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Operating Leverage, Profitability, and Capital Structure

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Abstract

Operating leverage increases profitability and reduces optimal financial leverage. Thus, operating leverage generates a negative relation between profitability and financial leverage that is thought to be inconsistent with the trade-off theory but is commonly observed in the data. We demonstrate the effect of operating leverage on firms' profitability and financial leverage, as well as on the empirical relation between profitability and financial leverage, by using China's entry into the World Trade Organization in 2001 and its effect on the capital–labor ratio of U.S. firms.

I. Introduction

Operating leverage has a first-order effect on corporate policies and performance and can be positively associated with profitability. When sales are growing, fixed and quasi-fixed costs do not increase at the same rate as sales, such that higher operating leverage leads to higher profitability. Of course, in a contraction, these fixed costs have the opposite effect. Hence, operating leverage and profitability are positively related when sales are growing, which is the typical state of the economy in the data.

The installation of capital is analogous to issuing internal debt. Once the capital is installed, its operating costs are like fixed, perpetual coupon payments. A firm must pay its operating costs, such as general and administrative expenses, in order to maintain its regular course of business and produce its operating income. Even when in distress, the firm must continue to pay its operating costs (some of which are contractual), which can force it into bankruptcy earlier than

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would otherwise be the case. Hence, there is a substitution effect between operating leverage (defined as fixed and quasi-fixed costs scaled by total assets) and financial leverage. Early empirical evidence of a negative relation between operating and financial leverage can be found in Lev (1974), Ferri and Jones (1979), and Mandelker and Rhee (1984). More recently, Reinartz and Schmid (2016) study a sample of power producers and show that power plants with more production flexibility support increased financial leverage.

In this study, we show that the generally positive effect of operating leverage on profitability, combined with managers' endogenous anticipation of operating leverage's effect on their probability of distress in a contraction, is an important channel that can help explain the negative relation between profitability and financial leverage observed in the data. We also provide evidence that higher operating leverage does lead to higher probabilities of default, rationalizing managers' trade-off.

A well-known empirical failure of the trade-off model is that highly profitable firms do not have as much leverage as predicted, and in fact, in a linear regression, the relation between leverage and profitability is negative (Myers (1984), Graham (2000), and Kayhan and Titman (2007)). As discussed earlier, because the long-run trend of the economy is positive, higher operating leverage results in higher profitability most of the time. In contrast, because firms cannot reduce their operating costs one-for-one with their revenues in bad times, higher operating leverage reduces their ability to pay their debt and increases their future probability of default, which causes firms to choose lower financial leverage ex ante. Consequently, the opposite effects of operating leverage on profitability and financial leverage result in a negative relation in a regression of financial leverage on profitability.

Although the intuition presented here predicts the effect of this channel, we face an empirical challenge because firms do not disclose variable or fixed costs, instead listing cost of goods sold (COGS) and selling, general, and administrative (SG&A) expenses. We use the relatively sticky SG&A costs to proxy for operating leverage.[1] We begin our empirical investigation by verifying that the SG&A costs are indeed quasi-fixed. We extend the sample period of the tests by Anderson, Banker, and Janakiraman (2003) and compare the responses of COGS and SG&A expenses to negative sales shocks. We find that, on average, firms adjust their COGS by 0.86% and their SG&A expenses by 0.41% in response to a 1% decrease in sales revenue, which strongly supports the assumption that the SG&A costs are a good proxy for operating leverage. One of our empirical contributions is that we provide a direct, simple measure of operating leverage by identifying the quasi-fixed component of costs. More importantly, compared with prior studies, which

[1]The literature has different measures of operating leverage. Mandelker and Rhee (1984) propose to measure the degree of operating leverage by the sensitivity of EBIT to sales. Note that the difference between sales and EBIT is the total costs. Kahl, Lunn, and Nilsson (2014) propose using the sensitivity of innovations in growth rates of operating costs to innovations in growth rates of sales. However, they use total operating costs and 7 years of annual data, which is a relatively short period, to obtain an accurate estimate. Our approach is different and more straightforward in construction. We estimate the sensitivity of each cost component in general (panel) first and then identify the cost component that is less sensitive (SG&A) to proxy for the operating leverage.

use the sensitivity of earnings before interest and taxes (EBIT) to sales to proxy for operating leverage, our empirical measure has the advantage of permitting the direct evaluation of its positive effect on profitability.

Having confirmed that the SG&A cost is a good proxy for operating leverage, we use Fama and MacBeth (1973) regressions to demonstrate empirically that firms with higher operating leverage have higher profitability and lower financial leverage, resulting in a negative association between profitability and financial leverage.

An obvious concern in a study such as this is causality. To be clear, we assume that a firm's operating leverage is determined by the production technology in its industry and, as such, is largely exogenous. Managers then endogenously choose financial leverage and investment, taking into account their operating leverage. To increase our confidence in the underlying channel and direction of causality, we use both natural experiments and industry-level tests to confirm our findings. First, we use China's entrance to the World Trade Organization (WTO) in 2001 as an exogenous shock to operating leverage. Pierce and Schott (2016) find that labor employment declines sharply from 2001 to 2008 for manufacturing firms. Because those firms become more capital intensive, their fixed costs and therefore operating leverage increase. We demonstrate that our proxy of operating leverage decreases financial leverage. Further, we use the 2008 financial crisis as a second natural experiment, where operating leverage increases the default probability given the exogenous decrease in demand and increase in demand volatility, and we analyze how firms with different operating leverage adjust their financial leverage. Finally, we conduct robustness tests at the industry level, where the assumption of exogenous operating leverage is even safer. The results of these further analyses support our inference that operating leverage and financial leverage are substitutes, which, together with a positive relation between operating leverage and profitability, create a negative relation between profitability and financial leverage in the data. Our article contributes to the capital structure literature by documenting a general substitution between operating leverage and financial leverage, with a causal effect from operating decisions to leverage. We further show that an important existing empirical puzzle, a negative relation between profitability and leverage, is in fact consistent with the trade-off theory.

Theoretical work on this puzzle has shown that static and dynamic trade-off models can generate a positive relation between profitability and financial leverage at (re)financing points. A nonexclusive list of such models includes Kraus and Litzenberger (1973), Leland (1994), Goldstein, Ju, and Leland (2001), and Strebulaev (2007).[2] Notably, Strebulaev (2007) points out that although profitable firms generally issue more debt at the *refinancing* points, transaction costs prevent profitable firms from adjusting their capital structure immediately, resulting in a negative relation between profitability and financial leverage at the

[2]Alternatively, Hennessy and Whited (2005) propose a dynamic model showing that highly profitable firms are reluctant to issue debt because in those firms additional debt finances a distribution to equity holders rather than replacing equity. Almeida and Campello (2010) show that the negative relation between profitability and debt issuance is concentrated among firms that are least likely to face high external financing costs.

off-refinancing points in a dynamic model. Leary and Roberts (2005), Flannery and Rangan (2006), and Danis, Rettl, and Whited (2014) provide supportive empirical evidence that the presence of adjustment costs affects the firm's refinancing behavior. Chen and Zhao (2005) show that transaction costs do not fully explain the negative association between profitability and leverage. We offer one complementary mechanism that can help explain the puzzling negative profitability–leverage association by focusing on the effect of (quasi-fixed) SG&A costs on both profitability and leverage.

The rest of the article is organized as follows: We develop testable hypotheses in Section II. Section III describes the data and empirical measures. Section IV reports the empirical tests of the predictions from Section II. Section IV extends the analysis to the case in which firms have differing flexibility to reduce their operating costs in bad times. Section V reports robustness tests. Section VI concludes.

II. Empirical Hypothesis Development

In this section, we develop three testable empirical hypotheses relating operating leverage, profitability, and financial leverage. We assume that managers rationally make joint optimal investment and financing decisions that maximize firm market value by anticipating the impact of these decisions on the probability of future bankruptcy. Managers take into account the fixed operating costs necessary to maintain the firm's optimal capital, in addition to its coupon payments determined by its optimal financial leverage. Managers counter the concern that in a period of distress, higher operating costs could push the firm toward default, by optimally reducing the firm's combination of capital investment and financial leverage ex ante. We assume that managers' flexibility over capital investment and its operating cost is restricted by the production function of their industry (e.g., we assume that you cannot make semiconductors using labor alone).

We advance three empirical hypotheses for firms with positive profits, which include about 80% of the firm-year observations in the data, as follows.[3]

Hypothesis 1. Profitability increases with operating leverage.

Because firms' fixed and quasi-fixed costs do not increase at the same rate as their revenues, their operating leverage further increases their profitability in good times. Hence (for firms with positive profits), operating leverage and profitability are positively related.

Hypothesis 2. Firms substitute between operating and financial leverage. Therefore, operating leverage and financial leverage are negatively correlated.

A firm must pay its operating costs before coupon and tax payments, even when it is in distress, to keep operating. When a firm is in distress, it has difficulty breaking existing contractual commitments and reducing operating costs. Inflexible operating costs reduce the firm's ability to pay its debt and may force it into bankruptcy earlier than would otherwise be the case. Because both

[3]We use positive-profit firms in our empirical tests and discuss negative-profit firms in the robustness section.

operating leverage and financial leverage increase the firm's default probability, there is a substitution effect between operating leverage and financial leverage. Depending on distress costs borne by the firm (as well as those borne by managers), the positive effect of higher operating costs on default probability will mitigate the positive effect of greater capital investment on expected recovery rates in default. Consequently, anticipating the possibility of distress, even profitable firms with greater amounts of inflexible operating costs choose lower financial leverage ex ante.

Combining Hypotheses 1 and 2, we get Hypothesis 3 about the effect of operating leverage on the relation between profitability and financial leverage:

Hypothesis 3. Operating leverage produces a negative relation between profitability and financial leverage.

Hypothesis 2 states that there exists a substitution effect between operating leverage and financial leverage, which is consistent with the evidence of Lev (1974), Ferri and Jones (1979), Mandelker and Rhee (1984), and Reinartz and Schmid (2016). In contrast, Hypotheses 1 and 3 are novel in proposing that because profitability increases with operating leverage, operating leverage can produce (and thus explain) the observed negative correlation between profitability and financial leverage.

III. Data and Empirical Measures

We use annual Compustat industrial data from 1963 to 2016. We exclude firms in the financial and utility sectors. We restrict our sample to include only firms with positive total assets and sales. After lagging for control variables, we have 53 years of data.

A. Empirical Measures

Our measure of operating leverage (OPERLEV) is intuitive and is similar to the empirical proxy used by Novy-Marx (2011). We calculate it as selling, general, and administrative expenses (SG&A, Compustat item XSGA) divided by total assets at the end of the previous year, in the same fashion as we use the assets at the end of the previous year to scale the measure of profitability. Because XGSA is quasi-fixed, we do not normalize XGSA by sales (as sales goes to 0, this variable will not go there as quickly). Different from Novy-Marx (2011), we do not include COGS in the numerator for two reasons. First, XGSA is much stickier than COGS. Compared with XSGA, COGS is much more responsive to fluctuations in sales and so is better characterized as variable costs.[4] Second, the exclusion of COGS helps mitigate endogeneity concerns. COGS depends on the

[4]Following Minton and Schrand (1999), we also construct an alternative measure of operating leverage by excluding the discretionary research and development (R&D) costs (XRD) and advertising expenses (XAD) when those data items are available. This alternative measure suits our study from two perspectives: First, Titman and Wessels (1988) use the same data item normalized by net sales to proxy for selling costs. They argue that high selling costs, such as advertising expenses to promote a product, indicate the uniqueness of that product. By excluding R&D and advertising costs, we are able to show that our results are *not* driven by product uniqueness. Second, these two expenses are more likely to be cut when the firm is in distress or in an economic downturn. We expect that the remaining

production of goods, and therefore the inclusion of COGS would make the firm's operating leverage dependent on the amount produced.

A textbook definition of operating leverage is the elasticity of profits to sales (i.e., Brealey, Myers, and Allen (2010)). This can be shown to be

$$1+\frac{\text{fixed cost}}{\text{profits}} \quad = \quad 1+\frac{\frac{\text{fixed cost}}{\text{assets}}}{\frac{\text{profits}}{\text{assets}}} \quad = \quad 1+\frac{\text{OPERLEV}}{\text{profitability}},$$

where OPERLEV is our measure. Our measure is thus positively correlated with the textbook measure in the observations with positive profitability. The advantages of our measure are that it does not require a long time series of data for each firm to measure and it is not a function of profitability, thereby allowing us to explore the relation between our measure and profitability. The alternative measures proposed by Mandelker and Rhee (1984) and Kahl, Lunn, and Nilsson (2014) are based on time-series regression coefficients. Mandelker and Rhee (1984) regress EBIT on sales, and Kahl et al. (2014) regress innovations in growth rates of operating costs on innovations in growth rates of sales. The larger the estimated regression coefficient, the smaller the degree of operating leverage. Because their measure decreases in operating leverage, our measure is expected to be negatively correlated with theirs. The mean and median of the year-by-year cross-sectional correlations between our measure and that advanced by Mandelker and Rhee (1984) are −0.11 and −0.12, respectively. Those between our measure and that of Kahl et al. (2014) are −0.12 and −0.11, respectively.

We construct our other variables following the literature (e.g., Rajan and Zingales (1995), Welch (2004), Kayhan and Titman (2007), and Lemmon, Roberts, and Zender (2008)). Book leverage (BOOKLEV) is defined as the ratio of the book value of total debt (DLTT + DLC) to total assets (AT); market leverage MKTLEV is the ratio of the total debt (DLTT + DLC) to the sum of the total debt and market value of equity (CSHO × PRCC_F); the log of sales (LOG_SALES) proxies for size; profitability (PROFIT) is operating income before depreciation (OIBDP) normalized by total assets of the previous year; TANGIBILITY is calculated as the ratio of property, plant, and equipment (PPENT) to total assets; R&D (RD) is the ratio of research and development expenses (XRD) to sales (SALE);[5] dividend ratio (DIV) is ratio of the cash dividend (DVC) to total assets; and cash holdings (CASH) is the ratio of cash and short-term investments (CHE) to total assets. Cash-flow volatility (CFV) is the standard deviation of the time series of operating income (OIBDP), and industry median book leverage (LEVMED) is the median value of the book leverage of the relevant industry using the Fama–French 48 industry portfolios. Market-to-book ratio (MTOB) is the ratio of the sum of the firm's market value (market equity + total debt) plus preferred stock liquidating value (PSTKL) minus deferred taxes and investment tax credit (TXDITC) to total assets.

core expenses, such as the general and administrative operating costs for maintaining the business, are stickier and should have a more significant impact on the probability of default.

[5]We follow Kayhan and Titman (2007) to scale the R&D expenditure. Our results are robust to scaling R&D by total assets.

B. Justification for the Empirical Definition of Operating Leverage

We start by empirically confirming our decision to exclude COGS (as a relatively flexible production cost) from the definition of operating leverage. We calculate profitability at time t as (sales(t) − SG&A(t) − COGS(t))/assets ($t-1$)). Therefore, profitability changes when the change in sales(t) is more than the change in (SG&A(t) + COGS(t)). In this section we compare how the two costs change when sales revenues increase versus decrease. The purpose is to confirm that production costs (COGS) are much less sticky than operating costs (SG&A).

We follow Anderson et al. (2003) and investigate and compare the sensitivities of the operating and production costs to increases and decreases in sales revenue. We examine the contemporaneous response of operating costs to a change in sales revenues by estimating the following regression:

$$(1) \qquad Y_t = \beta_0 + \beta_1 \text{REVRATE}_t + \beta_2(\text{REVRATE}_t \times \text{DECREASE\_DUMMY}_t) + e_t,$$

where Y_t is the logarithmic change in operating costs (SG&A) or in production costs (COGS), and REVRATE is the logarithmic change in sales revenues.

The variable DECREASE_DUMMY$_t$ takes the value of 1 when sales revenues decrease from period $t-1$ to t, and 0 otherwise. The coefficient β_1 measures the percentage change in costs for each 1% increase in sales revenues, and the sum $(\beta_1 + \beta_2)$ measures the percentage change in costs for each 1% decrease in sales revenues. The β_1 coefficient provides a measure of the responsiveness of costs to changes in sales, so the further it is below 1, the stickier are the costs. However, because of our focus on potential distress due to quasi-fixed costs, we are interested in the asymmetric adjustment of the costs to increases and decreases in sales. Conditional on $\beta_1 > 0$, a finding of $\beta_2 < 0$ indicates that the firm cannot decrease its costs when its sales decrease as much as the firm increases them when its sales increase.

We estimate the model with pooled ordinary least squares and report the results in Table 1. The estimate of β_1 is 0.605 when the dependent variable is the change in operating costs. It is much smaller than 0.939, the estimate of β_1 when the dependent variable is the change in production costs. In addition, the estimated value of β_2 is −0.192 for the change in operating costs, supporting the incremental difficulty in reducing operating costs when sales fall. It is also larger, in absolute value, than −0.084, the estimate of β_2 for the change in production costs.

The sum of $\beta_1 + \beta_2$ measures the percentage decrease in operating or production costs per each 1% decrease in sales revenues. The smaller the estimated value of the sum, the more fixed the costs are in a contraction. In response to each 1% decrease in revenues, operating costs decrease by 0.413% (0.605 − 0.192), which is approximately 63.5% (0.413/0.605) of the percentage change when revenues increase. In contrast, production costs decrease by 0.855%, which is 91.1% (0.855/0.939) of the percentage change when revenues increase. Thus, production costs move nearly symmetrically one-for-one with sales, whereas operating costs move in a much more muted fashion, especially in the face of declining sales, justifying their classification as quasi-fixed.

TABLE 1

Stickiness of Operating and Production Costs

Table 1 presents the results from testing the stickiness of operating and production costs in response to a negative change in sales revenue by following Anderson et al. (2003). We run panel regressions to examine the contemporaneous response of the costs to the changes in sales revenue as follows:

$$Y_t \quad = \quad \beta_0 + \beta_1 \text{REVRATE}_t + \beta_2(\text{REVRATE}_t \times \text{DECREASE\_DUMMY}_t) + e_t,$$

where Y_t stands for the logarithmic changes in either selling, general, and administrative expenses (XSGA) or costs of goods sold (COGS). REVRATE_t denotes the logarithmic change in sales revenues. We use all the firms from 1963 to 2016. The t-statistics (reported in parentheses) are calculated using clustered standard errors.

Variable	XSGA	COGS
β_0	0.028	0.005
	(12.688)	(3.441)
β_1	0.605	0.939
	(54.921)	(122.93)
β_2	−0.192	−0.084
	(−11.470)	(−6.203)
$\beta_1 + \beta_2$	0.413	0.855
Adj. R^2	0.368	0.719

C. Descriptive Statistics

Table 2 presents descriptive statistics for the variables of interest. We restrict the sample to firm-years with positive profitability, based on annual data from 1962 to 2016. We require that both book leverage and market leverage are in the closed-unit interval. All other constructed measures, except for the RD and DIV variables, are winsorized at the top and bottom two percentiles to eliminate outliers and account for errors in the data. We set RD and DIV to 0 when they are not reported and include a dummy variable indicating that the value is missing.

TABLE 2

Descriptive Statistics

Table 2 reports the number of observations, mean, standard deviation (STD), and distribution of the variables of interest. The variables include book leverage (BOOKLEV); market leverage (MKTLEV); operating leverage (OPERLEV); profitability (PROFIT); market-to-book asset ratio (MTOB); logarithmic value of sales (LOG_SALES); the ratio of property, plant, and equipment to total assets (TANGIBILITY); research and development normalized by sales (RD); cash-flow volatility (CFV); industry median book leverage (LEVMED); cash dividend (DIV); and cash holdings (CASH) scaled by assets. The sample includes all firm-years with positive profits from 1963 to 2016. All empirical measures are defined in Section III.A.

Variable	N	Mean	Std. Dev.	Min.	P5	P25	Median	P75	P95	Max.
BOOKLEV	184,495	0.252	0.199	0.000	0.000	0.087	0.231	0.372	0.628	1.000
MKTLEV	163,766	0.279	0.248	0.000	0.000	0.063	0.223	0.441	0.776	0.967
OPERLEV	167,487	0.322	0.285	0.001	0.033	0.125	0.254	0.434	0.858	7.209
PROFIT	186,368	0.168	0.103	0.000	0.029	0.095	0.152	0.221	0.379	0.545
MTOB	163,767	1.342	1.269	0.193	0.437	0.696	0.983	1.530	3.391	45.154
LOG_SALES	186,081	5.165	2.155	−2.343	1.723	3.656	5.098	6.639	8.866	10.815
TANGIBILITY	186,183	0.338	0.233	0.000	0.040	0.153	0.288	0.483	0.810	0.951
RD	186,081	0.020	0.052	0.000	0.000	0.000	0.000	0.015	0.118	2.779
CFV	185,598	0.097	0.112	0.000	0.026	0.051	0.077	0.113	0.206	3.904
LEVMED	186,368	0.228	0.091	0.000	0.063	0.178	0.236	0.287	0.373	0.562
DIV	186,368	0.012	0.019	0.000	0.000	0.000	0.000	0.018	0.052	0.152
CASH	186,368	0.116	0.140	0.000	0.002	0.022	0.062	0.155	0.420	0.946

Consistent with the documented low-leverage puzzle (Graham (2000)), the mean book leverage and mean market leverage are 0.252 and 0.279, and the medians are 0.231 and 0.223, respectively. About one-fourth of firms have no or very low debt in place. The mean of the industry medians of book leverage is 0.228, close to the mean and median of firm-level book leverage.

Profitability has mean and median values of 0.168 and 0.152, and operating leverage (OPERLEV) has mean and median values of 0.322 and 0.254. The logarithm of sales (LOG_SALES), our proxy for firm size, has mean and median values of 5.165 and 5.098. Our results also hold when we use the total value of assets to proxy for the firm size. The summary statistics of the firm-specific control variables that we use in the following tests are similar to the findings in the literature.

IV. Empirical Results

We start with sample sorts to obtain preliminary insights. We then follow Fama and French (2002) and use the Fama–MacBeth (1973) regression approach to perform the cross-sectional tests. Petersen (2009) suggests that when studying capital structure, the standard errors from the Fama–MacBeth regressions are downward biased and recommends the Newey–West (1987) method to adjust them. We adjust the standard errors using the Newey–West (1987) method with 4 lags.[6]

A. Sorting Procedure

As a first step, we sort the firms into deciles based on operating leverage and profitability in year $t-1$ and calculate their average characteristics in year t. Panel A of Table 3 reports the data for the operating leverage deciles. Consistent with Hypothesis 1, profitability increases almost monotonically across the operating-leverage deciles. Consistent with Hypothesis 2, book leverage and market leverage decrease monotonically across operating-leverage deciles, and the differences between the top and bottom deciles are statistically significant.

Panel B of Table 3 reports the data for the profitability deciles. The data show that operating leverage is U-shaped against profitability, decreasing from decile 1 to decile 3 and then increasing, particularly for decile 10. Notably, both book and market leverages are hump-shaped against profitability: Book leverage increases at first before peaking around decile 4 and ending at decile 10 well below decile 1; market leverage follows a similar pattern, although it peaks around decile 2. Similar to Panel A, the differences in the top and bottom deciles of OPERLEV, BOOKLEV, and MKTLEV are economically and statistically significant as well.

B. Fama–MacBeth Regressions

Following the Fama and French (2002) analysis of the pecking-order and trade-off models, we conduct cross-sectional Fama–MacBeth (1973) regressions but examine the relation between operating leverage, profitability, and financial leverage for firm-years with positive profits, which comprise almost 80% of firm-years in our sample. Our tests also include a set of firm-specific control variables that are commonly used in the literature: firm size (proxied by LOG_SALES),[7]

[6]We also perform panel regressions for our three main hypotheses as robustness tests, and the results are very similar.

[7]Because we use LOG_SALES to proxy for firm size, we do not include production costs (which scale with sales) as an additional control variable. Nonetheless, our conclusions remain the same when we include production costs as an additional variable.

TABLE 3

Firm Characteristics Sorted on Operating Leverage and Profitability

Table 3 presents 1-way sorts on operating leverage (Panel A) and profitability (Panel B). Each year we sort the firms into deciles based on the ranking variables, namely, operating leverage (OPERLEV) and profitability of the previous year, and then calculate the average values of the ranking variables and firm characteristics, including profitability (PROFIT), book leverage (BOOKLEV), and market leverage (MKTLEV). "H − L" denotes the difference in variables between the top decile and the bottom decile, with their t-statistics in parentheses. All the empirical measures are defined in Section III.A. The sample includes all firm-years with positive profits from 1963 to 2016.

Panel A. Sorted on Operating Leverage

Rank	No. of Obs.	OPERLEV	PROFIT	BOOKLEV	MKTLEV
Low	15,486	0.036	0.139	0.317	0.371
2	15,507	0.082	0.145	0.305	0.359
3	15,505	0.129	0.146	0.289	0.337
4	15,506	0.179	0.150	0.271	0.313
5	15,515	0.230	0.152	0.253	0.288
6	15,495	0.285	0.152	0.238	0.268
7	15,505	0.350	0.158	0.225	0.246
8	15,506	0.435	0.161	0.211	0.227
9	15,504	0.565	0.166	0.195	0.209
High	15,531	0.937	0.166	0.185	0.199
High − Low		0.901	0.027	−0.132	−0.172
		(70.980)	(6.510)	(−22.570)	(−22.310)

Panel B. Sorted on Profitability

Rank	No. of Obs.	PROFIT	OPERLEV	BOOKLEV	MKTLEV
Low	17,262	0.031	0.300	0.268	0.370
2	17,281	0.071	0.289	0.280	0.381
3	17,284	0.098	0.280	0.285	0.371
4	17,277	0.121	0.289	0.287	0.352
5	17,295	0.142	0.298	0.279	0.323
6	17,272	0.165	0.304	0.267	0.289
7	17,275	0.190	0.314	0.250	0.253
8	17,285	0.222	0.330	0.231	0.217
9	17,280	0.271	0.353	0.202	0.171
High	17,304	0.388	0.408	0.169	0.127
High − Low		0.357	0.108	−0.099	−0.243
		(99.000)	(14.960)	(−13.190)	(−20.250)

asset tangibility, market-to-book asset ratio, R&D expense, cash-flow volatility, industry median book leverage, dividend ratio, and cash holdings.

Panel A of Table 4 reports the results of year-by-year Fama–MacBeth regressions of profitability on operating leverage (OPERLEV) alone and with the firm-specific control variables. The t-statistics are adjusted using the Newey–West (1987) method with 4 lags. Hypothesis 1 predicts that for firms with positive profits, profitability increases with operating leverage. The data strongly support Hypothesis 1. The estimated coefficients on OPERLEV are significantly positive: 0.063 (t-statistic $=$ 14.774) when it is the only explanatory variable and 0.045 (t-statistic $=$ 12.029) when the regressions include firm-specific control variables. Using the difference of 0.901 between the mean values of the highest and lowest OPERLEV deciles (in Panel A of Table 3), an estimated coefficient of 0.045 implies an increase in profitability of 0.041 (0.901×0.045), which is 24% of the sample mean profitability of 0.168 (reported in Table 2).

We proceed to test Hypothesis 2, that the relation between financial leverage and operating leverage is negative. Panel B of Table 4 reports the results when the dependent variable is book leverage, and Panel C reports the results when the dependent variable is market leverage. The data strongly support Hypothesis 2. The coefficient on OPERLEV is always significantly negative. When OPERLEV is the

TABLE 4
Impact of Operating Leverage on Profitability and Financial Leverage

Table 4 reports the results of year-by-year Fama–MacBeth regressions of profitability and financial leverage on operating leverage (OPERLEV) and control variables at the firm level. The sample includes all firm-years with positive profits from 1963 to 2016. The control variables include firm size proxied by the log of sales (LOG_SALES); the ratio of property, plant, and equipment to total assets (TANGIBILITY); market-to-book asset ratio (MTOB); research and development normalized by sales (RD); cash-flow volatility (CFV); industry median book leverage (LEVMED); cash dividends scaled by assets (DIV); and cash holdings scaled by assets (CASH). All the empirical measures are defined in Section III.A. We set RD and DIV to 0 when they are not reported and include RD_DUMMY and DIV_DUMMY for the missing values. t-statistics, adjusted using the Newey–West (1987) method with 4 lags, are in parentheses.

	Panel A. Profitability		*Panel B. Book Leverage*		*Panel C. Market Leverage*	
Variable	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
INTERCEPT	0.149	0.058	0.283	0.190	0.331	0.299
	(40.032)	(11.924)	(46.437)	(22.635)	(24.266)	(17.856)
OPERLEV	0.063	0.045	−0.139	−0.066	−0.180	−0.074
	(14.774)	(12.029)	(−20.83)	(−12.93)	(−19.19)	(−10.79)
LOG_SALES		0.001		0.006		0.009
		(1.595)		(8.212)		(5.909)
TANGIBILITY		0.058		0.062		0.030
		(13.864)		(9.294)		(3.437)
MTOB		0.042		0.009		−0.044
		(13.133)		(2.742)		(−9.402)
RD		−0.164		−0.232		−0.498
		(−5.569)		(−3.185)		(−4.022)
RD_DUMMY		−0.003		0.015		0.020
		(−2.906)		(4.976)		(5.688)
CFV		0.114		−0.007		−0.036
		(3.383)		(−0.366)		(−1.441)
LEVMED		−0.015		0.393		0.439
		(−1.218)		(37.949)		(28.564)
DIV		1.025		−2.535		−3.753
		(13.223)		(−9.433)		(−10.600)
DIV_DUMMY		0.002		−0.005		0.011
		(0.304)		(−0.558)		(0.688)
CASH		0.032		−0.425		−0.446
		(4.320)		(−31.040)		(−17.680)
Adj. R^2	0.032	0.313	0.042	0.294	0.047	0.353
No. of obs.	138,603		137,542		137,777	

only explanatory variable, its coefficients are −0.139 (t-statistic = −20.830) and −0.180 (t-statistic = −19.190) when the dependent variables are book leverage and market leverage, respectively. Our conclusions remain the same after including the firm-specific control variables; the estimated coefficients on OPERLEV are −0.066 (t-statistic = −12.930) and −0.074 (t-statistic = −10.790) for book leverage and market leverage, respectively. Using the difference of 0.901, these coefficients imply decreases of 0.059 (0.901 × 0.066) in book leverage and 0.067 (0.901 × 0.074) in market leverage, which are almost 24% of the sample means of the book and market leverages (of 0.252 and 0.279). The signs of the coefficients on the control variables are consistent with the literature. In particular, the coefficients on asset tangibility are significantly positive, which is consistent with the view that tangible assets can serve as collateral and increase the expected recovery rate in bankruptcy.[8]

[8]Examining firms from 37 countries, Öztekin (2015) finds that firms that have more tangible assets tend to have higher financial leverage.

In summary, we find strong empirical support for our hypotheses using a large sample with 53 years of data. For firm-years with positive profitability, higher operating leverage is associated with higher profitability and lower financial leverage. Although the evidence in this section is consistent with our hypotheses, it merely establishes correlations. As discussed in the hypothesis development section (Section II), we argue that because managers are restricted by production technology, they take operating leverage as largely exogenous, so the causality runs from operating leverage to financial leverage. In the next section, we present further evidence consistent with the default-probability channel we propose, and in Section IV.D, we discuss endogeneity issues and provide support for Hypothesis 3.

C. Evidence on the Relation between Operating Leverage and Default Probability

Our rationale for Hypothesis 2 is that the firm is concerned that higher operating costs could push it into bankruptcy earlier than would otherwise be the case. In this section we directly test the relation between firms' operating leverage and default probability. We test the impact of operating leverage on default risk using two widely used measures of default risk: Merton's (1974) default probability and Ohlson's (1980) O-score. For Merton's (1974) default probability, we follow Vassalou and Xing (2004) and calculate objective default probability as $\pi = \mathrm{N}(-\mathrm{DD})$, where $\mathrm{N}(\cdot)$ is the cumulative probability function of a standard normal distribution, and DD denotes the distance to default, as follows:

$$\mathrm{DD} = \frac{\ln(V/F) + (\mu - 0.5\sigma^2)T}{\sigma\sqrt{T}},$$

where μ is the growth rate of the asset value V, $T=1$ is the time to maturity, σ is the volatility of the firm's asset value, and F is the face value of the firm's debt (annual Compustat item $1/2\times$ DLTT + DLC). Both the asset value V and its annual volatility σ are estimated using the iteration method suggested by Vassalou and Xing (2004). We lag annual accounting variables by 1 year to ensure that the accounting information is available for investors at the time of calculation.

Ohlson's (1980) O-score, which is an extension of Altman's (1968) Z-score, is calculated as follows:

$$\begin{aligned} O\text{-score} = & -1.32 - 0.407\ln(\mathrm{TA}) + 6.03\frac{\mathrm{TL}}{\mathrm{TA}} - 1.43\frac{\mathrm{WC}}{\mathrm{TA}} + 0.076\frac{\mathrm{CL}}{\mathrm{CA}} \\ & -2.37\frac{\mathrm{NI}}{\mathrm{TA}} - 1.83\frac{\mathrm{FFO}}{\mathrm{TA}} + 0.285 I_{(\mathrm{NI}_{t-1}<0< \text{ and } \mathrm{NI}_t<0)} \\ & -1.72 I_{(\mathrm{TL}>\mathrm{TA})} - 0.521\frac{\mathrm{NI}_t - \mathrm{NI}_{t-1}}{|\mathrm{NI}_t| - |\mathrm{NI}_{t-1}|}, \end{aligned}$$

where TA is the firm's total assets (Compustat item AT); TL is total liabilities (LT); WC is working capital (WCAP); CL and CA are current assets (ACT) and current liabilities (LCT), respectively; NI and FFO are net income (NI) and funds from operations (PI + DP), respectively; and $I_{(\cdot)}$ is an indicator that equals 1 if the condition is satisfied, and 0 otherwise. A higher value of the O-score indicates a greater degree of financial distress.

Table 5 reports the results of estimating the impact of operating leverage on the two default risk measures using the Fama–MacBeth regressions. The regressions include operating leverage and market leverage alone as well as with the other control variables, including asset tangibility, which is linked positively to the expected recovery rate in bankruptcy. The coefficient on OPERLEV is always positive and significant in each of the four regressions. For example, in column 2, the coefficient on OPERLEV is 0.018 (t-statistic = 2.610). Using the difference in operating leverage of 0.901 (highest minus lowest OPERLEV deciles in Panel A of Table 3), the estimate of 0.018 implies that the default probability increases by 0.016 (0.901×0.018), which is 25% of the sample mean implied default probability of 0.064. This supports our prediction that, controlling for the effect of financial leverage on default risk, higher operating leverage increases the expected cost of financial distress by increasing the probability that the firms will go bankrupt. It is worth noting that because we limit our sample to the firm-years with positive profitability only, the positive impact of operating leverage

TABLE 5
Default Risk and Operating Leverage

Table 5 reports the Fama–MacBeth regression of the implied default probability (Merton (1984)) and O-score (Ohlson (1980)) on operating leverage (OPERLEV), market leverage (MKTLEV), and control variables at the firm level. The sample includes all firm-years with positive profits from 1963 to 2016. The control variables include firm size proxied by the log of sales (LOG_SALES); the ratio of property, plant, and equipment to total assets (TANGIBILITY); market-to-book asset ratio (MTOB); research and development normalized by sales (RD); cash-flow volatility (CFV); industry median book leverage (LEVMED); cash dividends scaled by assets (DIV); and cash holdings scaled by assets (CASH). All the empirical measures are defined in Section III.A. We set RD and DIV to 0 when they are not reported and include RD_DUMMY and DIV_DUMMY for the missing values. t-statistics, adjusted using the Newey–West (1987) method with 4 lags, are in parentheses.

	Default Probability		O-Score	
Variable	Model 1	Model 2	Model 1	Model 2
INTERCEPT	−0.023 (−7.837)	0.021 (2.421)	−3.382 (−38.300)	−1.918 (−18.790)
OPERLEV	0.049 (4.682)	0.018 (2.610)	2.700 (8.656)	1.716 (11.469)
MKTLEV	0.289 (9.147)	0.307 (9.823)	5.694 (35.083)	5.244 (35.834)
LOG_SALES		−0.009 (−8.131)		−0.333 (−22.680)
TANGIBILITY		−0.022 (−1.778)		0.114 (1.061)
MTOB		0.011 (4.403)		0.136 (3.735)
RD		−0.033 (−1.147)		2.738 (2.260)
RD_DUMMY		0.000 (−0.119)		0.152 (3.901)
CFV		−0.012 (−0.579)		2.147 (10.477)
LEVMED		−0.391 (−2.988)		−14.632 (−5.129)
DIV		0.022 (1.639)		−0.187 (−2.045)
DIV_DUMMY		−0.020 (−1.870)		−2.836 (−17.470)
CASH		0.125 (5.763)		3.322 (6.871)
Adj. R^2	0.117	0.157	0.225	0.378

on default probability is much smaller than that for all firms.[9] Market leverage (MKTLEV) also has a significant positive effect on the default risk. However, market leverage is, by construction, a direct input in calculating Merton's (1974) default probability (i.e., V/F) and Ohlson's (1980) O-score (i.e., TL/TA). In contrast, our operating leverage measure is not a direct input in either measure. Lastly, controlling for the effects of operating leverage, market leverage, and the other control variables, the partial coefficients on asset tangibility are statistically insignificant for both default probability measures.

Overall, the evidence supports our assertion that a positive relation between operating leverage and default risk is an important channel that can help explain the observed negative relation between profitability and financial leverage.

D. China's WTO Entry as a Natural Experiment

China joined the World Trade Organization (WTO) in December 2001. Pierce and Schott (2016) find that this caused U.S. manufacturing firms to switch from labor-intensive to capital-intensive production technologies. More capital-intensive production technologies imply higher operating leverage. In this section we use China's WTO entry as a natural experiment to investigate the impacts of an exogenous increase in operating leverage on profitability and financial leverage and on the relation between them. Following Pierce and Schott (2016), we limit our sample to U.S. manufacturing firms. We continue to limit our sample to firm-years with positive profitability. Because it takes time to build new plants and machines, we look 3 years forward from 2001 to measure the effect.

1. How Changes in Operating Leverage Affect Profitability and Financial Leverage

To investigate how the increases in operating leverage affect profitability and financial leverage, we estimate the following regression:

$$Y_{2001,2004} \quad = \quad b_0 + b_1 \text{OPERCHG}_{2001,2004} + c\Delta X_{2001,2004} + e_t,$$

where $Y_{2001,2004}$ denotes the changes in either profitability or financial leverage between 2001 and 2004, $\text{OPERCHG}_{2001,2004}$ denotes the changes in operating leverage in that period, and $\Delta X_{2001,2004}$ is a vector of the changes in the control variables between 2001 and 2004. Hypothesis 1 predicts that $b_1 > 0$ when change in profitability is the dependent variable, and Hypothesis 2 predicts that $b_1 < 0$ for change in financial leverage.

The sample mean OPERLEV increases from 0.283 in 2001 to 0.321 in 2004 (mean XGSA and mean ASSETS are higher by approximately 29% and 33%). The sample mean PROFIT increases from 0.141 to 0.158, but the sample means of financial leverage fell: from 0.257 to 0.209 for BOOKLEV and from 0.288 to 0.188 for MKTLEV. Noticeable changes in the sample means of the control variables in 2004 versus in 2001 include 4% LOG_SALES, 18% MTOB, 14% RD, 23% DIV, 29% CASH, −12% TANGIBILITY, and −21% LEVMED.

[9]We repeated the tests of the relation between operating leverage and default probability for the sample that also includes firm-years with negative profits. The estimated coefficients on OPERLEV are 1.5–3 times larger and are always significantly positive at a less-than-1%, 2-tailed p-value.

TABLE 6
The 2001 Entry of China in the WTO as a Natural Experiment

The sample in Table 6 includes the period of 2001–2004 after China entered the World Trade Organization (WTO). We estimate the following regression:

$$Y_{2001,2004} \quad = \quad b_0 + b_1 \text{OPERCHG}_{2001,2004} + c\Delta X_{2001,2004} + e_t,$$

where $Y_{2001,2004}$ is the change in profitability (PROFIT), book leverage (BOOKLEV), or market leverage (MKTLEV) between 2001 and 2004; $\text{OPERCHG}_{2001,2004}$ is the change in operating leverage in the same period; and $\Delta X_{2001,2004}$ is a vector of the changes between 2001 and 2004 in the control variables: firm size proxied by the log of sales (LOG_SALES); the ratio of property, plant, and equipment to total assets (TANGIBILITY); market-to-book asset ratio (MTOB); research and development normalized by sales (RD); cash-flow volatility (CFV); cash dividends scaled by assets (DIV); and cash holdings scaled by assets (CASH). All the empirical measures are defined in Section III.A. We set RD and DIV to 0 when they are not reported and include RD_DUMMY and DIV_DUMMY for the missing values. Firms with negative profits are excluded. t-statistics, adjusted using the Newey–West (1987) method with 4 lags, are in parentheses.

Variable	PROFIT	BOOKLEV	MKTLEV
INTERCEPT	−0.025	−0.046	−0.063
	(−5.045)	(−5.486)	(−6.584)
$\text{OPERCHG}_{2001,2004}$	0.390	−0.106	−0.214
	(16.524)	(−2.646)	(−4.605)
LOG_SALES	0.088	0.033	0.057
	(14.407)	(3.126)	(4.748)
TANGIBILITY	−0.153	0.003	0.162
	(−4.784)	(0.058)	(2.576)
MTOB	0.024	−0.018	−0.039
	(11.281)	(−5.028)	(−9.289)
RD	−0.395	−0.056	−0.033
	(−6.246)	(−0.522)	(−0.269)
RD_DUMMY	−0.001	−0.006	−0.036
	(−0.255)	(−0.699)	(−3.920)
CFV	0.038	0.010	−0.023
	(0.900)	(0.144)	(−0.28)
DIV	0.453	−0.301	−0.578
	(2.482)	(−0.971)	(−1.612)
DIV_DUMMY	0.013	0.028	0.005
	(0.574)	(0.723)	(0.119)
CASH	0.099	−0.090	−0.085
	(4.609)	(−2.463)	(−2.000)
Adj. R^2	0.405	0.050	0.144

Table 6 shows that the increase in operating leverage from 2001 to 2004 causes a significant increase in profitability, with an estimated coefficient of 0.390 (t-statistic = 16.524). At the same time, it also causes a significant decrease in financial leverage. The estimated coefficient on changes in book leverage is –0.106 (t-statistic = −2.646), and the estimated coefficient on changes in market leverage is –0.214 (t-statistic = −4.605). Hence, supporting Hypotheses 1 and 2, the exogenous shock forcing increased operating leverage following China's WTO entry significantly increases the profitability and decreases the financial leverage for U.S. manufacturing firms with positive profitability.

2. Evidence on Operating Leverage's Influence on the Relation between Profitability and Financial Leverage

Because China's WTO entry provides us with an exogenous increase in operating leverage, we can use it to cleanly establish whether firms' substitution between operating and financial leverage helps explain the observed negative relation between profitability and financial leverage. The increase in mean operating leverage during this time period from 0.282 to 0.321 establishes that firms increased their operating leverage in response to the WTO shock.

To establish a direct causal link, we perform a 2-stage least squares (2SLS) regression. In the first stage, we regress profitability on operating leverage and control variables to obtain the fitted profitability. In the second stage, we regress financial leverage on the fitted profitability and control variables. We estimate 2SLS cross-sectional regressions separately for the 2001 data and the 2004 data. Table 7 reports the cross-sectional regressions of financial leverage on fitted profitability. Our coefficient of interest is on fitted profitability. It is negative in all four specifications, consistent with the extant literature, as expected. Importantly, the negative relation is stronger in 2004 than in 2001.[10] Thus, an exogenous shock causes firms to increase operating leverage, and recognizing the substitution between them, they endogenously decrease financial leverage.

TABLE 7

Financial Leverage–Profitability Relation Using China's WTO Entry as a Natural Experiment

The sample in Table 7 includes the period of 2001 to 2004 after China entered the World Trade Organization (WTO). We perform 2-stage least squares (2SLS) as follows. First, we estimate the following regression:

$$\text{PROFIT}_t = a_0 + a_1 \text{OPERLEV}_t + a_2 X_{2001} + e_t.$$

Then, we use the fitted profitability, $\widehat{\text{PROFIT}}_t$, in the second regression:

$$Y_t = b_0 + b_1 \widehat{\text{PROFIT}}_t + cX_{2001} + e_t,$$

where Y_t is the book leverage (BOOKLEV) and market leverage (MKTLEV) in 2001 or 2004, PROFIT_t is the profitability in 2001 or 2004, and X_{2001} is a vector of the control variables: firm size proxied by the log of sales (LOG_SALES); the ratio of property, plant, and equipment to total assets (TANGIBILITY); market-to-book asset ratio (MTOB); research and development normalized by sales (RD); cash-flow volatility (CFV); cash dividends scaled by assets (DIV); and cash holdings scaled by assets (CASH). All the empirical measures are defined in Section III.A. We set RD and DIV to 0 when they are not reported and include RD_DUMMY and DIV_DUMMY for the missing values. Firms with negative profits are excluded. t-statistics, adjusted using the Newey–West (1987) method with 4 lags, are in parentheses.

Variable	BOOKLEV_{2001}	MKTLEV_{2001}	BOOKLEV_{2004}	MKTLEV_{2004}
INTERCEPT	0.295 (11.184)	0.433 (13.895)	0.292 (6.692)	0.332 (7.116)
$\widehat{\text{PROFIT}}_{2001}$	−0.887 (−4.493)	−1.210 (−5.186)		
$\widehat{\text{PROFIT}}_{2004}$			−1.352 (−3.484)	−1.688 (−4.062)
LOG_SALES	0.019 (7.177)	0.016 (5.063)	0.013 (5.186)	0.016 (5.952)
TANGIBILITY	0.022 (2.803)	−0.007 (−0.753)	0.030 (3.181)	0.012 (1.236)
MTOB	−0.518 (−4.581)	−0.721 (−5.403)	−0.197 (−1.847)	−0.301 (−2.638)
RD	0.029 (2.830)	0.053 (4.334)	0.034 (3.298)	0.042 (3.799)
RD_DUMMY	0.129 (1.278)	0.064 (0.532)	0.189 (1.317)	0.127 (0.824)
CFV	0.004 (0.135)	0.090 (2.815)	0.111 (3.828)	0.202 (6.504)
DIV	−1.550 (−4.102)	−3.885 (−8.701)	−0.786 (−2.000)	−2.363 (−5.616)
DIV_DUMMY	−0.047 (−1.034)	−0.030 (−0.558)	0.033 (0.731)	0.043 (0.881)
CASH	−0.410 (−11.780)	−0.435 (−10.580)	−0.400 (−9.808)	−0.355 (−8.132)
Adj. R^2	0.271	0.423	0.183	0.284

[10]Using a seemingly unrelated regressions (SUR) framework, we test the difference in the coefficients on $\widehat{\text{PROFIT}}_{2001}$ and $\widehat{\text{PROFIT}}_{2004}$ and reject the null hypothesis that they are equal at p-values of 4.5% for book leverage and 12.7% for market leverage.

During the subsequent expansionary period, operating leverage and profitability are positively related, and as a result, the negative (substitute) relation between operating leverage and financial leverage produces a stronger negative relation between financial leverage and profitability.

E. The Impact of Operating Cost Flexibility

Our previous analysis assumes that the operating costs of invested capital are equally fixed for all firms. In reality, however, firms have heterogeneous flexibility to reduce their operating costs in bad times. The trade-off between operating leverage and financial leverage should be affected by the magnitude of this flexibility because operating cost flexibility lowers the effective operating leverage in bad times. In this section we examine the effect of operating cost flexibility on financial leverage.

Our measure of operating cost flexibility (OPERFLEX) is the sum of the time-series coefficients ($\beta_1+\beta_2$), which are estimated for the operating costs of each individual firm using equation (1). OPERFLEX measures the percentage decrease in operating costs for each 1% decrease in sales revenues. A greater value of OPERFLEX indicates greater adjustment flexibility. We require at least five annual observations for the firm-level regressions and trim the top and bottom two percentiles for OPERFLEX.

Table 8 reports the results of year-by-year Fama–MacBeth regressions of book and market leverage on OPERFLEX both as the only explanatory variable and as an additional variable to the corresponding regressions in Table 4 with OPERLEV and the firm-specific control variables. The coefficients on OPERFLEX are significantly positive in all the specifications. Hence, we find that when controlling for the effect of operating leverage, greater operating cost flexibility is associated with higher financial leverage.

V. Robustness Tests

We have undertaken robustness tests on our hypotheses, and our main results hold across the tests. For instance, we exclude zero-debt firm-year observations and confirm our results. In this section we also form industry-level portfolios to reexamine our hypotheses because the potential for endogeneity is much less severe at the industry level. That is, even if one accepts that individual firms have the ability to deviate endogenously somewhat from the production technology–driven operating leverage, the industry average will not. In addition, we use the 2008 financial crisis as a second natural experiment to test the negative causal channel from operating leverage to financial leverage.

A. Industry-Level Results

We repeat our tests for Tables 4 and 5 and replace all the variables with their equal-weighted averages in each industry. We use the Fama–French 48 classification to form the industry portfolios. We delete the industry median book leverage, LEVMED, as a control variable. We also remove the zero-dividend dummy variable because at the industry level, all the industry-year observations have a positive value for dividends.

TABLE 8
Impact of Operating Flexibility on Financial Leverage

Table 8 reports the results of year-by-year Fama–MacBeth regressions of book leverage and market leverage on operating flexibility (OPERFLEX), operating leverage (OPERLEV), and control variables at the firm level. The sample includes all firm-years with positive profits from 1963 to 2016. The control variables include firm size proxied by the log of sales (LOG_SALES); the ratio of property, plant, and equipment to total assets (TANGIBILITY); market-to-book asset ratio (MTOB); research and development normalized by sales (RD); cash-flow volatility (CFV); industry median book leverage (LEVMED); cash dividends scaled by assets (DIV); and cash holdings scaled by assets (CASH). All the empirical measures are defined in Section III.A. We set RD and DIV to 0 when they are not reported and include RD_DUMMY and DIV_DUMMY for the missing values. t-statistics, adjusted using the Newey–West (1987) method with 4 lags, are in parentheses.

Variable	Book Leverage		Market Leverage	
	Model 1	Model 2	Model 1	Model 2
INTERCEPT	0.295 (41.543)	0.237 (19.512)	0.253 (18.414)	0.299 (19.370)
OPERFLEX	0.019 (6.487)	0.013 (7.452)	0.008 (2.830)	0.010 (7.437)
OPERLEV		−0.090 (−15.520)		−0.096 (−13.680)
LOG_SALES		−0.005 (−1.529)		−0.046 (−13.840)
TANGIBILITY		0.013 (8.088)		0.004 (3.033)
MTOB		0.038 (5.473)		0.020 (2.144)
RD		−0.195 (−2.437)		−0.325 (−3.374)
RD_DUMMY		0.014 (4.117)		0.019 (7.319)
CFV		−0.071 (−4.576)		−0.114 (−5.058)
LEVMED		0.372 (21.120)		0.315 (15.065)
DIV		−1.921 (−5.941)		−1.886 (−6.144)
DIV_DUMMY		0.016 (1.498)		0.020 (1.483)
CASH		−0.508 (−29.920)		−0.419 (−15.720)
Adj. R^2	0.003	0.321	0.002	0.344

Table 9 reports the results, which are similar to the main results in Tables 4 and 5. When the dependent variable is profitability, the estimated coefficient on OPERLEV is 0.068 (t-statistic = 5.468). The next two columns show that both book and market leverages are significantly negatively associated with operating leverage.

B. Firms with Negative Profits

Our hypotheses are developed (and our tests are executed) for firms with positive profits because operating leverage magnifies positive profits in good times. The cost, which is the basis for the substitution between operating leverage and financial leverage, is that operating leverage magnifies losses in bad times. We check this prediction on the sample of negative-profit firms and find that, indeed, operating leverage magnifies losses (untabulated). We find further that there is no significant relation between profitability and financial leverage for negative-profit firms.

TABLE 9
Industry-Level Fama–MacBeth Regressions

Table 9 reports the results of year-by-year Fama–MacBeth regressions for three main hypotheses and control variables at the Fama–French 48-industry level. The sample period is from 1963 to 2016. The control variables include firm size proxied by the log of sales (LOG_SALES); the ratio of property, plant, and equipment to total assets (TANGIBILITY); market-to-book asset ratio (MTOB); research and development normalized by sales (RD); cash-flow volatility (CFV); cash dividends scaled by assets (DIV); and cash holdings scaled by assets (CASH). All the empirical measures are defined in Section III.A. t-statistics, adjusted using the Newey–West (1987) method with 4 lags, are in parentheses.

Variable	PROFIT	BOOKLEV	MKTLEV
INTERCEPT	0.045	0.258	0.393
	(3.677)	(10.077)	(12.269)
OPERLEV	0.068	−0.051	−0.081
	(5.468)	(−2.924)	(−4.837)
LOG_SALES	0.008	0.013	0.015
	(3.661)	(3.357)	(3.648)
TANGIBILITY	0.047	0.091	0.068
	(3.319)	(5.842)	(3.798)
MTOB	0.004	0.033	−0.038
	(0.653)	(3.214)	(−3.779)
RD	0.000	−0.911	−1.282
	(0.003)	(−4.257)	(−4.518)
CFV	−0.189	−0.202	0.091
	(−2.481)	(−1.862)	(0.832)
DIV	1.427	−2.710	−3.975
	(5.691)	(−3.909)	(−6.027)
CASH	0.053	−0.430	−0.543
	(1.302)	(−7.839)	(−7.255)
Adj. R^2	0.586	0.568	0.635

C. The Financial Crisis as a Natural Experiment

In Section IV.D we use China's WTO entry to support all three hypotheses. Here we provide further support for Hypothesis 2 using the 2008 financial crisis as a second natural experiment. Our rationale for using the crisis is that it decreases demand and increases systematic volatility exogenously for all firms and thus increases the likelihood that a given level of operating leverage will cause default. Although the crisis is a broad-based shock, for our purposes, we simply need it to be the case that its nondemand effects on firms are not systematically biased in a way that correlates with their operating leverage and simultaneously affects their financial leverage decisions in the same direction as our predictions.

Empirically, we use a difference-in-differences method to compare how firms with different operating leverage set financing policies before and after the onset of the financial crisis. For this section, we limit the sample period to the pre-crisis period of 2004–2007 and the post-crisis (onset) period of 2008–2011. Based on the sample median operating leverage at the end of 2007, we assign firms into high- and low-operating-leverage groups (greater and smaller than the sample median).

To examine the impact of operating leverage on financial leverage, we estimate the following regression:

$$(2) \quad Y_t = b_0 + b_1 \text{CRISIS}_t + b_2 \text{HOPERLEV} + b_3(\text{HOPERLEV} \times \text{CRISIS}_t) + cX_{t-1} + e_t,$$

where Y_t is financial leverage; CRISIS_t is an indicator variable that equals 1 if the year is after 2007, and 0 otherwise; HOPERLEV is an indicator variable that equals 1 if the firm is in the high-operating-leverage group, and 0 otherwise; and X_{t-1} is our vector of control variables.

In this exercise, the coefficient b_2 measures the difference in the financial leverage of high- and low-operating-leverage firms over the entire period 2004–2011, and the difference-in-differences coefficient, b_3, measures the *change* in the differences in the financial leverage of high- and low-operating-leverage firms after 2007. Hypothesis 2 predicts that b_2 and b_3 are negative.

That is indeed what we find in columns 1, 2, 5, and 6 of Table 10. The regressions reveal that operating leverage has a significant substitution effect on firms' financial leverage during the crisis. The coefficients on HOPERLEV and (HOPERLEV $\times$ CRISIS$_t$) are always significantly negative. In particular, when we include the control variables, the estimated coefficient on (HOPERLEV $\times$ CRISIS$_t$) is -0.013 (t-statistic $=-2.644$) for book leverage and -0.034 (t-statistic $=-6.116$) for market leverage. These estimates imply that the absolute values of the differences in financial leverage between high- and low-operating-leverage firms increase substantially after 2007: by 52%, from -0.025 to -0.038, for book leverage and by 126%, from -0.027 to -0.061, for market leverage.

The systemic nature of the shock suggests that the crisis also increases the expected amount of losses given default. For example, Conrad, Dittmar, and Hameed (2017) find that recovery rates fell substantially during the 2008 financial crisis. Altman, Brady, Resti, and Sironi (2005) document a negative relation between Moody-based default probabilities and recovery rates in default. Consequently, during the financial crisis, changes in default probability and changes in expected losses given default are likely to be positively correlated. Estimating recovery rates from credit default swap spreads, Elkamhi, Jacobs, and Pan (2014) find that firms with more tangible assets have higher recovery rates. This is also consistent with our results in Table 4 that, controlling for operating leverage, financial leverage is positively related to asset tangibility. However, for tangible assets that require high operating costs, the net result of the positive effect of higher expected recovery rates and the negative effect of higher operating leverage on default probability is an empirical question. We address this by dividing firms into high- and low-tangibility groups (based on the sample median tangibility at the end of 2007), which we proxy for high versus low expected recovery rates given default. We then replace the control variable TANGIBILITY with the variables HTANG, (HTANG $\times$ CRISIS$_t$), (HOPERLEV $\times$ HTANG), and (HOPERLEV $\times$ HTANG $\times$ CRISIS$_t$), where HTANG is an indicator variable for firms in the high-tangibility group. The extended specification is as follows:

$$
\begin{aligned}
(3) \qquad Y_t \; = \; & b_0 + b_1\text{CRISIS}_\text{t} + b_2\text{HOPERLEV} \\
& + b_3(\text{HOPERLEV} \times \text{CRISIS}_\text{t}) + b_4\text{HTANG} \\
& + b_5(\text{HTANG} \times \text{CRISIS}_t) + b_6(\text{HOPERLEV} \times \text{HTANG}) \\
& + b_7(\text{HOPERLEV} \times \text{HTANG} \times \text{CRISIS}_t) + cX_{t-1} + e_t.
\end{aligned}
$$

The results, shown in columns 3, 4, 7, and 8 of Table 10, suggest that the change in the differences in the financial leverage of high- and low-operating-leverage firms after 2007 is unaffected by the inclusion of HTANG, as the coefficients on (HOPERLEV $\times$ CRISIS$_t$) remain significantly negative and are of

TABLE 10
The 2008 Financial Crisis as a Natural Experiment

The data sample in Table 10 includes the period of 2004–2007 before the financial crisis and the period of 2008–2011 after the onset of the crisis. We use the difference-in-differences method and run the following regression:

$$\begin{aligned} Y_t \quad = \quad & b_0 + b_1\text{CRISIS}_t + b_2\text{HOPERLEV} + b_3(\text{HOPERLEV} \times \text{CRISIS}_t) + b_4\ \text{HTANG} + b_5(\text{HTANG} \times \text{CRISIS}_t) \\ & + b_6(\text{HOPERLEV} \times \text{HTANG}) + b_7(\text{HOPERLEV} \times \text{HTANG} \times \text{CRISIS}_t) + c\ X_{t-1} + e_t. \end{aligned}$$

where CRISIS_t is an indicator variable that equals 1 for the post-crisis period of 2008–2011, and 0 otherwise; HOPERLEV and HTANG are indicator variables for firms in the high-operating-leverage group or high-tangibility group at the end of 2007, respectively; and X_{t-1} is a vector of lagged control variables. The control variables are described in Table 4. We exclude firms with negative profits. t-statistics, adjusted using the Newey–West (1987) method with 4 lags, are in parentheses.

Variable	Book Leverage				Market Leverage			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
INTERCEPT	0.250	0.130	0.203	0.131	0.239	0.173	0.191	0.167
	(97.971)	(19.310)	(48.352)	(18.529)	(81.588)	(22.834)	(39.358)	(21.013)
CRISIS	0.017	0.011	0.012	0.010	0.076	0.069	0.064	0.060
	(4.501)	(3.112)	(1.906)	(1.686)	(17.136)	(17.436)	(8.535)	(8.998)
HOPERLEV	−0.088	−0.025	−0.056	−0.012	−0.098	−0.027	−0.066	−0.010
	(−24.570)	(−7.329)	(−10.77)	(−2.510)	(−23.86)	(−6.805)	(−10.980)	(−1.818)
HOPERLEV × CRISIS	−0.014	−0.013	−0.017	−0.018	−0.033	−0.034	−0.028	−0.033
	(−2.631)	(−2.644)	(−2.07)	(−2.464)	(−5.183)	(−6.116)	(−3.047)	(−3.994)
HTANG			0.073	0.026			0.075	0.024
			(13.878)	(5.275)			(12.441)	(4.367)
HTANG × CRISIS			0.006	0.001			0.018	0.013
			(0.739)	(0.159)			(1.929)	(1.613)
HOPERLEV × HTANG			−0.029	−0.038			−0.028	−0.041
			(−3.896)	(−5.656)			(−3.238)	(−5.332)
HOPERLEV × HTANG × CRISIS			0.015	0.015			0.005	0.009
			(1.283)	(1.479)			(0.418)	(0.740)
LOG_SALES		0.008		0.008		0.004		0.005
		(11.703)		(11.596)		(5.900)		(6.188)
TANGIBILITY		0.047				0.024		
		(7.542)				(3.439)		
MTOB		−0.001		−0.001		−0.019		−0.019
		(−1.415)		(−1.441)		(−18.490)		(−18.710)
RD		0.191		0.184		0.122		0.116
		(10.000)		(9.554)		(6.305)		(5.979)
RD_DUMMY		0.031		0.031		0.034		0.033
		(11.113)		(11.135)		(10.892)		(10.408)
CFV		0.003		0.002		0.023		0.022
		(0.297)		(0.211)		(1.892)		(1.764)
LEVMED		0.386		0.397		0.439		0.439
		(27.457)		(28.142)		(27.699)		(27.608)
DIV		−0.446		−0.425		−1.255		−1.253
		(−7.792)		(−7.436)		(−19.360)		(−19.380)
DIV_DUMMY		0.019		0.020		0.046		0.044
		(1.154)		(1.204)		(2.449)		(2.378)
CASH		−0.328		−0.338		−0.349		−0.351
		(−36.64)		(−38.400)		(−34.630)		(−35.490)
Adj. R^2	0.058	0.237	0.082	0.235	0.079	0.276	0.101	0.278

similar magnitude to the corresponding coefficients in the other columns. The results further suggest that higher tangibility is associated with higher financial leverage in general. In the regressions with the control variables, the estimated coefficient on HTANG is 0.026 (t-statistic = 5.275) for book leverage and 0.024 (t-statistic = 4.367) for market leverage. However, the interaction of HTANG and HOPERLEV is significantly negative, with a magnitude of approximately −0.04, showing that although tangibility is associated with higher leverage, tangibility that comes with higher operating leverage is not. In fact, the sum of the coefficients on HTANG and (HTANG $\times$ HOPERLEV) is significantly negative, so the effect of operating leverage dominates, making the net effect negative. This is consistent with the conclusion that distress costs (including those borne personally by the decision makers) are first order compared with potential recovery once in default. The coefficients on the interaction of HTANG and CRISIS_t as well as the triple interaction are not statistically significant, indicating that these relations do not change after the crisis. Thus, tangibility does increase debt capacity through the recovery-in-default channel, but when the tangibility creates higher operating leverage, the substitution effect neutralizes that effect.

In sum, the natural experiment of the 2008 crisis provides further support for Hypothesis 2. Confronted with higher default probabilities after the onset of the crisis, firms with high operating leverage decrease their financial leverage more than other firms. This exogenous event further supports the operating-leverage channel and a causal flow from operating leverage to financial leverage.

VI. Conclusion

We propose that because operating leverage increases default probabilities in contractions, high-operating-leverage firms optimally choose low financial leverage, creating a substitution between operating and financial leverage. In expansionary periods, higher operating leverage contributes to higher profitability. Because approximately 80% of firm-year observations have positive profitability, the combined result of these two effects contributes to a negative observed relation between profitability and financial leverage in the data.

We find that operating leverage is both significantly positively associated with profitability and, at that same time, significantly negatively associated with financial leverage. Our results also hold in industry-level regressions and using both China's WTO entry in 2001 and the 2008 financial crisis as natural experiments. We take the position that the firm's optimal capital–labor ratio is largely determined by technology and outside forces, so the causality runs from operating leverage to financial leverage. China's accession exogenously forced U.S. firms to increase their capital–labor ratio and, hence, their operating leverage. We show that they endogenously chose to decrease their financial leverage to substitute. Further, as profits subsequently increased, the estimated negative relation between profitability and financial leverage became stronger.

Thus, our findings suggest that high operating leverage is an important reason for the negative relation between profitability and financial leverage. Our results provide additional evidence that once one considers the operating leverage effect, the negative relation between profitability and financial leverage is consistent with the trade-off theory.

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