Aalto University
School of Business

Does operating leverage explain the gross profitability premium?

Finance

Master's thesis

Mikko Savolainen

2016

Department of Finance
Aalto University
School of Business

Aalto University
School of Business

Aalto University, P.O. BOX 11000, 00076 AALTO
www.aalto.fi

Abstract of master's thesis

Author Mikko Savolainen

Title of thesis Does Operating Leverage Explain the Gross Profitability Premium?

Degree Master of Science in Economics and Business Administration

Degree programme Finance

Thesis advisor(s) Markku Kaustia

Year of approval 2016 **Number of pages** 81 **Language** English

Purpose of the study

Empirically highly gross profitable firms have generated higher returns than firms with low gross profitability, hence implying that there exists a gross profitability premium. But the reason why such a premium exists has been unknown. Recently operating leverage has been proposed to cause the gross profitability premium. However, research has traditionally related the operating leverage to the value premium, which on the other hand has been shown to be negatively associated with gross profitability, thus resulting in an inconsistent triangle of relationships without an explanation why such contradictory results exist. As a result, the prior literature is lacking of a consistent view whether operating leverage can truly cause the gross profitability premium and how operating leverage should be linked to the value premium. The objective of this paper is to show both theoretically and empirically how operating leverage should be linked to the aforementioned premia.

Data and methodology

The dataset extends from January 1962 to December 2014 and comprises firms listed in NYSE, NASDAQ, and AMEX. The monthly market data for firms is obtained from Center of Research in Security Prices (CRSP) and the annual financial data is from Compustat. Several point-to-point and elasticity proxies for the degree of operating leverage (DOL) are employed, since DOL is not directly observable. To test the hypotheses, portfolio sorts are constructed by using gross profitability and different proxies for DOL, and similarly uni- and multivariate regressions are run by using both gross profitability and different DOL proxies.

Findings

Highly gross profitable firms have significantly higher degrees of operating leverage than their less profitable peers when employing a point-to-point proxy directly measuring the level of fixed costs for DOL. Whereas the elasticity measures of DOL are negatively linked to gross profitability as they capture the risk of low margins equivalently to book-to-market ratio. Due to the tendency to assign high DOL values for firms operating close to their break-even points, the elasticity measures of DOL can theoretically be considered as biased. Whereas a more direct proxy for operating leverage performs better in capturing the risk theoretically associated with high level of fixed costs.

By using such a direct point-to-point proxy for DOL, the empirical evidence shows that DOL should be negatively linked to the value premium, hence completing the picture regarding the triangle of relationships between DOL, gross profitability, and value. Furthermore, the gross profitability premium seems to be strong within industries, but rather weak across industries.

Keywords operating leverage, degree of operating leverage, gross profitability, gross profitability premium, value premium, risk and return, break-even point

Aalto-yliopisto
Kauppakorkeakoulu

Aalto-yliopisto, PL 11000, 00076 AALTO
www.aalto.fi

Maisterintutkinnon tutkielman tiivistelmä

Tekijä Mikko Savolainen

Työn nimi Selittääkö operatiivinen vipu bruttokannattavuuspreemion?

Tutkinto Kauppatieteiden maisteri

Koulutusohjelma Rahoitus

Työn ohjaaja(t) Markku Kaustia

Hyväksymisvuosi 2016 **Sivumäärä** 81 **Kieli** Englanti

Tutkimuksen tarkoitus

Empiirisesti yritykset, jotka ovat korkeasti bruttokannattavia, ovat tuottaneet osakemarkkinoilla suurempia tuottoja kuin alhaisemman bruttokannattavuuden omaavat yritykset, mikä viittaa bruttokannattavuuspreemion olemassaoloon. Syy kyseisen preemion olemassaoloon on kuitenkin toistaiseksi tuntematon. Operatiivista vipua on kuitenkin ehdotettu preemion aiheuttajaksi. Tosin aiempi kirjallisuus on perinteisesti liittänyt operatiivisen vivun arvopreemioon, jonka on toisaalta näytetty olevan negatiivisessa yhteydessä kannattavuuspreemioon. Kirjallisuus ei ole toistaiseksi onnistunut selittämään kyseistä epäjohdonmukaista kolmisuhdetta, minkä vuoksi käsitys siitä aiheuttaako operatiivinen vipu bruttokannattavuuspreemion vai ei, ja mikä on operatiivisen vivun suhde arvopreemioon, on puutteellinen. Siispä tämän tutkimuksen tavoitteena on sekä teoreettisesti että kokeellisesti selittää kuinka operatiivinen vipu suhteutuu edellä mainittuihin preemioihin.

Lähdeaineisto ja tutkimusmenetelmä

Tutkimuksen lähdeaineisto on ajalta 1962–2014 ja koostuu yrityksistä, jotka ovat listattuina NYSE-, NASDAQ- ja AMEX-pörsseissä. Kuukausittainen markkinainformaatio on kerätty Center of Research in Security Prices (CRSP) -tietojärjestelmästä ja vuosittainen tilinpäätösinformaatio on kerätty Compustat-tietojärjestelmästä. Useita piste- sekä joustavuuspohjaisia mittausmenetelmiä operatiivisen vivun suuruuden arvioimiseksi on hyödynnetty, sillä operatiivinen vipu ei ole suoraan havaittavissa. Hypoteesien testaamiseksi ovat sekä osakeportfoliot rakennettu että yksi- ja monimuuttujaregressiot ajettu käyttäen bruttokannattavuutta sekä eri operatiivisen vivun mittausmenetelmiä.

Tulokset

Yritykset, joilla on korkea bruttokannattavuus omaavat selkeästi korkeammat operatiiviset vivut kuin heidän heikommin kannattavat kilpailijansa, kun operatiivista vipua mitataan pistepohjaisella mittausmenetelmällä, joka arvioi suoraan kiinteiden kustannusten suhteellisen suuruuden. Joustavuusmittarit sen sijaan korreloivat negatiivisesti bruttokannattavuuden kanssa, sillä ne ovat ennemminkin yhteydessä alhaisiin voittomarginaaleihin samoin kuin arvopreemio. Täten joustavuusmittareita, jotka arvioivat operatiivisen vivun suureksi yrityksille, jotka toimivat lähellä kriittistä pistettään, voidaan pitää harhaisina. Sen sijaan suorempi pistepohjainen operatiivisen vivun mittausmenetelmä kuvaa paremmin korkeista kiinteistä kustannuksista aiheutuvaa riskiä.

Käyttämällä pistepohjaista arviointimenetelmää kokeelliset tulokset osoittavat, että suhde operatiivisen vivun ja arvopreemion välillä tulisi olla negatiivinen. Lisäksi bruttokannattavuuspreemion havaitaan olevan voimakas toimialoittain, mutta heikko yli toimialojen.

Avainsanat operatiivinen vipu, operatiivisen vivun aste, bruttokannattavuus, bruttokannattavuuspreemio, arvopreemio, riski ja tuotto, kriittinen piste

Table of contents

List of tables

List of figures

1. Introduction

Novy-Marx (2013) finds that profitable firms measured by gross profitability (sales minus cost of goods sold and scaled by total book assets) have historically generated significantly higher returns than firms having low profitability, even though they have higher valuation ratios. This spread in returns between profitable and unprofitable firms is called the gross profitability premium. Fama and French (2015) even added the profitability effect as a new factor to their latest asset pricing model, the five-factor model, to capture the excess returns emanating from profitability not captured by the original three-factor model. (See e.g., the evidence from Novy-Marx, 2013.)

The interrelation between risk and return is probably the most prominent corner stone of the financial theory, and at the same time is undoubtedly among the topics most researched by academics. The theory suggests that securities (e.g., stocks) with higher risk should be priced lower than similar securities carrying less risk, and thus have higher returns to compensate investors for holding those risky securities in their portfolios. According to the neo-classical financial theory based on the efficient market hypothesis, any additional factor (e.g., profitability in Fama-French five-factor model) explaining excess returns should characterize risk factors that investors require higher returns for.

However, profitability as a risk factor seems counterintuitive as profitable firms should in general be better positioned to cope with negative market shocks than firms operating with lower margins. For example, if an industry faces a shock that reduces the prices of goods by 1 percent the effect on a firm operating with a 10 percent margin is significantly different to the effect on a firm operating with a 2 percent margin. In the first case the margin decreases by 10 percent and in the second by 50 percent. The intuition here suggests that investors should require higher returns for holding firms with low levels of profitability. Although, the empirical findings suggest the opposite, there exists a profitability premium, i.e., profitable firms have higher average returns than unprofitable firms.

The profitability premium is relatively uncovered topic in the financial literature, thus lacking of a solid theoretical framework and well-tested empirical results, therefore the determinants of the profitability premium are not well understood. Furthermore, it seems difficult to reconcile the profitability premium with traditional risk-based explanations (Novy-Marx, 2013). The most recent contribution in order to explain why the profitability premium exists comes from Kisser (2014), who suggests that operating leverage (OL), which Lev (1974) defines as the proportional share of fixed operating costs relative to variable operating costs, as a risk factor, causes the profitability premium. Degree of operating leverage (DOL) describes the magnitude of this relationship between the fixed and variable costs.

Kisser (2014) uses sales, general, and administrative (SGA) expenses as a proxy for the actual fixed costs (SGA expenses are generally for the most part fixed, at least in a short-term). Using fixed costs as a proxy for the operating leverage is consistent with the previous literature (see e.g., Carlson et al., 2004; Zhang, 2005). Kisser (2014) finds a positive relationship between DOL and the gross profitability premium, but a negative relationship between DOL and the value premium – an anomaly, in which high book-to-market equity firms generate excess returns compared to low book-to-market equity firms (see e.g., Stattman, 1980, Rosenberg, 1985). Notably, this latter result contradicts with the majority of prior research, which reports theoretically and empirically the association between operating leverage and the value premium to be positive (see e.g., Mandelker and Rhee, 1984; Carlson et al., (2004); García-Feijóo and Jorgensen, 2010; Novy-Marx, 2011). Furthermore, Novy-Marx (2013) finds an inverse association between gross profitability and value. In other words, there is evidence that gross profitability is positively associated with both gross profitability and value, whereas those latter two should be inversely related to each other. Kisser (2014), nonetheless, cannot explain why his results are contradictory to the preceding literature, which means that in the light of the prior literature's evidence, one cannot conclude whether operating leverage truly causes the gross profitability premium.

However, intuitively DOL enables a high profitability, but simultaneously is a risk factor. A high DOL firm has high portion of its costs as fixed, meaning that they do not adjust effectively downwards when a negative market shock arises. High DOL may be due to either cost trade-off from variable operating costs to fixed operating costs (e.g., increasing the level of automation in production to build up scale and decrease the unit variable cost) or a plain increase in fixed costs not affecting the unit variable cost (e.g., increasing the sales personnel to boost sales). Higher DOL may also increase the break-even point (the level of sales, in which both the variable and fixed costs are fully covered), hence increasing the risk of not being able to cover the total amount of costs. Moreover, higher cost trade-off levers earnings relative to sales, causing the earnings to become more sensitive to changes in sales, which obviously is a risk factor as the losses accumulate quicker when sales go down. Note that increasing the break-even point causes the earnings to become more sensitive in relative terms due to the higher reference point (i.e., the break-even point). And, as DOL increases the risk of a firm, investors should require higher returns for holding such a firm in their portfolios. Furthermore, one can easily see that cost trade-off from variable costs to fixed costs increases gross profitability as well, but just increasing the amount of fixed costs without affecting the unit variable cost does not have an impact on gross profitability. Hence it seems that gross profitability is especially linked to operating leverage's cost trade-off channel of risk. The prediction of DOL enabling high gross profitability contradicts with the current perception of the gross profitability premium, which only says that gross profitable firms should have above average returns, whereas the operating leverage hypothesis says that firms with high DOL should have above average returns regardless of their profitability as DOL is assumed to be the real risk factor, not the profitability itself.

What makes it difficult to test any prediction regarding the degree of operating leverage is that operating leverage cannot be observed directly, since the true fixed costs of firms are not directly detectable as firms are generally not required to disclose the amount of fixed costs. Therefore, a method to approximate the fixed costs is required. Currently, there are two main approaches in the prior literature to determine the level of operating leverage: A point-to-point measure approach (e.g., Kisser, 2014), in which certain balance sheet or income statement items are directly deployed, for example, by dividing the amount of fixed assets by total assets to approximate DOL. Another approach, an elasticity measure based on time-series regression (e.g., García-Feijóo and Jorgensen, 2010), examines how sensitive earnings are to changes in sales. Both approaches are used in the literature, however, without conclusion which is the preferred choice to approximate DOL.

The situation of different methods to approximate DOL generating the opposite results is definitely puzzling. At first glance it makes sense that operating leverage determines the value premium as the majority of the prior literature suggests (see e.g., Mandelker and Rhee, 1984; Carlson et al., (2004); García-Feijóo and Jorgensen, 2010; Novy-Marx, 2011). High operating leverage indeed can cause high B/M as the higher risk required by investors decreases the market value of equity, hence increasing B/M. However, Novy-Marx (2013) points out that gross profitable firms have higher returns even though they have higher market valuations, i.e., he reports a negative relation between profitability and B/M ratios. And, as the value factor (the factor to capture the risk emanating from high B/M ratio – see Fama and French, 1993) captures the excess returns of high B/M firms, it is likely that the returns of profitable firms with high operating leverage are not captured by the B/M, as they should have higher valuations and lower B/M ratios than their less profitable peers. For those reasons, it would make sense that the value premium would not exclusively price the risk emanating from operating leverage.

As Kisser's (2014) proxy mimics the actual fixed costs, his results about inverse relationship between DOL and B/M are highly interesting, as logically higher risk caused by higher DOL should be reflected in a lower market value, and thus in a higher B/M ratio, which is also the view of the previous literature. I find Kisser's (2014) result possible if operating leverage enables high profitability (e.g., via high scale of production to drive the unit total cost down or boosting sales by employing additional sales staff), and as the higher profitability drives equity values up, investors are willing to pay premium for the additional cushion against negative market shocks, consequently decreasing B/M ratios, causing a negative relationship between operating leverage and the value premium. This prediction, if assumed that DOL causes the profitability premium, would be in line with Novy-Marx (2013), who reports that profitable firms has higher market valuations, and hence lower B/M ratios.

The real question is which affects the equity values more – the increased profitability pushing the equity values up or the increased risk pushing the equity values down? Logically, it would make sense that the gross profitability premium accrues to firms that are operationally levered, but at the same time are profitable enough to result in such high valuations that the risk emanating from DOL would not be captured by B/M, and hence that risk would not be priced by the value premium. This is possible as gross profitability measured by sales minus cost of goods sold divided by total book assets (Novy-Marx, 2013) enables the firms with the highest values of gross profitability to have very large profits relative to their size measured by book assets, which indicates these firms to be highly profitable also after the fixed costs, hence driving the equity values of these firms up. But as the previous literature suggests the positive association between DOL and the value premium, it seems obvious that the value premium prices the risk arising from high DOL for those firms, which have low margins, and thus low market valuations and high B/M ratios. Effectively, DOL could contribute as a risk factor to both the gross profitability premium and the value premium, but the value premium not being able to price the risk from high DOL carried by highly profitable firms, thus giving arise for the gross profitability premium.

It appears that the value premium, the gross profitability premium, and the operating leverage are all linked together, although the prior literature lacks of comprehending those relationships properly. If assumed that DOL causes the gross profitability premium, and by following Novy-Marx (2013) and assuming the negative relationship between the value premium and the gross profitability premium, then a negative association between DOL and the value premium should exist, meaning that high profitability increases the equity values more than increased risk pushes them down – otherwise either the hypothesis of DOL causing the gross profitability premium or the empirical results regarding the relationship between the gross profitability premium and the value premium would be flawed.

1.1. Research problem and purpose

Novy-Marx (2013) reports that highly gross profitable firms tend to earn significantly higher returns than their less profitable peers, which should either mean that there is some additional risk carried by those profitable firms or those excess returns are caused by market irrationality. Ball et al. (2015), however, argues that as the profitability premium has persisted that long it is unlikely that the market irrationality would be the key determinant behind the profitability premium. Thus, the solution should lie among risk-based explanations.

Kisser (2014) proposes that the degree of operating leverage (DOL) might cause the gross profitability premium. The prior research has indeed been able to show that DOL is associated with the systematic risk, and hence with returns (see e.g., Carlson et al., 2004; Zhang, 2005; Novy-Marx, 2011; García-Feijóo and Jorgensen, 2010). Nonetheless, the preceding literature (e.g., Carlson et al., 2004; Novy-Marx, 2011; García-Feijóo and Jorgensen, 2010) relates DOL to the value premium, which on the other hand, according to Novy-Marx (2013) is negatively related to the gross profitability premium. Thus, there seems to be an inconsistent triangle of relationships between these three; DOL, the value premium, and the gross profitability premium. Hence, this inconsistency suggests that something is missing in the theoretical framework, which is also stated by Novy-Marx (2013) who stresses that current theoretical frameworks are incapable of explaining the gross profitability from a risk-based view. Moreover, Kisser (2014) cannot explain why his results regarding DOL (based on SGA) contradict with the prior literature. Hence, in the light the of the evidence of the preceding literature, it is not possible to conclude from Kisser's results that operating leverage truly is the risk factor behind the gross profitability premium.

DOL is dependent on fixed costs, which cannot be observed directly, but indirectly by using different approximation approaches. And, currently there are no preferred way to approximate DOL, only two main approaches: a point-to-point measurement approach and an elasticity measurement approach. If there was a theory stating clearly the preferred way to construct a proxy for DOL, it would be considerably easier to examine the relationships between DOL and the gross profitability premium and between DOL and the value premium, potentially providing the missing piece that is needed to fully understand the relationships between these three.

This paper aims to provide this missing piece by comparing theoretically and empirically the two main approaches to construct a proxy for DOL, and from those results to draw a conclusion whether the gross profitability premium is truly driven by DOL or something else, and how DOL is linked to the value premium.

1.2. Contribution to the literature

In order to be able to explain the gross profitability premium from a risk-based point of view, this paper is a joint test of the preferred way to construct a proxy for the degree of operating leverage – as there is no conclusion of the preferred or the most rightful way to construct such a proxy in the existing literature – and whether DOL is fundamentally capable of explaining the gross profitability premium. Furthermore, Kisser (2014) finds his SGA-based DOL to be negatively correlated with the value premium, which is the exact opposite of the view of the prior literature, without being capable of explaining the contradiction between his results and the results of the prior literature. As a result, the prior literature cannot convincingly explain the gross profitability premium from a risk-based view. Therefore, my thesis contributes to the existing literature in the following ways:

1) By theoretically and empirically showing that a point-to-point approach, which directly approximates the relative size of fixed costs, is the preferred way to be employed when constructing a proxy for DOL, whereas elasticity based proxies are shown to be biased.

2) Empirically showing that the preferred choice to approximate DOL generates a proxy for DOL that is capable of describing the additional risk that is behind the excess returns of highly gross profitable firms.
3) And, providing empirical results stating that the interrelationship between DOL and the value premium should be negative, which is in line with the results of Kisser (2014), but contradicts with majority of the results of the prior literature.
4) Providing evidence that the gross profitability premium is strong within industries, but rather weak across industries.

As a result, this thesis brings to the literature a view how DOL should be understood, and hence approximated, and provide the missing piece that is required to understand the relationships between DOL, the gross profitability premium, and the value premium as the results of the prior literature provide only an inconsistent view of these relationships.

1.3. Limitations of the study

There are some obvious problems related to the approach of Kisser (2014) of using SGA expenses as a proxy for fixed costs as it does not consider the fixed costs, such as maintenance and repairs of production equipment, insurance and safety, licenses, rent and lease expenses, which might be included in the cost of goods sold (COGS) as Generally Accepted Accounting Principles (GAAP) does not determine how firms should allocate expenses between COGS and SGA, thus the discretion of such is left for firms (Weil et al., 2014). For that reason, SGA does not perfectly represent fixed costs. Additionally, as Novy-Marx (2011) points out, accounting practices vary across-industries, thus possibly weakening the reliability of cross-sectional results regarding the association between SGA-based DOL and the gross profitability premium. However, these across-industry differences in accounting policies do not interfere when studying the intra-industry context. Furthermore, there does not currently exist any alternative mean that is fundamentally equal to approximate fixed costs by using a point-to-point measurement approach, but the approach employing SGA expenses. For that reason, it is difficult to build a reliable robustness checks for the empirical findings.

The approximation of DOL by using a time-series regression approach by following the example of García-Feijóo and Jorgensen (2010) effectively requires each firm to have at least six years of financial data available. This reduces the amount of monthly observations, but should not affect the empirical results, as the reduction of observations should be evenly distributed among the firms within the sample. On the other hand, this procedure effectively removes all observations from the sample that have five years or less of active recorded operating history, hence mitigating the survival bias (García-Feijóo and Jorgensen, 2010).

1.4. Main findings

In my research I provide empirical evidence on the degree of operating leverage being the key risk factor behind the gross profitability premium. I show that DOL increases the risk of a firm, but when higher profitability is enabled by higher DOL (e.g., more favorable cost structure to reduce the unit total cost), the total risk actually decreases causing the market value of that particular firm to go up. Consequently, the traditional risk factors are unable to price that risk of relatively higher fixed costs, but covered by profitability. Therefore, as predicted, I show a positive association between DOL, gross profitability, and expected returns, while showing that gross profitability and DOL are negatively linked to the value premium and book-to-market ratio.

I also show that these results are highly sensitive to the definition of DOL, and thus the approach used for approximating it, as fixed costs are not directly observable. I show that majority of the methods used in the prior research, namely the methods applying an elasticity measurement approach or using total costs as a proxy for DOL, to approximate DOL are more linked to measuring the risk related to low operating margins, which is much of the risk that is described by the value premium as low margin firms tend to have high B/M ratios (Carlson et al., 2004; Zhang, 2005). These methods are biased with the size of variable costs, as higher unit variable cost can effectively lower the margins, and hence falsely increase the DOL estimates, even though there is a concurrent increase in the proportion of variable costs, which means lower estimates for DOL when considering the definition of DOL. This is obviously contradictory. By employing a proxy for DOL that is independent of the size of margins, I am empirically able to confirm the predictions on the associations between DOL, book-to-market, and gross profitability. As such a proxy, I employ the DOL measure defined by Kisser (2014), which effectively is sales, general, and administrative expenses divided by total book assets.

Furthermore, I show that gross profitability premium is stronger within industries than across industries, as different industries have different cost structures, and investors, when setting up their earnings expectations, are indifferent to these variations across industries. The result is similar to what Novy-Marx (2011) finds out regarding the value premium, in which the investors do not care about the differences in book-to-market ratios between different industries.

1.5. Structure

The remainder of the paper is organized as follows. Section 2 provides an overview of the relevant theory behind the profitability premium and the different approaches to measure of the degree of operating leverage. Section 3 presents the hypotheses and the rationale behind them. Section 4 describes the data and the methodology used in this paper. Section 5 presents the empirical results. Section 6 provides the robustness checks relevant to the main study. And finally, Section 7 concludes the key findings.

1.6. Key terminology on operating leverage

As fixed costs, and hence operating leverage are not directly observable, a proxy is needed. The prior literature includes several different ways to approximate the degree of operating leverage, which makes the field of proxies somewhat diverse. Consequently, I define below the usage of the terminology regarding the different proxies of operating leverage used in this paper. Firstly, operating leverage is intuitively defined as the proportion of fixed operating costs relative to the proportion variable operating costs (Lev, 1974). Secondly, degree of operating leverage (DOL) describes the magnitude of the operating leverage. In this paper, I refer to plain DOL when generally talking about the true, unobservable operating leverage and its magnitude without taking a stand on any specific method used in the proxy construction. Thus, such a plain DOL describes the operating leverage and its magnitude from the point of view of the intuitive definition. On the other hand, when referring to a certain approach to approximate DOL and its output value, I use subscripts to further define the specific approximation approach used for attaining the proxy for DOL. For instance, if I referred to a DOL value approximated by using EBITDA, I would refer to such an estimate of DOL as DOL_{EBITDA}. Or, if I used SGA-based DOL, I would use DOL_{SGA} to describe the corresponding DOL estimate. Table D1 describes the construction of different DOL proxies.

2. Theoretical background

2.1. The profitability premium

Earnings, defined as net income excluding extraordinary items, has predictive power on average returns in cross-section (Ball and Brown, 1968). Following research, however, suggests that earnings have only a little value adding information after controlling for size and book-to-market (see e.g., Fama and French, 1996, 2008). Novy-Marx (2013) suggests that gross profitability (measured by sales minus cost of goods sold), as the cleanest accounting measure of true economic profitability, has more power to predict average returns than earnings, and has roughly the same predictive power than book-to-market. His intuition is that the measure of gross profitability is not polluted by investments that are treated as expenses (e.g., research and development, sales and advertising, and human capital), and hence affect the earnings measure. Such expenses, if included in the profitability measure, would give a biased view on firm's profitability as they potentially affect the future profitability of the firm through, for example, increased human capital, i.e., learning. Also, Liu et al. (2009) and Hou et al. (2014) provide support for Novy-Marx's (2013) findings of the positive interrelationship between profitability and subsequent returns. They use a neoclassical q-theory model and report a positive association between profitability and required rates of return.

Ball et al. (2015), on the other hand, argues that bottom line earnings predict future returns as well as gross profits after deflating the values correctly. They also find a strong link between operating profitability (gross profit minus sales, general, and administrative expenses excluding research and development costs, and scaled by total book assets) and subsequent stock returns. However, operating profit as a measure of true economic profitability is not perfect as it fails to distinguish capitalized sales, general, and administrative expenses (e.g., employee incentives, internal communications systems, and other examples of organizational capital) from those that relate to generating the sales in a current year. In other words, operating profitability includes expensed investments (other than research and development) in organizational capital (see e.g., Eisfeldt and Papanikolaou, 2013). All in all, the empirical evidence suggests unanimously that profitable firms earn higher returns than unprofitable firms.

Predictable excess returns can either be due to "rational asset-pricing stories" or "irrational asset-pricing stories" (Fama and French, 1992). As the literature related to the profitability premium represents a fairly new line of research, the literature related to the topic is sparse, thus causing the absence of real consensus about the factors determining the profitability premium. So far, the approaches of the previous literature struggle considerably on reconciling the empirical findings regarding the gross profitability premium with a risk-based explanation. The model of Carlson et al. (2004), which linearly relates operating leverage to B/M ratio, for example, predicts lower operating leverage, lower risk, and lower expected returns for higher profitability. In their model, as the unit demand decreases, the equity value of the firm decreases, increasing the B/M ratio, thus increasing the operational leverage, risk, and expected returns, while margins and, consequently, the profitability sinks.

Zhang (2005), on the other hand, with a neoclassical model expects a divergent exposure to the economic risk for high and low profitability firms. His approach uses merely assets-in-place, and assumes that those assets are difficult to reduce due to costly reversibility and countercyclical price of risk, hence causing those assets-in-place to be riskier than growth opportunities. This phenomenon is more critical to low profitability firms as their assets are more likely to be in unprofitable use in an economic downturn than the assets of highly profitable firms, hence implying that low profitability firms should carry more risk, and thus earn higher returns than high profitability firms. Nevertheless, the intuition of Zhang (2005) is consistent with the idea of the value premium pricing the risk related to low profitable firms, but the existence of gross profitability premium cannot be reconciled by his model.

Whereas Lettau and Wachter (2007) proposes a model that employs a duration-based approach, in which short-duration assets are considered riskier than long-duration assets. In this framework, value firms are short-duration assets, whose valuation depends on shocks in cash flows, whereas growth firms are long-duration assets with valuations depending more on the changes in discount rates. And, as investors seem to be more concerned about cash flows than discount rates, making value firms riskier from the investors' point of view, hence causing the value premium. The problem of this approach arises with the presence of the gross profitability premium, as a highly profitable firms tend to be growth firms according to Novy-Marx (2013), thus predicting the opposite, as according to the empirical findings highly profitable firms seem to earn significantly higher returns than low profitability firms. Novy-Marx (2013) sums up that it is difficult to explain the profitability premium with existing models and approaches as highly profitable firms tend to have lower B/M ratios, they are less prone to risk, their cash flow durations are longer, and they have lower degrees of operating leverage. It is noteworthy that this paper argues with the last statement of Novy-Marx (2013) regarding the level of operating leverage, as the proxy for DOL Novy-Marx (2013) uses can be considered as noisy due to the inclusion of variable costs.

As a competing alternative to a risk-based explanation the existing literature suggests that profitability could be due to market irrationality emanating from factors such as behavioral biases, market frictions, and limits to arbitrage (see e.g., Lakonishok et al., 1994; Barberis and Thaler, 2003). In line with Lakonishok et al. (1994) Wang and Yu (2013) argues that low profitability firms suffer from overpricing as investors tend to have unjustifiably high expectations for low profitability firms, which consequently causes low subsequent returns giving arise for the profitability premium. The explanations based on market irrationality, nonetheless, violate the efficient market hypothesis. And, as the markets are efficient on average, anomalies based on irrationality should disappear as investors learn and exploit the anomalies in search of excess returns. Thus, Ball et al. (2015) argues that an explanation based on market irrationality seems inconsistent as the existence of profitability premium, has been persistent over time, and mispricing due to frictions are not likely to persist for long time periods.

Kisser (2014) finds indicative results for a risk-based explanation on the gross profitability premium. He finds that operating leverage, measured as sales, general, and administrative expenses relative to total assets by a large degree explains the excess returns of those gross profitable firms. He also finds that operating leverage is not related to the value premium, contrarily to what is suggested by the previous literature (see e.g., Carlson et al., 2004; García-Feijóo and Jorgensen, 2010; Novy-Marx, 2011). And, thus value firms do not have higher levels of operating leverage than growth firms as theories linking the value premium and operating leverage propose. Nevertheless, Kisser (2014) cannot explain why his results are the opposite of the prior literature concerning the association between DOL and the value premium.

Furthermore, Novy-Marx (2013) argues that profitability is the other side of value, as his empirical findings signal that controlling for profitability considerably increases the performance of value strategies. He rationalizes this result by assuming both strategies having the same ultimate aim: acquiring productive capacity cheaply. Profitability strategies obtains this goal by acquiring productive assets by selling less productive assets, whereas value strategies obtain the goal by financing the purchase of inexpensive assets by selling expensive assets. He reports a negative correlation between the two strategies. In other words, he finds that the value premium and the gross profitability premium are negatively related.

2.2. The degree of operating leverage

Operating leverage describes the proportional interrelationship between fixed operating costs and variable operating costs (Lev, 1974). A firm with high degree of operating leverage has a high proportion of its operating costs as fixed, hence its costs do not adjust as effectively in a short-term when a negative market shock arises. According to the operating leverage hypothesis a firm having a higher degree of operating leverage should carry more risk, which should be reflected by investors' required return as the operating leverage amplifies the exposure to economic risk, and thus increases the sensitivity of earnings in relation to sales (see e.g., Hamada, 1972; Rubinstein, 1973; Lev, 1974; Bowman, 1979; García-Feijóo and Jorgensen, 2010; Novy-Marx, 2011).

For instance, Lev (1974), Mandelker and Rhee (1984), and Carlson et al. (2004) propose theoretically that operating leverage increases the systematic risk of a firm. Empirical findings of, for example, García-Feijóo and Jorgensen (2010) and Novy-Marx (2011) have confirmed the positive association between their measures of DOL and expected returns. However, the literature, including García-Feijóo and Jorgensen (2010) and Novy-Marx (2011), has linked operating leverage to the value premium. For instance, Novy-Marx (2011) reports a positive relation between book-to-market ratio and operating leverage to be strong and monotonic within industries, but weak and non-monotonic in a cross-section. García-Feijóo and Jorgensen (2010) find similar evidence on the positive correlation between operating leverage and the value premium. These two papers, nonetheless, represent the two different lines of the related literature regarding the approach to measure the degree of operating leverage; the approach of Novy-Marx (2011) represents a point-to-point measurement, whereas the approach of García-Feijóo and Jorgensen (2010) represents a time-series regression-based elasticity measurement. A point-to-point measurement approach simply employs a certain income statement or balance sheet items to come up directly with a proxy for DOL, whereas an elasticity approach measures the sensitivity of earnings to sales usually employing time-series regressions.

Novy-Marx (2011) proposes a dynamic industry equilibrium model of operating leverage, in which operating leverage is a product of geared assets and limited operational flexibility. The geared assets or the gearing is defined as the capitalized total costs divided by the capitalized operating profits, V_C/V_A, meaning that the operating leverage should be higher when production is more costly, i.e., profitability is low. The limited operational flexibility is defined as $\beta_R >> \beta_C$, in which beta of revenues is much higher than the beta of total costs, meaning that high proportion of fixed costs reduces the ability to adjust costs when the sales go down.

$$\text{Operating leverage} = \frac{V_C}{V_A} (\beta_R - \beta_C) \tag{1}$$

Practically, Novy-Marx uses total operating costs (COGS plus SGA) to total book assets as a proxy for operating leverage, even though it would be a better proxy for gearing (V_C/V_A), hence implicitly assuming the gearing and the operational inflexibility to be uncorrelated across firms (Novy-Marx, 2011). Here, it is noteworthy that Novy-Marx (2011) involves the effect of variable costs in his proxy for DOL. In section *Hypothesis Development,* I show that the approach of including the variable costs is not a theoretically supported method, while Kisser (2014) provides empirical evidence for my prediction.

The traditional elasticity-based definition of the degree of operating leverage, an elasticity of earnings before interest and taxes (EBIT) with respect to sales (S) (see e.g., Dugan and Shriver, 1989), resembles more the approach taken by García-Feijóo and Jorgensen (2010).

$$DOL = \frac{\partial EBIT}{\partial S} \times \frac{S}{EBIT} \tag{2}$$

Their paper is the most recent paper using an elasticity approach. This particular method they are using is based on the work of Mandelker and Rhee (1984), which approximates DOL by running a simple time-series regression of EBIT on sales, and using the regression coefficient as a proxy of DOL. O'Brien and Vanderheiden (1987) argues that this particular method proposed by Mandelker and Rhee (1984) generates DOL estimates converging too much towards one. O'Brien and Vanderheiden (1987) reasons that this problem can be solved by detrending the time-series. And, this particular adjustment for growth in time-series is also employed by García-Feijóo and Jorgensen (2010).

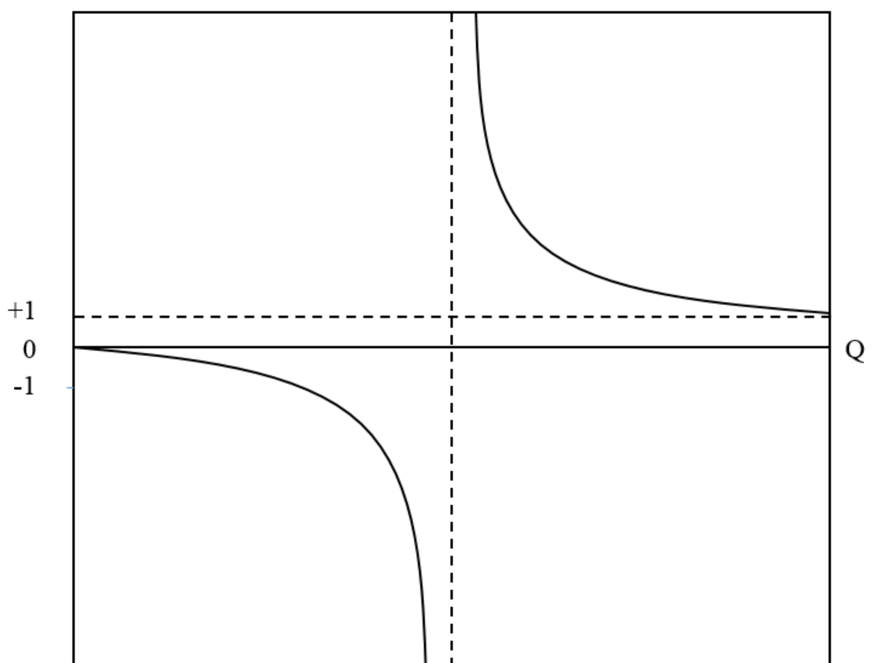
Interestingly, the results attained by Novy-Marx (2011) and García-Feijóo and Jorgensen (2010) do differ from each other in one significant way: When Novy-Marx (2011) tests the risk captured by his measure of DOL, including book-to-market ratio, effectively the value factor, as control, does not remove the positive and statistically significant contribution of operating leverage to expected returns. Whereas the economical and the statistical significance of the DOL proxy used by García-Feijóo and Jorgensen (2010) disappears when adding a control for value. These divergent results may indicate that those estimates of DOL, approximated by using completely different approaches, capture somewhat different risk.

Due to unobservable nature of true operating leverage, approximating DOL is highly method sensitive. The prior literature includes some research regarding different methods. Firstly, Dugan and Shriver (1989) argues that a time-series regression-based elasticity measure is theoretically the most consistent way of approximating the degree of operating leverage as it takes into account the flow measures, sales and EBIT, relevant to the traditional elasticity-based definition of the degree of operating leverage. They further argue that the modification proposed by O'Brien and Vanderheiden (1987) generates more consistent DOL estimates in relation to the classical ex ante model than the method of Mandelker and Rhee (1984) (Dugan and Shriver, 1992). Lord (1998), on the other hand, finds that this time-series regression approach by O'Brien and Vanderheiden (1987) is the most volatile method being most likely exposed to the fluctuations in operating parameters, such as unit price, unit variable cost, or periodic fixed cost. Lord (1998) also points out the obvious danger of an elasticity measure approach: a tendency to assign high DOL estimates for firms, which are operating close to their break-even points, i.e., firms either generating small operating profits or small operating losses. Figure 1 portrays this problem of elasticity-based DOL estimates converging towards infinity when operating with low positive operating margins (and towards negative infinity when operating below the break-even point), towards one when firm is operating far above the break-even point, or zero when the firm is operating far below the break-even point. Lord (1995) stresses also that when using an elasticity approach and substituting variable costs for fixed costs (cost trade-off) at certain rate, the degree of operating leverage remains unaltered, which obviously is counter-intuitive as, for example, substituting variable costs for fixed costs should increase the risk through increased earnings sensitivity to sales and higher fixed costs in absolute terms.

Additionally, the literature has not considered the effect of capital investment activity through depreciation and amortization in the traditional elasticity measurement approach of DOL. As higher level of investments implies higher depreciations and amortizations (D&A), and as the traditional elasticity approach to estimate DOL employs EBIT sensitivity to sales, EBIT is truly affected by the level of D&A, thus falsely increasing the estimated DOL values. This, on the other hand, leads to a contradicting conclusion, in which higher DOL should imply higher returns, but higher capital investments should imply lower returns (see Berk et al., 1999). This paper considers this defect by constructing a new elasticity-based proxy for the degree of operating leverage by using EBITDA to sales sensitivity instead, thus eliminating the potential distorting effect of capital investment activity to results.

Figure 1: Behavior of elasticity measure of DOL across different levels of sales

Figure exhibits the convergence of the degree of operating leverage towards infinity in the proximity of break-even point (BE), when unit price, unit variable cost, and fixed costs are held constant, and only quantity sold (Q) is allowed to vary. The vertical-axis describes the degree of operating leverage, measured by using an elasticity measure. The horizontal-axis describes the quantity sold, and thus indirectly describes the size of operating margin.



Using a proxy for fixed costs to approximate operating leverage is not new to the literature (see e.g., Carlson et al., 2004; Zhang, 2005). Carlson et al. (2004) and Zhang (2005) find risk and expected returns increasing with operating leverage. They also report a positive association between operating leverage and the value premium, meaning that higher operating leverage increases risk, hence lowering the equity value and increasing the B/M ratio. Kisser (2014) is the latest to employ such a fixed cost point-to-point measurement approach. He uses explicit sales, general, and administration (SGA) expenses as a proxy for operating leverage whereas Novy-Marx (2011) uses the sum of COGS and SGA expenses as a proxy for operating leverage. Kisser finds a strong link between his measure of operating leverage and risk and returns. Interestingly he also reports results indicating that there is a negative correlation between operating leverage and the value premium, which exactly the opposite to the empirical findings of the previous literature (see e.g., Carlson et al., 2004; Zhang, 2005; García-Feijóo and Jorgensen, 2010; Novy-Marx, 2011). However, the disadvantage of such a SGA-based proxy for fixed costs, and hence for operating leverage, is that SGA does not necessarily consider all the fixed-like costs that are potentially included in cost of goods sold (COGS).[1] Whereas a time-series regression approach, for example employed by García-Feijóo and Jorgensen (2010), implicitly considers all the fixed costs, also the fixed-like costs included in COGS. Similarly to the results of Kisser (2014) it is particularly interesting when García-Feijóo and Jorgensen (2010) apply the methodology of Gulen et al, 2011 to estimate DOL at the portfolio level and attain a negative relation between DOL and B/M. Despite of the supporting arguments and defects recognized on each approach taken to approximate the operating leverage, the discussion about the most correct method has definitely not reached the conclusion yet.

3. Hypothesis development

3.1. The association between operating leverage and risk

It intuitively makes sense to think about a degree of operating leverage both as a risk factor and a determinant of high profitability, as high DOL enables both high gross profitability and high risk. Let us first examine the channels the operating leverage affects the risk, and then intuitively relate DOL to gross profitability. A high DOL firm has high fixed operating costs relative to variable operating costs, thus having a larger portion of its costs in a form that does not adjust efficiently downwards when a negative market shock hits. For instance, such a

[1] Generally Accepted Accounting Principles (GAAP) does not determine how firms should allocate expenses between COGS and SGA, thus the allocation decision is largely at the discretion of firms (Weil et al., 2014). Thus, it is highly likely that SGA excludes some of the important fixed operating costs. Examples of such fixed costs could be related to maintenance and repairs of production equipment, insurance and safety, licenses, and rent and lease expenses.

negative shock may decrease the unit sales (Q), decrease the unit price (p), or increase the unit variable cost (VC), hence making it more difficult to cover the fixed costs.

A firm may have a high DOL for two reasons, it either trades-off variable costs to fixed costs, for example, by increasing the level of automation in manufacturing, and hence reducing a unit variable cost while increasing the proportion of fixed costs out of total costs. Or it can increase its fixed costs while not affecting the unit variable cost. This is the case, for instance, when a firm increases its sales personnel. Also higher DOL may indicate higher break-even point (the amount of sales, in which both the variable and fixed costs are fully covered), which obviously is a risk factor, since the firm needs more sales to become profitable. Cost trade-off may increase the break-even point if the unit total cost, defined here as variable plus fixed costs divided by the quantity sold, increases through the execution of cost trade-off.[2] Whereas increasing non-production fixed costs, such as sales personnel, undoubtedly increases the break-even point. Moreover, cost trade-off makes earnings to be more sensitive to sales in absolute terms as an incremental unit sales increases earnings more for a firm with low variable costs than for a firm with high variable costs. But this is coupled with the possibility of quickly accumulating losses for a firm with relatively high fixed costs versus a firm with relatively low fixed costs when the sales plummet and cannot cover the fixed costs. In other words, a firm with a high DOL has operationally levered earnings, and hence carries more risk than firm with a low DOL. Increasing the break-even point, on the other hand, makes earnings to become more sensitive in relative terms, as the reference point, from which the earnings change (i.e., the break-even point) is at a higher level.

Either way, increasing fixed costs increases DOL, as the proportion of fixed costs out of total costs increases. This means that a relatively larger portion of firm's costs cannot be adjusted downwards in case of a negative market shocks in a short-term, hence making the firm less operationally flexible, and in effect increasing the firm's risk exposure. However, the important difference between increasing DOL through cost trade-off and plainly increasing the amount of fixed costs is how gross profitability is affected. Cost trade-off from variable costs to fixed costs by definition increases gross profitability, whereas increasing fixed costs, but not

[2] The change of a break-even point depends on how the unit total cost changes – if a cost trade-off manages to lower the unit total cost at the current level of sales, then the break-even point would actually decline - but this would not remove the risk from increased sensitivity of earnings to sales nor the higher fixed costs in absolute terms.

affecting the unit variable cost, has no impact on gross profitability. This logic indicates that the gross profitability premium is be merely linked to the cost trade-off channel of DOL, while the operating profitability premium recognized by Ball et al. (2015) is linked generally to high DOL firms that are highly profitable even after covering the fixed costs. The predictions regarding how different channels of risk of DOL affect different profitability measures are not in the scope of this paper.

As I showed, DOL affects the risk via higher absolute fixed costs, higher absolute sensitivity of earnings to sales though cost trade-off, and potentially higher break-even point. Consequently, firms with relatively higher fixed costs should carry more risk than firms with relatively lower fixed costs. Thus, high DOL firms should earn higher returns than low DOL firms. To demonstrate how the risk associated with DOL formally affects the risk of a firm, I build a model of operating leverage as a risk factor following the work of Carlson et al. (2004) and Novy-Marx (2011). Their approaches both involve a real options model, in which the value of the firm is the sum of currently deployed assets and growth options, $V = V_A + V_G$, where the subscripts A and G denote assets-in-place and growth options, respectively. The exposure to the underlying risk factors defines the expected returns of the firm. And, this particular risk exposure can be expressed as a value weighted sum of the risk loadings in firm's assets-in-place and growth options:

$$\beta = \frac{V_A}{V}\beta_A + \frac{V_G}{V}\beta_G, \tag{3}$$

where $V_A = V_R - V_{VC} - V_{FC}$. Here V_A denotes the capitalized value of assets-in-place, which can further be divided into the capitalized value of revenues less the capitalized value of variable costs and fixed costs, contrary to Novy-Marx (2011), who does not separate variable costs from fixed costs. This approach is analogical to determining the value of equity by subtracting the value of debt from the value of assets. Assets, V_A, are exposed to the underlying risks through a value-weighted average of the exposures of the capitalized revenues, capitalized variable costs, and capitalized fixed costs:

$$\beta_A = \beta_R + \frac{V_{VC}}{V_A}(\beta_R - \beta_{VC}) + \frac{V_{FC}}{V_A}(\beta_R - \beta_{FC}). \tag{4}$$

According to the intuition of Carlson et al. (2004), growth options are usually riskier than revenues generated from deployed capital in real options models, however, the presence of operating costs, more specifically fixed operating costs, allows the deployed assets to be riskier than growth options. Variable costs, V_{VC}, by definition vary with sales, and when assuming the constant level of variable unit cost, the beta of variable costs equals to the beta of revenues. Furthermore, if fixed costs are assumed not to vary with sales, making the beta of fixed costs effectively equal to zero. These assumptions regarding the sensitivities of variable costs and fixed costs relative to sales are perfectly reasonable in a short-term, thus reducing the equation (4) as follows:

$$\beta_A = [\beta_R (1 + \frac{V_{FC}}{V_A})] \tag{5}$$

In equation (5), the total risk of assets-in-place is determined by the beta of revenues, which is magnified by the amount capitalized fixed costs relative to capitalized value of assets-in-place. The equation (5) is equivalent to the definition of DOL of Novy-Marx (2011), with an important distinction of not being affected by variable costs (see the equation 1). However, if we assumed that β_{FC} was not zero but small, then the risk of assets-in-place would be described as (V_{FC}/V_A) $(\beta_R - \beta_{FC})$, in which the risk arises from the actual amount of fixed costs relative to the size of a firm, measured by total book assets, and from the adaptability of fixed costs to changes in sales. However, if the time period is short enough, then β_{FC} is virtually zero. Further in this paper, such a beta is assumed to be zero or to lie very close to zero. As a consequence, the risk from operating leverage could be described as the relative size of fixed costs, V_{FC}/V_A. Using a similar interpretation as Novy-Marx (2011), fixed costs (FC) to total book assets (AT) should be a valid proxy for the capitalized fixed costs to capitalized assets-in-place, and hence for operating leverage. Thus, within any given industry a relatively high FC/AT should predict a relatively high level of fixed costs compared to peers, and likely as a consequence a high proportion of fixed costs out of total costs when operating close to break-even point, and high degree of cost trade-off from variable operating costs to fixed variable costs. This prediction applies only within industries as different industries have their own characteristic levels for fixed costs-to-total book assets.

Hence the total risk of a firm can be expressed as follows consisting of the risk exposure to the assets-in-place through operating fixed costs and the risk exposure to growth opportunities:

$$\beta = \frac{V_A}{V} [\beta_R (1 + \frac{V_{FC}}{V_A})] + \frac{V_G}{V} \beta_G. \quad (6)$$

The first term of the equation (6) equals to the book-to-market ratio in the model employed by Carlson et al. (2004), and the equation predicts that the book-to-market ratio contributes to the total risk along with the fixed operating costs and the growth opportunities. And, as the market value of equity is dependent on profitability, the model predicts that (V_A/V) captures the risk related to low margins. The model, most importantly, proposes that the operating leverage contributes to the overall risk through the relative size of fixed costs alongside with the book-to-market ratio, and the size of the firm, which are the well-known risk factors (see e.g., Fama and French, 1992, 1993). This prediction implies, that the operating leverage should capture the risk related to limited operational flexibility, which cannot be captured by B/M ratio. Deciphering from the hypothesis of operating leverage being the risk factor behind the profitability premium, it seems intuitive that the value factor fails to capture the risk associated with the firms with high profitability as they have higher valuations (lower B/M ratios). This might be the reality especially when the high profitability is enabled by large production investments implying large fixed costs, in other words, high operating leverage.

This paper employs empirical tests to examine whether there is a link between the gross profitability premium and the operating leverage, and whether the gross profitability premium co-exists with the value premium and the size premium (an anomaly, in which small firms tend to generate higher returns than large firms – see e.g., Banz, 1981) as the model predicts. It is also noteworthy that the model gives a prediction on the interrelationship between the operating leverage and the value premium. Higher operating leverage causes higher risk, thus causing upward pressure on the book-to-market ratios. Nonetheless, in the case of a profitable firm, the ratio decreases as well resulting in a puzzling situation, in which the association between DOL and the value premium depends on which affects more on the B/M ratio: higher profitability increasing equity values or higher risk decreasing equity values. If profitability premium is directly linked to DOL, and profitability is negatively related to B/M as Novy-Marx (2013) suggests, then the profitability should increase the valuations more than the incremental risk decreases them, hence causing a negative relationship observed by Kisser (2014). And, this extra risk, not captured by the value factor, might be the one causing the gross profitability premium. As a consequence, the formal hypotheses of this paper are as follows:

H1: High gross profitability is associated with high DOL, while DOL being the real risk factor causing the gross profitability premium.

Note that H1 states that both risk and returns should increase monotonically with DOL. But as high DOL companies can be unprofitable as well, the positive and monotonic relationships between gross profitability and risk, and hence returns, are not predicted by this model. Intuitively the gross profitability premium captures the increased risk from high DOL that cannot be captured by the value factor due to high valuations, thus DOL being the risk factor behind the profitability premium. The rest of the non-methodological hypotheses are as follows:

H2: If H1 is proved to be right, then there should be a negative relation between DOL and the value premium.

Novy-Marx (2011) shows that investors price only within industry variation in book-to-market ratios, whereas not pricing the across-industry variation in B/M due to different capital intensities across industries. Similarly, I expect that the gross profitability premium is stronger within industries than across industries, as it is natural that different industries have distinctive characteristics regarding cost allocation, and investors are indifferent to these differences across industries, whereas within industries differences in DOL might signal different level of risk.

H3: The gross profitability premium is stronger within industries than across industries.

3.2. Preferred choice of the proxy for operating leverage

The operating leverage should magnify the exposure of a firm to economic risk, as profits can be understood as levered claims on revenues (Novy-Marx, 2013). Therefore, a firm being more exposed to economic risk, and thus having more levered profits relative to revenues, should have higher operating leverage. I compose a simplified back-of-an-envelope example to demonstrate the behavior of operating leverage measure constructed by using the traditional elasticity-based definition of the degree of operating leverage presented in the equation (2) with a slight modification of using EBITDA instead of EBIT. In the example, presented in Table 1, the starting point is a perfect competition with equal market shares each firm initially selling a quantity of one (Q = 1), the unit price of a good is assumed to be one at time t. It is further assumed that at time t, all four firms are exact copies of each other, all equaling to firm A. The only change that is assumed to happen between t and t+1 is the cost allocation between variable and fixed costs and the technology selection decisions reflected by the varying unit total costs. The decisions are different to each firm, in other words, the four different firms employ different strategies in operating cost allocation between variable costs and fixed costs with varying technologies. Firm A decides to do nothing at all, while three other firms switch part of their variable costs to fixed costs. Let us first examine firms A and B, whose total costs, and thus the break-even points as well are indifferent of the choice of cost allocation. The example of A and B describes the perfect cost trade-off from variable to fixed costs, in which at the current level of sales (Q = 1) the total costs for both firms stay the same. Nonetheless, the cost allocation affects the sensitivity of EBITDA relative to sales, firm B having four times more sensitive earnings in absolute terms relative to firm A. Note that the losses in absolute terms would accumulate four times faster for firm B if the sales dropped below the break-even point, which in this example is built to be one for both firms. When employing the traditional elasticity-based definition of DOL, which measures the proportional changes of earnings relative to the proportional changes in sales, the equal estimates for DOL are assigned for both A and B, even though investors of B most probably should require higher returns for their investment in order to have firm B in their portfolios.

Firms C and D describe similar firms as B, but with different production technologies. Firm C has the equal fixed costs as firm B, but it has not managed to decrease its unit variable cost to as low level as B, thus having higher total costs and a higher break-even point. The case with the firm D is the opposite, with better manufacturing technology it has managed to lower its total costs at the given level of sales, and thus the break-even point. The variation in DOL estimates close to the break-even point is clearly visible with the firms C and D, the DOL estimates increasing closer to the break-even point. When examining all the four firms, the example shows that the elasticity measure of DOL is capable of capturing the risk that is related to the proximity of the break-even point, in other words, the elasticity measure of DOL predicts higher risk for a firm closer to the break-even, but it cannot capture the increased absolute sensitivity of earnings to sales nor the increased absolute fixed costs as the case with firms A and B shows. Furthermore, the example of firms C and D shows how an elasticity measure of DOL is sensitive to changes in total costs, even though the change comes from a change in unit variable cost, which according to my model of operating leverage should not affect DOL, but rather the margins. Higher DOL due to higher unit variable cost contradicts also with the fundamental intuition of operating leverage. And, the increase in risk due to lower margins should be priced by the value premium as Carlson et al. (2004) and Zhang (2005) predict – but not priced by the gross profitability premium especially when lower margins arise from higher unit variable cost. The break-even point plays such an important role with an elasticity measure of DOL, since the earnings' sensitivity to sales becomes clearly higher the closer the reference point, i.e., the point of zero earnings (the break-even point), is.

Table 1: Behavior of elasticity measure of DOL close to a break-even point

A simplified back-of-an-envelope example to describe the behavior of the elasticity measure of the degree of operating leverage (DOL) when firms have different cost allocation between variable costs and fixed costs and with varying technological capability reflected by the amount of unit total cost. The example assumes one market with only one product. The starting point is a perfect competition with equal market shares and each firm having the quantity sold (Q) initially one, the unit price of a good is assumed to be one at time t. It is further assumed that at time t, all four firms are exact copies of each other, all equaling to firm A in the table below. The only change that is assumed to happen between t and t+1 is the cost allocation and technology selection decisions that are different to each firm, the firm A deciding to do nothing at all. The table presents how those decisions affect gross profitability, total costs, the break-even point, and DOL estimates measured according to the traditional elasticity-based definition of DOL (the elasticity of earnings to sales, but using EBITDA instead of EBIT): $DOL = \frac{\partial EBITDA}{\partial S} \text{ x } \frac{S}{EBITDA}$.

Firm	**A**	**B**	**C**	**D**
Sales	1.00	1.00	1.00	1.00
Variable costs (% of Sales)	80 %	20 %	30 %	10 %
Gross profit	**0.20**	**0.80**	**0.70**	**0.90**
Fixed costs	0.20	0.80	0.80	0.80
Total costs	1.00	1.00	1.10	0.90
Break-even point	1.00	1.00	1.14	0.89
EBITDA	**0.00**	**0.00**	**-0.10**	**0.10**

	A		**B**		**C**		**D**	
Sales	EBITDA	DOL	EBITDA	DOL	EBITDA	DOL	EBITDA	DOL
1.00	0.00	Nm	0.00	Nm	-0.10	Nm	0.10	Nm
1.10	0.02	Nm	0.08	Nm	-0.03	-7.00	0.19	9.00
1.20	0.04	11.00	0.16	11.00	0.04	Nm	0.28	5.21
1.30	0.06	6.00	0.24	6.00	0.11	21.00	0.37	3.86
1.40	0.08	4.33	0.32	4.33	0.18	8.27	0.46	3.16
1.50	0.10	3.50	0.40	3.50	0.25	5.44	0.55	2.74

The problem highlighted by Lord (1998) considering elasticity-based DOL estimates approaching infinity (and negative infinity when operating below the break-even point) very close to a break-even point is clearly visible in the example, in which DOL estimates tend to increase towards the break-even. This suggests that the risk, DOL is describing, is the proximity of the break-even point, and thus the uncertainty on whether the sign of profits is plus or minus. If investors thought that firms operating close to their break-even points (i.e., having low or slightly negative margins) were riskier than those operating far above the break-even point, then empirical tests should document the risk priced to the elasticity-based DOL. However, the elasticity measure of DOL in the example does not seem to capture the extra risk associated to the cost trade-off decision causing the higher sensitivity of earnings to sales, and importantly differences in gross profitability, firm B having considerably higher gross profits above the break-even point. The radical prediction here is that at least the operating leverage measured by an elasticity measure cannot explain the gross profitability premium. On the contrary, a measure of operating leverage capturing the increased sensitivity of earnings relative to sales and higher fixed costs, and not being sensitive to the proximity of break-even point could be linked to the gross profitability premium. As the example of firm A and B shows the cost allocation decision directly affects both the risk and the gross profits implying that a more direct measure of fixed costs should perform well in explaining the extra risk that causes the gross profitability premium. Therefore, I hypothesize along the lines of the previous section regarding the risk of assets-in-place that a point-to-point approach including the fixed costs should perform better than an elasticity measure of operating leverage in explaining the gross profitability premium.

However, the fixed costs are not directly observable, and thus a proxy is needed. Sales, general, and administrative (SGA) expenses used by Kisser (2004), even with its defects, such as ineptitude to capture the fixed costs included in costs of goods sold and the lack of consistency in allocating costs into SGA, it seems the closest proxy for fixed costs available with the current regulation of disclosing financial information, especially as SGA costs tend to be fixed at least in a short-term. An alternative approach used in the literature to proxy fixed costs using a point-to-point measurement is fixed assets-to-total assets ratio, which is usually used for confirming the results obtained by using an elasticity measure approach (e.g., García-Feijóo and Jorgensen, 2010). The validity of fixed assets as a proxy of fixed costs might be biased due to the fact that fixed costs usually include also other fixed costs than just costs related to fixed assets, such as costs related to sales force or general administration. Therefore, the SGA seems to be the preferred way of approximating the amount of operating leverage a firm is exposed to. As a consequence of the prior reasoning, the hypotheses related to methodologies to approximate DOL are as follows:

H4: An elasticity measure of DOL captures merely the risk related to the proximity of the break-even point, effectively the risk related to the low margins, while not being able to capture cleanly the risks fundamentally associated with relatively high fixed costs.

With H4 it is noteworthy that in the theory of Carlson et al. (2004) regarding the operating leverage, the operating leverage, defined to be in direct relationship with book-to-market ratio, increases along with the B/M ratio when operating margins and earnings fall, thus predicting higher returns for firms with low profitability. This basically predicts that elasticity measure of DOL is capable of capturing some of the systematic risk, especially the similar risk that is priced by the value premium (see the evidence from García-Feijóo and Jorgensen, 2010). But in the light of empirical evidence regarding the gross profitability premium, an elasticity measure of DOL cannot explain the gross profitability premium as the elasticity measurement approach produces low DOL estimates for firms operating far above their break-even points. For that reason, I expect the following hypotheses to be true as well:

H5: Following H4, a point-to-point approach using a direct proxy for fixed costs to approximate DOL, more specifically SGA-to-total book assets, should outperform any elasticity measure of earnings to sales in capturing the risks associated with relatively high fixed costs.

H6: Consequently, it is not possible to link DOL to the profitability premium, if DOL is measured by using an elasticity measure.

4. Data and methodology

4.1. Data sample

I obtain the monthly stock returns and the market values from the Center for Research in Security Prices (CRSP). The accounting data is obtained from Compustat. The sample period extends from 1962 to 2014 and includes stocks listed in NYSE, AMEX, and NASDAQ. Consistent with the previous literature (e.g., Fama and French, 1993; García-Feijóo and Jorgensen, 2010; Novy-Marx, 2011, 2013; Kisser, 2014), the accounting data (represents firm's financial position at the end of fiscal year t–1) is merged with returns generated between July in fiscal year t and June in fiscal year t+1 (assuming that the accounting data is available by the end of June in t), market equities (ME) are calculated by using the share price at the end of

June in year t, book-to-market ratios (B/M) are calculated by using the market equity at end of December in year t–1 and the corresponding book equity at the end of December in year t–1. The risk-free rates, monthly market returns, returns on the value, size, and momentum factors are obtained from the data library of Kenneth French.

In line with the prior related literature, I exclude financial firms (SIC 6000 – 6999) and utilities (SIC 4000 – 4999) and firms with negative book equity from the sample. Moreover, only stocks with CRSP and Compustat share codes of 10 or 11 are included in the sample. Along with the previous literature, also firms with missing values for book equity, market equity, and valid estimate for the operating leverage are excluded.

To mitigate the survivorship bias, I follow the prescriptions of Shumway (1997) and Shumway and Warther (1999) to remove the performance effect of firms delisted from CRSP. In line with García-Feijóo and Jorgensen (2010), I use -30 percent as the last monthly return for firms listed in NYSE and AMEX and -55 percent as the last monthly return for firms listed in NASDAQ. By conducting so, I am able to reduce the impact on results emanating from small, young growth stocks. Additionally, by following García-Feijóo and Jorgensen (2010), I mitigate the survival bias. The survival bias is automatically considered, as the availability of financial data at least for six years is the minimum requirement for a firm to be included in the data sample, as that is the amount of data needed to estimate the elasticity DOL estimates by following the methodology of García-Feijóo and Jorgensen (2010). Also, to mitigate the impact of extreme observations to results, I follow the methodology of Fama and French (1992) and Dichev (1998) to set the top 95.5 percentile and the bottom 0.5 percentile equal to 95.5 percentile and 0.5 percentile, respectively. This methodology is applied to monthly stock returns, B/M ratios, and operating leverage distributions.

As a result, the final data sample consists of 4,407 firms and 724,324 monthly observations. The final data sample is used for tests with all the different DOL estimates. The data sample is further summarized in Table 2 and Table 3 of *Empirical Results* section. Also, the Pearson correlation coefficients are presented in the Panel B of Table 2 to show how the different variables co-vary in a cross-section. *Appendix A* further describes the data sample characteristics on annual basis (Table A1) and industry-wise (Table A2).

Consistent with the prior literature (see e.g., Fama and French, 1993), I use only NYSE stocks as portfolio breakpoints in order to avoid sorts that are biased by the large amount of small stocks listed in AMEX and NASDAQ. From now on I refer to these breakpoints as NYSE breakpoints.

4.2. Methodology

4.2.1. Defining gross profitability and degree of operating leverage

Gross profits are defined as sales minus cost of goods sold. Thus, I define the variable for gross profitability (GP) as revenues minus cost of goods sold to total book assets similarly to Novy-Marx (2013). As there is no conclusion in the previous literature on the preferred approach to estimate the level of operating leverage, it is required to use both alternatives: a point-to-point measurement approach and the elasticity measurement approach based on time-series regressions. The point-to-point measurement approach, I employ in this paper, is based on the work of Kisser (2014). He uses fixed sales, general, administrative (SGA) expenses as a proxy for fixed costs, he scales SGA expenses with total book assets uniformly with the previous literature in order to make the operating leverage estimates comparable between firms.

As an elasticity measure in this paper, I employ the approach based on the work of Mandelker and Rhee (1984), O'Brien and Vanderheiden (1987), and García-Feijóo and Jorgensen (2010). However, different to the prior literature related to the elasticity measure of operating leverage, I will measure the sensitivity of EBITDA to sales instead of the sensitivity of EBIT to sales. My hypothesis is that by using EBITDA instead of EBIT, I am able to reduce the effect of investment activity on DOL estimates. As amounts of depreciation and amortization neither change together with sales, but rather stay as fixed due to their basis on accounting principles, nor are actual operating costs, including them into a proxy measuring fixed operating costs would probably cause biased results. Otherwise, I will conduct the approximation of DOL similarly to the preceding literature.

As I am interested in relating gross profitability to DOL, I need to estimate DOL for each firm at the end of each year. By following the prior literature (see Mandelker and Rhee, 1984; O'Brien and Vanderheiden, 1987; García-Feijóo and Jorgensen, 2010) will run the regressions at five-year overlapping intervals. For that reason, I need financial data for each company at least from a period of six years in order to compute the elasticity measure proxies for DOL, thus effectively reducing the sample size to extend from 1967 to 2014, simultaneously mitigating the survival bias mentioned in the section *Data sample.* Next, I explain the estimation method in more detail.

First, I run the following two regressions to detrend the time-series recommended by the previous literature (see e.g., O'Brien and Vanderheiden, 1987; Dugan and Shriver, 1992):

$$lnEBITDA_t = lnEBITDA_0 + g_{ebitda} + \mu_{t,\ ebitda}, \tag{6}$$

$$lnSales_t = lnSales_0 + g_{sales} + \mu_{t,\ sales}, \tag{7}$$

in which $EBITDA_0$ and $Sales_0$ represent the starting levels of EBITDA and sales, respectively. Terms g_{ebitda} and g_{sales} represent the growth trend in EBITDA and sales, respectively, while $\mu_{t,ebitda}$ and $\mu_{t,\ sales}$ represent the residuals. I follow the common transformation in accounting research to compute the logs of negative earnings (Ljungqvist and Wilhelm, 2005), ln (1 + EBITDA) if EBITDA ≥ 0, and –ln (1 – EBITDA) if EBITDA < 0.

Second, I run a regression to estimate the following equation:

$$\mu_{t,\ ebitda} = OL\ \mu_{t,\ sales} + e_t, \tag{8}$$

where *OL* is an estimate of DOL and e_t is an error term. *OL* measures the average sensitivity of the percentage deviation of EBITDA form its trend relative to the percentage deviation of sales from its trend.

The elasticity DOL estimates are calculated also by using EBIT instead of EBITDA by following the preceding literature (see e.g., Mandelker and Rhee, 1984; O'Brien and Vanderheiden, 1987; García-Feijóo and Jorgensen, 2010) for comparison. In this paper, when using EBIT to construct a proxy for DOL, I use an abbreviation of DOL_{EBIT} to refer to the estimate of DOL that is attained by using EBIT-based approximation. Similarly, DOL_{EBITDA} is used when referring to a proxy of DOL attained by using EBITDA.

I use sales, general, and administrative (SGA) expenses to total book assets (AT) as a point-to-point proxy for DOL similarly to Kisser (2014). I adopt the abbreviation of DOL_{SGA} when referring to such a DOL value attained by using SGA/AT as a proxy. DOL_{TC}, another point-to-point proxy, refers to an estimate of DOL obtained by dividing total costs (cost of goods sold plus sales, general, and administrative expenses) by total book assets equivalently to Novy-Marx (2011). As a third point-to-point proxy for DOL, I use book DOL (DOL_{Book}), which is the five-year-average of fixed assets (PPENT; property, plant, and equipment) to total book assets (García-Feijóo and Jorgensen, 2010).

4.2.2. The power of gross profitability and DOL to predict returns

In this section, by running Fama-MacBeth regressions (see Fama and MacBeth, 1973), I examine whether the gross profitability premium exists in the sample. I also verify here whether the evidence of prior literature (see e.g., Novy-Marx, 2011) about the return predicting ability of operating leverage holds. Simultaneously, I aim to validate the return predicting power of newly constructed proxy for operating leverage using EBITDA sensitivity instead of EBIT sensitivity, and compare the risk capturing ability of that particular measurement approach to a point-to-point DOL estimate (DOL_{SGA}). Therefore, I run the following regression of returns on gross profitability and different operating leverage estimates.

$$r_{tj} = \boldsymbol{\beta}' \boldsymbol{x}_{tj} + e_{tj}, \tag{9}$$

where $\boldsymbol{\beta}$ represents the vector of time-series means of slope coefficients for an explanatory variable (GP or DOL) and the regression controls, $\boldsymbol{x}_{tj}$ represents the vector of an explanatory variable and the regression controls, and e_{tj} is an error term. As the regression controls I use the logarithm of book-to-market, the logarithm of market equity, and the momentum effect measured at the horizons of one month and 12 to 2 months. I hypothesize that both gross profitability and different measures of DOL are positive and statistically significant indicating a power to explain returns in cross-section, but that power to predict returns is weakened for gross profitability when DOL is added as a control variable.

To show further evidence, I conduct two set of regressions according to Fama and French (1993) and Carhart (1997), in which the portfolio of stocks is either sorted on gross profitability or DOL into quintiles. The portfolios are formed by using NYSE breakpoints, and those are rebalanced at the end of each June. The value factor (HML: high-minus-low), size factor (SMB: small-minus-big), and the momentum factor (UMD: up-minus-down) are used as controls.

$$r_t^e = \alpha_t + \beta_{MKT}\, r_{t,\,MKT} + \beta_{MKT}\, SMB_t + \beta_{HML}\, HML_t + \beta_{UMD}\, UMD_t \qquad (10)$$

Therefore, I should be able show a positive spread in excess returns r_t^e and especially in alphas α_t between high gross profitability firms and low gross profitability firms and similarly between high DOL and low DOL firms. (Novy-Marx, 2013)

4.2.3. The association between the gross profitability premium and DOL

By following García-Feijóo and Jorgensen (2010) and Fama and French (1993), I form quintile portfolios on size (used for controlling purposes) and gross profitability into 25 portfolios and present their average monthly returns and corresponding estimates for operating leverage. Portfolios are constructed by using NYSE breakpoints, and they are rebalanced at the end of each June. After forming the portfolios, I test the statistical difference of equally weighted returns and operating leverages between the highest and the lowest quintile of portfolios sorted on gross profitability.

Additionally, by following García-Feijóo and Jorgensen (2010), I run a cross-sectional regression on annual basis of operating leverage on gross profitability at individual firm level to examine further the interrelationship between these two. The time series standard errors are adjusted for autocorrelation following Loughran and Schultz (2005).

$$lnDOL_t = a_t + lnME_t + lnB/M_t + lnGP_t, \qquad (11)$$

where $lnME_t$ and lnB/M_t are used as control variables in addition to $lnGP_t$. I perform the regression by using various combinations of controls. I follow the common transformation in accounting research to compute the logs of negative profitability values (Ljungqvist and Wilhelm, 2005), ln (1 + GP) if GP ≥ 0, and –ln (1 – GP) if GP < 0. DOL is set to be a left-hand side variable, so that the measurement error can be absorbed by the disturbance term.

To extend the examination of association between gross profitability and DOL, I conduct the analysis deployed by Kisser (2014), in which firms are sorted into five quintile portfolios according to gross profitability, and regressions are run for each quintile with the following controls proposed by Carhart (1997) and adding a control for DOL as well (Kisser, 2014). The portfolios are formed by using NYSE breakpoints, and those are rebalanced at the end of each

June. The DOL factor uses independent sorts of stocks into two size groups and three DOL groups, effectively independent 2x3 sort. As the size breakpoint the NYSE median market capitalization is used and the DOL breakpoints are the 30th and the 70th percentiles of DOL estimates for NYSE stocks. The DOL factor used in the regression is the average of the two high DOL portfolio returns minus the average of the two low DOL portfolio returns.

$$r_t^e = \alpha_t + \beta_{MKT} r_{t,\,MKT} + \beta_{MKT} SMB_t + \beta_{HML} HML_t + \beta_{MOM} MOM_t + \beta_{DOL} DOL_t, \quad (12)$$

where controls are constructed according to the previous literature. (Fama and French, 1993; Carhart, 1997; Kisser, 2014)

4.2.4. The association between the value premium and DOL

By following Kisser (2014) I will create 25 portfolios (5 x 5) sorted first on gross profitability and then on value (B/M) and present the returns and the DOL estimates for each portfolio to see the link between DOL and the value premium. Also, I will employ the exactly same analysis, but sorting the firms first on value and then on gross profitability to show how the results are sensitive to such a change. The first sort measures how DOL varies in book-to-market within gross profitability sorts, whereas the second sort measures how DOL changes in B/M in absolute terms. The portfolios are constructed by using NYSE breakpoints and rebalanced at the end of each June.

4.2.5. The gross profitability premium within and across industries

I also provide supplementary research whether the gross profitability premium is stronger within industries than in the cross-section by following the methodology of Novy-Marx (2011), in which firms' gross profitability ranking within industry is used as the intra-industry gross profitability measure and the ranking of the gross profitability of firm's industry is used as the industry gross profitability measure. Fama-MacBeth regressions (see Fama and MacBeth, 1973) are employed in order to measure the risk exposures for within-industry and across-industry variables (see equation 9). Along with the within- and across-industry measures the logarithm of book-to-market, the logarithm of market equity, and the momentum effect measured at the horizons of one month and 12 to 2 month are used as control variables. The expectation here is that within-industry variable should capture risk better than the across-industry variable.

I further extend this examination of gross profitability effect being stronger within industries than across industries similarly to Novy-Marx (2011). Consequently, I create quintile portfolio sorts on intra-industry gross profitability and industry gross profitability. The intra-industry sort assigns each firm each year to a portfolio based on the firm's gross profitability relative to other firms within the same industry. The industry sort assigns each firm each year to a portfolio based on the gross profitability of the firm's industry (total industry gross profits scaled by total industry book assets). Similarly, to Novy-Marx (2011), there are 49 industries defined by Fama and French (1997). The Carhart four-factor model (see equation 10) is then employed to the portfolios in order to find out whether the model is capable of pricing the risk associated with each of the portfolios. I expect to see the within-industry sort generating high excess returns and high alphas, whereas across-industry measure sort generating lower and statistically less significant excess returns and alphas.

5. Empirical results

5.1. Preliminary results

This section provides the initial results regarding the cross-sectional association between the degree of operating leverage, the gross profitability, and the value (B/M). First, I provide the DOL estimates obtained by using different estimation approaches. Second, I show how these proxies for DOL correlate with each other and with other test variables, most interestingly with the gross profitability (GP) and the value (B/M), in a cross-section. The data sample and the test variables are summarized in Table 2. Also, the Pearson correlation coefficients are presented to show how the different variables co-vary in a cross-section.

EBIT-based DOL values obtained from the regressions are similar to those of García-Feijóo and Jorgensen (2010) as their average DOL estimate for a time-period extending from 1986 to 2003 is 3.96, and the corresponding median equals to 1.69. While the EBIT-based DOL mean and median are 3.88 and 1.88 in the data sample used in this study, respectively. The minor differences arise from using a longer dataset and excluding utilities from the sample. Other descriptive statistics are similar to those of García-Feijóo and Jorgensen (2010). From the table one sees that DOL estimates based on EBIT are more sensitive to changes in sales than DOL estimates based on EBITDA, as their dispersion is significantly higher. This is natural and predicted ex ante as the EBIT-based DOL includes the magnifying effect emanating from the inclusion of depreciation and amortization, which are falsely considered as operating costs by the traditional elasticity-based definition of DOL.

The simple Pearson correlation coefficients initially show a positive correlation between elasticity measures of DOL and B/M, which is also the main view of the preceding literature (see e.g., García-Feijóo and Jorgensen, 2010; Novy-Marx, 2011). Whereas the correlation between SGA/AT and B/M seems to be negative, thus having a sign of correlation that is aligned with the hypotheses presented in this study. The book DOL measure used by García-Feijóo and Jorgensen (2010), and defined as the five-year-average of fixed assets divided by total book assets, seems to be inversely related to the SGA-based DOL, and correlates positively with B/M. The observed correlation with the B/M is in line with the prior literature, in which such a book DOL is primarily used as a robustness check. But the observed correlation of DOL_{Book} with the SGA-based DOL indicates that fixed assets are not directly linked to the true amount of fixed costs, in other words, fixed costs arise by large part from other sources than only fixed assets, such as from administration or sales force. The total costs-to-total assets proxy for DOL used by Novy-Marx (2011) seems to be positively correlated with B/M, which is aligned with his empirical findings.

The descriptive statistics and the correlations between different test variables seem to be well aligned with the previous literature. The Pearson correlation coefficients also present very interesting initial results regarding the associations between DOL and the gross profitability (GP) and between DOL and the value (B/M), and between GP and B/M, which are in the interest of this research. It seems that DOL_{SGA} and GP are highly correlated with a Pearson correlation coefficient of 0.88. The correlation between GP and B/M in the sample is negative, thus being aligned with the findings of Novy-Marx (2013). Also, the correlation between DOL_{SGA} and B/M seems to have a negative sign as I predict in this paper, thus the correlation being aligned with the results of Kisser (2014). Furthermore, as I predicted, DOL values approximated by using an elasticity measure approach seem to incapable of explaining the gross profitability premium, the correlations between those EBIT- and EBITDA-based DOL values and GP are negative, hence being in line with my hypotheses.

Table 2: Summary sample statistics

The data sample used for estimating the elasticity measure of DOL (using both EBITDA and EBIT sensitivity to changes in sales) consists of firms listed in NYSE, AMEX, and NASDAQ and included in Compustat/CRSP merged database over the fiscal years 1962-2014. In order to calculate the elasticity proxies for DOL, I collect the data on sales, earnings before interest, taxes, depreciation, and amortizations (EBITDA), and earnings before interest and taxes (EBIT). I estimate the elasticity measures of DOL for fiscal years 1967-2014 by running the regressions at five-year overlapping intervals for each company and for each year as follows:

$$lnEBITDA_t = lnEBITDA_0 + g_{ebitda} + \mu_{t,\ ebitda},$$

$$lnSales_t = lnSales_0 + g_{sales} + \mu_{t,\ sales},$$

in which $EBITDA_0$ and $Sales_0$ represent the starting levels of EBITDA and sales, respectively, terms g_{ebitda} and g_{sales} represent the growth trend in EBITDA and sales, respectively, $\mu_{t,\ ebitda}$ and $\mu_{t,\ sales}$ represent the residuals. I follow the common transformation in accounting research to compute the logs of negative earnings (Ljungqvist and Wilhelm, 2005), ln (1 + EBITDA) if EBITDA ≥ 0, and –ln (1 – EBITDA) if EBITDA < 0.

Second, I run a regression to estimate the following equation:

$$\mu_{t,\ ebitda} = OL\ \mu_{t,\ sales} + e_t,$$

where *OL* is an estimate of DOL and e_t is an error term. *OL* measures the average sensitivity of the percentage deviation of EBITDA from its trend relative to the percentage deviation of sales from its trend. The book-to-market ratio (B/M) is calculated by using end-of-fiscal year values from Compustat from 1967 to 2013, and market capitalization (ME) is calculated by using at the end of June values in the year following the end of fiscal year. The market data is from CRSP covering the years from 1967 to 2014. Gross profitability is calculated as follows: sales minus cost of goods sold (COGS) to total book assets (AT). DOL_{EBITDA} and DOL_{EBIT} are calculated as described above. DOL_{SGA} is calculated by dividing sales, general, and administrative expenses with total book assets. DOL_{TC} is calculated as DOL_{SGA}, but including COGS in the numerator as well. Book DOL is the five-year-average of fixed assets to total book assets. The data sample excludes financial firms and utilities, and those firms with negative book equity. Also firms with missing values for B/M, ME, or DOL estimates are excluded. Survivorship bias is mitigated by following Shumway (1997) and Shumway and Warther (1999). Also, by following García-Feijóo and Jorgensen (2010), the last monthly returns are set to be -30 percent for firms listed in NYSE and AMEX, and -50 percent in NASDAQ. Survival bias is mitigated by requiring at least six years of financial data for each firm by following García-Feijóo and Jorgensen (2010). Monthly returns, B/M ratios, and DOL estimate distributions are winsorized at 0.5 percent level. The data sample consists of 4,407 firms and 724,324 monthly observations.

Panel A: Data sample characteristics

			Percentile				
Variable	Mean	SD	5 %	25 %	50 %	75 %	95 %
Returns, %	1.53	12.99	-17.63	-5.63	0.53	7.48	23.33
B/M	0.86	0.74	0.17	0.39	0.65	1.08	2.25
lnME	5.36	2.28	1.97	3.65	5.19	6.91	9.35
GP	0.42	0.26	0.11	0.25	0.38	0.54	0.87
DOL_{EBITDA}	2.60	3.86	0.18	0.79	1.48	2.73	8.76
DOL_{EBIT}	3.88	6.38	0.19	0.91	1.88	3.90	14.54
DOL_{SGA}	0.29	0.22	0.04	0.14	0.25	0.39	0.70
DOL_{TC}	1.24	0.81	0.28	0.73	1.10	1.53	2.69
DOL_{Book}	0.31	0.20	0.05	0.16	0.27	0.42	0.71

Panel B: Pearson correlation coefficients for the test variables

Variable	lnB/M	lnME	lnGP	$lnDOL_{EBIT}$	$lnDOL_{EBITDA}$	$lnDOL_{SGA}$	$lnDOL_{TC}$	$lnDOL_{Book}$
lnB/M	1.00							
lnME	-0.50	1.00						
lnGP	-0.22	-0.10	1.00					
$lnDOL_{EBIT}$	0.12	-0.07	-0.02	1.00				
$lnDOL_{EBITDA}$	0.15	-0.02	-0.06	0.89	1.00			
$lnDOL_{SGA}$	-0.09	-0.23	0.88	0.09	0.03	1.00		
$lnDOL_{TC}$	0.17	-0.32	0.49	0.03	0.01	0.51	1.00	
$lnDOL_{Book}$	0.09	0.10	-0.21	-0.07	0.02	-0.37	-0.12	1.00

As correlations only tell how different variables co-vary in a data sample, not telling anything about causalities, it is required to examine those relationships between different variables in more detail. However, as the signs and the magnitudes of those Pearson correlation coefficients between the key variables are as predicted by the hypotheses of this paper, a fruitful setting for further research is definitely set up.

5.2. DOL, GP, and the cross-sectional average stock returns

In this section, I empirically show that both DOL and gross profitability are positively linked to stock returns, consequently confirming that my data sample is capable of producing results obtained by the prior literature. First, by running firm level regressions by following Fama and MacBeth (1973) I examine whether investors require extra returns for gross profitability and DOL. Second, by sorting firms into quintile portfolios on gross profitability and DOL, I am able to show whether high profitability firms produce higher excess returns than low profitability firms and whether high DOL firms produce higher excess returns than their peers with lower DOL values. Additionally, by comparing different definitions of DOL, I am able to examine whether their capability of explaining returns, and thus risk, differs from each other.

Table 3 presents the results regarding the Fama-MacBeth regressions, and how investors require premium for being exposed to certain risk factors. Specifications (1) – (4) involve either GP or DOL in addition to the other control variables and specifications (5) and (6) examine the risk premium when GP and DOL are employed simultaneously. As control variables I use the logarithms of B/M and ME, and the returns for the past month and year. Firstly, the regressions indicate that investors actually do require risk premium for being exposed to gross profitability. The sign of GP is always positive and significant (excluding the 5^{th} specification in Panel C) regardless of the control variables. It is noteworthy that GP is positive and significant even after controlling for the value factor B/M, which signals that there is a risk premium associated with gross profitability that cannot be captured by B/M, in which (see specification 4) the coefficient for GP is 0.54 with a t-statistic of 4.35, meaning that the result is significant at the confidence level of 0.1 percent. Secondly, the regressions indicate that the required compensation for being exposed to different definitions of DOL seems to have considerably more variation in results. In Panel A, the DOL is based on an EBIT elasticity measure, and the regression results show that DOL_{EBIT} individually captures some risk premium, the result though being statistically insignificant (t-statistic of 1.45). The sign of the coefficient falls negative and the statistical significance drops dramatically when other control variables are included in the regression, signaling that DOL_{EBIT} do not very well possess any risk that could not be already captured by the control variables.

Table 3: Fama-MacBeth regressions employing gross profitability and degree of operating leverage

Table reports the results from Fama-MacBeth regressions of firms' returns on gross profitability (GP), which is sales minus cost of goods sold scaled by total book assets (AT), and the different measures of degree of operating leverage (DOL). Logarithms of book-to-market (B/M) and size (ME), and the past returns for one month and one year are used as controls. The data sample extends from 1967 to 2014, and excludes financials and utilities.

	Slope coefficients (x10^2) and [t-statistics] from the regression $r_{tj} = \boldsymbol{\beta}' \boldsymbol{x}_{tj} + e_{tj}$,					
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Fama-MacBeth regressions using DOL_{EBIT}						
DOL	0.01		0.00		0.01	0.00
	[1.45]		[-0.73]		[1.62]	[-0.71]
GP		0.33		0.54	0.34	0.54
		[2.58]		[4.35]	[2.64]	[4.33]
lnB/M			0.34	0.40		0.40
			[5.22]	[6.04]		[5.92]
lnME			-0.13	-0.12		-0.12
			[-3.91]	[-3.61]		[-3.61]
$r_{1,0}$			-4.58	-4.64		-4.64
			[-14.52]	[-14.78]		[-14.80]
$r_{12,2}$			0.15	0.13		0.12
			[1.27]	[1.10]		[1.07]
Panel B: Fama-MacBeth regressions using DOL_{EBITDA}						
DOL	0.01		0.00		0.01	0.00
	[1.90]		[-0.49]		[1.96]	[-0.51]
GP		0.33		0.54	0.32	0.54
		[2.58]		[4.35]	[2.53]	[4.31]
lnB/M			0.35	0.40		0.40
			[5.30]	[6.04]		[6.00]
lnME			-0.13	-0.12		-0.13
			[-3.95]	[-3.61]		[-3.67]
$r_{1,0}$			-4.59	-4.64		-4.66
			[-14.51]	[-14.78]		[-14.79]
$r_{12,2}$			0.16	0.13		0.13
			[1.35]	[1.10]		[1.14]
Panel C: Fama-MacBeth regressions using DOL_{SGA}						
DOL	0.72		0.66		1.42	-0.50
	[4.07]		[4.20]		[2.89]	[-1.36]
GP		0.33		0.54	-0.72	1.12
		[2.58]		[4.35]	[-1.75]	[3.34]
lnB/M			0.40	0.40		0.45
			[6.22]	[6.04]		[6.54]
lnME			-0.11	-0.12		-0.13
			[-3.34]	[-3.61]		[-3.77]
$r_{1,0}$			-4.77	-4.64		-4.80
			[-14.47]	[-14.78]		[-14.53]
$r_{12,2}$			0.10	0.13		0.09
			[0.87]	[1.10]		[0.79]

In Panel B I report the results of equal regressions, but using EBITDA-based DOL instead. The results are similar to those of Panel A, however, DOL_{EBITDA} seemingly being better able to capture risk premium than DOL_{EBIT}, as in individual regressions (specification 1) DOL_{EBITDA} has twice the coefficient (0.013) than DOL_{EBIT} (0.006), simultaneously the result being considerably more significant, being almost statistically significant at 5 percent confidence level (t-statistic of 1.90). This result, in spite of not being statistically significant, indicates lightly that inclusion of depreciation and amortization (D&A) weakens the capability of DOL_{EBIT} to capture risk, and thus predict returns, as the amount of D&A is directly linked to firm's capital investment level, which on the other hand, is related to lower risk and lower expected returns (e.g., Berk et al., 1999). Similarly to Panel A, when adding other control variables than GP, DOL_{EBITDA} loses much of its power to predict returns.

Contrary to the results regarding DOL_{EBIT} and DOL_{EBITDA}, which are elasticity measures, the DOL based on SGA expenses (a point-to-point measure) seems to capture the risk premium considerably better than those elasticity measures of DOL, individually and with other control variables (excluding GP) producing positive coefficients (0.72 in specification 1 and 0.66 in specification 3) that are statistically highly significant (t-statistics of 4.07 and 4.20, respectively) both being statistically significant at 0.1 percent confidence level. Moreover, it is important for one to note that the individual risk premium, and the risk premium when controlling for other variables is higher for DOL_{SGA} than for GP, which would obviously be natural if DOL was the real risk factor behind the gross profitability premium.

Thirdly, when employing DOL and GP simultaneously in Fama-MacBeth regression specifications (5) and (6), the results are very different for elasticity measures of DOL than for SGA-based DOL. Specification (5) of Panel A and Panel B shows that elasticity measure of DOL and GP are capturing very different risk. The coefficients for DOL_{EBIT} and DOL_{EBITDA} are considerably higher than in any other specification, while the statistical significance being higher as well – actually the coefficient of DOL_{EBITDA} is significant at 5 percent confidence level in specification (5). But, when other controls are added in specification (6) the coefficients for both drop negative while the statistical significance falling. Again, the results are somewhat opposite to DOL_{SGA} in Panel C, as DOL_{SGA} and GP seem to capture much of the same risk, GP even being statistically insignificant in specification (5) and DOL_{SGA} being significant at 1 percent confidence level. When adding the other control variables in specification (6) the statistical significance of DOL_{SGA} falls to insignificant, signaling that the risk DOL_{SGA} represents can already be captured by other controls, namely GP and B/M.

To further examine the interrelation between gross profitability, risk, and expected returns and between different measures of DOL, risk, and expected returns, I conduct a four-factor portfolio analysis by following Fama and French (1993), but augmenting their three-factor model with a factor capturing the effect of momentum similar to Carhart (1997), and sorting the stocks first into quintile portfolios on gross profitability (Table 4 displays the gross profitability portfolio characteristics). From here on, to such a model, I will refer as a Carhart four-factor model. Next, I run four-factor regressions on each of the portfolios while controlling for the effect of size, value, and momentum, and finally presenting the value-weighted excess returns, alphas, and factor loadings for each portfolio. Table 5 presents the results of this particular analysis, and it is immediately visible that excess returns increase almost monotonically, while the alpha increases monotonically and high-minus-low strategy on gross profitability generating a monthly abnormal returns of 0.60 percent (t-statistic of 3.13). These results of highly gross profitable firms earning higher returns than firms with low gross profitability resemble the results on gross profitability obtained by Novy-Marx (2013). The results of Table 5 signal that gross profitability is associated with risk that cannot be captured by the value factor, the size factor, or the momentum factor of the Carhart four-factor model, hence supporting the findings of preceding Fama-MacBeth regression analysis. Furthermore, the loadings on the value factor HML decrease in gross profitability, indicating that the value premium and the gross profitability premium are negatively correlated as Novy-Marx (2013) finds. The results are insensitive to excluding the momentum factor (UMD), and effectively employing a Fama-French three-factor model (Fama and French, 1993).

I also employ the previous analysis on different definitions of DOL, consequently sorting the stocks into quintile portfolios on each measure of DOL. In Table 6, I present the results of this analysis. Panel A, using DOL_{EBIT} as a sorting variable, provides empirical results that support the findings obtained from the previous Fama-MacBeth regression analysis. Importantly, the results tell that the portfolio including the stocks with highest DOL_{EBIT} has not historically provided any additional returns for investors than the stocks with the lowest DOL_{EBIT}, and the high-minus-low strategy has even generated negative abnormal returns of 0.18 percent per month (t-statistic of -1.00) after controlling for other risk factors. Altogether it seems that there is no additional risk emanating from DOL_{EBIT} that could not already be captured by the controls, which nonetheless does not contradict with the previous literature arguing that the value premium and DOL (especially an elasticity measure) are positively related to each other.

Table 4: Gross profitability portfolio summary statistics

Table presents time-series average characteristics of portfolios sorted on gross profitability (GP), defined as sales minus cost of goods sold (COGS), and scaled by total book assets (AT). Portfolios are constructed by using NYSE breakpoints and rebalanced at the end of each June. Tables 2 and D1 describe the construction of DOL estimates in more detail. Summary statistics are for the time period 1967– 2014. Financials and utilities are excluded from the sample. The data sample consists of 4,407 firms and 724,324 monthly observations.

	Gross profitability portfolio				
	Low	2	3	4	High
GP	0.13	0.27	0.36	0.48	0.76
Book-to-market	1.09	0.94	0.86	0.78	0.69
Average capitalization ($\$10^6$)	2,587	3,571	2,674	3,312	2,761
DOL_{EBITDA}	2.80	2.36	2.39	2.39	2.71
DOL_{EBIT}	4.42	3.70	3.52	3.41	3.75
DOL_{SGA}	0.09	0.15	0.22	0.31	0.57
DOL_{TC}	0.80	1.05	1.17	1.28	1.76
DOL_{Book}	0.40	0.36	0.30	0.27	0.25
Number of firms	237	226	247	279	309

Table 5: Excess returns to portfolios sorted on gross profitability

Table presents the monthly value-weighted average excess returns to portfolios sorted on gross profitability, which is defined as sales minus cost of goods sold scaled by total book assets. The table shows also the monthly value-weighted average abnormal returns and returns for the market factor (MKT), the size factor (SMB), the value factor (HML), and the momentum factor (UMD) from portfolio-wise time-series regressions by following Fama and French (1993) and Carhart (1997). The t-statistics are presented in square brackets. Portfolios are constructed by using NYSE breakpoints and rebalanced at the end of each June. The data sample extends from 1967 to 2014, and excludes financials and utilities.

		Alphas and four-factor loadings				
Portfolio	r^e	α	MKT	SMB	HML	UMD
Portfolios sorted on gross profitability						
Low	0.53	-0.09	1.04	0.01	0.30	0.06
	[2.44]	[-0.79]	[23.02]	[0.19]	[4.01]	[0.81]
2	0.60	0.07	1.07	-0.08	0.24	-0.02
	[2.95]	[0.52]	[25.99]	[-1.41]	[2.90]	[-0.22]
3	0.64	0.25	1.09	0.00	-0.01	-0.02
	[2.91]	[2.40]	[32.08]	[-0.09]	[-0.15]	[-0.38]
4	0.63	0.36	1.00	-0.11	-0.32	-0.13
	[2.94]	[2.91]	[21.64]	[-2.41]	[-5.14]	[-2.63]
High	0.64	0.51	0.79	-0.15	-0.51	-0.04
	[2.98]	[3.73]	[15.94]	[-2.46]	[-7.10]	[-0.81]
High-Low	0.11	0.60	-0.25	-0.16	-0.81	-0.11
	[0.58]	[3.13]	[-3.35]	[-1.81]	[-8.15]	[-1.13]

Table 6: Excess returns to portfolios sorted on degree of operating leverage

Table presents the monthly value-weighted average excess returns to portfolios sorted on degree of operating leverage (DOL) estimates. The table shows also the monthly value-weighted average abnormal returns and returns to the market factor (MKT), the size factor (SMB), the value factor (HML), and the momentum factor (UMD) from portfolio-wise time-series regressions by following Fama and French (1993) and Carhart (1997). The t-statistics are presented in square brackets. Portfolios are constructed by using NYSE breakpoints and rebalanced at the end of each June. The data sample extends from 1967 to 2014, and excludes financials and utilities. Tables 2 and D1 describe the construction of DOL estimates in more detail.

		Alphas and four-factor loadings				
Portfolio	r^e	α	MKT	SMB	HML	UMD
Panel A: Portfolios sorted on DOL_{EBIT}						
Low	0.59	0.36	0.88	-0.16	-0.23	-0.07
	[2.88]	[2.74]	[19.64]	[-3.53]	[-3.31]	[-1.26]
2	0.64	0.23	1.00	-0.16	-0.11	0.03
	[3.12]	[1.82]	[20.17]	[-4.39]	[-1.56]	[0.59]
3	0.59	0.20	0.95	-0.07	-0.04	-0.01
	[2.96]	[2.00]	[24.73]	[-1.48]	[-0.59]	[-0.09]
4	0.67	0.30	1.02	-0.04	-0.06	-0.05
	[3.16]	[2.73]	[24.49]	[-0.88]	[-1.12]	[-0.79]
High	0.60	0.19	1.15	0.09	0.07	-0.19
	[2.75]	[1.41]	[33.31]	[1.53]	[0.77]	[-2.56]
High-Low	0.02	-0.18	0.28	0.26	0.30	-0.13
	[0.14]	[-1.00]	[4.61]	[3.21]	[2.79]	[-1.44]
Panel B: Portfolios sorted on DOL_{EBITDA}						
Low	0.64	0.33	0.89	-0.11	-0.18	-0.03
	[3.00]	[2.26]	[21.46]	[-2.26]	[-2.84]	[-0.58]
2	0.56	0.25	1.00	-0.21	-0.11	-0.01
	[2.78]	[2.31]	[25.07]	[-5.07]	[-1.61]	[-0.20]
3	0.63	0.33	0.95	-0.06	-0.10	-0.02
	[3.06]	[2.71]	[23.75]	[-1.19]	[-1.28]	[-0.27]
4	0.60	0.11	1.06	-0.01	-0.04	-0.12
	[2.88]	[0.95]	[31.54]	[-0.22]	[-0.77]	[-2.32]
High	0.72	0.24	1.07	0.12	-0.02	-0.10
	[3.33]	[2.31]	[26.93]	[2.04]	[-0.19]	[-1.31]
High-Low	0.08	-0.08	0.17	0.24	0.17	-0.07
	[0.54]	[-0.51]	[2.90]	[3.06]	[1.47]	[-0.70]
Panel C: Portfolios sorted on DOL_{SGA}						
Low	0.43	-0.09	1.13	-0.09	0.37	0.00
	[1.81]	[-0.55]	[24.98]	[-1.25]	[2.98]	[-0.01]
2	0.68	0.20	1.09	-0.12	0.13	-0.10
	[3.33]	[1.84]	[26.36]	[-2.21]	[1.93]	[-1.37]
3	0.67	0.23	1.00	0.02	-0.27	-0.01
	[2.90]	[1.81]	[31.04]	[0.44]	[-4.42]	[-0.28]
4	0.57	0.41	0.90	-0.06	-0.40	-0.19
	[2.63]	[2.98]	[14.88]	[-1.01]	[-5.41]	[-3.58]
High	0.76	0.51	0.83	-0.15	-0.45	0.04
	[3.59]	[3.48]	[22.28]	[-2.88]	[-5.38]	[0.50]
High-Low	0.33	0.60	-0.30	-0.07	-0.81	0.04
	[1.37]	[2.54]	[-4.58]	[-0.72]	[-5.47]	[0.28]

Panel B of Table 6 provides the results regarding the sort on EBITDA-based DOL. The results are very similar those of Panel A, high-minus-low strategy, however, producing slightly higher excess returns than the sort on EBIT-based DOL (0.08 percent vs. 0.02 percent), and less negative monthly alpha (-0.08 percent vs. -0.18 percent), the results though being statistically insignificant again. All in all, the results of the Carhart four-factor regression analysis regarding DOL values approximated by using an elasticity measure approach are in line with those obtained in the Fama-MacBeth regression analysis, indicating the low capability of explaining risk and expected returns after adding the control variables.

As with Fama-MacBeth regressions the results regarding the deployment of SGA/AT as a proxy for DOL generates considerably different results to those of using an elasticity measurement approach. Panel C of Table 6 gives results showing that there is significant abnormal returns of 0.60 percent (t-statistic of 2.54) per month to be made with levered-minus-unlevered strategy, which cannot be captured by the four-factor model. However, the excess returns are not monotonically increasing with DOL_{SGA}, but this might be due the fact that SGA costs cannot capture all the fixed costs firms have, thus somewhat biasing the results. Other possible reason might be varying accounting practices across industries, hence biasing the cross-sectional results. Moreover, in alignment with the previous results, there seems to be more risk and expected returns associated with DOL_{SGA} than with gross profitability.

5.2.1. Discussion

Concluding from the empirical results obtained in this section, the higher gross profitability seems to be associated with higher expected returns, highly gross profitable firms earning higher excess returns and significantly higher abnormal returns than those with lower gross profitability. These results are consistent with the findings of Novy-Marx (2013), and consequently I can provide further empirical support for the existence of the gross profitability premium.

Furthermore, I am able to provide some insight on how degree of operating leverage is linked to systematic risk and expected returns. García-Feijóo and Jorgensen (2010), for instance, provides evidence that an elasticity measure of DOL (using EBIT-based value) is the risk factor affecting the level of the B/M ratio. Contrary to García-Feijóo and Jorgensen (2010), I was not able to provide statistically significant results on the association between EBIT-based DOL and expected returns, nonetheless, my data sample being considerably larger than that employed by them and excluding utilities, thus the results likely being reliable. However, if I use a data sample covering the years 1986-2003 similarly to García-Feijóo and Jorgensen (2010), I obtain economically somewhat similar results regarding the Fama-MacBeth risk premia on DOL_{EBIT} as they do, and with similar statistical significance. Importantly, when testing DOL_{EBITDA} with years 1986-2003, it performs considerably better in economical and statistical terms than DOL_{EBIT} in capturing risk (see Table C1 for further details), which is again in agreement with my other results.

Economically these results regarding the association between elasticity measure of DOL and expected returns, nonetheless, are similar to the results of García-Feijóo and Jorgensen (2010) suggesting that individually DOL_{EBIT} (and DOL_{EBITDA}) may be a risk factor, but losing its power completely when adding the value as a control. The indicative results are in line with Carlson et al. (2004) as they predict the risk to increase when a firm operates closer to its break-even point, the firm effectively having higher book-to-market ratio and higher operating leverage, which is linearly related to B/M in their model. And, as the elasticity measures of DOL assign high DOL values for those firms operating in the proximity of their break-even points, along Carlson et al. (2004), it is likely that B/M ratio already captures this risk emanating from low profit margins. So, my results of this section are consistent with the previous literature (Carlson et al., 2004; García-Feijóo and Jorgensen, 2010) stating that elasticity measures of DOL are closely related to the value premium. These results are consistent with my theory that the closeness of the break-even point, causes the risk premium that can be captured by an elasticity measure of DOL. Moreover, the results indicate that GP and elasticity measures of DOL are not positively connected to each other, which is consistent with my theory and ex ante predictions.

Contrary to the elasticity measures of DOL, DOL_{SGA} seems to capture a different risk, as the Fama-MacBeth regressions show economically and statistically significant risk premium for DOL_{SGA} even after controlling for value, size, and momentum. These results appear to be somewhat equivalent to gross profitability. These empirical findings are further supported in four-factor analysis, in which GP sort and DOL_{SGA} sort seems to provide similar excess and abnormal returns for a high-minus-low strategy, thus giving some preliminary insights of the interrelation between these two.

These results, in consonance with the existence of gross profitability premium, cast a serious doubt on the traditional elasticity-based definition of DOL, as fundamentally any firm whose earnings are highly sensitive to changes in sales due to high fixed costs, regardless of the current level of sales, should be riskier than similar firms with less fixed costs. As elasticity measurement approach is highly dependent on the reference point from which the sales and the earnings change, it obviously assigns the highest DOL_{EBITDA} and DOL_{EBIT} values for those firms having the initial earnings close to zero (which is the case at the break-even point), and the opposite values for those firms whose reference earnings are already at a high level regardless of the actual amount of fixed costs. And, as the example in Table 1 showed, the elasticity measurement approach may even assign same DOL estimates for firms that in absolute terms have considerably different earnings sensitivities, just because the proportional changes in sales and earnings are equivalent. According to the results, a more direct proxy for fixed costs to represent the operating leverage, here SGA-to-total book assets, seems to capture the risk intuitively associated with fixed costs better than an indirect proxy.

Drawing from the results of this chapter, I will continue to compare an elasticity-based DOL to a point-to-point measure of DOL when examining the association between DOL and the gross profitability premium, but excluding DOL_{EBIT} from the further tests, as it cannot provide any additional information above DOL_{EBITDA}. The inferior performance of DOL_{EBIT} was predicted ex ante due to its tendency to implicitly include the effect of capital investments.

5.3. DOL and the gross profitability premium

In this section I present the test results on the association between DOL and the gross profitability premium, and how the results are sensitive to the definition of operating leverage. Table 7 exhibits 25 portfolios sorted by using NYSE breakpoints on size and gross profitability. The average monthly returns and average DOL estimates by using different estimation methods are presented for each portfolio. DOL values are based on EBITDA and SGA, additionally I present the book DOL values for each portfolio by following García-Feijóo and Jorgensen (2010) who define book DOL as the five-year-average of the ratio of fixed assets-to-total book assets. Firstly, one can see from Table 7 that returns generally increase with gross profitability, each high-minus-low strategy on gross profitability generating positive, though statistically insignificant, returns across all the size sorts.

Table 7: Quintile portfolio sorts on gross profitability and size

Table presents average monthly returns and operating leverage estimates for 25 portfolios created by sorting stocks on size (at the end of June of year t) and then on gross profitability, which is defined as sales minus cost of goods sold scaled by total book assets (at the end of December of year t-1). Portfolios are constructed by using NYSE breakpoints and rebalanced at the end of each June. Degree of operating leverage (DOL) estimates include EBITDA-based DOL, SGA-based DOL, and book DOL. Tables 2 and D1 describe the construction of DOL estimates in more detail. The data sample extends from 1967 to 2014, and excludes financials and utilities.

Gross profitability quintile	Size quintile					
	Small	2	3	4	Big	All
Panel A: Average monthly returns (%)						
Low	1.77	1.28	1.31	1.22	0.90	1.42
2	1.62	1.46	1.15	1.19	0.98	1.41
3	1.77	1.26	1.23	1.14	1.05	1.43
4	1.82	1.37	1.25	1.12	1.05	1.48
High	2.00	1.50	1.55	1.32	1.14	1.70
All	1.80	1.37	1.31	1.20	1.03	
High-Low	0.24	0.23	0.24	0.10	0.24	0.29
	[1.50]	[1.33]	[1.53]	[0.52]	[1.28]	[1.94]
Panel B: Average DOL_{EBITDA}						
Low	2.87	3.08	2.83	2.62	2.04	2.77
2	2.77	2.43	2.20	1.90	1.61	2.40
3	2.81	2.67	2.06	1.79	1.71	2.44
4	2.83	2.23	1.99	1.80	1.64	2.37
High	3.38	2.55	2.16	1.71	1.37	2.70
All	2.97	2.57	2.25	1.96	1.67	
High-Low	0.51	-0.53	-0.67	-0.92	-0.67	-0.07
	[4.86]	[-4.25]	[-5.43]	[-5.63]	[-4.98]	[-1.06]
Panel C: Average DOL_{SGA}						
Low	0.13	0.08	0.07	0.06	0.07	0.09
2	0.19	0.14	0.13	0.12	0.11	0.15
3	0.25	0.22	0.20	0.18	0.19	0.22
4	0.34	0.31	0.29	0.28	0.28	0.31
High	0.61	0.55	0.54	0.49	0.47	0.56
All	0.33	0.28	0.26	0.24	0.24	
High-Low	0.49	0.47	0.47	0.44	0.40	0.47
	[70.34]	[64.75]	[41.63]	[45.09]	[47.85]	[92.52]
Panel D: Average DOL_{Book}						
Low	0.35	0.41	0.45	0.46	0.42	0.40
2	0.31	0.36	0.37	0.43	0.44	0.36
3	0.28	0.29	0.32	0.34	0.35	0.30
4	0.25	0.25	0.28	0.29	0.32	0.27
High	0.22	0.25	0.29	0.29	0.31	0.25
All	0.28	0.31	0.34	0.36	0.37	
High-Low	-0.13	-0.16	-0.16	-0.17	-0.12	-0.15
	[-24.09]	[-20.13]	[-14.80]	[-19.98]	[-12.59]	[-32.75]

Panel B provides EBITDA-based DOL values for each portfolio, and one can see that those DOL values strongly decrease when gross profitability increases within each size quintile excluding the smallest stocks, hence the result being an exact opposite for the original prediction of DOL causing the gross profitability premium. However, this result just underlines the theory that it is not possible to capture the risk that causes the gross profitability premium with an elasticity-based DOL. The results in Panel D with book DOL are very similar to those obtained by using DOL_{EBITDA}, which is consistent with the findings of the previous literature (see e.g., García-Feijóo and Jorgensen, 2010). But fixed costs affecting the break-even point of a firm and affecting its earnings' sensitivity, include plenty of costs that do not have representation in fixed assets, such as administration related costs. SGA-based proxy for DOL, on the other hand, also considers these fixed costs that are not tied to fixed assets, and which are likely to become even more important as more and more of the firms operate nowadays without considerable fixed manufacturing assets, but merely with only intellectual assets characteristic to the era of information technology. For that reason, it is not a surprise to see in Table 7 DOL_{SGA} values increasing perfectly monotonically within each size sort, while the difference between the extreme GP quintiles being highly significant statistically, the p-values effectively being 0.00.

By following the methodology of García-Feijóo and Jorgensen (2010), I report in Table 8 the results regarding the annual cross-sectional regressions of DOL on GP, thus providing direct evidence that DOL (SGA-based) is directly linked to gross profitability, and DOL_{EBITDA}, based on an elasticity measure, is rather not. Table 8 shows the time-series average of coefficient estimates and corresponding t-statistics.

When regressing DOL_{EBITDA} against GP, the coefficient of GP does not attain economically nor statistically significant values. Interestingly, when controlling for B/M, the economical and statistical significance of GP's coefficient increases dramatically. This might signal that after adding the control for value, effectively the control for the proximity of break-even point (Carlson et al., 2004), further increases in gross profitability are linked to higher sensitivity of earnings to sales. This is in consonance with the fundamental intuition on how operating leverage levers the operations and increases the operational risk, which is that the risk increases either through the cost trade-off channel or increased fixed costs (which may or may not increase the break-even point as well). And, the cost trade-off channel of risk affects the gross profitability and the sensitivity of earnings to sales, which here seems to be captured by

DOL_{EBITDA} after controlling for the risk from low margins. Controlling for size does not affect the results.

Table 8: Firm level regressions of operating leverage measures on gross profitability

Table presents the annual cross-sectional regression results of operating leverage measures (the degree of operating leverage measures are based on 1) EBITDA and 2) SGA expenses) on gross profitability (GP). Book-to-market (B/M) and size (ME) are used as controls. The t-statistics are adjusted for autocorrelation by following Loughran and Schultz (2005). The data sample extends from 1967 to 2014, and excludes financials and utilities.

	Average parameter values and [t-statistics]			
Dependent variable	Intercept	lnGP	lnME	lnB/M
$\ln DOL_{EBITDA}$	0.30	0.07		
	[5.76]	[0.36]		
	0.65	0.03	-0.06	
	[4.70]	[0.19]	[-4.53]	
	0.32	0.32		0.25
	[4.05]	[2.15]		[12.27]
	0.49	0.26	-0.03	0.22
	[2.42]	[2.28]	[-1.19]	[4.87]
$\ln DOL_{SGA}$	-3.04	4.35		
	[-92.88]	[74.03]		
	-2.61	4.30	-0.08	
	[-22.99]	[67.43]	[-12.37]	
	-3.05	4.50		0.13
	[-67.52]	[65.45]		[6.34]
	-2.63	4.33	-0.07	0.03
	[-18.81]	[50.88]	[-9.12]	[1.19]

When switching from DOL_{EBITDA} to DOL_{SGA}, the results change completely, being both economically and statistically highly significant for each of the specifications. To provide an example to stress the link between DOL_{SGA} and GP, think of increasing GP from the median value of 0.38 to the 75th percentile value with GP of 0.54, with the regression coefficient of GP being 4.35, the increase in DOL_{SGA} would be 183 percent. These results as well are robust for adding size as control, but consistent with the previous results of this paper and contrary to regressions of DOL_{EBITDA} on GP, controlling for B/M does not have an impact on these results.

In Table 9 I report results from a four-factor regression analysis, which is augmented by DOL factor. I conduct the analysis by following the example of Kisser (2014), first by sorting the stocks into quintile portfolios on gross profitability by using NYSE breakpoints. The additional factor for DOL is constructed in a similar manner to other controls (Fama and French, 1993;

Carhart, 1997) for both DOL based on EBITDA and DOL based on SGA. The second column reports the value-weighted excess returns to each portfolio, while the third portfolio reports the abnormal returns the employed five-factor model cannot capture. The rest of the columns exhibit the factor loadings for each of the risk factor trying to explain the returns.

Table 9: Excess returns to portfolios sorted on gross profitability (a five-factor model)

Table presents the monthly value-weighted average excess returns to portfolios sorted on gross profitability into quintile portfolios. The table shows also the monthly value-weighted average abnormal returns and returns to the market factor (MKT), the size factor (SMB), the value factor (HML), the momentum factor (UMD), and the operating leverage factor (DOL) from portfolio-wise time-series regressions by following Fama and French (1993), Carhart (1997), and Kisser (2014). The construction of DOL is equivalent to other factors (see *Methodology*), and it is constructed for both EBITDA-based DOL and SGA-based DOL. The t-statistics are presented in square brackets. Portfolios are constructed by using NYSE breakpoints and rebalanced at the end of each June. The data sample extends from 1967 to 2014, and excludes financials and utilities.

		Alphas and five-factor loadings					
Portfolio	r^e	α	MKT	SMB	HML	UMD	DOL
Panel A: DOL factor based on EBITDA							
Low	0.53	-0.09	1.00	-0.02	0.28	-0.03	0.23
	[2.44]	[-0.78]	[22.53]	[-0.27]	[3.24]	[-0.40]	[1.59]
2	0.60	0.08	1.02	-0.06	0.20	-0.11	0.13
	[2.95]	[0.55]	[21.62]	[-0.93]	[2.22]	[-1.01]	[1.07]
3	0.64	0.33	1.02	-0.04	-0.01	-0.07	0.35
	[2.91]	[2.93]	[32.45]	[-0.74]	[-0.22]	[-0.89]	[3.70]
4	0.63	0.33	0.95	-0.09	-0.38	-0.17	0.06
	[2.94]	[2.82]	[25.72]	[-1.73]	[-6.48]	[-2.68]	[0.80]
High	0.64	0.48	0.90	-0.12	-0.45	0.06	-0.33
	[2.98]	[4.03]	[20.20]	[-2.04]	[-6.13]	[0.68]	[-2.96]
High-Low	0.11	0.57	-0.10	-0.10	-0.72	0.09	-0.57
	[0.58]	[3.14]	[-1.27]	[-1.12]	[-6.00]	[0.62]	[-2.64]
Panel B: DOL factor based on SGA							
Low	0.53	0.15	0.93	0.02	-0.08	0.09	-0.48
	[2.44]	[1.55]	[23.77]	[0.41]	[-0.89]	[0.75]	[-8.34]
2	0.60	0.35	0.95	-0.08	-0.16	0.03	-0.67
	[2.95]	[3.80]	[23.50]	[-1.99]	[-2.77]	[0.80]	[-14.78]
3	0.64	0.44	1.03	-0.04	-0.19	-0.04	-0.31
	[2.91]	[3.99]	[37.61]	[-1.13]	[-3.40]	[-0.63]	[-7.18]
4	0.63	0.29	1.01	-0.07	-0.27	-0.05	0.12
	[2.94]	[1.79]	[16.97]	[-1.14]	[-3.62]	[-0.91]	[1.49]
High	0.64	0.32	0.92	-0.13	-0.25	-0.01	0.43
	[2.98]	[2.63]	[18.03]	[-3.14]	[-2.91]	[-0.16]	[7.60]
High-Low	0.11	0.17	0.00	-0.15	-0.17	-0.11	0.91
	[0.58]	[1.31]	[-0.05]	[-2.64]	[-1.44]	[-0.60]	[12.42]

In Panel A the DOL factor is constructed by using DOL_{EBITDA}, and in Panel B by using DOL_{SGA}. First, it is noteworthy that while the excess returns almost monotonically rise in gross profitability, the abnormal returns in Panel A increase monotonically, and the high-minus-low strategy on gross profitability generates 57 basis points of abnormal returns on a monthly basis, meaning that the five-factor model is not very good at capturing the risk and returns that co-exist with gross profitability. Second, and more importantly, the abnormal returns do not increase with GP when using DOL_{SGA} to construct the DOL variable for the model, and the difference between the extreme quintiles being statistically indistinguishable from zero. This result indicates that the five-factor model with the additional SGA-based DOL can price the risk involved in gross profitability. Furthermore, the t-statistic of high-minus-low strategy for DOL factor being the highest (12.42) among the risk factors, which demonstrates significance of the link between the amount of fixed costs and the gross profitability premium. However, similar to Kisser (2014) some of the quintile portfolios in Panel B continue to generate significant abnormal returns even after controlling for DOL. Kisser (2014) mentioned in his paper that this might be due to differing asset risks that cannot be captured by the pricing model, nevertheless, not elaborating those risks in any more detail. However, finding out the reason for such abnormal returns is not in the scope of this study.

Figure 2: Historical cumulative returns on high-minus-low strategies

Figure displays the historical cumulative returns on high-minus-low strategies based on gross profitability, DOL_{SGA}, and DOL_{EBITDA} with the initial investment of $1 between July 1967 and December 2014. The returns are value-weighted monthly returns, and the high portfolio includes the top quintile of stocks regarding the variable of interest, whereas the low portfolio includes the bottom quintile of stocks regarding the same variable. The portfolios are rebalanced at the end of each June. The axis for the high-minus-low strategy based on DOL_{SGA} is on the right hand side of the figure.

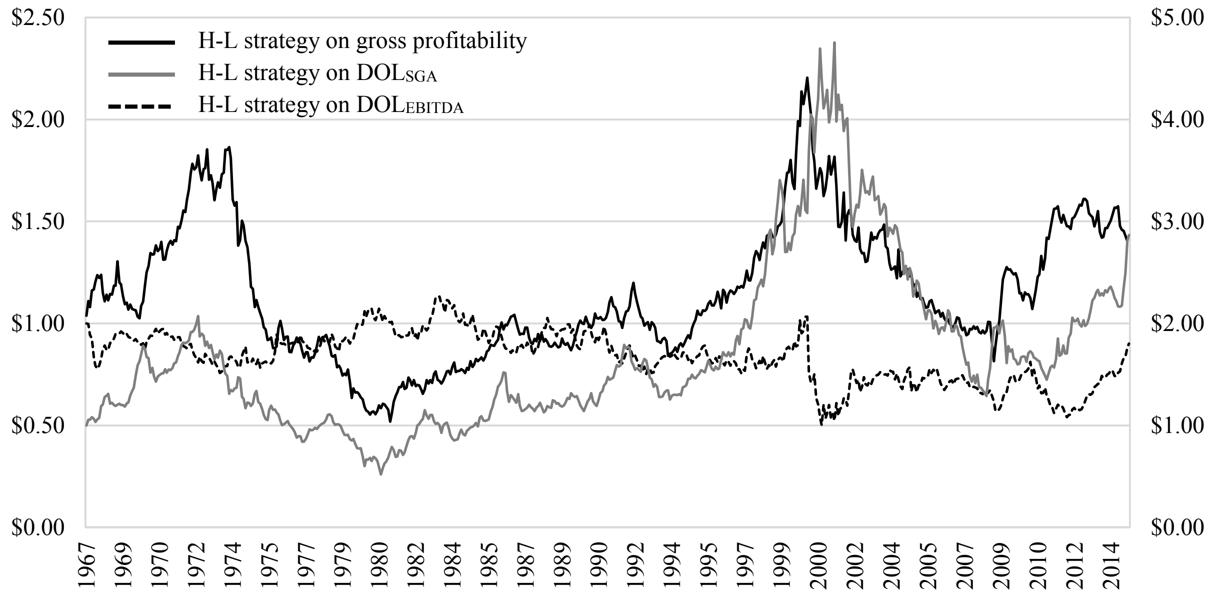


Figure 2 nicely illustrates the results of this section regarding the association between the gross profitability premium and different measures of DOL. Whereas the returns on high-minus-low strategy based on gross profitability and DOL_{SGA} have historically moved together while generating positive cumulative returns, the returns on high-minus-low strategy based on DOL_{EBITDA} have been somewhat flat, and the cumulative returns even being negative. Figure 2 underlines the association between the gross profitability premium and DOL, when using DOL_{SGA} as a proxy, but also shows that its association with an elasticity measure of DOL, when using DOL_{EBITDA} as a proxy, is non-existent. It is also noteworthy, that the cumulative returns on high-minus-low strategy based on DOL_{SGA} are considerably higher than the cumulative returns on the equal strategy employing gross profitability. This observation is in line with the idea of DOL being the real risk factor behind the gross profitability premium – not the gross profitability per se – for which investors require compensation.

5.3.1. Discussion

The results I present in this section unanimously suggest the positive link between DOL and the gross profitability premium and support the hypothesis that DOL is the true risk factor largely determining the gross profitability premium. However, these results are highly method sensitive whether a point-to-point measure with SGA expenses or an elasticity measure measuring the sensitivity of EBITDA to sales is used. The aforementioned results apply only to SGA-based DOL measure, the result being consistent with the findings of Kisser (2014), whilst the link between EBITDA-based DOL and GP seems weak or even negative, as interestingly EBITDA-based DOL increases when gross profitability decreases. In other words, the lowest GP quintile of stocks seems to be associated with the highest DOL_{EBITDA} values. And as gross profitability is defined as sales minus costs of goods sold (i.e., variable costs), the firms in the lowest gross profitability quintile should consequently have the highest variable costs relative to sales. Therefore, it seems that an elasticity measure of DOL is not purely related the actual scale of fixed costs, as the theory of an elasticity measurement approach claims, but merely related to the proximity of the break-even point. Therefore, it is not difficult to see that the value premium, which is related to margins, and thus to break-even point according to Carlson et al. (2004), is positively linked to DOL measured by using an elasticity measurement approach.

As a result, the empirical findings support the hypothesis that the elasticity measures of DOL cannot very well capture the risk fundamentally associated with high operating leverage. It seems that the elasticity measures of DOL only captures the relative sensitivity of earnings to sales without distinguishing where the sensitivity of earnings is originated from (high unit variable cost or fixed costs). Whereas, a non-elasticity measure of DOL, such as SGA-to-AT, describes more directly the actual level of fixed costs, without considering the biasing effect of unit variable cost. If firm A has a high DOL_{SGA}, the information already gives indication that firm A has high fixed costs relative to its operating metrics (such as variable costs and total costs) in a given industry, whereas a firm B with a low DOL_{SGA}, is more likely to actually have lower fixed costs relative to its operating metrics. For that reason, it is likely that firm B is able to better adjust its operations than firm A if sales contract, as a result carrying less risk. Therefore, I can conclude that DOL_{SGA} more directly describes the magnitude of risk emanating from operating leverage through cost trade-off (highly linked to gross profitability), relatively high level of fixed costs, and higher break-even point because of high fixed costs, hence describing the fundamental risks that high fixed costs cause. If firm A, on the other hand, has higher DOL_{EBITDA} than firm B, one could only say that firm A has earnings to be relatively more sensitive to sales than firm B, without giving any hint on the true level of fixed costs, and thus on operating leverage. Furthermore, the existence of the gross profitability premium and its positive linkage with DOL_{SGA}, suggests that investors do care about the relative level of fixed costs and the risks linked to it, and less interested whether the earnings are only relatively sensitive to sales.

Interestingly, if a firm only increased its fixed costs (without affecting the level of its unit variable cost), hence increasing its break-even point, its operating profits would decrease. If the sales stayed on a current level, the risk from decreased margins would be reflected in lower market value of equity, effectively increasing the B/M ratio. Virtually, the increased risk, in this case, would be captured by the value premium. But if sales increased well above the new break-even point, the operating profits surging, the market value of equity would increase so that the value factor could not anymore capture the risk associated with the firm's high fixed costs. And, as there was no cost trade-off between variable and fixed costs, the gross profitability did not change. This logic gives an interesting prediction that operating profitability[3] captures generally the risk related to high fixed costs, whereas the gross profitability premium captures the risk regarding the cost trade-off between variable and fixed operating costs. However, examination of this prediction is not in the scope of this paper.

5.4. DOL and the value premium

In this section I primarily provide insight on the relationship between DOL and the value premium, but understanding this relationship helps also to see the link between DOL and the gross profitability premium and between the gross profitability premium and the value premium. Currently the literature seems to be missing a clear view on the relationships of this triangle as traditionally DOL has been associated with the value premium (see e.g., Carlson et al., 2004; Zhang, 2005; García-Feijóo and Jorgensen, 2010; Novy-Marx, 2011), whereas Kisser (2014) proposes that there is a negative relationship between DOL and the value premium. Also, García-Feijóo and Jorgensen (2010) find similarly to Gulen et al. (2011) that by employing a different methodology to measure the relationship between DOL and the value premium, this particular relationship would be negative. However, the previous literature, including Kisser (2014) has not been able to explain why such differences exist.

In Table 10 I report the average returns and average DOL estimates for different measures of DOL, namely DOL_{EBITDA}, DOL_{SGA}, and DOL_{Book} for 25 portfolios first sorted on gross profitability and then on B/M. First, I aim to show that the risk increasing effect of a high DOL is actually visible in equity values, hence higher risk decreasing the equity values, and consequently increasing B/M ratios. This has been the dominant view of the previous literature, and in Table 10 I show that when controlling for gross profitability, each measure of DOL (excluding the DOL_{Book}) increases in book-to-market ratio, and the differences between the extreme B/M quintiles being generally statistically highly significant. As a result, there appears to be a positive link between DOL and B/M when gross profitability is controlled.

[3] Ball et al. (2015) finds that firms with high operating profitability (defined as gross profit minus sales, general, and administrative expenses excluding research and development costs, and scaled by total book assets) earn higher excess returns compared to firms with low operating profitability.

Table 10: Quintile portfolio sorts on gross profitability and value

Table presents average monthly returns and operating leverage estimates for 25 portfolios created by sorting stocks first on gross profitability, which is defined as sales minus cost of goods sold scaled by total book assets (at the end of December of year t-1) and then on book-to-market (at the end of December of year t-1). Portfolios are constructed by using NYSE breakpoints and rebalanced at the end of each June. Degree of operating leverage (DOL) estimates include EBITDA-based DOL, SGA-based DOL, and book DOL. Tables 2 and D1 describe the construction of DOL estimates in more detail. The data sample extends from 1967 to 2014, and excludes financials and utilities.

B/M quintile	Gross profitability quintile					
	Low	2	3	4	High	All
Panel A: Average monthly returns (%)						
Low	0.94	0.95	0.94	0.98	1.20	1.00
2	1.24	1.17	1.25	1.24	1.39	1.26
3	1.42	1.24	1.43	1.29	1.58	1.39
4	1.53	1.49	1.51	1.63	1.73	1.59
High	1.92	1.86	1.95	1.98	2.13	1.99
All	1.42	1.37	1.47	1.50	1.68	
High-Low	0.98	0.91	1.01	1.01	0.94	0.98
	[4.71]	[4.85]	[6.36]	[4.72]	[4.78]	[6.14]
Panel B: Average DOL_{EBITDA}						
Low	2.37	2.11	2.06	1.84	1.85	2.06
2	2.50	2.09	1.98	1.96	2.06	2.13
3	2.85	2.28	2.24	2.06	2.28	2.33
4	2.99	2.21	2.24	2.40	2.59	2.50
High	3.26	2.83	2.97	3.11	3.86	3.26
All	2.80	2.36	2.39	2.39	2.71	
High-Low	0.89	0.72	0.90	1.27	2.01	1.20
	[7.29]	[5.48]	[7.77]	[9.62]	[14.97]	[14.33]
Panel C: Average DOL_{SGA}						
Low	0.11	0.14	0.20	0.28	0.51	0.26
2	0.08	0.13	0.20	0.28	0.53	0.27
3	0.08	0.14	0.21	0.30	0.54	0.28
4	0.09	0.15	0.22	0.32	0.57	0.30
High	0.10	0.17	0.25	0.36	0.63	0.33
All	0.09	0.15	0.22	0.31	0.57	
High-Low	-0.02	0.04	0.06	0.08	0.12	0.07
	[-3.18]	[8.75]	[14.26]	[27.36]	[14.22]	[20.52]
Panel D: Average DOL_{Book}						
Low	0.36	0.35	0.30	0.27	0.26	0.31
2	0.41	0.38	0.32	0.28	0.26	0.32
3	0.42	0.38	0.31	0.27	0.25	0.32
4	0.43	0.37	0.30	0.26	0.26	0.32
High	0.41	0.35	0.29	0.25	0.25	0.30
All	0.40	0.36	0.30	0.27	0.25	
High-Low	0.05	-0.01	-0.01	-0.02	-0.01	-0.01
	[4.00]	[-0.70]	[-1.45]	[-5.00]	[-1.23]	[-1.82]

Next, I conduct the exactly same analysis but controlling for B/M instead of GP first. Table 11 exhibits the average returns and DOL estimates for each of the 25 portfolios. The results are slightly, but importantly different to those presented in Table 10. I have already showed that high DOL, when using a SGA-based point-to-point measurement, is very much linked to high gross profitability. When examining Panel C of Table 11, one sees that DOL_{SGA} tends to decrease monotonically in B/M, the t-statistic for the difference between the extreme B/M quintiles being -10.04, the result effectively having the p-value of 0.00. This result indicates that the relationship between DOL_{SGA} and the value premium is actually negative in a cross-section, hence the result being consistent with the findings of Kisser (2014). Economically this means that gross profitability has a risk decreasing effect, virtually this reduction in the risk appearing to be greater than the risk increasing effect of increased DOL, hence the total risk seems to go down, thus causing the negative interrelationship between DOL and B/M. Remarkably, this result is not visible for other measures of DOL, whose result patterns do not much change from the previous analysis, thus providing more support for the positive linkage between an elasticity measure of DOL and the value premium, and for the negative linkage between an elasticity measure of DOL and the gross profitability premium.

Table 11: Quintile portfolio sorts on value and gross profitability

Table presents average monthly returns and operating leverage estimates for 25 portfolios created by sorting stocks first on book-to-market (at the end of December of year t-1) and then on gross profitability, which is defined as sales minus cost of goods sold scaled by total book assets (at the end of December of year t-1). Portfolios are constructed by using NYSE breakpoints and rebalanced at the end of each June. Degree of operating leverage (DOL) estimates include EBITDA-based DOL, SGA-based DOL, and book DOL. Tables 2 and D1 describe the construction of DOL estimates in more detail. The data sample extends from 1967 to 2014, and excludes financials and utilities.

B/M quintile	Gross profitability quintile					
	Low	2	3	4	High	All
Panel A: Average monthly returns (%)						
Low	0.88	0.93	1.06	1.14	1.42	1.08
2	1.11	1.13	1.21	1.30	1.51	1.27
3	1.26	1.20	1.40	1.33	1.74	1.42
4	1.50	1.35	1.40	1.61	1.84	1.57
High	1.79	1.71	1.94	2.00	2.08	1.96
All	1.08	1.27	1.42	1.57	1.96	
High-Low	0.91	0.78	0.87	0.86	0.66	0.88
	[3.96]	[3.37]	[3.98]	[4.45]	[3.78]	[4.71]
Panel B: Average DOL_{EBITDA}						
Low	2.25	2.06	1.83	1.84	2.15	2.04
2	2.25	1.85	1.97	2.07	2.28	2.10
3	2.58	2.26	2.12	2.16	2.54	2.36
4	2.97	2.25	2.26	2.41	3.04	2.65
High	3.35	2.88	2.78	3.03	3.82	3.26
All	2.04	2.10	2.36	2.65	3.26	
High-Low	1.10	0.82	0.95	1.19	1.67	1.22
	[6.91]	[7.63]	[8.72]	[11.25]	[12.07]	[15.84]
Panel C: Average DOL_{SGA}						
Low	0.14	0.21	0.29	0.39	0.64	0.35
2	0.10	0.16	0.22	0.31	0.56	0.30
3	0.09	0.15	0.21	0.28	0.52	0.28
4	0.08	0.13	0.19	0.27	0.51	0.27
High	0.08	0.12	0.18	0.27	0.53	0.28
All	0.35	0.30	0.28	0.27	0.28	
High-Low	-0.06	-0.09	-0.11	-0.12	-0.11	-0.07
	[-9.54]	[-12.49]	[-14.63]	[-12.31]	[-7.47]	[-10.04]
Panel D: Average DOL_{Book}						
Low	0.34	0.29	0.28	0.26	0.25	0.29
2	0.38	0.34	0.30	0.27	0.25	0.30
3	0.41	0.38	0.31	0.28	0.26	0.32
4	0.42	0.39	0.33	0.28	0.25	0.32
High	0.40	0.42	0.35	0.29	0.25	0.33
All	0.29	0.30	0.32	0.32	0.33	
High-Low	0.06	0.13	0.08	0.03	0.00	0.04
	[4.47]	[10.15]	[8.65]	[4.19]	[-0.48]	[6.76]

5.4.1. Discussion

The prior literature dominantly provides empirical evidence on the positive association between DOL and the value premium (see e.g., Carlson et al., 2004; Zhang, 2005; García-Feijóo and Jorgensen, 2010; Novy-Marx, 2011). For instance, García-Feijóo and Jorgensen (2010) uses an elasticity measure of DOL in order to examine the relationship, however, this study has shown how such an approach inevitably links their measure of DOL to the value premium. Carlson et al. (2004), on the other hand, define the operating leverage to be in a direct relationship with the B/M, as they define fixed costs to be directly related to the amount of book assets. Their results are empirically aligned with those found by García-Feijóo and Jorgensen (2010) as both approaches are virtually dependent on the size of margins, de facto the proximity of the break-even point. Zhang (2005) finds also analogous evidence that low margins are linked to higher expected earnings. Novy-Marx (2011) finds similar results by using a point-to-point proxy for DOL employing practically total costs-to-total assets as a proxy. However, his results are not very significant in a cross-section contrary to the aforementioned papers. But the reason, why his results indicate to the similar conclusion as the papers by Carlson et al. (2004), Zhang (2005), and García-Feijóo and Jorgensen (2010), might be the biased proxy for DOL including the variable costs as well. As the example of Table 1 shows, the higher total costs may indicate a higher break-even point, thus being exposed to the risk related to low margins, and concluding a positive relationship between DOL and the value premium.

The results I provide in this section are consistent with the previous literature regarding the positive association between certain measures of DOL and the value premium. But when trying to capture directly the actual fixed costs with SGA-based DOL, the results are completely different. Those contradicting results are, even so, very intuitive and consistent with my hypotheses. The results regarding DOL_{SGA} indicate that a higher DOL actually causes additional risk, consequently increasing B/M ratio. But at the same time due to the positive and strong linkage between DOL and profitability, the profitability causes the risk to decrease as firms have higher margins to cope better with economic shocks. Practically, it seems that DOL increases the risk while profitability decreases the risk, the impact from the increase in profitability on risk being greater, which results in lower total risk. However, these firms with high fixed costs and high operating leverages, still have their earnings to be sensitive to changes in sales due to the size of operating leverage, they also have a large part of their cost in a form that cannot be quickly adjusted downwards if a negative market shock arises. And, this extra risk emanating from DOL that cannot be captured by the value factor due to higher valuations, appears to be the risk factor behind the gross profitability premium. This result is consistent with the observation of Novy-Marx (2013), who says that highly gross profitably firms earn significantly higher returns than firms with low profitability even though having higher valuations.

The results of this section also fills in the picture regarding the triangle of relationships between DOL and the value premium, between the gross profitability premium and the value premium, and between DOL and the gross profitability premium exactly as my hypotheses state. Apparently, the missing piece is the definition of the degree of operating leverage, which should be fundamentally concerned about the relative size of fixed costs, and not only be concerned about the current level of operating margins. Importantly, the proximity of break-even point is highly dependent on the actual size of unit variable cost as well, as a firm with a high unit variable cost virtually requires a relatively high quantity of sales in order to cover the fixed costs.

5.5. The gross profitability premium within and across industries

By following the methodology of Novy-Marx (2011), who examines the link between operating leverage and the value premium within and across industries, I present in this section the results regarding whether the gross profitability premium is stronger within industries than across industries. Such a line of research is relevant as the cost structures between industries vary, effectively different industries having different levels of average operating leverage. This variation in cost structures may result in the profitability premium to be stronger within industries than across industries if investors are indifferent to differences in characteristic cost structures across industries, but more concerned about the differences within industries.

Table 12 reports results regarding Fama-MacBeth regressions, showing that intra-industry gross profitability ranking within the firm's industry (parameterized from zero to one) has significant power to predict returns even after controlling for value, size, and momentum. One can interpret the coefficients regarding the intra-industry GP ranking as the difference in required monthly returns between the firms with the highest and the lowest gross profitability ranking within the given industry. Contrarily, the inter-industry GP ranking, defined as the industry ranking of the firm's industry (parameterized from zero to one) does not seem to provide any explanatory power on returns, meaning that there does not seem to be any difference in required returns between the industry with the highest gross profitability and the industry with the lowest gross profitability. These results confirm that the gross profitability premium is strong within industries and seemingly weak across industries.

Table 12: Fama-MacBeth regressions with measures of gross profitability within and across industries

Table reports the results from Fama-MacBeth regressions of firms' returns on gross profitability rankings within and across industries. The within industry ranking is the firm's gross profitability ranking (percentile) within industry, and the industry ranking is the industry's gross profitability ranking (percentile). Logarithms of book-to-market (B/M) and size (ME), and the past returns for one month and one year are used as controls. The data sample extends from 1967 to 2014, and excludes financials and utilities.

	Slope coefficients (x10^2) and [t-statistics] from the regression $r_{tj} = \boldsymbol{\beta}' \boldsymbol{x}_{tj} + e_{tj}$ for intra- and inter-industry measures				
Independent variable	(1)	(2)	(3)	(4)	(5)
lnGP	0.82				
	[4.14]				
Intra-industry GP ranking		0.50		0.25	0.51
		[6.50]		[3.31]	[6.27]
Inter-industry GP ranking			0.13	0.05	0.17
			[0.87]	[0.30]	[1.17]
lnB/M	0.40	0.41	0.36		0.42
	[6.05]	[6.05]	[5.64]		[6.36]
lnME	-0.13	-0.13	-0.13	-0.19	-0.12
	[-3.69]	[-3.68]	[-3.91]	[-5.52]	[-3.63]
$r_{1,0}$	-4.66	-4.62	-4.69	-4.56	-4.73
	[-14.78]	[-14.62]	[-14.98]	[-14.45]	[-15.12]
$r_{12,2}$	0.13	0.15	0.13	0.19	0.12
	[1.17]	[1.27]	[1.15]	[1.69]	[1.05]

Equivalently, to the methodology of Novy-Marx (2011), I further test the priced component related to gross profitability, which seems to be linked to variation in firms' operating leverages within any given industry, while the unpriced component appears to be linked to variations in operating leverages between industries. In order to test those components, I create two distinct portfolio sorts, one based on intra-industry gross profitability and another based on industry gross profitability. The more detailed description regarding the construction of such variables is presented in *Methodology* section.

Table 13: Excess returns to portfolios sorted on gross profitability within and across industries

Table presents the monthly value-weighted average excess returns to portfolios sorted on A) gross profitability within industries and B) industry gross profitability. The table shows also the monthly value-weighted average abnormal returns and returns to the market factor (MKT), the size factor (SMB), the value factor (HML), and the momentum factor (UMD) from portfolio-wise time-series regressions by following Fama and French (1993) and Carhart (1997). The t-statistics are presented in square brackets. The data sample extends from 1967 to 2014, and excludes financials and utilities.

		Alphas and four-factor loadings				
Portfolio	r^e	α	MKT	SMB	HML	UMD
Panel A: Intra-industry portfolios						
Intra-industry GP quintiles						
Low	0,30	-0,04	0,96	0,10	0,24	-0,12
	[6,07]	[-1,18]	[25,65]	[9,67]	[8,07]	[-11,31]
2	0,41	0,13	1,06	-0,03	0,04	-0,04
	[9,80]	[8,14]	[177,08]	[-4,84]	[4,39]	[-5,14]
3	0,49	0,33	0,98	-0,14	-0,13	-0,07
	[10,28]	[11,76]	[107,27]	[-23,92]	[-23,04]	[-4,13]
4	0,61	0,35	0,96	-0,17	-0,15	-0,06
	[15,81]	[15,77]	[118,83]	[-35,72]	[-18,36]	[-7,52]
High	0,48	0,41	0,88	-0,20	-0,24	0,00
	[7,36]	[11,97]	[73,70]	[-9,79]	[-19,56]	[-0,13]
High-Low	0,17	0,45	-0,08	-0,30	-0,47	0,12
	[2,87]	[7,93]	[-2,00]	[-13,19]	[-17,82]	[7,75]
Panel B: Industry portfolios						
Industry GP quintiles						
Low	0.55	0.07	1.01	-0.09	0.28	0.08
	[2.53]	[0.55]	[24.17]	[-1.45]	[3.53]	[1.12]
2	0.74	0.17	1.12	-0.01	0.07	-0.05
	[3.26]	[1.19]	[28.43]	[-0.15]	[0.80]	[-0.82]
3	0.60	0.29	1.03	0.09	-0.37	-0.12
	[2.79]	[1.93]	[24.82]	[1.81]	[-4.39]	[-2.07]
4	0.60	0.22	0.88	-0.02	-0.31	-0.09
	[2.81]	[1.65]	[15.01]	[-0.31]	[-3.56]	[-1.49]
High	0.67	0.39	0.84	-0.12	-0.46	-0.07
	[3.28]	[2.47]	[17.01]	[-1.82]	[-6.70]	[-0.97]
High-Low	0.13	0.32	-0.17	-0.03	-0.74	-0.15
	[0.69]	[1.60]	[-2.41]	[-0.27]	[-6.94]	[-1.34]

Table 13 gives the value-weighted time-series average excess returns, abnormal returns, and loadings of the Carhart four-factor model factors. Panel A displays the regression results for intra-industry sort on gross profitability and Panel B for industry sort on gross profitability. The excess returns for intra-industry sort increase almost monotonically, while the statistical significance between the extreme quintiles is statistically highly significant at 1 percent confidence level. Notably, the abnormal returns increase monotonically, signaling that the component unpriced by the four-factor model grows while moving towards more gross profitable firms within industries. The opposite results apply to Panel B and the industry-sort, in which the difference in excess returns between the industries with the highest gross profitability and the industries with the lowest gross profitability does not statistically differ from zero. Moreover, the difference in abnormal returns for the industry sort is not statistically significant between the high and the low gross profitability industries. However, interestingly the industries belonging to the highest industry gross profitability quintile generate statistically significant monthly alpha of 0.39 percent, while for other quintiles the four-factor model seems to price the risk associated to portfolios well enough not to generate any significant alphas.

5.5.1. Discussion

The value premium, which according to Novy-Marx (2011) appears to be primarily driven by variation in B/M ratios within industries, but not by the variation in B/M ratios across industries. This finding signals that investors are indifferent to differences in B/M ratios when those differences arise from industry characteristics. This section finds similar results regarding the gross profitability premium. As operating leverage appears to be a considerable risk factor behind the gross profitability premium, and there are considerable differences in cost structures across industries, and hence in degrees of operating leverage, it would make sense if the gross profitability premium was more driven by priced differences within industry and not so much driven by the differences across industries. And, this is the direction my results are pointing at. Higher gross profitability premium within given industry predicts higher excess returns, while there is no statistically meaningful difference in excess returns between different industries.

6. Robustness tests

To check the robustness of the results of this paper, I conduct the analyses of this paper by using subperiods of time to examine whether the results are robust in time and whether there are any noteworthy differences. In practice, I divide the main dataset covering the years from 1967 to 2014 into two halves of same length (1967-1990 and 1991-2014) and run the tests employed in this paper for the both datasets by using DOL_{EBITDA} and DOL_{SGA} as proxies for DOL. Selected results regarding the robustness checks are presented in *Appendix B*, while rest of the results are unreported as they are aligned with the main findings, and hence do not provide any further insight.

Most importantly the results of the analyses regarding the two subperiods are in line with the main results indicating the existence of the gross profitability premium, and that DOL (when approximated by using DOL_{SGA}) is the risk factor behind the particular premium within the two subperiods. However, it actually seems that the gross profitability premium has strengthened in time. For example, the high-minus-low strategy on gross profitability has generated considerably higher abnormal returns in the latter period of time both in economic and statistical terms (see Table B3). Simultaneously, risk associated with DOL_{SGA} has strengthened while the risk captured by DOL_{EBITDA} has remained at somewhat same level within the two subperiods of time (see Table B4 and Table B5).

Furthermore, the results show that elasticity measures of DOL (when approximated by using DOL_{EBITDA}) have been merely linked to the value premium over time, while DOL_{SGA} has negatively been linked to book-to-market. Also, the results regarding the gross profitability premium within and across industries are aligned with the main results within the two subperiods.

There are two interesting differences between different periods of time. Firstly, the statistical significance of the risk premium required by investors for being exposed to DOL_{EBITDA} seems to become statistically highly significant in the latter period, while completely lacking (without any controls) of statistical significance in the earlier period of time (see Table B1). However, in economic terms this result is somewhat insignificant. Secondly, DOL_{EBITDA} seems to be more related to gross profitability in the latter time period. Nonetheless, the economical and statistical significance of this result is still far from that of DOL_{SGA}. Consequently, I conclude that the main findings of this paper are robust in time.

7. Conclusion

The gross profitability premium is an anomaly in stock markets found by Novy-Marx (2013), in which highly profitable firms tend to earn higher excess returns than firms with low profitability. The prior literature finds it hard to reconcile this anomaly from a rational risk-based view, as profitable firms should be better positioned to cope with negative market shocks than those with a low profitability. Kisser (2014) proposes that operating leverage, which is traditionally defined as the proportion of fixed costs to variable costs, causes the gross profitability premium. However, he could not explain why his approach of measuring DOL can explain the profitability premium and has simultaneously negative correlation with the value premium, whereas the plethora of prior research suggests the exact opposite, hence not providing a robust proof whether DOL causes the gross profitability premium.

My paper answers to these questions, and provides explanation why different methods of approximating DOL either can or cannot explain the gross profitability premium, and why the sign of the correlation between DOL and the value premium appears to be sensitive to approach to create a proxy for DOL, and whether DOL really causes the gross profitability premium. For that reason, it is crucial to understand how operating leverage affects firms' risk characteristics, and hence how the proxy for operating leverage should behave.

Fundamentally operating leverage should describe the operational leverage of a firm, which boosts the operating profits once sales are above the break-even point, but limits the firm's operational flexibility when sales are low as fixed costs do have much lower beta than revenues have, effectively being zero when a short enough period of time is considered. Thus, operating leverage should affect the operational risk of a firm via the following channels: Cost trade-off from variable costs to fixed costs increasing the absolute sensitivity of earnings to sales, higher break-even point, and higher fixed costs in absolute terms. Even though higher operating leverage increases risk, it enables high profitability as well. A firm may have a high gross profitability if it prefers to have low variable costs but relatively higher fixed costs, hence it seems that gross profitability is merely linked to cost trade-off. But operating leverage may increase the risk also by increasing the amount of fixed costs in a way that variable unit cost remains the same. Here the gross profitability does not change, even though incremental fixed costs (such as additional sales force) are introduced, but if the sales rise well above the break-even point, boosting the operating margins, then the firm enjoys high operating profitability. This intuition gives an interesting prediction that gross profitability premium and the operating profitability premium (empirically recognized by Ball et al., 2015) are caused by the different channels of operating leverage affecting the operational risk. But this prediction is left for further research.

To complement the previous reasoning the gross profitability premium should accrue for high DOL firms that are highly gross profitable, i.e., they have relatively low variable costs, but they are operationally profitable enough to have such high valuations leading to lower book-to-market ratios. And as the B/M ratios are at a relatively low level, the risk emanating from high DOL cannot be captured by the value premium, but the gross profitability premium.

My paper provides strong empirical support for the aforementioned intuition of the gross profitability premium being caused in general by the degree of operating leverage. First, I confirm that the measure of DOL proposed by Kisser (2014) captures much of the same risk as gross profitability. Second, I show that gross profitable companies have considerably higher levels of operating leverage than their less gross profitable peers. Third, I confirm the direct link between DOL and the gross profitability, hence concluding that the empirical evidence supports the hypothesis that operating leverage is the primary risk factor behind the observed gross profitability premium. Furthermore, I show that this particular link is highly sensitive to how DOL is understood and how the proxy is constructed as fixed costs are not directly observable. These findings will explain why the literature has a controversial view regarding the triangle of relationship between DOL, the gross profitability premium, and the value premium.

The intuition behind DOL affecting the risk and simultaneously enabling high profitability is obvious, but difficulties arise when one needs to measure the degree of operating leverage, as the clean amount of fixed costs is not available. Consequently, a method to approximate DOL is required. Furthermore, as this paper shows, the choice of an approach to measure DOL has a high significance on the results, which seems to be the missing piece why the prior literature has not been able to link the gross profitability premium to risk-based explanations convincingly.

The traditional elasticity-based definition of DOL, a flow measure of sales and earnings, appears not to be purely linked to the relation of fixed and variable operating costs, but to the margins, i.e., the closer a firm operates to its break-even point the higher is its elasticity measure of DOL. Notably, margins do depend on both the variable and the fixed costs, thus enabling a high elasticity measure of DOL for a firm with low fixed costs and extremely high variable costs, effectively causing a low profit margin. This particular firm then operates close to its break-even point, which means that earnings may be highly sensitive to changes in sales when just operating above the zero earnings. Well, this description contradicts with the fundamental idea of DOL, in which fixed costs are relatively large, for instance, compared to variable costs. Hence, it appears intuitively and empirically confirmed in this paper, that an elasticity measure of DOL is strongly related to operating margins, regardless whether the proximity of margins is due to high unit variable cost or high fixed costs. My empirical findings confirm that with an elasticity measure of DOL it is not possible to explain the gross profitability premium as it does not seem to capture the absolute sensitivity of earnings arising from higher proportion of fixed costs relative to variable costs (cost trade-off) nor the risk of having a greater proportion of total costs as fixed, and hence having a large part of costs not well adaptable for negative changes in the market. Therefore, a DOL measure, which is independent of the level of sales, the level of unit variable cost, the level of margins, and the proximity of the break-even point should be able to capture the risk emanating from relatively high fixed costs, thus from relatively high degree of operating leverage.

When approximating the relative size of fixed costs and DOL by using a direct approach that is not biased by the aforementioned defects, my predictions regarding the risk fundamentally associated with operating leverage and regarding the association between operating leverage and the gross profitability premium can be confirmed. As such an approximation approach I use the measure of DOL proposed by Kisser (2014), which is sales, general, and administration expenses (SGA) relative to total book assets (AT). Empirically, SGA/AT seems to describe the risk associated with the relatively high fixed costs better than any other currently available approach, thus representing the true degree of operating leverage somewhat well. This discussion suggests that the definition of DOL, and its implications on constructing a proxy for it, need to be considerably reconsidered and unified in the literature.

Furthermore, my research makes a contribution to explain the triangle of relationships between DOL, the gross profitability premium, and the value premium. The previous literature possesses an inconsistent view regarding the correlations between those three. Novy-Marx (2013) finds evidence of the negative correlation between gross profitability (GP) and the value premium, and number of research report the positive association between DOL and the value premium. Kisser (2014), on the other hand, finds a negative relation between GP and the value premium, while providing support on the positive link between his measure of DOL and the gross profitability premium. I provide evidence that examination of these relationships is sensitive to the choice of a method to approximate DOL. An elasticity measure of DOL explains why the previous literature has linked the value premium and DOL, as their DOL captures the risk of low margins as the B/M ratio does. Whereas the DOL based on fixed costs explain the negative relationship between DOL and the value premium, as it enables high profitability, which in effect, decreases B/M ratios, causing a negative relationship between those two.

Finally, I provide evidence that similarly to the characteristics of the value premium, the gross profitability premium is also stronger within industries than across industries, as cost structures vary between industries and investors seem to be indifferent to these differences.

By unraveling the true cause of the gross profitability premium, both in academic and economic terms this paper provides an interesting basis for researching and constructing new investment strategies that employ DOL as a risk factor instead of gross profitability. Especially, as the association between DOL and the value premium is negative, the setting is established for examining strategies that capture the value premium, but also capture the risk of high DOL simultaneously without increasing the overall risk.

Appendix A – Data sample characteristics

Table A1: Annual sample characteristics for low (high) gross profitability firms

Table displays average annual values of gross profitability (GP), book-to-market (B/M), market equity (ME), degrees of operating leverage based on earnings before interest, taxes, depreciation and amortization (EBITDA), earnings before interest and taxes (EBIT), and sales, general, and administrative expenses (SGA) for low (high) gross profitability portfolios. Portfolios are constructed by using NYSE breakpoints and rebalanced at the end of each June. See Table D1 for DOL definitions. Summary statistics are for the time period starting in January 1967 and ending in December 2014. Financials and utilities are excluded from the sample. The sample consists of 4,407 firms and 724,324 monthly observations.

	GP		B/M		ME ($\$10^6$)		DOL_{EBITDA}		DOL_{EBIT}		DOL_{SGA}		Number
Year	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	of firms
1967	0.23	0.87	0.90	0.87	179	139	2.50	2.20	2.71	2.70	0.15	0.66	107
1968	0.17	0.81	0.71	0.46	354	433	2.07	1.62	2.84	1.92	0.09	0.58	836
1969	0.17	0.81	0.56	0.37	354	568	1.62	1.55	2.46	1.84	0.08	0.57	891
1970	0.17	0.79	0.91	0.51	239	464	1.98	1.71	2.90	2.12	0.09	0.56	928
1971	0.15	0.78	1.15	0.60	298	643	2.46	1.86	3.17	2.27	0.09	0.57	972
1972	0.15	0.75	1.11	0.59	287	729	2.21	2.01	3.34	2.56	0.10	0.56	1,030
1973	0.17	0.75	1.16	0.65	270	685	2.34	1.95	3.58	2.46	0.09	0.54	1,099
1974	0.19	0.74	1.77	1.35	235	521	2.08	1.93	3.03	2.45	0.09	0.53	1,220
1975	0.19	0.75	2.81	1.96	209	422	2.29	2.16	3.31	2.75	0.11	0.55	1,265
1976	0.18	0.79	2.14	1.34	274	444	1.91	1.98	2.80	2.48	0.11	0.58	1,269
1977	0.20	0.82	1.60	1.12	308	363	2.05	2.26	2.86	2.81	0.10	0.60	1,305
1978	0.20	0.81	1.50	1.12	319	373	2.22	2.31	3.15	2.79	0.10	0.59	1,301
1979	0.20	0.80	1.44	1.11	484	376	2.13	2.57	2.93	3.11	0.10	0.58	1,294
1980	0.21	0.80	1.26	0.99	444	357	2.08	2.18	2.92	2.69	0.10	0.58	1,354
1981	0.19	0.80	1.17	0.95	509	489	2.20	2.05	3.03	2.49	0.10	0.59	1,310
1982	0.19	0.82	1.30	0.96	434	477	2.26	2.23	3.31	2.66	0.11	0.60	1,259
1983	0.16	0.81	1.21	0.77	560	820	2.52	2.07	4.51	2.68	0.11	0.61	1,223
1984	0.15	0.82	0.99	0.63	536	830	2.63	2.20	5.06	2.97	0.10	0.61	1,189
1985	0.16	0.82	1.17	0.71	625	947	2.76	2.35	5.39	3.21	0.10	0.62	1,146
1986	0.15	0.80	1.04	0.57	628	1,204	3.21	2.50	5.81	3.44	0.10	0.60	1,145
1987	0.11	0.79	1.11	0.59	1,011	1,047	3.17	2.57	5.26	3.61	0.09	0.60	1,095
1988	0.13	0.80	1.14	0.66	813	1,142	3.16	2.13	4.45	2.98	0.09	0.60	1,118
1989	0.12	0.81	0.97	0.58	1,107	1,219	3.27	2.52	4.30	3.67	0.10	0.62	1,153
1990	0.14	0.81	0.88	0.55	1,561	1,571	2.90	2.07	4.35	2.96	0.10	0.61	1,139
1991	0.13	0.80	1.23	0.80	1,280	1,626	2.51	2.47	3.66	3.47	0.09	0.61	1,259
1992	0.11	0.80	1.00	0.56	1,489	1,896	2.92	2.57	4.52	3.73	0.09	0.61	1,343
1993	0.11	0.80	0.98	0.50	1,699	1,537	3.23	2.65	5.34	3.67	0.08	0.60	1,391
1994	0.11	0.79	0.75	0.49	2,040	1,447	3.41	3.09	5.83	4.39	0.09	0.60	1,407
1995	0.10	0.76	0.84	0.51	2,409	2,219	3.05	2.90	5.68	4.18	0.08	0.56	1,432
1996	0.11	0.76	0.75	0.52	2,659	2,693	2.97	2.89	5.45	4.07	0.08	0.56	1,437
1997	0.11	0.75	0.72	0.49	3,312	4,148	2.65	2.46	4.74	3.68	0.07	0.55	1,495
1998	0.11	0.76	0.67	0.42	4,781	6,202	2.64	2.73	3.69	3.55	0.08	0.56	1,507
1999	0.08	0.74	0.93	0.47	5,574	7,322	3.14	2.65	4.88	3.52	0.08	0.54	1,491
2000	0.09	0.75	0.96	0.53	4,537	7,109	2.73	3.36	4.98	4.31	0.07	0.55	1,476
2001	0.11	0.76	1.26	0.74	4,700	6,035	2.87	3.16	4.22	4.62	0.10	0.56	1,588
2002	0.10	0.73	1.06	0.64	4,136	4,684	3.21	3.21	4.86	4.54	0.10	0.57	1,626
2003	0.08	0.71	1.13	0.75	4,335	4,732	3.44	3.39	5.21	4.70	0.09	0.55	1,621
2004	0.09	0.67	0.74	0.45	4,193	5,121	3.17	3.36	5.73	5.00	0.09	0.52	1,666
2005	0.11	0.69	0.65	0.42	5,203	4,346	3.14	3.60	5.47	4.92	0.09	0.52	1,651
2006	0.10	0.70	0.69	0.43	5,389	6,035	2.86	3.56	4.79	5.19	0.09	0.52	1,598
2007	0.12	0.69	0.68	0.41	7,434	6,755	2.92	3.65	5.01	5.16	0.10	0.51	1,521
2008	0.10	0.70	0.77	0.50	7,143	5,876	3.32	3.55	4.98	4.97	0.10	0.51	1,473
2009	0.07	0.72	1.61	0.97	4,224	5,071	4.76	3.90	6.79	5.68	0.11	0.54	1,511
2010	0.07	0.69	0.90	0.57	6,365	4,924	3.55	3.79	5.74	5.60	0.09	0.53	1,497

2011	0.09	0.69	0.80	0.50	7,696	5,621	3.65	4.21	5.52	6.90	0.08	0.50	1,486
2012	0.08	0.68	1.12	0.57	6,167	6,388	2.95	4.15	5.07	6.38	0.09	0.50	1,491
2013	0.05	0.68	1.08	0.55	7,826	6,731	3.02	3.80	5.24	6.28	0.09	0.51	1,478
2014	0.05	0.62	1.02	0.44	7,552	7,731	4.15	3.84	7.44	5.68	0.10	0.46	1,263
Average	0.13	0.76	1.09	0.69	2,587	2,761	2.80	2.71	4.42	3.75	0.09	0.57	1,299

Table A2: Industry-wise sample characteristics

Table displays time-series averages of industry characteristics including gross profitability (GP), book-to-market (B/M), market equity (ME), degrees of operating leverage based on earnings before interest, taxes, depreciation and amortization (EBITDA), earnings before interest and taxes (EBIT), and sales, general, and administrative expenses (SGA). See Table D1 for DOL definitions. Summary statistics are for the time period starting in January 1967 and ending in December 2014. Industries are based on the classification of Fama and French (1997). Financials and utilities are excluded from the sample. The total sample consists of 4,407 firms and 724,324 monthly observations. 28 firms have no identifiable industry within the classification of Fama and French (1997), and are thus excluded from the table.

Code	Industry	GP	B/M	ME ($\$10^6$)	DOL_{EBITDA}	DOL_{EBIT}	DOL_{SGA}	Number of firms
1	Agriculture	0.26	0.83	2,441	2.75	4.01	0.17	16
2	Food products	0.51	0.89	2,098	2.61	3.93	0.35	127
3	Candy and soda	0.55	0.64	11,471	1.31	1.73	0.37	23
4	Beer and liquor	0.43	0.71	9,455	1.64	2.17	0.28	27
5	Tobacco products	0.32	0.87	19,398	2.09	3.13	0.24	9
6	Recreation	0.49	1.05	461	3.28	4.46	0.36	60
7	Entertainment	0.27	0.95	1,484	2.23	3.53	0.16	79
8	Printing and publishing	0.49	0.79	972	1.98	2.71	0.34	42
9	Consumer goods	0.58	0.90	2,925	2.41	3.30	0.42	103
10	Apparel	0.53	1.12	730	2.76	3.58	0.38	95
11	Healthcare	0.35	0.77	968	2.15	2.81	0.27	104
12	Medical equipment	0.47	0.58	1,438	2.43	3.14	0.36	155
13	Pharmaceutical products	0.43	0.43	11,037	1.97	2.46	0.38	177
14	Chemicals	0.40	0.74	2,858	1.86	3.04	0.25	112
15	Rubber and plastic	0.40	0.97	332	1.86	2.51	0.24	70
16	Textiles	0.34	1.68	303	2.66	4.32	0.20	45
17	Construction materials	0.36	1.06	706	2.21	3.55	0.22	151
18	Construction	0.20	1.12	887	2.77	3.49	0.13	63
19	Steel works	0.25	1.13	1,966	2.73	4.78	0.11	102
20	Fabricated products	0.33	1.15	124	2.14	3.16	0.20	21
21	Machinery	0.40	0.89	1,298	2.53	3.60	0.26	228
22	Electrical equipment	0.41	0.81	1,477	2.22	3.13	0.28	89
23	Automobiles and trucks	0.36	0.94	3,538	2.30	3.46	0.21	87
24	Aircraft	0.29	1.01	3,097	2.73	3.83	0.17	41
25	Shipbuilding and railroad equipment	0.29	0.92	513	1.91	2.25	0.15	12
26	Defense	0.27	0.74	2,981	2.42	3.04	0.14	8
27	Precious metals	0.12	0.60	3,816	4.70	7.15	0.05	38
28	Non-metallic and industrial mining	0.20	0.83	8,247	3.05	4.14	0.08	35
29	Coal	0.19	0.70	3,074	1.45	5.05	0.05	10
30	Petroleum and natural	0.23	0.78	9,104	2.16	4.22	0.08	284
33	Personal services	0.40	0.96	943	2.44	3.34	0.26	54
34	Business services	0.46	0.71	3,593	2.92	4.16	0.36	528
35	Computers	0.48	0.66	4,729	3.67	5.24	0.38	192
36	Electronic equipment	0.38	0.83	2,978	3.31	5.21	0.27	315
37	Measuring and control	0.47	0.74	1,163	3.11	4.14	0.35	135
38	Business supplies	0.42	0.90	2,308	2.19	3.52	0.26	84
39	Shipping containers	0.31	1.09	584	1.98	2.94	0.15	24
41	Wholesale	0.46	1.04	780	2.19	3.08	0.33	217
42	Retail	0.71	0.99	2,868	3.31	5.14	0.56	313
43	Restaurants, hotels, and motels	0.30	0.82	2,107	2.08	3.33	0.14	104

Appendix B – Subperiod analysis

Table B1: Fama-MacBeth regressions employing gross profitability and EBITDA-based DOL

Table reports the results from Fama-MacBeth regressions of firms' returns on gross profitability (GP), which is sales minus cost of goods sold scaled by total book assets (AT), and EBITDA-based degree of operating leverage (DOL_{EBITDA}) – see Table D1 for the description. Logarithms of book-to-market (B/M) and size (ME), and the past returns for one month and one year are used as controls. The data sample covers A) 1967-1990 and B) 1991-2014. Financials and utilities are excluded from the sample.

	Slope coefficients (x10[2]) and [t-statistics] from the regression $r_{tj} = \boldsymbol{\beta}' \boldsymbol{x}_{tj} + e_{tj}$,					
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Fama-MacBeth regressions using DOL_{EBITDA} (1967-1990)						
DOL	0.00		-0.02		0.00	-0.02
	[0.08]		[-1.54]		[0.17]	[-1.46]
GP		0.29		0.60	0.30	0.61
		[1.66]		[3.56]	[1.68]	[3.55]
lnB/M			0.41	0.47		0.47
			[4.19]	[4.77]		[4.73]
lnME			-0.13	-0.12		-0.13
			[-2.4]	[-2.28]		[-2.31]
$r_{1,0}$			-6.9	-7.04		-7.04
			[-14.24]	[-14.58]		[-14.57]
$r_{12,2}$			0.35	0.29		0.29
			[1.68]	[1.45]		[1.43]
Panel B: Fama-MacBeth regressions using DOL_{EBITDA} (1991-2014)						
DOL	0.03		0.01		0.03	0.01
	[3.02]		[1.34]		[2.99]	[1.19]
GP		0.36		0.48	0.35	0.48
		[1.95]		[2.61]	[1.89]	[2.58]
lnB/M			0.28	0.34		0.33
			[3.25]	[3.76]		[3.71]
lnME			-0.14	-0.13		-0.13
			[-3.36]	[-3.04]		[-3.03]
$r_{1,0}$			-2.20	-2.22		-2.22
			[-6.30]	[-6.37]		[-6.40]
$r_{12,2}$			-0.04	-0.03		-0.03
			[-0.34]	[-0.31]		[-0.32]

Table B2: Fama-MacBeth regressions employing gross profitability and SGA-based DOL

Table reports the results from Fama-MacBeth regressions of firms' returns on gross profitability (GP), which is sales minus cost of goods sold scaled by total book assets (AT), and the degree of operating leverage based on sales, general, and administrative expenses (DOL_{SGA}) – see Table D1 for the description. Logarithms of book-to-market (B/M) and size (ME), and the past returns for one month and one year are used as controls. The data sample covers A) 1967-1990 and B) 1991-2014. Financials and utilities are excluded from the sample.

	Slope coefficients (x10^2) and [t-statistics] from the regression $r_{tj} = \boldsymbol{\beta}' \boldsymbol{x}_{tj} + e_{tj}$,					
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Fama-MacBeth regressions using DOL_{SGA} (1967-1990)						
DOL	0.57		0.60		0.82	-1.59
	[2.75]		[3.13]		[1.14]	[-3.24]
GP		0.29		0.60	-0.30	2.09
		[1.66]		[3.56]	[-0.46]	[4.36]
lnB/M			0.47	0.47		0.57
			[4.82]	[4.77]		[5.50]
lnME			-0.11	-0.12		-0.13
			[-2.01]	[-2.28]		[-2.42]
$r_{1,0}$			-7.16	-7.04		-7.19
			[-14.40]	[-14.58]		[-14.38]
$r_{12,2}$			0.30	0.29		0.27
			[1.48]	[1.45]		[1.37]
Panel B: Fama-MacBeth regressions using DOL_{SGA} (1991-2014)						
DOL	0.87		0.73		2.04	0.60
	[3.03]		[2.88]		[3.02]	[1.08]
GP		0.36		0.48	-1.15	0.13
		[1.95]		[2.61]	[-2.27]	[0.29]
lnB/M			0.33	0.34		0.33
			[3.93]	[3.76]		[3.65]
lnME			-0.12	-0.13		-0.12
			[-2.95]	[-3.04]		[-3.12]
$r_{1,0}$			-2.33	-2.22		-2.35
			[-6.12]	[-6.37]		[-6.22]
$r_{12,2}$			-0.09	-0.03		-0.09
			[-0.73]	[-0.31]		[-0.71]

Table B3: Excess returns to portfolios sorted on gross profitability

Table presents the monthly value-weighted average excess returns to portfolios sorted on gross profitability, defined as sales minus cost of goods sold (COGS) to total book assets (AT). The table shows also the monthly value-weighted average abnormal returns and returns to the market factor (MKT), the size factor (SMB), the value factor (HML), and the momentum factor (UMD) from portfolio-wise time-series regressions by following Fama and French (1993) and Carhart (1997). The t-statistics are presented in square brackets. Portfolios are constructed by using NYSE breakpoints and rebalanced at the end of each June. The data sample covers A) 1967-1990 and B) 1991-2014. Financials and utilities are excluded from the sample.

		Alphas and four-factor loadings				
Portfolio	r^e	α	MKT	SMB	HML	UMD
Panel A: Portfolios sorted on gross profitability (1967-1990)						
Low	0.39	-0.03	1.14	0.05	0.38	0.17
	[1.16]	[-0.19]	[22.95]	[0.61]	[3.87]	[1.45]
2	0.52	0.17	1.07	-0.11	0.30	0.10
	[1.65]	[1.02]	[20.11]	[-1.59]	[3.09]	[1.10]
3	0.54	0.34	1.04	0.05	-0.11	0.07
	[1.54]	[2.93]	[23.71]	[0.82]	[-1.42]	[0.85]
4	0.37	0.17	0.97	-0.05	-0.40	-0.05
	[1.08]	[1.24]	[35.14]	[-0.72]	[-5.48]	[-0.73]
High	0.51	0.42	0.82	-0.10	-0.49	-0.04
	[1.62]	[2.42]	[14.28]	[-1.22]	[-4.10]	[-0.47]
High-Low	0.11	0.45	-0.32	-0.15	-0.87	-0.21
	[0.42]	[1.58]	[-3.44]	[-1.38]	[-6.26]	[-1.40]
Panel B: Portfolios sorted on gross profitability (1991-2014)						
Low	0.68	-0.16	0.94	-0.02	0.22	-0.05
	[2.42]	[-0.90]	[13.23]	[-0.28]	[1.95]	[-0.48]
2	0.67	-0.03	1.07	-0.05	0.19	-0.13
	[2.60]	[-0.12]	[16.74]	[-0.55]	[1.36]	[-1.10]
3	0.73	0.15	1.14	-0.05	0.09	-0.11
	[2.74]	[0.90]	[22.58]	[-0.66]	[1.27]	[-1.27]
4	0.89	0.56	1.03	-0.17	-0.24	-0.21
	[3.50]	[2.72]	[11.58]	[-2.98]	[-2.41]	[-3.15]
High	0.78	0.60	0.77	-0.19	-0.54	-0.05
	[2.57]	[2.81]	[9.33]	[-2.28]	[-6.35]	[-0.70]
High-Low	0.11	0.76	-0.18	-0.16	-0.76	0.00
	[0.40]	[2.89]	[-1.54]	[-1.19]	[-5.21]	[-0.01]

Table B4: Excess returns to portfolios sorted on EBITDA-based DOL

Table presents the monthly value-weighted average excess returns to portfolios sorted on degree of operating leverage based on EBITDA (DOL_{EBITDA}) – see Table D1 for the description. The table shows also the monthly value-weighted average abnormal returns and returns to the market factor (MKT), the size factor (SMB), the value factor (HML), and the momentum factor (UMD) from portfolio-wise time-series regressions by following Fama and French (1993) and Carhart (1997). The t-statistics are presented in square brackets. Portfolios are constructed by using NYSE breakpoints and rebalanced at the end of each June. The data sample covers A) 1967-1990 and B) 1991-2014. Financials and utilities are excluded from the sample.

		Alphas and four-factor loadings				
Portfolio	r^e	α	MKT	SMB	HML	UMD
Panel A: Portfolios sorted on DOL_{EBITDA} (1967-1990)						
Low	0.59	0.34	0.92	-0.06	-0.20	0.09
	[1.81]	[2.56]	[32.56]	[-1.15]	[-3.07]	[1.79]
2	0.42	0.26	0.98	-0.15	-0.09	0.03
	[1.38]	[2.38]	[36.98]	[-2.64]	[-0.78]	[0.49]
3	0.41	0.29	0.96	-0.04	-0.14	0.12
	[1.26]	[1.97]	[19.62]	[-0.52]	[-1.63]	[1.49]
4	0.41	0.13	1.03	0.01	0.04	-0.04
	[1.23]	[0.86]	[29.03]	[0.20]	[0.58]	[-0.46]
High	0.57	0.19	1.06	0.10	0.05	-0.17
	[1.69]	[1.21]	[21.19]	[0.95]	[0.42]	[-1.40]
High-Low	-0.02	-0.15	0.14	0.16	0.26	-0.25
	[-0.13]	[-0.78]	[2.40]	[1.21]	[1.53]	[-1.95]
Panel B: Portfolios sorted on DOL_{EBITDA} (1991-2014)						
Low	0.70	0.32	0.86	-0.17	-0.17	-0.15
	[2.44]	[1.22]	[10.96]	[-1.96]	[-1.47]	[-1.64]
2	0.70	0.25	1.02	-0.27	-0.14	-0.05
	[2.64]	[1.28]	[13.39]	[-4.58]	[-1.57]	[-0.98]
3	0.85	0.36	0.93	-0.07	-0.05	-0.16
	[3.37]	[1.87]	[14.61]	[-1.33]	[-0.40]	[-1.59]
4	0.79	0.09	1.09	-0.03	-0.12	-0.21
	[3.15]	[0.50]	[18.99]	[-0.65]	[-1.74]	[-3.11]
High	0.87	0.30	1.07	0.15	-0.09	-0.04
	[3.15]	[2.06]	[17.15]	[2.33]	[-0.80]	[-0.39]
High-Low	0.18	-0.02	0.20	0.32	0.08	0.11
	[0.71]	[-0.07]	[1.96]	[3.69]	[0.51]	[0.76]

Table B5: Excess returns to portfolios sorted on SGA-based DOL

Table presents the monthly value-weighted average excess returns to portfolios sorted on degree of operating leverage based on sales, general, and administrative expenses (DOL_{SGA}) – see Table D1 for the description. The table shows also the monthly value-weighted average abnormal returns and returns to the market factor (MKT), the size factor (SMB), the value factor (HML), and the momentum factor (UMD) from portfolio-wise time-series regressions by following Fama and French (1993) and Carhart (1997). The t-statistics are presented in square brackets. Portfolios are constructed by using NYSE breakpoints and rebalanced at the end of each June. The data sample covers A) 1967-1990 and B) 1991-2014. Financials and utilities are excluded from the sample.

		Alphas and four-factor loadings				
Portfolio	r^e	α	MKT	SMB	HML	UMD
Panel A: Portfolios sorted on DOL_{SGA} (1967-1990)						
Low	0.45	0.15	1.06	-0.09	0.40	0.20
	[1.40]	[0.69]	[20.12]	[-0.89]	[2.83]	[1.51]
2	0.57	0.20	1.11	-0.08	0.11	-0.04
	[1.61]	[1.70]	[35.60]	[-1.34]	[1.28]	[-0.63]
3	0.49	0.14	1.03	0.07	-0.24	0.05
	[1.36]	[1.40]	[24.66]	[1.20]	[-2.96]	[0.97]
4	0.31	0.28	0.83	-0.04	-0.54	-0.17
	[0.96]	[1.37]	[15.05]	[-0.35]	[-6.63]	[-1.96]
High	0.67	0.40	0.87	-0.09	-0.41	0.06
	[2.09]	[2.80]	[21.05]	[-1.22]	[-3.28]	[0.53]
High-Low	0.22	0.25	-0.18	0.00	-0.81	-0.14
	[0.69]	[0.77]	[-2.36]	[-0.04]	[-4.39]	[-0.73]
Panel B: Portfolios sorted on DOL_{SGA} (1991-2014)						
Low	0.40	-0.33	1.20	-0.08	0.33	-0.20
	[1.14]	[-1.34]	[16.79]	[-0.86]	[1.61]	[-1.44]
2	0.79	0.20	1.07	-0.16	0.16	-0.16
	[3.73]	[1.07]	[13.83]	[-1.75]	[1.43]	[-1.22]
3	0.84	0.32	0.97	-0.04	-0.30	-0.08
	[2.92]	[1.36]	[19.67]	[-0.71]	[-3.23]	[-1.17]
4	0.83	0.55	0.97	-0.09	-0.27	-0.20
	[2.89]	[2.92]	[9.03]	[-1.28]	[-2.20]	[-3.52]
High	0.85	0.61	0.78	-0.21	-0.49	0.02
	[3.01]	[2.39]	[12.78]	[-2.90]	[-4.32]	[0.18]
High-Low	0.45	0.94	-0.42	-0.13	-0.82	0.22
	[1.20]	[2.86]	[-4.10]	[-0.93]	[-3.44]	[1.03]

Table B6: Firm level regressions of operating leverage measures on gross profitability

Table presents the annual cross-sectional regression results of operating leverage based on A) EBITDA and B) SGA (see Table D1 for the descriptions) on gross profitability (GP). Book-to-market (B/M) and size (ME) are used as controls. The t-statistics are adjusted for autocorrelation by following Loughran and Schultz (2005). The data sample covers 1) 1967-1990 and 2) 1991-2014. Financials and utilities are excluded from the sample.

	Average parameter values and [t-statistics]			
Dependent variable	Intercept	lnGP	lnME	lnB/M
Panel A: DOL_{EBITDA} as dependent variable				
$lnDOL_{EBITDA}$ (1967-1990)	0.29	-0.23		
	[2.80]	[-2.28]		
	0.46	-0.24	-0.04	
	[2.83]	[-2.75]	[-2.87]	
	0.26	0.04		0.26
	[1.74]	[0.36]		[12.47]
	0.28	0.04	0.26	0.00
	[1.00]	[0.28]	[8.06]	[0.01]
$lnDOL_{EBITDA}$ (1991-2014)	0.32	0.37		
	[10.50]	[2.41]		
	0.84	0.30	-0.08	
	[6.37]	[2.49]	[-5.41]	
	0.39	0.61		0.25
	[14.90]	[4.39]		[5.06]
	0.72	0.49	0.18	-0.05
	[5.65]	[5.07]	[2.54]	[-2.56]
Panel B: DOL_{SGA} as dependent variable				
$lnDOL_{SGA}$ (1967-1990)	-3.03	4.31		
	[-47.33]	[43.31]		
	-2.73	4.30	-0.07	
	[-41.82]	[44.68]	[-16.54]	
	-3.07	4.46		0.14
	[-30.61]	[35.01]		[3.04]
	-2.80	4.38	0.07	-0.06
	[-25.88]	[35.25]	[2.15]	[-16.00]
$lnDOL_{SGA}$ (1991-2014)	-3.05	4.40		
	[-78.55]	[57.44]		
	-2.48	4.31	-0.09	
	[-10.12]	[41.37]	[-3.85]	
	-3.03	4.55		0.12
	[-81.06]	[68.72]		[7.35]
	-2.46	4.28	-0.01	-0.09
	[-11.81]	[41.29]	[-0.56]	[-4.29]

Table B7: Fama-MacBeth regressions with measures of gross profitability within and across industries

Table reports the results from Fama-MacBeth regressions of firms' returns on gross profitability rankings within and across industries. The within industry ranking is the firm's gross profitability ranking (percentile) within industry, and the industry ranking is the industry's gross profitability ranking (percentile). Logarithms of book-to-market (B/M) and size (ME), and the past returns for one month and one year are used as controls. The data sample covers A) 1967-1990 and B) 1991-2014. Financials and utilities are excluded from the sample.

Independent variable	Slope coefficients (x10^2) and [t-statistics] from the regression $r_{tj} = \boldsymbol{\beta}' \boldsymbol{x}_{tj} + e_{tj}$ for intra- and inter-industry measures				
	(1)	(2)	(3)	(4)	(5)
Panel A: 1967-1990					
lnGP	0.93				
	[3.44]				
Intra-industry value		0.56		0.28	0.56
		[5.43]		[2.63]	[5.22]
Inter-industry value			0.20	0.10	0.26
			[1.19]	[0.60]	[1.52]
lnB/M	0.47	0.48	0.42		0.49
	[4.77]	[4.81]	[4.44]		[5.05]
lnME	-0.12	-0.12	-0.13	-0.19	-0.12
	[-2.29]	[-2.29]	[-2.36]	[-3.34]	[-2.25]
$r_{1,0}$	-7.05	-6.98	-7.08	-6.89	-7.14
	[-14.59]	[-14.39]	[-14.69]	[-14.17]	[-14.87]
$r_{12,2}$	0.29	0.33	0.29	0.38	0.27
	[1.45]	[1.59]	[1.44]	[1.91]	[1.32]
Panel B: 1991-2014					
lnGP	0.71				
	[2.43]				
Intra-industry value		0.44		0.22	0.45
		[3.84]		[2.03]	[3.72]
Inter-industry value			0.05	-0.02	0.45
			[0.22]	[-0.06]	[0.35]
lnB/M	0.33	0.34	0.29		0.35
	[3.74]	[3.71]	[3.48]		[3.90]
lnME	-0.13	-0.13	-0.14	-0.19	-0.13
	[-3.08]	[-3.06]	[-3.38]	[-4.95]	[-3.04]
$r_{1,0}$	-2.22	-2.21	-2.25	-2.17	-2.26
	[-6.37]	[-6.32]	[-6.57]	[-6.26]	[-6.62]
$r_{12,2}$	-0.03	-0.04	-0.03	-0.01	-0.03
	[-0.29]	[-0.34]	[-0.33]	[-0.06]	[-0.33]

Appendix C – Subperiod analysis according to García-Feijóo and Jorgensen (2010)

Table C1: Fama-MacBeth regressions employing gross profitability and degree of operating leverage

Table reports the results from Fama-MacBeth regressions of firms' returns on gross profitability (GP), which is sales minus cost of goods sold scaled by total book assets (AT), and the different definitions of degree of operating leverage (DOL) based on EBITDA and EBIT – see Table D1 for the descriptions. Logarithms of book-to-market (B/M) and size (ME), and the past returns for one month and one year are used as controls. By following García-Feijóo and Jorgensen (2010), the data sample extends from 1986 to 2003, and excludes financials and utilities. The difference to García-Feijóo and Jorgensen (2010) here is that they included utilities in their dataset.

	Slope coefficients (x10^2) and [t-statistics] from the regression $r_{tj} = \boldsymbol{\beta}' \boldsymbol{x}_{tj} + e_{tj},$					
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Fama-MacBeth regressions using DOL_{EBITDA} (1986-2003)						
DOL	0.03		0.01		0.03	0.01
	[2.56]		[1.26]		[2.57]	[1.17]
GP		0.52		0.68	0.52	0.68
		[2.52]		[3.24]	[2.49]	[3.21]
lnB/M			0.25	0.34		0.34
			[2.26]	[2.95]		[2.88]
lnME			-0.17	-0.15		-0.15
			[-2.97]	[-2.69]		[-2.69]
$r_{1,0}$			-3.17	-3.19		-3.20
			[-8.08]	[-8.14]		[-8.17]
$r_{12,2}$			0.10	0.09		0.09
			[0.86]	[0.81]		[0.80]
Panel B: Fama-MacBeth regressions using DOL_{EBIT} (1986-2003)						
DOL	0.01		0.01		0.01	0.01
	[2.02]		[1.16]		[2.11]	[1.06]
GP		0.52		0.68	0.52	0.67
		[2.52]		[3.24]	[2.53]	[3.18]
lnB/M			0.25	0.34		0.33
			[2.19]	[2.95]		[2.80]
lnME			-0.17	-0.15		-0.15
			[-2.99]	[-2.69]		[-2.71]
$r_{1,0}$			-3.17	-3.19		-3.20
			[-8.05]	[-8.14]		[-8.13]
$r_{12,2}$			0.09	0.09		0.08
			[0.82]	[0.81]		[0.76]

Table C2: Excess returns to portfolios sorted on degree of operating leverage

Table presents the monthly value-weighted average excess returns to portfolios sorted on degree of operating leverage (DOL) based on EBITDA and EBIT – see Table D1 for the descriptions. The table shows also the monthly value-weighted average abnormal returns and returns to the market factor (MKT), the size factor (SMB), the value factor (HML), and the momentum factor (UMD) from portfolio-wise time-series regressions by following Fama and French (1993) and Carhart (1997). The t-statistics are presented in square brackets. Portfolios are constructed by using NYSE breakpoints and rebalanced at the end of each June. By following García-Feijóo and Jorgensen (2010), the data sample extends from 1986 to 2003, and excludes financials and utilities. The difference to García-Feijóo and Jorgensen (2010) here is that they included utilities in their dataset.

		Alphas and four-factor loadings				
Portfolio	r^e	α	MKT	SMB	HML	UMD
Panel A: Portfolios sorted on DOL_{EBITDA} (1986-2003)						
Low	0.83	0.40	0.91	-0.11	-0.15	-0.18
	[2.01]	[1.12]	[16.12]	[-1.01]	[-0.85]	[-1.34]
2	0.64	0.57	0.94	-0.22	-0.11	-0.03
	[2.15]	[2.02]	[10.01]	[-2.85]	[-0.86]	[-0.61]
3	1.05	0.56	0.87	-0.05	-0.08	-0.04
	[3.75]	[2.27]	[11.71]	[-0.78]	[-0.57]	[-0.59]
4	0.66	0.17	0.99	-0.01	-0.13	-0.30
	[2.09]	[0.65]	[21.43]	[-0.12]	[-1.23]	[-4.70]
High	0.87	0.22	1.09	0.19	-0.04	-0.27
	[2.41]	[0.73]	[26.31]	[1.63]	[-0.23]	[-2.09]
High-Low	0.04	-0.17	0.18	0.30	0.11	-0.10
	[0.16]	[-0.41]	[2.11]	[2.33]	[0.47]	[-0.48]
Panel B: Portfolios sorted on DOL_{EBIT} (1986-2003)						
Low	0.73	0.73	0.84	-0.32	-0.34	-0.18
	[2.07]	[2.35]	[10.89]	[-4.10]	[-2.12]	[-1.45]
2	0.87	0.50	0.99	-0.15	-0.05	0.01
	[2.61]	[1.45]	[7.85]	[-2.48]	[-0.43]	[0.15]
3	0.79	0.20	0.88	0.01	-0.01	-0.01
	[2.69]	[0.79]	[13.06]	[0.09]	[-0.08]	[-0.18]
4	0.73	0.31	0.97	0.04	-0.07	-0.35
	[2.23]	[1.36]	[22.14]	[0.49]	[-0.64]	[-5.53]
High	0.78	0.07	1.12	0.15	0.14	-0.30
	[2.22]	[0.19]	[20.59]	[1.19]	[0.66]	[-1.98]
High-Low	0.05	-0.66	0.29	0.47	0.47	-0.12
	[0.20]	[-1.29]	[2.52]	[3.23]	[2.04]	[-0.67]

Appendix D – DOL definitions

Table D1: DOL definitions

Table displays definitions for the degree of operating leverage (DOL) proxies used in this paper. EBITDA refers to earnings before interest, taxes, depreciation, and amortization, and EBIT refers to earnings before interest and taxes. SGA refers to sales, general, and administrative expenses, AT refers to total book assets, COGS refers to cost of goods sold, TC refers to total costs including COGS and SGA, and PPENT refers to property, plant, and equipment, i.e., fixed assets. Table 2 describes the construction of elasticity proxies for DOL.

Variable	Description
Operating leverage	The proportion of fixed operating costs to the proportion of variable operating costs
Degree of operating leverage (DOL)	Magnitude of operating leverage
Elasticity proxies for DOL:	
DOL_{EBITDA}	Sensitivity of EBITDA to sales
DOL_{EBIT}	Sensitivity of EBIT to sales
Point-to-point proxies for DOL:	
DOL_{SGA}	SGA/AT
DOL_{TC}	(COGS + SGA)/AT
DOL_{Book}	5-year average of PPENT/AT

References

Ball, R., Gerakos, J., Linnainmaa, J.T. & Nikolaev, V.V. 2015, "Deflating profitability", *Journal of Financial Economics,* vol. 117, no. 2, pp. 225-248.

Banz, R.W. 1981, "The relationship between return and market value of common stocks", *Journal of Financial Economics,* vol. 9, no. 1, pp. 3-18.

Barberis, N. & Thaler, R. 2003, "A survey of behavioral finance", *Handbook of the Economics of Finance,* vol. 1, pp. 1053-1128.

Berk, J.B., Green, R.C. & Naik, V. 1999, "Optimal investment, growth options, and security returns", *The Journal of Finance,* vol. 54, no. 5, pp. 1553-1607.

Bowman, R.G. 1979, "The theoretical relationship between systematic risk and financial (accounting) variables", *The Journal of Finance,* vol. 34, no. 3, pp. 617-630.

Carhart, M.M. 1997, "On persistence in mutual fund performance", *The Journal of Finance,* vol. 52, no. 1, pp. 57-82.

Carlson, M., Fisher, A. & Giammarino, R. 2004, "Corporate investment and asset price dynamics: implications for the cross-section of returns", *The Journal of Finance,* vol. 59, no. 6, pp. 2577-2603.

Cohen, R.B., Gompers, P.A. & Vuolteenaho, T. 2002, "Who underreacts to cash-flow news? Evidence from trading between individuals and institutions", *Journal of Financial Economics,* vol. 66, no. 2, pp. 409-462.

Cooper, M.J., Gulen, H. & Schill, M.J. 2008, "Asset growth and the cross-section of stock returns", *The Journal of Finance,* vol. 63, no. 4, pp. 1609-1651.

Dugan, M.T. & Shriver, K.A. 1992, "An empirical comparison of alternative methods for the estimation of the degree of operating leverage", *Financial Review,* vol. 27, no. 2, pp. 309-321.

Dugan, M.T. & Shriver, K.A. 1989, "The effects of estimation period, industry, and proxy on the calculation of the degree of operating leverage", *Financial Review,* vol. 24, no. 1, pp. 109-122.

Eisfeldt, A.L. & Papanikolaou, D. 2013, "Organization capital and the cross-section of expected returns", *The Journal of Finance,* vol. 68, no. 4, pp. 1365-1406.

Fama, E.F. & French, K.R. 2015, "A five-factor asset pricing model", *Journal of Financial Economics,* vol. 116, no. 1, pp. 1-22.

Fama, E.F. & French, K.R. 2008, "Dissecting anomalies", *The Journal of Finance,* vol. 63, no. 4, pp. 1653-1678.

Fama, E.F. & French, K.R. 2006, "Profitability, investment and average returns", *Journal of Financial Economics,* vol. 82, no. 3, pp. 491-518.

Fama, E.F. & French, K.R. 1996, "Multifactor explanations of asset pricing anomalies", *The Journal of Finance,* vol. 51, no. 1, pp. 55-84.

Fama, E.F. & French, K.R. 1993, "Common risk factors in the returns on stocks and bonds", *Journal of Financial Economics,* vol. 33, no. 1, pp. 3-56.

Fama, E.F. & French, K.R. 1992, "The cross-section of expected stock returns", *The Journal of Finance,* vol. 47, no. 2, pp. 427-465.

Fama, E. F. & MacBeth, J. D. 1973, "Risk, return, and equilibrium: Empirical tests", *The Journal of Political Economy*, pp. 607-636.

García-Feijóo, L. & Jorgensen, R. D. 2010, "Can operating leverage be the cause of the value premium? ", *Financial Management*, vol. 39, no. 3, pp. 1127-1154.

Gulen, H., Xing, Y. & Zhang, L. 2011, "Value versus Growth: Time-Varying Expected Stock Returns", *Financial Management,* vol. 40, no. 2, pp. 381-407.

Hamada, R.S. 1972, "The effect of the firm's capital structure on the systematic risk of common stocks", *The Journal of Finance,* vol. 27, no. 2, pp. 435-452.

Haugen, R.A. & Baker, N.L. 1996, "Commonality in the determinants of expected stock returns", *Journal of Financial Economics,* vol. 41, no. 3, pp. 401-439.

Hou, K., Xue, C. & Zhang, L. 2014, "Digesting anomalies: An investment approach", *Review of Financial Studies,* pp. hhu068.

Kisser, M. 2014, "What explains the gross profitability premium? ", *Available at SSRN 2526686*.

Lakonishok, J., Shleifer, A. & Vishny, R.W. 1994, "Contrarian investment, extrapolation, and risk", *The Journal of Finance,* vol. 49, no. 5, pp. 1541-1578.

Lettau, M. & Wachter, J.A. 2007, "Why is long-horizon equity less risky? A duration-based explanation of the value premium", *The Journal of Finance,* vol. 62, no. 1, pp. 55-92.

Lev, B. 1974, "On the association between operating leverage and risk", *Journal of financial and quantitative analysis,* vol. 9, no. 04, pp. 627-641.

Liu, L.X., Whited, T.M. & Zhang, L. 2009, "Investment-based expected stock returns", *Journal of Political Economy,* vol. 117, no. 6, pp. 1105-1139.

Ljungqvist, A. & Wilhelm, W. J. 2005, "Does prospect theory explain IPO market behavior?", *The Journal of Finance*, vol. 60, pp. 4, 1759-1790.

Lord, R.A. 1998, "Properties of time-series estimates of degree of leverage measures", *Financial Review,* vol. 33, no. 2, pp. 69-84.

Lord, R.A. 1995, "Interpreting and measuring operating leverage", *Issues in Accounting Education,* vol. 10, no. 2, pp. 317.

Loughran, T. & Schultz, P. 2005, "Liquidity: Urban versus rural firms", *Journal of Financial Economics,* vol. 78, no. 2, pp. 341-374.

Mandelker, G.N. & Rhee, S.G. 1984, "The impact of the degrees of operating and financial leverage on systematic risk of common stock", *Journal of Financial and Quantitative Analysis,* vol. 19, no. 1, pp. 45-57.

Novy-Marx, R. 2013, "The other side of value: The gross profitability premium", *Journal of Financial Economics,* vol. 108, no. 1, pp. 1-28.

Novy-Marx, R. 2011, "Operating leverage*", *Review of Finance,* vol. 15, no. 1, pp. 103-134.

O'Brien, T.J. & Vanderheiden, P.A. 1987, "Empirical measurement of operating leverage for growing firms", *Financial Management,* , pp. 45-53.

Rosenberg, B., Reid, K. & Lanstein, R. 1985, "Persuasive evidence of market inefficiency", *The Journal of Portfolio Management,* vol. 11, no. 3, pp. 9-16.

Rubinstein, M.E. 1973, "A mean-variance synthesis of corporate financial theory", *The Journal of Finance,* vol. 28, no. 1, pp. 167-181.

Stattman, D. 1980, "Book values and stock returns", *The Chicago MBA: A journal of selected papers,* vol. 4, no. 1, pp. 25-45.

Titman, S., Wei, K.J. & Xie, F. 2004, "Capital investments and stock returns", *Journal of financial and Quantitative Analysis,* vol. 39, no. 04, pp. 677-700.

Wang, H. & Yu, J. 2013, "Dissecting the profitability premium", *AFA 2013 San Diego Meetings Paper*.