firm's mix of fixed and variable costs would affect its vulnerability to business cycles.

We hypothesize that *higher fixed costs inhibit firms' capability to adjust their operations to market shocks such as changing demand and supply, which in turn puts firms in financial constraints and can squeeze firm profitability.* Such inhibition consequently introduces more uncertainty to firms' profitability, making equity investment riskier and increasing idiosyncratic volatility.

Counterargument – Under this assumption, a competing hypothesis is that a firm's cost structure does not affect its idiosyncratic risk. Consider a hypothetical market that comprises of two firms, i.e., Firm F with a fixed cost structure and Firm V with a variable cost structure. Since these two firms comprise the market, volatility in market returns is wholly dictated by the stock returns of the two firms. Given its high fixed cost structure, investors' returns from investing in Firm F will be more volatile than their returns from investing in Firm V. And, since the market is comprised solely of Firms F and V, Firm F's cost structure contributes more to the volatility in stock market return than Firm V. It could be shown that (i) the market beta of Firm F will be higher than that of Firm V, and (ii) the variance in the stock return of each firm is fully accounted by the equation $\sigma_i^2 = \beta_i^2 \sigma_M^2$.[3] As a result, the standard error of the residual stock returns of each of Stock F and V (i.e., $\sigma_{e_i}^2$) would be zero.

3. Data and Summary Statistics

Our empirical analysis is based on a sample of publicly listed firms in the US and covers over three decades of observations (1981-2015). We exclude firms with SICs 4900-4999 and 6000-6999 since they are highly regulated. All data have been gathered from the Compustat database. In Panel A of Table 1, we present the sample distribution by year and by industry. The sample period starts in 1981 and ends in 2015; there are 99,441 firm-year observations partitioned over 42 industries.

[INSERT TABLE 1 ABOUT HERE]

3.1 Risk Measures

[3] Based on the capital asset pricing model.

We examine three measures of stock return risk/volatility. Idiosyncratic risk (*IDIORISK*) is measured as the annualized standard deviation of a firm's daily stock return residuals obtained from the Fama-French *Plus* Momentum model (Carhart, 1997). Systematic risk (*SYSRISK*) refers to the market beta from the Fama-French *Plus* Momentum model. Total risk (*TOTRISK*) refers to the annualized standard deviation of a firm's daily stock returns.

The Fama-French *Plus* Momentum model is as follows:

$$R_t = \alpha + \beta_m\left(R_{m,t} - R_{f,t}\right) + \beta_s SMB_t + \beta_h HML_t + \beta_p UMD_t + \varepsilon_t \tag{7}$$

where R_t is the dividend-adjusted CRSP[4] daily stock return, $\left(R_{m,t} - R_{f,t}\right)$ is the market risk premium, SMB_t is the size factor, HML_t is the book-to-market factor, and UMD_t is the momentum factor.

3.2 Measures of Operating Leverage

Our measure of operating leverage (*OPERLEV*) follows Kahl et al. (2012) and Kulchania (2016). It starts with the estimation of the ex-ante expectations of operating costs and sales that are based on the growth rate over the prior two years.

$$E\left[S_{i,t}\right] = S_{i,t-1}\sqrt{\frac{S_{i,t-1}}{S_{i,t-3}}} \tag{8}$$

$$E\left[C_{i,t}\right] = C_{i,t-1}\sqrt{\frac{C_{i,t-1}}{C_{i,t-3}}} \tag{9}$$

[4] University of Chicago's Center for Research in Security Prices

where $S_{i,t}$ and $C_{i,t}$ represent sales and operating costs, respectively for firm i in year t. They are both normalized by the total asset size.

The differences between the actual and expected values of $S_{i,t}$ and $C_{i,t}$ are calculated as follows:

$$[u_{S_{i,t}}] = \frac{[S_{i,t} - E[S_{i,t}]]}{S_{i,t-1}} \qquad (10)$$

$$[u_{C_{i,t}}] = \frac{[C_{i,t} - E[C_{i,t}]]}{C_{i,t-1}} \qquad (11)$$

We run a firm-level regression of $u_{C_{i,t}}$ on $u_{S_{i,t}}$ as follows using seven years of data (i.e., a rolling window from year -6 to 0) in each case:

$$u_{C_{i,t}} = \beta \times u_{S_{i,t}} + \epsilon_{i,t}, \text{ where } t \in [-6,0] \qquad (12)$$

β, i.e., beta, measures the sensitivity of growth in operating costs to growth in sales. The higher the value of β, the higher the firm's ability to respond to changes in sales.[5] These firms have more variable costs relative to total costs. Conversely, firms with higher proportions of fixed costs to total operating costs have lower βs.

Following Kulchania (2016), we also define dummy variables to capture the lowest (highest) tercile of operating leverage measure (*OPERLEV)* in a given year and industry. In each year and each industry, we rank the firms by their *OPERLEV*. The fixed cost structure is a dummy variable representing firms with an *OPERLEV* in the lowest tercile (*FIXED*). The flexible cost structure is a dummy variable representing firms with an *OPERLEV* in the highest tercile (*FLEXIBLE*). We create industry-adjusted operating leverage (*ADJOPERLEV*) measure by subtracting the

[5] Cost structure is defined as the sensitivity of change in the operating costs to changes in sales.

median industry (as captured by Fama-French 48-sector classification) operating leverage from the firm's operating leverage.

3.3 Control Variables

We create several variables to control for the effects on risk. All control variables are measured at the end of the fiscal year preceding the year the risk characteristics are measured.

SIZE is the natural logarithm of firm market capitalization. Perez-Quiros and Timmerman (2000) argue that small firms with little collateral are more vulnerable to business downturns than large firms. They find that small firms have a higher sensitivity of expected stock return to market conditions.

ADJMKBK is the industry-adjusted ratio of the market capitalization scaled by the book value of common equity and balance sheet deferred tax. It is an important control variable since the existence of a value premium is well documented, i.e., the stock returns of value firms exceed those of growth firms (Fama and French, 1992, 1996). Value firms are associated with lower MKBK, while growth firms are associated with higher *MKBK*. *MKBK* is also a good proxy for V^i/V^i_A (Novy-Marx, 2011), and is associated with firms' systematic risk (Carlson, Fisher and Giammarino, 2004).

ADJDEBT is the industry-adjusted debt-to-asset ratio. Leveraged firms are at risk in business downturns since they have fixed finance expenses to pay. We control for this variable since it is well established that financial leverage contributes to a firm's systematic risk (Modigliani and Miller, 1958).

ROAVOL is the standard deviation of firm returns on assets over the preceding five years. The higher the volatility in ROA, the less certainty are the returns on investment, and investors would expect returns from these companies to be more volatile. We also control for *ADJROA*, which is the industry-adjusted return on assets. This is another important control variable since higher profits provide a cushion against adverse business and economic shocks. To conserve space, the remaining variables are defined in Appendix 1.

We present the summary statistics for the key variables in Panel B of Table 1. Extreme values of all variables are winsorized at the 99th and 1st percentiles. The mean (median) values of the three risk measures, i.e., *IDIORISK, SYSRISK* and *TOTRISK* are 0.539 (0.434), 0.918 (0.919) and 0.580 (0.480), respectively.

4. Empirical analyses

4.1. Operating leverage and stock return volatility

In this subsection, we examine whether the firms' cost structure can explain their stock return risk. In Table 3, we report the univariate comparison of stock return risk between the lowest tercile and the highest tercile of operating leverage (i.e., fixed cost structure vs flexible cost structure, respectively). Firms with flexible cost structure are associated with significantly lower idiosyncratic risk, systematic risk and total risk than firms with fixed cost structure.

[INSERT TABLE 3 ABOUT HERE]

In Table 4, we report the results from the OLS regressions of idiosyncratic risk on the alternative operating leverage measures while controlling for other firm characteristics. We control for year fixed effects and industry fixed effects in all models. The standard errors are corrected for clustering effects among observations of the same firms. The results are based on a panel estimation.[6] The coefficients on the raw operating leverage (*OPERLEV* in Model 1) and the industry-adjusted operating leverage (*ADJOPERLEV* in Model 4) are negative and significant at the 1% level, confirming the results in Table 3 that higher flexibility in cost structure is associated with lower idiosyncratic risk. The coefficient on the dummy variable for fixed cost structure (*FIXED* in Model 2) is positive and significant at the 1% level, suggesting higher idiosyncratic risk among firms with fixed cost structure. The coefficient on the dummy variable for flexible cost structure (*FLEXIBLE* in Model 3) is negative and significant at the 1% level, suggesting lower idiosyncratic risk among firms with flexible cost structure.

[INSERT TABLE 4 ABOUT HERE]

In Table 5, we report the results from the OLS regressions of systematic risk on the alternative operating leverage measures while controlling for other firm characteristics.[7] The coefficients on the raw operating leverage (*OPERLEV* in Model

[6] The regression results in Tables 4 to 6 are obtained using a panel data setting, not a cross-sectional or time series setting.

[7] We control for year fixed effects and industry fixed effects in all models. The standard errors are corrected for clustering effects among observations of the same firms.

1) and the industry-adjusted operating leverage (*ADJOPERLEV* in Model 4) are negative and significant at the 1% level, confirming the results in Table 3 that higher flexibility in cost structure is associated with lower systematic risk. The coefficient on the dummy variable for fixed cost structure (*FIXED* in Model 2) is positive and significant at the 1% level, suggesting higher systematic risk among firms with fixed cost structure. The coefficient on the dummy variable for flexible cost structure (*FLEXIBLE* in Model 3) is negative and significant at the 1% level, suggesting lower systematic risk among firms with flexible cost structure. These findings are consistent with the theoretical predictions of Rubinstein (1972), Percival (1974), Lev (1974) and Gahlon (1981), who predict that operating leverage affects systematic risk.[8]

[INSERT TABLE 5 ABOUT HERE]

In Table 6, we estimate the Fama-MacBeth regressions of stock return volatility measures on industry-adjusted operating leverage measures for each sample year and report the average coefficients on the control variables. The Fama-MacBeth regressions are ran for each year, and the coefficients are averaged over the years. The coefficient on the industry-adjusted operating leverage (*ADJOPERLEV* in Model 1) is always negative and significant at the 1% level, confirming the results in Table 3 that higher flexibility in cost structure is associated with lower risk. The dummy variable for fixed cost structure (*FIXED* in Model 2) is always positive and

[8] The results of Tables 4 & 5 are re-estimated using a single factor model as opposed to the three-factor Fama-French model, and the results stay qualitatively the same. Results are available upon request from the authors.

significant at the 1% level, suggesting higher risk among firms with fixed cost structure. The dummy variable for the flexible cost structure (*FLEXIBLE* in Model 3) is always negative and significant, suggesting lower risk among firms with flexible cost structure.

[INSERT TABLE 6 ABOUT HERE]

4.2. Accounting for sample selection issues

The results in Table 3 through Table 6 present consistent and robust evidence of a negative relationship between operating leverage and stock return risk. Nonetheless, while cost structure affects the firm stock return risk, a firm might self-select a particular cost structure. Furthermore, we might not account for other firm characteristics that might affect both its risk and cost structure in the previous tables. To control for such sample selection issues, we take a multipronged approach as explained below.

First, we use a propensity-score matching approach to find firms with similar observable characteristics but different cost structures. We then compare the stock return risk between the two groups of firms. Differences in stock return risk would be attributed to the different cost structures rather than other firm observable characteristics. We report the results of this test in Table 7.

In Panel A of Table 7, we report the results from the three specifications of a probit regression to capture the choice of a fixed cost structure. Following Kulchania (2016), the control variables used in each specification are: (Model 1) the natural logarithm of asset (*LNAT*) with year and industry fixed effects; (Model 2) *LNAT*, industry-adjusted debt (*ADJDEBT*), industry-adjusted return on asset volatility (*ROAVOL*), industry-adjusted return on asset (*ADJROA*) with year and industry fixed effects; and (Model 3) *LNAT*, industry-adjusted debt (*ADJDEBT*), industry-adjusted return on asset volatility (*ROAVOL*), industry-adjusted return on asset (*ADJROA*) and industry-adjusted sales growth (*ADJSALEGROWTH*) with year and industry fixed effects. We obtain the predicted values from the probit regression (i.e. propensity score) and match each fixed cost firm with a variable cost firm with the closest propensity score. In Panel B of Table 7, we compare the three measures of stock return risk between a firm with a fixed cost structure and its nearest neighborhood matched firm with a flexible cost structure. Consistent with the results in Table 3, firms with fixed cost structure have significantly higher stock return risk than firms with flexible cost structure.

[INSERT TABLE 7 ABOUT HERE]

Second, we implement a Heckman self-selection model to control for cost structure self-selection bias. Using the predicted probabilities from the three estimated probit regressions in Panel A of Table 7, we calculate the three alternative inverse Mills ratios and include these ratios into the baseline regressions of stock return risk on industry-adjusted operating leverage. We report the results of this analysis in Table 8. The coefficients on the *ADJOPERLEV* are significant at the 1% level and consistent with the results in the above tables, confirming solid evidence of a negative relationship between flexibility in cost structure and stock return risk.

[INSERT TABLE 8 ABOUT HERE]

Third, we conduct an instrument variable (IV) analysis. In the first stage regression, we use the median cost structure of firms in the same industry (classified using Fama-French 48 sector classification) and the same tercile of market capitalization at the end of the preceding fiscal year as an instrument for the firm's cost structure and perform the IV analysis. We control for year and firm fixed effects. The first-stage results are not shown for brevity. Table 9 shows the results of the second-stage regressions using fitted values of operating leverage. Results of the Hansen test indicate that the instrument passes the validity test. The results show a negative coefficient on the instrumented industry-adjusted operating leverage (*ADJOPERLEV_INST)*, confirming the results in the preceding tables.

[INSERT TABLE 9 ABOUT HERE]

4.3. Operating leverage and stock return volatility in crisis periods vs. non-crisis period

In Table 10, we explore whether the relationship between cost structure and firm stock return risk differs between crisis and non-crisis periods. The years 2007 and 2008 are designated as crisis years. It is well documented that this period was associated with an atypical adverse effect on stock prices and stock indexes plunged to record levels during that time. Panel A of Table 10 contains the observations from the non-crisis period while the crisis period observations are analyzed in Panel B. Irrespective of the period (i.e., crisis or non-crisis), the coefficient representing operating leverage is consistently negative and significant beyond the 1% level. The relationship between cost structure and firm stock return risk is stable between both crisis and non-crisis periods. In non-tabulated findings the relationship between operating leverage and the various risk measures persist in subsamples based on market-to-book ratio, return on assets, debt ratio, and volatility in the returns on assets.[9]

[INSERT TABLE 10 ABOUT HERE]

4.4. Reverse Causality

Finally, to further check whether our results are biased due to the possible presence of reverse causality, in Table 11, we have presented results based on 4-digit and 3-digit SIC codes. The results confirm the insignificant effects of operating leverage on stock volatility, implying that our earlier regression specification holds, unbiased and correctly specified.

[INSERT TABLE 11 ABOUT HERE]

5. Conclusions

In this work, we studied the effect of a firms' cost structure on their total and firm-specific risks. While various asset pricing models focus on systematic risk, yet total risk and firm-specific risk are important determinants in pricing options and stock portfolio composition, among others. We test the theoretical predictions of earlier studies that forecast that a firm's cost structure affects its systematic risk. The cost

[9] Results are available upon request.

structure is the coefficient derived from a time series regression of firms' operating costs on sales revenues following Kahl et al. (2012) and Kulchania (2016). Using a sample of US publicly listed corporations from 1981 to 2015, we find that annualized daily idiosyncratic risk, beta, and annualized daily total return risk are all significantly higher for fixed cost structure firms than firms with the flexible cost structure. The findings persist in a battery of robustness checks including propensity score matching analyses, Heckman self-selection analysis and instrument variable analysis, and across crisis and non-crisis periods.

Our results have important lessons for a firm's choice of a specific cost-type concentration. There are two moderators: degree of competition within an industry pushes a firm to innovate so as to survive and lead the market. When the perturbations within an economy is zero, investment in fixed costs may beget high return. Through a positive signal to the market, a high stock performance is a natural outcome. However, when uncertainty pervades the realm of firms' decision-making process, a noisy information leads firms to indulge further to innovate more to stay alive and weather the storm of uncertainty. More often than not, such a decision does not bring expected revenue gains, thus through a negative signal to the market about underperformance, the firms' stock performance becomes highly volatile. Our work is able to demonstrate that if the extent of uncertainty can be controlled for or be partially predicted by the dynamic movements of macroeconomic fundamentals, a cost-specific indulgence of investment leading to greater volatility in the stock returns can be significantly minimized.

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Appendix 1 – Variables Definition	
Variable	***Variable Definition***
IDIORISK	The annualized standard deviation of a firm's daily stock return residuals obtained from the Fama-French plus Momentum model.
SYSRISK	The market beta from the Fama-French *Plus* Momentum model.
TOTRISK	The annualized standard deviation of a firm's daily stock returns.
OPERLEV	Our measure of operating leverage (*OPERLEV*) follows Kahl et al. (2012) and Kulchania (2016). It starts with the estimation of the ex-ante expectations of operating costs and sales that are based on the growth rate over the prior two years. $$E[S_{i,t}] = S_{i,t-1}\sqrt{\frac{S_{i,t-1}}{S_{i,t-3}}}$$ (A1) $$E[C_{i,t}] = C_{i,t-1}\sqrt{\frac{C_{i,t-1}}{C_{i,t-3}}}$$ (A2) where $S_{i,t}$ and $C_{i,t}$ represent sales and operating costs, respectively for firm i in year t. They are both normalized by the total asset size. The differences between the actual and expected values of $S_{i,t}$ and $C_{i,t}$ are calculated as follows: $$[u_{S_{i,t}}] = \frac{[S_{i,t} - E[S_{i,t}]]}{S_{i,t-1}}$$ (A3) $$[u_{C_{i,t}}] = \frac{[C_{i,t} - E[C_{i,t}]]}{C_{i,t-1}}$$ (A4) We run a firm-level regression of $u_{C_{i,t}}$ on $u_{S_{i,t}}$ as follows using seven years of data (i.e. a rolling window from year -6 to 0) in each case: $u_{C_{i,t}} = \beta \times u_{S_{i,t}} + \epsilon_{i,t}$, where $t \in [-6,0]$ beta measures the sensitivity of growth in operating costs to growth in sales. The higher the value of beta, the higher the firm's ability to respond to changes in sales. These firms have more variable costs relative to total costs. Conversely, firms with higher proportions of fixed costs to total operating costs have lower betas.

FIXED	A dummy variable representing firms with an *OPERLEV* in the lowest tercile.
FLEXIBLE	A dummy variable representing firms with an *OPERLEV* in the highest tercile.
LEV	Leverage which is the ratio of total debt-to-total assets
ADJOPERLEV	An industry-adjusted operating leverage measure (i.e. the difference between the firm's operating leverage and the median industry).
SIZE	The natural logarithm of firm market capitalization.
AT	Total Assets
MKBK	Market-to-book ratio
ADJMKBK	The industry-adjusted ratio of the market capitalization scaled by the book value of common equity and balance sheet deferred tax.
ADJDEBT	The industry-adjusted debt-to-asset ratio.
ROA	Return on Assets
ROAVOL	The standard deviation of firm returns on assets over the preceding five years.
ADJROA	The industry-adjusted return on asset ratio.
ADJSALEGROWTH	The industry-adjusted sale growth.
MKCAP	Market capitalization
RE2AT	retained earnings / asset
RE2CEQ	retained earnings /common equity
RE2TEQ	retained earnings / total equity
HERFINDAHLSIC	Product market concentration for each 4-digit SIC code in each year = sum of squared of firm sale proportion to the total sale of 4-digit SIC code in each year.
HERFINDAHLSIC3	Product market concentration for each 3-digit SIC code in each year = sum of squared of firm sale proportion to the total sale of 3-digit SIC code in each year.
PRODMKTFLUID	This is a text-based production market competition developed by Hoberg and Phillips (2016). Notice that using this variable FLUIDITY will cause the sample size to go down by 40%.
FF3IVOL	Idiosyncratic risk from the Fama-French 3 factor model.
FF3TVOL	Total stock return volatility using daily stock returns in the year
FF4IVOL	Idiosyncratic risk from the Fama-French 4 factor model.
FF4TVOL	Total stock return volatility using daily stock returns in the year
FF3ANNIVOL	Annualized idiosyncratic risk from the Fama-French 3 factor model
FF3ANNTVOL	Annualized total stock return volatility using daily stock returns in the year
FF4ANNIVOL	Annualized idiosyncratic risk from the Fama-French 4 factor model
FF4ANNTVOL	Annualized total stock return volatility using daily stock returns in the year
FF4B_MKT	Market beta from the Fama-French 3 factor model.

FF3B_MKT	Market beta from the Fama-French 4 factor model.
DA	Discretionary accruals. Notice that this variable is only available after 1990 due to the fact that Compustat only consistently reports the variable OANCF after 1990
	The prefix *"LAG1", "LAG2", "LAG3*" indicate the 1, 2, 3 lagged values of a variable. The prefix "*LEAD1", "LEAD2", "LEAD3*" indicate the 1, 2, 3 forward values of a variable.

Table 1 – Sample Distribution and Descriptive Statistics

Panel A - Sample Distribution

Year	N	Percent	Industry	N	Percent
1981	1,564	1.57	AERO	728	0.73
1982	1,543	1.55	AGRIC	248	0.25
1983	1,585	1.59	AUTOS	2,069	2.08
1984	1,821	1.83	BEER	427	0.43
1985	1,914	1.92	BLDMT	2,795	2.81
1986	2,306	2.32	BOOKS	943	0.95
1987	2,381	2.39	BOXES	401	0.4
1988	2,383	2.4	BUSSV	11,898	11.96
1989	2,420	2.43	CHEM	2,579	2.59
1990	2,491	2.51	CHIPS	7,430	7.47
1991	2,519	2.53	CLTHS	1,791	1.8
1992	2,583	2.6	CNSTR	1,479	1.49
1993	3,162	3.18	COAL	114	0.11
1994	3,262	3.28	COMPS	4,749	4.78
1995	3,454	3.47	DRUGS	4,415	4.44
1996	3,673	3.69	ELCEQ	2,042	2.05
1997	3,768	3.79	FABPR	459	0.46
1998	3,766	3.79	FOOD	2,105	2.12
1999	4,020	4.04	FUN	1,612	1.62
2000	3,839	3.86	GOLD	818	0.82
2001	3,617	3.64	GUNS	213	0.21
2002	3,702	3.72	HLTH	1,935	1.95
2003	3,525	3.54	HSHLD	2,234	2.25
2004	3,399	3.42	LABEQ	2,678	2.69
2005	3,225	3.24	MACH	4,462	4.49
2006	3,141	3.16	MEALS	2,316	2.33
2007	2,959	2.98	MEDEQ	3,505	3.52
2008	2,882	2.9	MINES	623	0.63
2009	2,845	2.86	OIL	5,189	5.22
2010	2,740	2.76	PAPER	1,898	1.91
2011	2,665	2.68	PERSV	1,017	1.02
2012	2,650	2.66	RTAIL	6,310	6.35
2013	2,585	2.6	RUBBR	1,163	1.17
2014	2,537	2.55	SHIPS	233	0.23
2015	2,515	2.53	SMOKE	32	0.03
Total	99,441	100	SODA	328	0.33
			STEEL	1,938	1.95
			TELCM	3,574	3.59
			TOYS	956	0.96
			TRANS	3,180	3.2
			TXTLS	742	0.75
			WHLSL	4,373	4.4
			OTHER	1,440	1.45

Panel B - Sample Characteristics

Variables	N	Mean	Median	Standard deviation	25th Percentile	75th Percentile
IDIORISK	99,415	0.539	0.434	0.355	0.295	0.664
SYSRISK	99,415	0.918	0.919	0.613	0.539	1.282
TOTRISK	99,415	0.580	0.480	0.355	0.335	0.711
OPERLEV	99,441	0.941	0.968	0.347	0.810	1.058
FIXED	99,441	0.338	0.000	0.473	0.000	1.000
FLEXIBLE	99,441	0.328	0.000	0.470	0.000	1.000
ADJOPERLEV	99,441	-0.010	0.000	0.340	-0.138	0.101
LNL1MKCAP	99,441	5.465	5.342	2.234	3.793	6.972
ADJMKBK	99,262	0.331	0.000	1.193	-0.282	0.512
ADJDEBT	99,262	0.012	0.000	0.217	-0.137	0.141
ROAVOL	88,845	0.082	0.039	0.198	0.018	0.086
ADJROA	99,441	-0.033	0.000	0.165	-0.048	0.041

Table 2 - Correlation Matrices

The variables are defined in Appendix 1. The correlation coefficients are statistically significant beyond the 1% level

Panel A – Correlation between contemporaneous cost structure variables and other firm characteristics

	FIXED	*FLEXIBLE*	*OPERLEV*	*HERFINDA HLSIC*	*HERFINDA HLSIC3*	*PRODMKT FLUID*	*SIZE*	*RE2AT*	*RE2CEQ*	*RE2TEQ*
FIXED	1									
FLEXIBLE	-0.383	1								
OPERLEV	-0.714	0.588	1							
HERFINDAHLSIC	-0.106	0.0186	0.0587	1						
HERFINDAHLSIC3	-0.146	0.0475	0.103	0.677	1					
PRODMKTFLUID	0.229	-0.0356	-0.148	-0.243	-0.265	1				
SIZE	-0.156	0.0227	0.0787	-0.0324	0.0234	0.0622	1			
RE2AT	-0.286	0.0651	0.240	0.0885	0.147	-0.273	0.323	1		
RE2CEQ	-0.170	0.0309	0.126	0.0540	0.0932	-0.159	0.214	0.566	1	
RE2TEQ	-0.192	0.0357	0.147	0.0627	0.104	-0.178	0.245	0.648	0.870	1

Panel B – Correlation between 1-year forward cost structure variables and other firm characteristics

	LEAD1FIXED	*LEAD1FLEXI BLE*	*LEAD1OPER LEV*	*HERFINDA HLSIC*	*HERFINDA HLSIC3*	*PRODMKT FLUID*	*SIZE*	*RE2AT*	*RE2CEQ*	*RE2TEQ*
LEAD1FIXED	1									
LEAD1FLEXIBLE	-0.371	1								
LEAD1OPERLEV	-0.752	0.596	1							
HERFINDAHLSIC	-0.112	0.0221	0.0762	1						
HERFINDAHLSIC3	-0.152	0.0548	0.124	0.675	1					
PRODMKTFLUID	0.235	-0.0418	-0.177	-0.244	-0.267	1				
SIZE	-0.155	0.0353	0.100	-0.0296	0.0278	0.0638	1			
RE2AT	-0.291	0.0750	0.275	0.0879	0.147	-0.278	0.296	1		
RE2CEQ	-0.176	0.0374	0.149	0.0566	0.0994	-0.171	0.213	0.605	1	
RE2TEQ	-0.197	0.0407	0.173	0.0647	0.109	-0.188	0.237	0.678	0.878	1

Panel C – Correlation between 1-year lagged cost structure variables and other firm characteristics

	LAG1FIXED	*LAG1FLEXIB LE*	*LAG1OPERL EV*	*HERFINDA HLSIC*	*HERFINDA HLSIC3*	*PRODMKT FLUID*	*SIZE*	*RE2AT*	*RE2CEQ*	*RE2TEQ*
LAG1FIXED	1									
LAG1FLEXIBLE	-0.392	1								
LAG1OPERLEV	-0.698	0.596	1							
HERFINDAHLSIC	-0.103	0.0157	0.0515	1						
HERFINDAHLSIC3	-0.142	0.0411	0.0888	0.677	1					
PRODMKTFLUID	0.222	-0.0267	-0.126	-0.243	-0.265	1				
SIZE	-0.152	0.0140	0.0620	-0.0324	0.0234	0.0622	1			
RE2AT	-0.277	0.0576	0.213	0.0885	0.147	-0.273	0.323	1		
RE2CEQ	-0.166	0.0268	0.110	0.0540	0.0932	-0.159	0.214	0.566	1	
RE2TEQ	-0.183	0.0297	0.127	0.0627	0.104	-0.178	0.245	0.648	0.870	1

Table 3 – Comparison of Stock Return Risk by Terciles of Operating Leverage

Tercile of Operating Leverage	*Variables*	*IDIORISK*	*SYSRISK*	*TOTRISK*
Low – *FIXED*	Mean	0.593	0.927	0.634
	Median	0.487	0.929	0.534
Medium	Mean	0.568	0.918	0.580
	Median	0.453	0.922	0.489
	Mean	0.536	0.908	0.577
High – *FLEXIBLE*	Median	0.430	0.903	0.475
High minus Low	Mean	-0.057	-0.020	-0.057
	Median	-0.057	-0.026	-0.059
	t-stat	-20.12***	-3.97***	-20.14***
	Wilcoxon-stat	-24.53***	-4.59***	-24.43***

Table 4 - Baseline Regressions of Idiosyncratic Risk (*IDIORISK*)

Variables	*Model 1*	*Model 2*	*Model 3*	*Model 4*
L1.OPERLEV	-0.014			
	(-2.923***)			
L1.FIXED		0.023		
		(8.121***)		
L1.FLEXIBLE			-0.001	
			(-2.469**)	
L1.ADJOPERLEV				-0.015
				(-3.063***)
L1.SIZE	-0.087	-0.086	-0.087	-0.087
	(-76.322***)	(-76.194***)	(-76.585***)	(-76.338***)
L1.ADJMKBK	0.023	0.022	0.023	0.023
	(15.447***)	(15.249***)	(15.780***)	(15.426***)
L1.ADJDEBT	0.128	0.132	0.127	0.128
	(14.867***)	(15.325***)	(14.718***)	(14.879***)
ROAVOL	0.083	0.082	0.082	0.083
	(3.156***)	(3.172***)	(3.148***)	(3.156***)
L1.ADJROA	-0.448	-0.444	-0.451	-0.448
	(-32.980***)	(-33.059***)	(-33.209***)	(-32.917***)
Constant	0.743	0.705	0.731	0.730
	(21.316***)	(20.229***)	(21.136***)	(21.089***)
Adj. R-squared	0.552	0.552	0.551	0.552
Year fixed effect	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Clustered std error by firms	Yes	Yes	Yes	Yes
Observations	88,663	88,663	88,663	88,663

Table 5 - Baseline Regressions of Systematic Risk (*SYSRISK*)				
Variables	***Model 1***	***Model 2***	***Model 3***	***Model 4***
L1.OPERLEV	-0.043			
	(-3.843***)			
L1.FIXED		0.044		
		(6.876***)		
L1.FLEXIBLE			-0.015	
			(-2.383**)	
L1.ADJOPERLEV				-0.048
				(-4.261***)
L1.SIZE	0.083	0.084	0.083	0.083
	(34.218***)	(34.449***)	(34.120***)	(34.214***)
L1.ADJMKBK	0.039	0.039	0.040	0.039
	(13.500***)	(13.411***)	(13.862***)	(13.461***)
L1.ADJDEBT	0.093	0.098	0.090	0.094
	(5.403***)	(5.711***)	(5.235***)	(5.434***)
ROAVOL	0.095	0.092	0.093	0.095
	(4.205***)	(4.235***)	(4.182***)	(4.207***)
L1.ADJROA	-0.210	-0.205	-0.216	-0.209
	(-8.888***)	(-8.709***)	(-9.143***)	(-8.842***)
Constant	0.817	0.731	0.780	0.778
	(13.931***)	(12.422***)	(13.459***)	(13.418***)
Adj. R-squared	0.121	0.122	0.121	0.122
Year fixed effect	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Clustered std error by firms	Yes	Yes	Yes	Yes
Observations	88,663	88,663	88,663	88,663

Table 6 – Fama-McBeth Regressions of Stock Risk on Cost Structure

	Panel A - IDIORISK			*Panel B - SYSRISK*			*Panel C - TOTRISK*		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
L1.ADJOPERLEV	-0.015			-0.074			-0.017		
	(-4.11***)			(-6.24***)			(-4.93***)		
L1.FIXED		0.020			0.043			0.022	
		(10.83***)			(7.67***)			(11.33***)	
L1.FLEXIBLE			-0.003			-0.020			-0.004
			(-1.73*)			(-4.11***)			(-2.22**)
L1.SIZE	-0.079	-0.079	-0.080	0.075	0.075	0.074	-0.073	-0.072	-0.073
	(-18.67***)	(-18.66***)	(-18.69***)	(13.59***)	(13.57***)	(13.45***)	(-16.16***)	(-16.14***)	(-16.19***)
L1.ADJMKBK	0.024	0.024	0.025	0.038	0.038	0.039	0.026	0.026	0.027
	(7.13***)	(7.04***)	(7.30***)	(5.22***)	(5.26***)	(5.37***)	(6.56***)	(6.47***)	(6.71***)
L1.ADJDEBT	0.139	0.142	0.138	0.144	0.148	0.140	0.142	0.146	0.141
	(12.57***)	(12.88***)	(12.39***)	(4.63***)	(4.68***)	(4.49***)	(11.86***)	(12.16***)	(11.69***)
ROAVOL	0.288	0.286	0.288	0.395	0.382	0.391	0.301	0.298	0.300
	(7.89***)	(7.86***)	(7.88***)	(4.79***)	(4.69***)	(4.70***)	(7.74***)	(7.71***)	(7.74***)
L1.ADJROA	-0.450	-0.447	-0.452	-0.150	-0.146	-0.156	-0.455	-0.452	-0.458
	(-17.32***)	(-17.15***)	(-17.50***)	(-3.91***)	(-3.79***)	(-4.06***)	(-17.52***)	(-17.34***)	(-17.70***)
Constant	0.900	0.893	0.903	0.462	0.448	0.472	0.901	0.893	0.904
	(24.34***)	(24.32***)	(24.34***)	(9.62***)	(9.39***)	(9.73***)	(24.50***)	(24.47***)	(24.53***)
Avg. R-squared =	0.4977	0.4983	0.4973	0.1124	0.1121	0.1112	0.4595	0.4603	0.459

Table 7 – Comparisons of Stock Risk between Propensity Matching Samples

Panel A - Probit Regressions of Having Fixed Cost

Variables	Model 1	Model 2	Model 3
LNAT	-0.480	-0.331	-0.319
	(-48.139***)	(-26.870***)	(-25.468***)
ADJDEBT		-0.252	-0.260
		(-23.252***)	(-23.490***)
ROAVOL		0.066	0.073
		(6.940***)	(7.595***)
ADJROA		-0.251	-0.245
		(-23.232***)	(-22.326***)
ADJSALEGROWTH			0.059
			(6.326 ***)
Constant	0.399	0.143	0.077
	(4.566***)	(1.434)	(0.753)
Pseudo R-squared	0.0189	0.0289	0.0289
Chi- squared	2412	2892	2803
% correct classification	66.28%	67.58%	67.93%
Observations	99,441	78,822	76,948

Panel B - Comparison of Stock Risk for Propensity Matched Samples

B1 - Matched on Model 1 from Panel A (N = 33,608)

	Fixed cost	Flexible cost	Difference		
Variables	Mean	Mean	Mean	t-stat	Wilcoxon
IDIORISK	0.593	0.589	-0.004	-2.77***	-4.52***
SYSRISK	0.927	0.870	-0.058	-12.58***	-13.53***
TOTRISK	0.634	0.627	-0.007	-3.26***	-3.57***

B2 - Matched on Model 2 from Panel A (N = 25,936)

	Fixed cost	Flexible cost	Difference		
Variables	Mean	Mean	Mean	t-stat	Wilcoxon
IDIORISK	0.563	0.543	-0.020	-8.20***	-9.89***
SYSRISK	0.917	0.877	-0.040	-7.98***	-8.58***
TOTRISK	0.605	0.583	-0.022	-8.97***	-10.94***

B3 - Matched on Model 3 from Panel A (N = 24,985)

	Fixed cost	Flexible cost	Difference		
Variables	Mean	Mean	Mean	t-stat	Wilcoxon
IDIORISK	0.558	0.538	-0.020	-8.03***	-9.23***
SYSRISK	0.919	0.874	-0.045	-8.78***	-8.94***
TOTRISK	0.600	0.578	-0.022	-8.78***	-10.53***

Table 8 – Heckman Self-Selection Model

MILLS1, MILLS2 and MILLS3 are the inverse Mills ratios calculated from the predicted probabilities obtained from models 1, 2 and 3, respectively, in Panel A of Table 8.

Variables	*IDIORISK*	*SYSRISK*	*TOTRISK*	*IDIORISK*	*SYSRISK*	*TOTRISK*	*IDIORISK*	*SYSRISK*	*TOTRISK*
L1.ADJOPERLEV	-0.018	-0.047	-0.019	-0.023	-0.050	-0.024	-0.024	-0.051	-0.024
	(-3.613***)	(-4.231***)	(-3.743***)	(-4.388***)	(-4.064***)	(-4.421***)	(-4.410***)	(-4.061***)	(-4.403***)
L1.SIZE	-0.160	0.094	-0.152	-0.138	0.114	-0.129	-0.124	0.118	-0.114
	(-45.11***)	(13.24***)	(-41.74***)	(-27.06***)	(17.129***)	(-24.70***)	(-23.79***)	(18.920***)	(-21.57***)
L1.ADJMKBK	0.061	0.034	0.064	0.050	0.021	0.052	0.045	0.018	0.046
	(27.766***)	(7.575***)	(27.748***)	(19.493***)	(4.849***)	(19.498***)	(17.496***)	(4.176***)	(17.610***)
L1.ADJDEBT	0.014	0.110	0.015	-0.366	0.400	-0.346	-0.263	0.454	-0.240
	(1.502)	(5.666***)	(1.603)	(-7.323***)	(6.289***)	(-6.779***)	(-4.747***)	(7.213***)	(-4.246***)
ROAVOL	0.093	0.094	0.098	0.171	0.046	0.173	0.182	0.049	0.183
	(3.058***)	(4.217***)	(3.084***)	(3.743***)	(1.998**)	(3.684***)	(2.880***)	(1.685*)	(2.835***)
L1.ADJROA	-0.434	-0.211	-0.445	-0.987	0.124	-0.978	-0.857	0.167	-0.844
	(-29.79**)	(-8.932***)	(-29.55***)	(-21.56***)	(1.704*)	(-20.89***)	(-19.03***)	(2.447**)	(-18.47***)
MILLS1	1.029	-0.152	1.025						
	(21.562***)	(-1.521)	(20.902***)						
MILLS2				1.073	-0.631	1.033			
				(10.191***)	(-4.733***)	(9.609***)			
MILLS3							0.835	-0.729	0.788
							(7.295***)	(-5.686***)	(6.767***)
Constant	-0.050	1.357	-0.044	-0.146	1.047	-0.134	0.010	1.158	0.029
	(-1.051)	(14.547***)	(-0.897)	(-1.517)	(8.236***)	(-1.360)	(0.091)	(9.103***)	(0.264)
Adj. R-squared	0.562	0.122	0.535	0.559	0.129	0.531	0.558	0.130	0.529
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered std err by firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	88,662	88,662	88,662	78,802	78,802	78,802	76,929	76,929	76,929

Table 9 – Instrumental Variable Approach

Variables	*Panel A - IDIORISK*	*Panel B - SYSRISK*	*Panel C- TOTRISK*
L1.ADJOPERLEV_INST	-0.049	-0.144	-0.030
	(-2.808***)	(-3.571***)	(-1.689*)
L1.SIZE	-0.087	0.081	-0.080
	(-75.438***)	(33.018***)	(-69.360***)
L1.ADJMKBK	0.023	0.042	0.026
	(15.577***)	(14.250***)	(16.935***)
L1.ADJDEBT	0.128	0.086	0.128
	(14.831***)	(5.012***)	(14.492***)
ROAVOL	0.082	0.094	0.086
	(3.144***)	(4.168***)	(3.170***)
L1.ADJROA	-0.449	-0.222	-0.461
	(-33.259***)	(-9.404***)	(-32.954***)
Constant	0.772	0.659	0.767
	(20.364***)	(9.809***)	(19.947***)
Hansen J-statistics	0.215	0.206	0.211
p-value	0.513	0.511	0.512
Adj. R-squared	0.552	0.121	0.524
Year fixed effect	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Clustered std err by firms	Yes	Yes	Yes
Observations	88,663	88,663	88,663

Table 10 – Non-Crisis Period vs. Crisis Period

	Panel A - Non-Crisis Period			*Panel B - Crisis Period*		
VARIABLES	*IDIORISK*	*SYSRISK*	*TOTRISK*	*IDIORISK*	*SYSRISK*	*TOTRISK*
L1.ADJOPERLEV	-0.014	-0.048	-0.015	-0.041	-0.030	-0.043
	(-2.711***)	(-4.181***)	(-2.869***)	(-3.866***)	(-2.363**)	(-3.980***)
L1.SIZE	-0.088	0.082	-0.081	-0.074	0.090	-0.058
	(-75.092***)	(33.362***)	(-69.301***)	(-36.467***)	(23.373***)	(-28.254***)
L1.ADJMKBK	0.023	0.040	0.027	0.010	0.026	0.010
	(15.407***)	(13.274***)	(16.692***)	(3.534***)	(5.085***)	(3.517***)
L1.ADJDEBT	0.128	0.096	0.128	0.127	0.065	0.138
	(14.381***)	(5.424***)	(14.019***)	(7.453***)	(1.886*)	(8.004***)
ROAVOL	0.087	0.102	0.092	0.030	0.021	0.030
	(3.030***)	(4.113***)	(3.058***)	(1.090)	(1.042)	(1.024)
L1.ADJROA	-0.447	-0.222	-0.459	-0.454	0.058	-0.444
	(-30.999***)	(-9.119***)	(-30.796***)	(-14.880***)	(1.183)	(-14.519***)
Constant	0.731	0.765	0.743	0.860	0.463	0.803
	(21.031***)	(13.038***)	(21.094***)	(15.673***)	(9.677***)	(16.090***)
Adj. R-squared	0.553	0.119	0.524	0.561	0.304	0.575
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Clustered std err by firm	Yes	Yes	Yes	Yes	Yes	Yes
Observations	83,211	83,211	83,211	5,452	5,452	5,452

Table 11: Test of Reverse Causality

Variables	Panel A: Market share by 4-digit SIC codes				Panel B: Market share by 3-digit SIC codes			
	Model I	Model II	Model III	Model IV	Model I	Model II	Model III	Model IV
Constant	0.059	0.061	0.137	0.140	0.027	0.028	0.084	0.086
	(7.594***)	(7.880***)	(20.366***)	(21.366***)	(4.589***)	(4.824***)	(16.825***)	(17.392***)
FIXED COSTS		-0.002		-0.006		0.000		-0.004
		(-0.479)		(-1.507)		(0.119)		(-1.031)
FLEXIBLE COSTS		0.002		-0.001		0.003		0.000
		(0.527)		(-0.200)		(0.833)		(0.129)
	0.003		0.004		0.003		0.004	
OPERATING LEVERAGE	(0.988)		(1.252)		(1.121)		(1.396)	
SIZE	0.226	0.226			0.221	0.221		
	(14.862***)	(14.852***)			(14.292***)	(14.320***)		
MKBK	-0.045	-0.045	-0.002	-0.002	-0.045	-0.045	-0.003	-0.003
	(-11.066***)	(-11.064***)	(-0.769)	(-0.773)	(-10.809***)	(-10.837***)	(-0.946)	(-0.955)
ROA	-0.021	-0.021	0.006	0.006	-0.020	-0.020	0.006	0.006
	(-8.353***)	(-8.374***)	(2.853***)	(2.797***)	(-8.508***)	(-8.517***)	(3.197***)	(3.160***)
Observations	108,086	108,086	108,086	108,086	108,086	108,086	108,086	108,086
Number of firms	11,640	11,640	11,640	11,640	11,640	11,640	11,640	11,640
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-squared	0.0405	0.0405	0.0184	0.0185	0.0341	0.0341	0.0117	0.0116
F-statistics	13.86	13.54	8.983	8.803	11.05	10.80	7.059	6.921

Note: Market share by 4-digit SIC codes = firm sales / sum sales by all firms in the same 4-digit SIC codes in the same year. Market share by 3-digit SIC codes = firm sales / sum sales by all firms in the same 3-digit SIC codes in the same year.