Profitability Decomposition and Operating Risk

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Abstract

The DuPont decomposition of profitability into profit margin and asset turnover has been applied extensively to forecast future profits. This paper provides a complementary analysis under which the DuPont decomposition also informs about the risk that profits may differ from expectation. In the standard decomposition, the profit margin describes how sales translate into operating profit. Correspondingly, the analysis here shows how the profit margin informs about how variance in sales growth rates translates into variance in the growth rate of operating profit. We identify a measure that captures the effect. That measure also points to a role for the asset turnover. In the standard decomposition, the asset turnover describes how operating assets yield sales, while our analysis shows how the asset turnover combines with the profit margin to indicate the variability of operating profit resulting from those sales. The empirical results validate that the DuPont decomposition is useful for forecasting the variance in future growth rates in operating profits and also for forecasting the variance in future stock returns. Moreover, the decomposition also explains the implied volatility in option prices.

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1. Introduction

Financial statement analysis text books emphasize the DuPont margin/turnover decomposition of profitability as a primary tool for analyzing and forecasting operating profitability.[1] In support, research has demonstrated the explanatory power of asset turnover and profit margin for forecasting profits, for example in Nissim and Penman (2001), Fairfield and Yohn (2001), Soliman (2008), and Amir, Kama, and Livnat (2011). However, investors are presumably concerned, not only with expected profits, but also with the risk that the expected profits may not be achieved. How, then, do the profit margin and asset turnover inform about this risk?

This paper answers this question and so extends the DuPont decomposition analysis to the evaluation of risk as well as profitability. Accordingly, the analyst applying the DuPont method is made aware of the risks implied. As equity value is based not only on expected profits but also the risk surrounding those expectations, the paper provides a more complete analysis of how DuPont decomposition is applied in valuation.

In the DuPont analysis, the profit margin explains how (expected) sales translate into (expected) operating profit. Our focus is on the variance of operating profit from expectation, so the complementary question is how the operating profit margin informs about how the variability in sales (relative to expected sales) translates into variability in operating profit (relative to expected profit). We introduce a formal analysis to answer the question. As is well appreciated, operating leverage—the amount of fixed cost relative to variable cost—plays a role because, unlike variable costs, fixed costs do not offset the variability of sales. But we show that the operating profit margin itself also plays a role: for a given level of operating leverage, the impact of a shock to sales on the rate of change in operating profit is decreasing in the base level of

[1] For example, Palepu and Healy (2013), Penman (2013), and White, Sondhi and Fried (2003).

operating profit relative to sales. Thus, for example, while a low operating leverage (i.e., high variable costs) implies that a given change in sales will result in a relatively small change in operating profits (variable costs offset the variability of sales), a high profit margin indicates that the rate of change in operating profit will be relatively small. We introduce a leverage sensitivity measure, the *degree* of operating leverage (DOL), which shows how operating leverage and the profit margin jointly determine the percentage change in profit from a percentage change in sales. It has the property of being empirically estimable and so is amenable to testing the relevance of the DuPont decomposition for informing about the risk surrounding operating profit.

Our analysis with respect to the asset turnover is less formal. The variance of operating profit from expectation depends not only on how the variance in sales translates into variance in profit but also on the variance of sales. Asset turnover indicates how operating assets translate into sales, so the corresponding question with respect to risk would be how the measure informs about the variability of sales. However, sales variability is driven by product market factors that are presumably remote from the level of assets relative to sales. One might entertain conjectures of course (and we do), but a formal analysis escapes us. Nonetheless, it is likely that asset turnover is indicative of operating leverage, with higher asset levels relative to sales—particularly "fixed assets" like property, plant and equipment— indicating higher fixed costs. As operating leverage is a difficult measure to extract from the financial statements, asset turnover then becomes a proxy for unobservable operating leverage. Thus, as both operating leverage and the operating profit margin combine to explain the variability of the growth rate in operating profits associated with sales variability, so do the asset turnover and the operating profit margin.

Our empirical analysis shows that, in the cross-section, both profit margin and asset turnover are negatively related the degree of operating leverage (DOL). The negative relation for profit margin accords with our modeling. That for the asset turnover is consistent with the turnover being a proxy for operating leverage. In short, the margin and turnover work together to indicate the DOL and thus the effect of the variation in sales growth rates on the variation in the growth rate in operating profits.

Further, we show that both profit margin and the asset turnover forecast the variance of future operating profits after controlling for the forecast indicated by observed historical volatility. Similarly, both DuPont measures forecast stock return variability, though the result for asset turnover is sensitive to the measure used. Profit margin also explains the implied volatility in stock option prices, even after controlling for historical volatility and other commonly used risk and volatility predictors. Indeed, profit margin and asset turnover also forecast actual future return volatility incrementally to implied volatility and other control variables related to volatility. This result suggests that the DuPont measures serve as an improvement to implied volatility as a predictor of actual volatility—either because investors underweight the financial statement information in setting option prices or because of the deficiency in the option pricing model used for inferring implied volatility.

This paper is related to the recently reinvigorated literature on fundamentals-based risk analysis. While the early literature on bankruptcy prediction emphasized financial ratios (e.g. Altman 1968, Ohlson 1980), until recently there has been relatively little research on ratio analysis for evaluating risk. Following the financial crisis, an increasing number of studies examine the risk implications of financial disclosures.[2] The current study contributes to this

[2] For example, Nekrasov and Shroff (2009), Beaver, Correia, and McNichols (2010), Nelson and Rupar (2011), Kravet and Muslu (2011), and Campbell, Chen, Dhaliwal, Lu, and Steele (2011).

growing literature by examining the risk implications of key financial ratios—asset turnover and profit margin.

The paper proceeds as follows. Section 2 develops hypotheses about how the profit margin and asset turnover inform about the variability in profits, with formal modeling in the case of the profit margin and a less formal analysis for the asset turnover. Section 3 discusses the sample and data and introduces the empirical measure of degree of operating leverage. The main empirical analysis is in Section 4, and Section 5 concludes.

2. Operating risk and the DuPont decomposition

Earnings forecasting is at the heart of equity analysis and valuation. However, valuation involves not only expected profits but also a discount for the risk that realizations will differ from expectation. Research has confirmed that DuPont analysis—that decomposes operating profitability into the operating profit margin (OPM) and asset turnover (OAT)—aids in forecasting expected values, but little has been done on how these measures inform about risk. This section examines how OPM and OAT inform about the variability of operating profits, setting up hypotheses for the empirical work.

2.1 Operating risk and the operating profit margin

The operating profit margin indicates how a given level of sales impacts operating profit. Here we analyze how the profit margin indicates how a given volatility of the sales growth rate impacts the volatility of the rate of change in operating profit. We focus on the volatility of growth rates or rates of change rather than the volatility of levels because equity risk is related to the volatility of stock return (rate of change in price) rather than to the volatility of stock price.[3]

The operating profit margin is equal to the ratio of Operating Profit (OP) to Sales, where

$$\begin{aligned} Operating\ Profit\ (OP) &= Sales - Variable\ Cost\ (VC) - Fixed\ Cost\ (FC) \\ &= Sales \times (1 - vc) - FC \end{aligned} \tag{1}$$

and $vc = \frac{VC}{Sales}$, the variable cost per dollar of sales, is assumed to be constant. Thus, the change in operating profit for a given change in sales is given by

$$\frac{\partial OP}{\partial Sales} = 1 - vc \tag{2}$$

That is, as sales vary, the effect on operating profit is indicated by variable cost relative to sales (which yields the contribution margin ratio familiar from managerial accounting texts). However, variable costs are not observable in published financial statements.

An alternative measure, the degree of operating leverage, attempts to finesse the problem. It measures the percentage change in operating profit for a given percentage change in sales. Alternatively stated, the degree of operating leverage measures the extent to which shocks to the sales growth rate affect the growth rate in operating profit. Under the assumption that vc is constant (i.e., that variable costs are proportional to sales), the degree of operating leverage (DOL), defined for operating profit (OP) > 0, is given by:

$$\begin{aligned} DOL &= \frac{\partial OP}{\partial Sales} \times \frac{Sales}{OP} = (1 - vc) \times \frac{Sales}{OP} = \frac{OP + FC}{OP} = 1 + \frac{FC}{OP} \\ &= 1 + \frac{FC/Sales}{OPM} = 1 + \frac{\frac{FC}{FC + VC} \times \frac{FC + VC}{Sales}}{OPM} = 1 + \frac{\frac{FC}{FC + VC} \times (1 - OPM)}{OPM} \end{aligned} \tag{3}$$

[3] For example, if price is proportional to earnings, then stock return should be proportional to the rate of change in earnings, and thus the volatility of stock returns (a proxy for equity risk) should be proportional to the volatility of the rate of change in earnings.

Importantly for our purpose, the profit margin (in the DuPont decomposition) surfaces in the measure, and the profit margin is observable.

Recognizing that $\frac{FC}{FC+VC}$, the proportion of fixed costs to total costs, is operating leverage (OL), then

$$DOL = 1 + \frac{OL \times (1 - OPM)}{OPM} = 1 - OL + \frac{OL}{OPM} \tag{4}$$

As shown, DOL is determined by both OL and OPM, and it is generally greater than unity. Specifically, DOL = 1 if there are no fixed costs (OL = 0); DOL > 1 with fixed costs (for 0 < OPM < 1); and DOL → 1 as the firm moves further above breakeven point (OPM → 1); that is, the farther from breakeven point, the lower the DOL. In addition, with no variable costs (OL = 1) DOL is determined solely by the profit margin.

As is well appreciated, the effect of a change in sales on operating profit is increasing in operating leverage ($\frac{\partial DOL}{\partial OL} = \frac{1}{OPM} - 1 > 0$): the contribution of sales to profit is higher the higher the fixed cost component of total costs. Importantly for our analysis, Equation (4) shows that, for a given (positive) OL, the DOL decreases in OPM ($\frac{\partial DOL}{\partial OPM} = \frac{-OL}{OPM^2} < 0$). The DOL decreases in OPM because a relatively high base level of operating profit (high OPM) implies that a given shock to operating profit has a relatively small effect on the rate of change in operating profit (low DOL).[4] We demonstrate these relationships using two numerical examples below.

While OL and DOL are unobservable in published financial statements, DOL can be estimated empirically. Given such estimate, Equation (4) and the (observable) OPM can be used to solve for OL, as we will show.

[4] Profit margin may also have an indirect negative effect on DOL due to its relationship with sales. Profit margin increases as sales (and therefore variable costs) increase, leading to a decline in operating leverage (i.e., the proportion of fixed cost relative to total cost).

The DOL measure is not new to this paper. It has been applied to investigate the sensitivity of profits to sales, often with the purpose of connecting operating leverage to market betas (see, for example, Gahlon and Gentry 1982, Mandelker and Rhee 1984, and O'Brien and Vanderheiden 1987). The measure has also been embraced to explain the value premium in stock returns associated with high book-to-price ratios (see García-Feijóo and Jorgensen 2010). Our contribution is to show that this measure involves both operating leverage and the profit margin, and thus to introduce the DuPont decomposition into the analysis of risk. We next demonstrate the relationships among DOL, OL and OPM using two numerical examples.

Exhibit 1: Example of the impact of operating leverage on the DOL

Case		Sales	Fixed costs	Variable costs	Profit
A	Base level (*DOL* = 1+0/120)	200	0	80	120
	After a 50% sales decline	100	0	40	60
	Percentage change	-50%	NA	-50%	-50%
B	Base level (*DOL* = 1+40/120)	200	40	40	120
	After a 50% sales decline	100	40	20	40
	Percentage change	-50%	0%	-50%	-67%
C	Base level (*DOL* = 1+80/120)	200	80	0	120
	After a 50% sales decline	100	80	0	20
	Percentage change	-50%	0%	NA	-83%

In Exhibit 1, the base profit margin is the same (OPM = 120/200 = 0.6) across three cases but the operating leverage differs. When all costs are variable (case A, OL = 0/80 = 0), the DOL (1 + 0/120) is equal to one and profit and sales change by the same percentage (-50%). With fixed costs (case B, OL = 40/80 = 0.5), the DOL (1 + 40/120 = 1.33) is greater than one and the magnitude of the percentage change in profit is larger than the percentage change in sales (-67% compared to -50%). As the proportion of fixed costs increases (case C, *OL* = 80/80 = 1.0), so do the degree of operating leverage (1+80/120 = 1.67) and the magnitude of the decline in profit for the same sales shock (-83% versus -67% in case B).

Exhibit 2: Example of the impact of operating profit margin on the DOL

Case		Sales	Fixed costs	Variable costs	Profit
A	Base level (*DOL* = 1+40/120)	200	40	40	120
	After a 50% sales decline	100	40	20	40
	Percentage change	-50%	0%	-50%	-67%
B	Base level (*DOL* = 1+40/220)	300	40	40	220
	After a 50% sales decline	150	40	20	90
	Percentage change	-50%	0%	-50%	-59%
C	Base level (*DOL* = 1+40/320)	400	40	40	320
	After a 50% sales decline	200	40	20	140
	Percentage change	-50%	0%	-50%	-56%

In Exhibit 2, the cost structure is the same across the three cases with OL = 40/80 = 0.5, but the profit margin differs. When the profit margin is relatively low (case A, OPM = 120/200 = 60%), the DOL is relatively large (1 + 40/120 = 1.33) and so is the magnitude of the percentage change in profit (-80/120 = -67%). When the profit margin is high (case C, OPM = 320/400 = 80%), the DOL is relatively small (1 + 40/320 = 1.12) and so is the magnitude of the percentage change in profit (-180/320 = -56%).

This analysis demonstrates a deterministic relationship between profit margin and the DOL. But the ability of current profit margin to inform about future values of the DOL and hence future operating profit volatility depends on its persistence. This is an empirical question which we address in our tests.

While the analysis points to the profit margin as an indicator of how the growth in operating profit varies in response to changes in sales growth, one also requires the operating leverage, OL. This presents a difficulty, for fixed and variable costs are not easily identifiable in financial statements. The analyst needs a proxy, and for this we turn to the asset turnover, the second component of the DuPont decomposition.

2.2 Operating risk and the asset turnover

The asset turnover (OAT) indicates sales generated per dollar of operating assets (OA). Just as the profit margin can be modeled as indicting the sensitivity of operating profit to a change in sales, $\frac{\partial OP}{\partial Sales} \times \frac{Sales}{OP}$, as above, one might think of modeling how the asset turnover is involved in determining $\frac{\partial Sales}{\partial OA} \times \frac{Sales}{OA}$, the sensitivity of sales to changes in operating assets. Thus one would have a couple, $\frac{\partial OP}{\partial Sales} \times \frac{Sales}{OP}$ and $\frac{\partial Sales}{\partial OA} \times \frac{Sales}{OA}$, for the analysis of variability that complements the couple, OPM and OAT, of the DuPont decomposition. With a constant OAT over all levels of OA (that is, sales proportional to OA), the analysis is quite straightforward, of course, and in many cases this may be a reasonable (local) approximation. If not, one must model the nonlinearities. One might, as a matter of economic analysis, model the effect of added operating assets on changes in sales, but there is no modeling that can be done purely as a matter of accounting analysis: sales are largely driven by product market factors not captured by accounting. Thus, we have nothing by means of financial statement analysis to put on the table. We do, however, entertain three conjectures.

First, the asset turnover may serve as a proxy (negative relationship) for the proportion of fixed costs in the cost structure and thus for the OL component of DOL. Firms with relatively low asset turnover, especially fixed asset turnover, tend to have a high proportion of fixed costs because investments in property, plant, equipment, and other deferred costs (e.g., prepaid expenses, finite-life intangibles) will be depreciated, amortized, or otherwise expensed in subsequent periods, largely independent of the level of future sales. In other words, these assets are costly to reverse (Ferri and Jones 1979, Mandelker and Rhee 1984, Rajan and Zingales 1995) and therefore generate future fixed costs (Saunders et al. 1990). However, not all assets represent future fixed costs; some represent future variable costs (e.g., inventory) or are related to revenue rather than cost (e.g., accounts receivables). Thus, the ability of asset turnover to serve as a proxy for the proportion of fixed costs depends on asset composition. Accordingly, we consider three alternative turnover ratios. The first is the (total) operating asset turnover as defined above. The second is the fixed asset turnover, Sales/Property, Plant, and Equipment (net). Because firms commit to operating capacity in ways that are not reflected on the balance sheet, a third measure adds the present value of non-cancelable operating lease payments to property, plant, and equipment in the fixed asset turnover.[5]

The second conjecture focuses on the OAT as an indicator of capacity utilization and thus as an indicator (negative relationship) of the percentage change in operating profit for a given percentage change in sales, i.e., the DOL. Firms with idle capacity benefit substantially from positive sales shocks because they do not need to invest in additional capacity (which would increase fixed costs), but they incur large losses from negative sales shocks because they have few investments that can be reduced. In contrast, firms with high capital utilization can adjust their capital investments in response to sales growth volatility. This effect is related to but yet different from the OL effect. In the long-run, all costs are variable. Low capacity utilization implies that fixed costs are likely to remain fixed for an especially long period of time.[6]

The third conjecture sees low sales relative to operating assets as indicative of assets whose sales-generating ability are unproven and uncertain: these firms have upside potential matched with downside risk, projecting higher sales and earnings volatility. Correspondingly, a

[5] Asset turnover may be negatively related to operating leverage also due to its association with sales. Asset turnover increases as sales (and therefore variable costs) increase, leading to a decline in operating leverage (i.e., the ratio of fixed cost to total cost).

[6] Recent research has used a similar argument to explain the value premium (e.g., Berk et al. 1999, Carlson et al. 2004, Zhang 2005, Cooper 2006, Gulen et al. 2008). These studies argue that the low market-to-book ratios of value firms reflect their low productivity and excess installed capital capacity. Therefore, value firms benefit from positive aggregate shocks without undertaking costly investment, but are less flexible than growth firms in adjusting to worsening economic conditions. Consistent with this argument, value firms have higher ratios of fixed assets to total assets than growth firms, larger operating leverage, and higher stock returns (the value premium).

firm with high sales relative to assets is one where the uncertainty has been resolved. Consistent with this conjecture, Carlson, Fisher and Giammarino (2004) show that firm beta increases in the ratio of growth opportunities to assets in place, and Kogan and Papanikolaou (2012) explain this result by arguing that growth opportunities behave as a levered claim on assets in place.[7]

These three conjectures paint the asset turnover as being negatively correlated with future earnings volatility, in the first two cases through the relation to OL (the proportion of fixed cost to total cost), and in the third case through the relation to sales volatility that increases earnings volatility. They remain conjectures to be evaluated in empirical tests. Indeed, alternative conjectures may point to a positive relationship between the asset turnover and volatility. Conservative accounting (that omits assets from the balance sheet) produces higher asset turnovers and conservative accounting may be associated with risk. That accounting is often applied to internally-generated intangibles such as R&D where the outcomes are more risky, as in Kothari, Laguerre, and Leone (2002). Countering that conjecture is the point that high sales relative to assets for these firms indicate that the risk associated with intangible assets has been resolved: the investment in the intangible assets has paid off. In addition, low sales relative to operating assets may indicate a low sales realization from very variable sales, but a high sales realization might also be observed from the same variability. Finally, one also must be concerned about reverse causation: firms invest less when volatility is high.

[7] Asset turnover may serve as a risk proxy (negative relationship) for an additional, related reason. A low asset turnover may reflect overstated assets (e.g., Barton and Simko 2002) rather than investments in assets that are expected to generate future sales. Uncertainty regarding the cause of low turnover represents a source of information risk. Overstated assets will reduce rather than increase future profits, through impairments or overstated expenses (e.g., recognition of inflated inventory in cost of goods sold). A similar argument has been made, and related evidence provided, with respect to measures of accruals quality, which are likely correlated with asset turnover. For example, Francis et al. (2005) and Ogneva (2012) use a measure of accruals quality (the standard deviation of residuals from regressions relating current accruals to cash flows) as a proxy for information risk, and show that accruals quality is correlated with estimates of the cost of equity capital.

3. Sample and variables

3.1 Sample

The sample includes all firm-year observations of U.S. firms during the period 1968-2012 that satisfy the following criteria: (1) accounting data are available from COMPUSTAT, (2) the company fiscal year-end is in December, (3) total assets are at least 10 million USD in December 2012 prices, (4) stock return data are available from the CRSP monthly return files, and (5) the firm is not a financial institution or a utility company (GIC sector 40 or 55, respectively). Utilities are excluded because the impact of regulation in these industries may constraint profitability measures, and financial firms are excluded because profit margin and asset turnover are not always meaningful for parts of the business.[8] Very small firms are omitted because the distributions of the ratios are often poorly-behaved for these firms.

3.2 A measure of the degree of operating leverage (DOL)

The risk of operating profit relates to the potential magnitude of *unexpected* changes in operating profit. Under some simplifying assumptions, DOL captures the ratio of the rate of deviation of operating profit from its expected value to the rate of deviation of sales from its expected value:

$$DOL = \frac{\frac{OP_t}{E[OP_t]} - 1}{\frac{Sales_t}{E[Sales_t]} - 1} \tag{5}$$

Setting E[$Sales_t$] = $Sales_{t-1}$ and E[OP_t] = OP_{t-1}, then, for a time change infinitesimally small, $DOL = \frac{\partial OP}{\partial Sales} \times \frac{1}{OPM}$, the expression for DOL in Equation (3). As in Mandelker and Rhee (1984),

[8] We merge the current and historical GIC classification files and fill up missing GICs by extrapolating from the closest available classification. For some companies that delisted prior to 1999, GIC classifications are not available. Because the sample period starts prior to 1999, omitting these firms would introduce survivorship bias. Therefore, we assign GIC to these companies based on an empirical mapping of SIC to GIC for firms with available classifications. This mapping is re-estimated each month (prior to 1999) to account for changes over time in SIC and GIC classifications. None of inferences of this study are affected by the inclusion of these companies.

for example, DOL is estimated for each firm-year observation *t* as the slope coefficient from firm-specific time-series regressions of log operating profit on log sales using the five annual consecutive observations ending in year *t*:[9]

$$log(OP_{jt}) = \propto_{jt} + \beta_{jt} log(Sales_{jt}) + \varepsilon_{jt} \quad (6)$$

The slope coefficient from this log-transformation regression (β_{jt}) measures the average elasticity of earnings with respect to changes in sales, that is, $\frac{\partial OP}{\partial Sales} \times \frac{Sales}{OP}$, which, by definition, is equal to the DOL. This commonly used approach for estimating the DOL should be viewed as an approximation. In fact, under the assumption that vc is constant (i.e., that variable costs are proportional to sales), DOL can only be constant over the estimation period if OP is constant (recall from Equation (3) that $DOL = 1 + \frac{FC}{OP}$). In addition, for the DOL to capture risk, Equation (6) effectively assumes that any change in earnings or sales is unexpected.

O'Brien and Vanderheiden (1987) refine the regression approach by de-trending the log-earnings and log-sales series before estimating the slope coefficient. This adjustment reduces the spurious growth-related correlation between earnings and sales, which biases the DOL toward one. It also allows the estimated slope coefficient to better reflect the relationship between *unexpected* changes in earnings and sales. When using the de-trended series, the slope coefficient measures the average sensitivity of the percentage deviation of earnings from its trend relative to the percentage deviation of sales from its trend. Dugan and Shriver (1992) find that de-trending the series generates DOL estimates which are more consistent with the classical ex ante model in that they are more likely to be greater than one, as expected when there are fixed costs (see

[9] The choice of a five-year window is made to minimize the trade-off between (1) loss of observations and potential bias due to changes in the firm's cost structure over time, and (2) degrees of freedom (e.g., Garcia-Feijoo and Jorgensen 2010).

Equation (3)). Based on these findings, subsequent studies have used the de-trended approach (e.g., DeYoung and Roland 2001, Griffin and Dugan 2003, Garcia-Feijoo and Jorgensen 2010).

In the empirical section below, we use both regression measures of operating leverage, estimated using net operating profit after tax (NOPAT, discussed below) as the earnings construct. We refer to the DOL estimate derived using the de-trended series as DOL_DeTr, and to the original estimate as DOL.

3.3 Other variables

Operating profit margin (OPM) is the ratio of net operating profit after tax (NOPAT) to sales, where NOPAT is calculated as net income before extraordinary items and noncontrolling interests, minus after-tax special items, minus after-tax foreign exchange income, minus after-tax interest income, and plus after-tax interest expense. The tax adjustment is calculated by multiplying pretax items by one minus the median effective tax rate across all companies in that year.[10]

Asset turnover (OAT) is measured as the ratio of sales to the average of beginning- and end-of-period operating assets, where operating assets are measured as total assets minus cash and short-term investments.[11] Fixed asset turnover (PP&ET) is measured as the ratio of sales to average net property, plant and equipment. Adjusted fixed asset turnover (APP&ET) is measured as the ratio of sales to average adjusted PP&E, where the latter is calculated as the total of net

[10] We do not apply the tax adjustments to goodwill impairment and in-process R&D (components of "special items"), because these items typically have zero tax bases. Results are similar when we measure the tax rate using the top federal statutory tax rate plus 2% (an estimate of the average incremental effect of state taxes). We use the median tax rate in the primary results due to the increasing significance of global operations over the sample period, which are often subject to substantially lower tax rates than the US marginal tax rate.

[11] Sales are divided by operating assets rather than net operating assets (that subtracts operating liabilities) because fixed costs tend to be generated by assets rather than liabilities. In any case, we repeat the tests with the alternative measure, sales relative to net operating assets, and find similar results to those reported.

PP&E and capitalized operating lease payments discounted using the annual median effective interest rate on long-term debt.[12]

We use the standard deviation of log sales during the five years that end in the current year (Volat_Sales) as a proxy for the volatility of the rate of change in sales. Similarly, we use the standard deviation of log NOPAT (Volat_NOPAT) as a proxy for the volatility of the rate of change in NOPAT. We also calculate the volatility of the de-trended series as the standard deviations of de-trended log sales (Volat_Sales_DeTr) and de-trended log NOPAT (Volat_NOPAT_DeTr).[13]

A number of measures are used when we come to investigating stock market data. BTM is measured as the ratio of common equity to the adjusted market value of common equity, calculated by multiplying the end-of-period market value of common equity by one plus the cumulative stock return over the first four months of the following year. The reason for the return adjustment is that end-of-period stock price is not likely to fully reflect the value implications of book value and other financial information, which is reported several weeks or months after the fiscal period end. Size is the log of the market value of common equity on April 30 of the following year. MLev is the ratio of debt to the total of the book value of debt and the adjusted market value of equity. Beta is the slope coefficient from a regression of monthly stock return on the S&P500 total return using up to five years of data (through April 30 of the following year) but no less than 30 monthly observations. Ret_Volat is the annualized standard

[12] Firms are required to disclose operating lease commitments for each of the subsequent five years as well as the total of all commitments after year five. We assume that annual commitments after year 5 are constant and equal to the average commitment during years 1 through 5, and that all payments are made at the middle of each year. We estimate the median effective interest rate on long-term debt by calculating the median effective interest rate on debt using firms with a long-term debt to total debt ratio of at least 2/3. Using an estimate of the interest rate on long-term debt is important because lease obligations are akin to long-term debt and long-term interest rates are typically substantially higher than short-term rates.

[13] The standard deviation of a log of a variable is approximately equal to the standard deviation of the rate of change in that variable relative to its average level.

deviation of the monthly stock returns. Idio_Volat is the annualized root mean squared error of the market model regression.

For the market pricing tests, we also use a measure of stock options' implied volatility. We calculate implied volatility using data from the Standardized (i.e., interpolated) Option Price datasets of the OptionMetrics database. For each firm-year, we obtain the interpolated at-the-money-forward implied volatilities of call and put options with the longest maturity as of the end of April of the following year, and calculate implied volatility (Imp_Volat) as the average of the call and put implied volatilities. We consider both calls and puts to mitigate any measurement error in implied volatility induced by the Black-Scholes method. We focus on options with the longest maturities because our focus is on long-term volatility, and traded options tend to be short-term. We use interpolated at-the-money-forward implied volatilities because prior research has demonstrated that at-the-money options perform better in predicting future volatility than in- or out-of-the-money options (see, e.g., Mayhew, 1995, Hull, 2000).

4. Empirical results

4.1 Summary statistics

Table 1 presents summary statistics for the pooled time series cross-section distribution of the variables. To mitigate the effects of outliers, we trim extreme values of all variables.[14] As expected, median DOL is relatively small at 1.09, close to the no leverage value of one, due to

[14] Extreme values of the variables are identified using the following procedure. For each variable, we calculate the 5^{th} and 95^{th} percentiles of the empirical distribution (P5 and P95 respectively) and trim observations outside the following range: P5 – 0.5 × (P95 – P5) to P95 + 0.5 × (P95 – P5). For normally distributed variables, this range covers approximately 3.3 standard deviations from the mean in each direction (= 1.645 + .5 × (1.645 – (-1.645)), which is more than 99.8% of the observations. For variables with relatively few outliers, the percentage of retained observations is very high. However, for poorly-behaved variables a relatively large proportion of the observations is deleted. Still, the overall loss of observations is much smaller than under the typical 1%-99% approach. Moreover, unlike the "traditional" 1%-99% range, which still retains some outliers, all extreme observations are removed.

the common trend in NOPAT and sales which biases the coefficient toward unit (O'Brien and Vanderheiden 1987). This estimate suggests that the median rate of change in NOPAT is only 9% larger than the rate of change in sales. In contrast, the median value of the de-trended DOL (1.45) implies that shocks to sales growth rates are associated with a median earnings growth shock that is 45% larger than the sales shock, a more reasonable estimate.

4.2 Profit margin, asset turnover, and future operating volatility

Table 2 reports summary statistics for the coefficients from cross-sectional regressions of various future volatility measures on past values of these measures, profit margin and asset turnover. So, with past volatility as a predictor in the regression, the regressions examine whether the two profitability measures add to the forecast from historical volatility. The volatility measures examined are: the degree of operating leverage (DOL, Panel A), the degree of operating leverage calculated using de-trended variables (DOL_DeTr, Panel B), the volatilities of log sales and log NOPAT (Volat_Sales, Panel C, and Volat_NOPAT, Panel E, respectively); and the volatilities of the de-trended log sales and log NOPAT (Volat_Sales_DeTr, Panel D, and Volat_NOPAT_DeTr, Panel F, respectively). The future values of the volatility measures are estimated over the years t+1 through t+5. In all cases, volatility estimates are set to missing values when they are estimated using fewer than three observations.[15]

For each volatility measure we report six sets of regressions, three OLS and three with fixed industry effects. To distinguish incremental information from overall explanatory power, we start by separately examining the information content of past volatility and the profitability components (OAT and OPM), before including all three measures in the same model. Profit margins and turnovers vary by industry (e.g., Nissim and Penman 2001), often because of

[15] We rerun all analyses using only volatility estimates derived when all five annual observations are available and obtain similar results.

varying structures to deliver profits from sales—tangible assets (capital intensive industries) versus intangible assets (service industries), for example. These structures may well induce profit volatility that is captured by the profit margin and turnover, but volatility may also be associated with other factors identified with an industry. Including fixed industry effects allows us to control for correlated omitted industry-driven risk factors. At the same time, controlling for industry effects risk throwing out the baby with the bathwater, so we report results both with and without industry effects.

Panel A of Table 2 shows that past values of the DOL measure provide little or no explanatory power for future DOL values, demonstrating the difficulty of estimating operating leverage from historical earnings-sales correlations. However, this may be partially due to measurement error in DOL. As noted earlier, the DOL measure captures common growth in earnings and sales in addition to the earnings-sales sensitivity, and growth tends to have low persistence (e.g., Chan et al 2001). Indeed when the DOL is measured using the de-trended series, it is strongly auto-correlated (Panel B of Table 2). Given the higher persistence of the de-trended DOL compared to the DOL, its more reasonable values (Table 1), and its better ability to capture the relationship between unexpected changes in earnings and sales (Section 3.2), we will focus on results obtained using the de-trended DOL instead of the DOL.

As predicted, operating profit margin is significantly negatively related to both measures of future DOL. This result holds after controlling for past values of the DOL as well as to fixed industry effects. Asset turnover is negatively related to future DOL but insignificantly related to future DOL_DeTr (the measure that we give more weight to, as explained earlier).

Unlike the DOL measures, NOPAT volatility and sales volatility are highly persistent and thus provide significant explanatory power for future values of these volatility measures. For sales volatility (Panels C and D of Table 2), profit margin provides little or no incremental information after controlling for past volatility. Asset turnover, in contrast, is negatively related to future volatility, but this effect disappears when industry fixed effects are included. Overall, it appears that profit margin and asset turnover do not help predict sales volatility once industry effects are accounted for.

The results for future NOPAT volatility are different, however. Even after controlling for historical NOPAT volatility, profit margin and asset turnover consistently add to the prediction of future NOPAT volatility. For the profit margin, this is due to the strong negative relationship with the DOL, that is, profit margin explains profit volatility via a leverage effect rather than a correlation with sales volatility. For asset turnover, this is due to somewhat weak correlations with both the DOL and sales volatility, that together add up to a significant correlation with future NOPAT volatility. Still, profit margin is consistently more significant than turnover in explaining future NOPAT volatility.

Table 3 provide the regression estimates when turnover is measured relative to reported fixed assets (PP&E) and adjusted fixed assets (APP&E) in addition to operating assets (OAT). As expected, focusing on fixed assets turnover strengthens the negative correlation of turnover with the DOL measures (Panels A and B of Table 3), especially the de-trended measure. The results are particularly strong when fixed industry effects are included and when fixed assets are adjusted to reflect leased operating capacity in addition to owned fixed assets. However, unlike operating asset turnover, the two measures of fixed asset turnover are positively related to sales growth volatility after controlling for fixed industry effects (Panels C and D). Reverse causation may explain this differential result: firms with high anticipated sales volatility invest less in PPE because of the uncertainty. Accordingly, the two measures of fixed asset turnover have less explanatory power in forecasting NOPAT volatility compared to OAT (Panel E and F).

4.3 Profit margin, asset turnover, and future stock return volatility

Having demonstrated that profit margin and asset turnover are negatively related to future operating volatility, we next examine whether these profitability components also help predict stock return volatility. To this end we regress future values of stock return volatility and its systematic and idiosyncratic components on the two operating profitability components. The results, reported in Table 4, are generally consistent with the relations between the profitability components and future operating volatility, providing further support for the hypothesis that profit margin and asset turnover inform about risk. In each of the eighteen sets of cross-sectional regressions (three stock return volatility measures, three turnover measures, and with and without fixed industry effects), profit margin is negatively and significantly related to the measure of future stock return volatility. Operating asset turnover (Panel A) is also negatively related to all three volatility measures, especially after controlling for industry effects. In contrast, the two measures of fixed asset turnover are insignificantly related to each of the three stock return volatility measures. Overall, these results are consistent with the findings of Tables 2 and 3: profit margin has a strong negative relation with future risk, and asset turnover has a weaker negative relation with future risk.

4.4 Profit margin, asset turnover, and implied volatility

If profit margin and asset turnover forecast future volatility, they should explain implied stock return volatility. Table 5 investigates. As expected, implied volatility is strongly related to historical volatility. Importantly, even after controlling for historical volatility, profit margin is strongly negatively related to implied volatility. This result, which is consistent with the findings of Tables 2, 3, and 4, demonstrates that investors use the information in profit margin when predicting stock return volatility for the purpose of valuing stock options. The risk-related information in profit margin is incremental to that in other risk proxies, including size, book-to-market, beta, idiosyncratic volatility and market leverage. Asset turnover, in contrast, is positively related to implied volatility, especially after controlling for industry fixed effects.

Table 6 examines the incremental information in profit margin and asset turnover for future stock return volatility after controlling for both historical and implied volatility as well as other relevant volatility predictors. This investigation is partially motivated by the observations that implied volatility is positively related to asset turnover while future stock return volatility is negatively related to asset turnover (in Table 4). The results reveal that profit margin (though not OAT) remains strongly related to future stock return volatility even after controlling for implied volatility and other relevant volatility predictors. This result might suggest that investors do not fully use the information in profit margin when predicting stock return volatility. An alternative explanation is that implied volatility is measured with error, either due to model error or estimation error given the model. Indeed, the high significance of size, historical volatility, and market leverage in predicting future stock return volatility, after controlling for implied volatility, supports this alternative explanation. We note that Black-Scholes models (from which implied volatility is derived) do not entertain jumps or stochastic variances.

One issue qualifies these findings. The regressions in Tables 2, 3 and 4 require volatility measures estimated over three-to-five years after the profit margin and asset turnover are observed. Thus, to be included in the analysis, a firm must have survived for three years.[16] A potential survivorship bias would seem to work against the results: firms that disappear (because of failure, for example), would have significant ex post shocks to earnings, and this is likely to be associated with low margins and low turnovers. The observation that the two metrics are associated with implied volatility in Table 4 is reassuring because survivorship is not an issue there. Indeed, that test can be viewed as a robustness test for survivorship.

4.5 Decomposition of asset turnover

Operating asset turnover (OAT) is equal to the product of fixed asset turnover (PP&ET) and the ratio of fixed assets to operating assets (PP&E_OA). These two component ratios may have different implications for risk. Indeed, the results in Tables 3 and 4 indicate substantial differences in the relationships of OAT and PP&ET with future volatility. In addition, compared to PP&ET, PP&E_OA is a more direct measure of the proportion of fixed costs (i.e., operating leverage) and it is not directly affected by sales. We therefore report in Table 7 estimates from regressions in which PP&E_OA is used instead of OAT. We also report results with the other component of OAT (PP&ET) as well as with OAT itself (PP&E_OA and PP&ET provide a multiplicative, not additive decomposition of OAT, so OAT may still contain incremental information relative to the two components ratios). Controlling for industry fixed effects, PP&E_OA is strongly positively related to the two measures of DOL, especially to the de-trended DOL (Panel B). This result is consistent with prior studies (e.g., Ferri and Jones 1979, Mandelker and Rhee 1984, Rajan and Zingales 1995). However, with control for industry fixed effects, PP&E_OA is also negatively related to sales volatility (Panel C and D), and accordingly its relationship with NOPAT volatility is insignificant (Panels E and F).

[16] As explained earlier, the volatility measures are estimated using up to five years of data with a minimum of three annual observations (for operating volatility) or 30 months (for stock returns). We obtain similar results when requiring five years of data as well as when measuring volatility over three years.

4.6 Implied operating leverage

Operating leverage is unobservable, but it can be estimated by "reverse engineering" the DOL expression derived in Section 2.1 using the DOL and the operating profit margin:

$$DOL = 1 - OL + \frac{OL}{OPM}$$

Thus,

$$OL = (DOL - 1) \times \frac{OPM}{1 - OPM}$$

Substituting the estimated de-trended DOL and the mean operating profit margin during the DOL estimation period (three to five years) allows us to derive an estimate of the mean (unobservable) operating leverage during the DOL estimation period. To evaluate this estimate we correlate it with the mean ratio of PP&E to operating assets during the DOL estimation period. We find that both the Pearson and Spearman cross-sectional correlations between the implied operating leverage and the proportion of fixed costs are positive and significant in each of the years 1968 through 2012. Figure 1 provides an alternative presentation of the relationship between the proportion of fixed assets (PP&E / Operating assets) and the implied operating leverage. To create the figure, the pooled sample is sorted based on implied operating leverage and divided into 100 equal size groups. The medians of the proportion of fixed assets and operating leverage are then calculated for each group and are plotted in the figure. The strong positive relationship is very clear.

5. Conclusion

The commonly used DuPont technique decomposes profitability into profit margin and asset turnover. While the relevance of these ratios for evaluating performance and predicting future profitability is well-established, their potential risk implications are not understood. This study assesses how the profit margin and asset turnover inform about the volatility of future net operating profit.

The profit margin describes how sales translate into operating profit. In a complementary way, our analysis shows how the profit margin informs about how the variation in sales growth rates translates into variation in the growth rate of operating profit. A measure, the degree of operating leverage (DOL), indicates the percentage change in operating profit associated with a percentage change in sales. The paper shows that this measure involves operating leverage (fixed cost relative to variable costs) but also the profit margin: for a given level of operating leverage, a high profit margin predicts a low proportional change in profit for the same sales shock. The empirical results confirm that the operating profit margin forecasts the variance of the rate of change in operating profit in a negative direction.

The operating leverage component of DOL is difficult to extract from published financial statements, but the paper shows that the second component of the DuPont decomposition, asset turnover, proxies as a measure of operating leverage that also forecasts operating profit volatility in a negative direction.

In sum, both elements in the DuPont decomposition, the operating profit margin and asset turnover, provide information that forecasts the volatility of operating profit. Further, these financial statement measures also predict stock return volatility and both the systematic and idiosyncratic aspects of stock return volatility, although the result for asset turnover is sensitive to the turnover measure used.

The paper also finds that stock option implied volatility is strongly negatively related to profit margin, even after controlling for historical volatility and other commonly used risk proxies and volatility predictors. This result indicates that investors use the information in profit margin when predicting stock return volatility for the purpose of valuing stock options. However, the profit margin forecasts stock return volatility incrementally to estimated implied volatility, suggesting that either the risk-related information in profit margin is not fully impounded in stock option prices or the profit margin identifies measurement error in estimating implied volatilities with standard Black-Scholes option pricing models.

While operating leverage is difficult to identify in published financial statements, our formulation of the DOL measure into operating leverage and profit margin components enables a measurement: given DOL and the profit margin, operating leverage can be inferred. In support, we find that the inferred measure of operating leverage is strongly correlated with the ratio of property, plant and equipment (PP&E) to total operating assets, and it is with PP&E that fixed costs are often identified.

The paper extends the analyst's DuPont into the analysis of risk. However there is one aspect that is missing. The paper deals with the variability of operating profit relative to the variability of sales, but has no analysis of the volatility of sales. An analysis of the latter, sometimes referred to as "business risk," is required to complete the analysis of the risk to operating profit.

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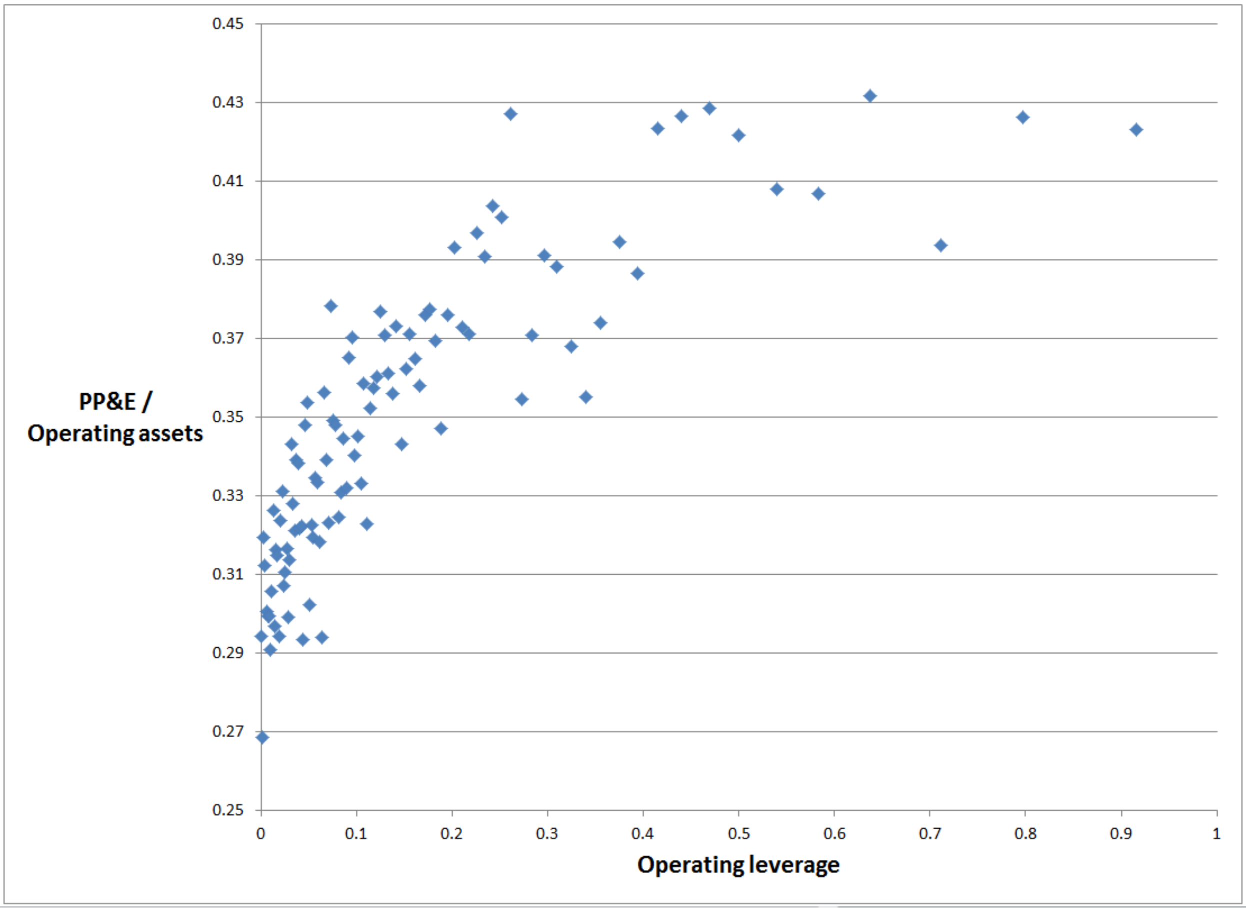
Figure 1
Implied operating leverage and the proportion of fixed assets



The figure depicts the relationship between the proportion of fixed assets (PP&E / Operating assets) and the operating leverage as implied by the de-trended DOL and operating profit margin. The pooled sample is sorted based on implied operating leverage and divided into 100 equal size groups. The medians of the proportion of fixed assets and operating leverage are then calculated for each group and are plotted in the figure.

Table 1
Descriptive statistics

	Obs.	Mean	StdDev	5%	25%	50%	75%	95%
DOL	65,322	1.254	1.921	-1.525	0.486	1.089	1.842	4.638
DOL_DeTr	64,680	1.841	4.002	-3.655	0.325	1.447	3.043	8.713
Volat_Sales	66,491	0.236	0.171	0.050	0.115	0.191	0.306	0.587
Volat_Sales_DeTr	66,423	0.100	0.084	0.014	0.040	0.075	0.133	0.278
Volat_NOPAT	66,560	0.484	0.358	0.107	0.227	0.380	0.639	1.234
Volat_NOPAT_DeTr	66,570	0.338	0.319	0.035	0.113	0.232	0.457	1.023
OPM	96,247	-0.021	0.409	-0.499	0.011	0.049	0.094	0.221
OAT	89,487	1.335	0.840	0.240	0.722	1.222	1.758	2.952
PP&ET	87,835	6.728	8.473	0.375	1.729	4.067	8.071	23.198
APP&ET	87,872	5.447	6.070	0.359	1.580	3.613	6.807	17.942
Size	95,642	5.299	2.145	2.002	3.738	5.186	6.717	9.036
BTM	92,791	0.653	0.566	0.073	0.281	0.510	0.869	1.756
MLev	95,580	0.248	0.242	0.000	0.033	0.183	0.398	0.739
Ret_Volat	79,334	0.510	0.248	0.224	0.330	0.453	0.627	0.990
Beta	79,655	1.140	0.726	0.106	0.678	1.072	1.514	2.438
Idio_Volat	79,309	0.471	0.245	0.190	0.292	0.413	0.589	0.946
Imp_Volat	24,154	0.485	0.232	0.217	0.318	0.429	0.599	0.948

For all variables other than implied volatility (*Imp_Volat*), the sample spans fiscal years 1968 through 2012. For implied volatility, the sample spans fiscal years 1995 to 2011 (implied volatility measured in April 1996 through April 2012). The variables are defined as follows (see Section 3 for additional details):

DOL	=	The degree of operating leverage, estimated as the slope coefficient from firm-specific time-series regressions of log NOPAT on log sales over the five years that end in the current year
DOL_DeTr	=	The slope coefficient from firm-specific time-series regressions of de-trended log NOPAT on de-trended log sales over the five years that end in the current year
Volat_Sales	=	The standard deviation of log sales during the five years that end in the current year
Volat_Sales_DeTr	=	The standard deviation of de-trended log sales during the five years that end in the current year
Volat_NOPAT	=	The standard deviation of log NOPAT during the five years that end in the current year
Volat_NOPAT_DeTr	=	The standard deviation of de-trended log NOPAT during the five years that end in the current year
OPM	=	Operating profit margin, calculated as the ratio of net operating profit after tax (NOPAT) to sales
OAT	=	Operating asset turnover, calculated as the ratio of sales to average operating assets
PP&ET	=	Fixed asset turnover
APP&E	=	Adjusted fixed asset turnover, calculated by adding capitalized operating lease payments to reported fixed assets
Size	=	Log of market value of equity

BTM	=	Ratio of book value of equity to the adjusted market value of equity (market value of equity at year end × (1+cumulative stock returns over the first 4 months of the following year)
MLev	=	Ratio of debt to the total of the book value of debt and the adjusted market value of equity
Ret_Volat	=	Annualized standard deviation of monthly stock returns over up to sixty months through April of the following year
Beta	=	Slope coefficient from the market model estimated using monthly stock returns over the 60 months through April of the following year (a minimum of 30 months is required)
Idio_Volat	=	Annualized root mean squared error of the market model regression
Imp_Volat	=	Stock options' implied volatility

Table 2
Summary statistics from cross-sectional regressions of alternative measures of future operating volatility on historical operating volatility and components of current profitability

Panel A: Explaining future values of the degree of operating leverage (*DOL*)

	OLS			Industry fixed effects		
Intercept	1.312	1.657	1.650			
	30.5	27.5	23.2			
OAT		-0.088	-0.095		-0.057	-0.059
		-3.0	-2.9		-2.0	-1.7
OPM		-2.468	-2.748		-2.439	-2.797
		-4.6	-5.7		-4.0	-5.2
DOL	0.015		0.022	-0.001		0.007
	1.1		1.8	-0.1		0.5
R-squared	0.003	0.015	0.018	0.145	0.138	0.158
Obs.	1,048	1,196	1,004	1,048	1,196	1,004

Panel B: Explaining future values of the de-trended degree of operating leverage (*DOL_DeTr*)

	OLS			Industry fixed effects		
Intercept	1.721	2.187	1.993			
	36.5	21.7	21.1			
OAT		-0.047	-0.037		-0.022	-0.041
		-0.9	-0.8		-0.5	-0.8
OPM		-2.949	-2.538		-2.512	-1.951
		-5.1	-4.7		-5.5	-4.9
DOL_DeTr	0.072		0.065	0.057		0.052
	9.3		8.4	5.6		5.1
R-squared	0.006	0.006	0.011	0.140	0.121	0.146
Obs.	1,036	1,185	992	1,036	1,185	992

Panel C: Explaining future values of sales volatility (*Volat_Sales*)

	OLS			Industry fixed effects		
Intercept	0.151	0.210	0.153			
	16.7	35.9	16.8			
OAT		-0.008	-0.007		-0.001	-0.002
		-3.5	-2.6		-0.5	-0.7
OPM		0.113	0.136		0.089	0.121
		1.7	2.7		1.7	2.6
Volat_Sales	0.205		0.191	0.161		0.156
	8.2		7.5	8.3		7.6
R-squared	0.065	0.019	0.082	0.252	0.214	0.255
Obs.	1,083	1,222	1,041	1,083	1,222	1,041

Panel D: Explaining future values of the volatility of de-trended sales (*Volat_Sales_DeTr*)

	OLS			Industry fixed effects		
Intercept	0.070	0.105	0.077			
	24.8	27.6	20.6			
OAT		-0.009	-0.005		-0.003	-0.000
		-5.4	-3.1		-1.7	-0.3
OPM		-0.006	0.024		-0.015	0.010
		-0.5	1.7		-1.0	0.7
Volat_Sales_DeTr	0.219		0.200	0.146		0.139
	14.2		13.3	13.5		13.3
R-squared	0.055	0.015	0.064	0.243	0.206	0.243
Obs.	1,081	1,220	1,037	1,081	1,220	1,037

Panel E: Explaining future values of the volatility of net operating profit after tax (*Volat_NOPAT*)

	OLS			Industry fixed effects		
Intercept	0.330	0.561	0.423			
	28.9	48.6	35.7			
OAT		-0.034	-0.032		-0.019	-0.021
		-3.8	-4.4		-1.9	-3.0
OPM		-0.720	-0.587		-0.775	-0.673
		-6.5	-5.6		-6.0	-6.9
Volat_NOPAT	0.246		0.239	0.183		0.173
	28.6		25.3	45.7		38.3
R-squared	0.058	0.038	0.079	0.219	0.208	0.241
Obs.	1,082	1,220	1,039	1,082	1,220	1,039

Panel F: Explaining future values of the volatility of de-trended net operating profit after tax (*Volat_NOPAT_DeTr*)

	OLS			Industry fixed effects		
Intercept	0.233	0.411	0.299			
	14.1	38.2	19.3			
OAT		-0.029	-0.022		-0.013	-0.013
		-4.7	-5.3		-2.0	-3.4
OPM		-0.618	-0.386		-0.631	-0.479
		-5.4	-5.7		-5.2	-7.5
Volat_NOPAT_DeTr	0.266		0.244	0.201		0.175
	12.2		12.9	12.0		12.5
R-squared	0.063	0.033	0.075	0.223	0.201	0.237
Obs.	1,082	1,219	1,036	1,082	1,219	1,036

In each panel, the dependent variable is an alternative volatility measure calculated over the five years subsequent to the year in which the independent variables are measured. For each independent variable (listed in the first column of each table), the first (second) row reports the time-series mean (t-statistic) of the annual cross-sectional coefficients from the corresponding regression. The t-statistics are calculated using Newey-West corrected standard errors allowing for 5 lags. The variables are defined in Table 1. The sample spans base years 1968 to 2007 (future volatility through 2012).

Table 3
Summary statistics from cross-sectional regressions of alternative measures of future operating volatility on historical operating volatility and components of current profitability using alternative turnover measures

Panel A: Explaining future values of the degree of operating leverage (*DOL*)

	OLS			Industry fixed effects		
Turnover measure	*OAT*	*PP&ET*	*APP&ET*	*OAT*	*PP&ET*	*APP&ET*
Intercept	1.650	1.540	1.539			
	23.2	35.7	35.1			
Turnover (first row)	-0.095	-0.007	-0.007	-0.059	-0.007	-0.009
	-2.9	-2.1	-1.9	-1.7	-2.1	-2.5
OPM	-2.748	-2.582	-2.574	-2.797	-2.781	-2.774
	-5.7	-7.0	-6.9	-5.2	-5.9	-5.9
DOL	0.022	0.021	0.021	0.007	0.005	0.004
	1.8	1.8	1.7	0.5	0.4	0.4
R-squared	0.018	0.016	0.016	0.158	0.161	0.161
Obs.	1,004	989	991	1,004	989	991

Panel B: Explaining future values of the de-trended degree of operating leverage (*DOL_DeTr*)

	OLS			Industry fixed effects		
Turnover measure	*OAT*	*PP&ET*	*APP&ET*	*OAT*	*PP&ET*	*APP&ET*
Intercept	1.993	2.015	2.020			
	21.1	29.4	29.5			
Turnover (first row)	-0.037	-0.013	-0.014	-0.041	-0.018	-0.023
	-0.8	-1.9	-2.1	-0.8	-3.7	-4.8
OPM	-2.538	-2.680	-2.690	-1.951	-2.056	-2.069
	-4.7	-5.7	-5.7	-4.9	-5.7	-5.8
DOL_DeTr	0.065	0.065	0.066	0.052	0.051	0.051
	8.4	8.1	8.3	5.1	4.9	5.1
R-squared	0.011	0.011	0.011	0.146	0.148	0.148
Obs.	992	978	979	992	978	979

Panel C: Explaining future values of sales volatility (*Volat_Sales*)

	OLS			Industry fixed effects		
Turnover measure	*OAT*	*PP&ET*	*APP&ET*	*OAT*	*PP&ET*	*APP&ET*
Intercept	0.153	0.142	0.142			
	16.8	17.4	17.6			
Turnover (first row)	-0.007	-0.000	-0.000	-0.002	0.001	0.001
	-2.6	-0.4	-0.5	-0.7	1.8	2.1
OPM	0.136	0.162	0.162	0.121	0.130	0.130
	2.7	2.9	2.9	2.6	2.3	2.3
Volat_Sales	0.191	0.190	0.190	0.156	0.153	0.153
	7.5	7.7	7.7	7.6	7.6	7.7
R-squared	0.082	0.080	0.079	0.255	0.257	0.257
Obs.	1,041	1,026	1,028	1,041	1,026	1,028

Panel D: Explaining future values of the volatility of de-trended sales (*Volat_Sales_DeTr*)

	OLS			Industry fixed effects		
Turnover measure	*OAT*	*PP&ET*	*APP&ET*	*OAT*	*PP&ET*	*APP&ET*
Intercept	0.077	0.070	0.070			
	20.6	25.8	26.0			
Turnover (first row)	-0.005	-0.000	-0.000	-0.000	0.000	0.000
	-3.1	-2.8	-2.3	-0.3	2.0	2.4
OPM	0.024	0.028	0.029	0.010	0.002	0.002
	1.7	3.3	3.3	0.7	0.2	0.2
Volat_Sales_DeTr	0.200	0.205	0.205	0.139	0.136	0.136
	13.3	14.1	14.0	13.3	12.3	12.3
R-squared	0.064	0.057	0.057	0.243	0.241	0.241
Obs.	1,037	1,024	1,026	1,037	1,024	1,026

Panel E: Explaining future values of the volatility of net operating profit after tax (*Volat_NOPAT*)

	OLS			Industry fixed effects		
Turnover measure	*OAT*	*PP&ET*	*APP&ET*	*OAT*	*PP&ET*	*APP&ET*
Intercept	0.423	0.381	0.380			
	35.7	47.6	48.4			
Turnover (first row)	-0.032	-0.003	-0.002	-0.021	-0.001	-0.001
	-4.4	-2.6	-2.5	-3.0	-2.1	-1.8
OPM	-0.587	-0.532	-0.528	-0.673	-0.662	-0.660
	-5.6	-7.8	-7.6	-6.9	-8.8	-8.7
Volat_NOPAT	0.239	0.246	0.246	0.173	0.174	0.174
	25.3	27.3	27.5	38.3	41.0	41.2
R-squared	0.079	0.077	0.077	0.241	0.243	0.243
Obs.	1,039	1,024	1,025	1,039	1,024	1,025

Panel F: Explaining future values of the volatility of de-trended net operating profit after tax (*Volat_NOPAT_DeTr*)

	OLS			Industry fixed effects		
Turnover measure	*OAT*	*PP&ET*	*APP&ET*	*OAT*	*PP&ET*	*APP&ET*
Intercept	0.299	0.273	0.272			
	19.3	19.3	19.6			
Turnover (first row)	-0.022	-0.002	-0.002	-0.013	-0.001	-0.001
	-5.3	-3.1	-2.9	-3.4	-1.8	-1.3
OPM	-0.386	-0.365	-0.362	-0.479	-0.493	-0.493
	-5.7	-6.9	-6.7	-7.5	-9.0	-8.9
Volat_NOPAT_DeTr	0.244	0.253	0.253	0.175	0.178	0.178
	12.9	12.7	12.7	12.5	12.0	12.0
R-squared	0.075	0.076	0.076	0.237	0.240	0.239
Obs.	1,036	1,022	1,023	1,036	1,022	1,023

In each panel, the dependent variable is an alternative volatility measure calculated over the five years subsequent to the year in which the independent variables are measured. For each independent variable (listed in the first column of each table), the first (second) row reports the time-series mean (t-statistic) of the annual cross-sectional coefficients from the corresponding regression. The t-statistics are calculated using Newey-West corrected standard errors allowing for 5 lags. The variables are defined in Table 1. The sample spans base years 1968 to 2007 (future volatility through 2012).

Table 4
Summary statistics from cross-sectional regressions of alternative measures of future stock return volatility on components of current profitability

Panel A: Turnover measured using reported operating assets

	OLS			Industry fixed effects		
Volatility measure	*Ret_Volat*	*Beta*	*Idio_Volat*	*Ret_Volat*	*Beta*	*Idio_Volat*
Intercept	0.197	0.770	0.174			
	11.4	8.3	14.8			
OAT	-0.008	-0.011	-0.007	-0.010	-0.028	-0.009
	-1.7	-0.7	-1.6	-2.6	-3.4	-2.2
OPM	-0.254	-0.258	-0.256	-0.274	-0.172	-0.276
	-5.1	-2.1	-5.1	-4.8	-1.8	-4.8
Volatility (first row)	0.612	0.313	0.628	0.562	0.237	0.584
	13.8	9.4	14.6	17.6	9.2	16.8
R-squared	0.454	0.122	0.475	0.558	0.334	0.568
Obs.	1,097	1,102	1,097	1,097	1,102	1,097

Panel B: Turnover measured using reported fixed assets

	OLS			Industry fixed effects		
Volatility measure	*Ret_Volat*	*Beta*	*Idio_Volat*	*Ret_Volat*	*Beta*	*Idio_Volat*
Intercept	0.181	0.748	0.158			
	9.3	9.2	10.7			
PP&ET	0.000	0.000	0.000	0.000	-0.001	0.000
	0.4	0.0	0.5	1.0	-0.4	1.1
OPM	-0.230	-0.183	-0.232	-0.261	-0.136	-0.264
	-5.8	-2.0	-5.7	-5.3	-1.7	-5.2
Volatility (first row)	0.613	0.311	0.630	0.561	0.236	0.584
	13.9	9.5	14.5	17.3	9.5	16.6
R-squared	0.455	0.119	0.477	0.560	0.335	0.570
Obs.	1,082	1,086	1,081	1,082	1,086	1,081

Panel C: Turnover measured using adjusted fixed assets

	OLS			Industry fixed effects		
Volatility measure	*Ret_Volat*	*Beta*	*Idio_Volat*	*Ret_Volat*	*Beta*	*Idio_Volat*
Intercept	0.181	0.748	0.158			
	9.3	9.3	10.7			
APP&ET	0.000	-0.000	0.000	0.001	-0.001	0.001
	0.5	-0.0	0.6	1.4	-0.7	1.4
OPM	-0.229	-0.182	-0.232	-0.261	-0.135	-0.264
	-5.8	-2.0	-5.7	-5.3	-1.7	-5.2
Volatility (first row)	0.613	0.311	0.630	0.561	0.236	0.584
	13.9	9.5	14.5	17.2	9.5	16.4
R-squared	0.455	0.118	0.477	0.560	0.335	0.570
Obs.	1,083	1,087	1,082	1,083	1,087	1,082

In each panel, turnover (an independent variable) is measured differently. The dependent variable in each regression is a measure of stock return volatility calculated over the five years subsequent to the year in which the independent variables are measured. For each independent variable (listed in the first column of each table), the first (second) row reports the time-series mean (t-statistic) of the annual cross-sectional coefficients from the corresponding regression. The t-statistics are calculated using Newey-West corrected standard errors allowing for 5 lags. The variables are defined in Table 1. The sample spans base years 1968 to 2007 (future volatility through 2012).

Table 5
Summary statistics from cross-sectional regressions explaining implied volatility using components of current profitability and control variables

	OLS			Industry fixed effects		
Intercept	0.156	0.174	0.390			
	17.0	14.0	22.7			
OAT		0.004	0.001		0.003	0.006
		2.0	0.5		1.5	4.9
OPM		-0.086	-0.070		-0.089	-0.069
		-4.8	-6.1		-6.0	-7.2
Ret_Volat	0.620	0.574		0.565	0.524	
	9.7	8.8		11.4	10.6	
Beta			0.030			0.028
			4.8			5.6
Idio_Volat			0.442			0.369
			7.2			8.4
Size			-0.025			-0.027
			-23.9			-19.8
BTM			0.020			0.017
			5.8			5.3
MLEV			0.008			0.070
			0.7			6.1
R-squared	0.550	0.576	0.650	0.628	0.648	0.714
Obs.	1,237	1,174	1,156	1,237	1,174	1,156

The dependent variable in each regression is implied volatility. For each independent variable (listed in the first column of each table), the first (second) row reports the time-series mean (t-statistic) of the annual cross-sectional coefficients from the corresponding regression. The t-statistics are calculated using Newey-West corrected standard errors allowing for 5 lags. The variables are defined in Table 1. The sample spans fiscal years 1995 to 2011 (implied volatility measured on April 1996 through April 2012).

Table 6
Summary statistics from cross-sectional regressions explaining future stock return volatility using components of current profitability, implied volatility and control variables

	OLS			Industry fixed effects		
Intercept	0.125	0.212	0.327			
	5.6	6.0	15.2			
OAT	-0.002	0.002	-0.009	-0.002	0.002	-0.008
	-0.9	0.5	-3.0	-1.3	0.5	-1.9
OPM	-0.039	-0.044	-0.158	-0.055	-0.055	-0.157
	-2.7	-3.2	-6.2	-3.0	-3.3	-7.0
Imp_Volat	0.569	0.500		0.511	0.414	
	10.8	13.2		7.3	7.1	
Ret_Volat	0.246			0.247		
	2.2			3.1		
Beta		0.025	0.025		0.021	0.016
		3.5	5.1		6.9	5.5
Idio_Volat		0.211	0.483		0.199	0.419
		1.9	11.8		2.6	14.5
Size		-0.013	-0.018		-0.017	-0.020
		-3.9	-8.4		-16.4	-10.9
BTM		0.023	0.001		0.012	-0.001
		0.9	0.1		0.4	-0.1
MLEV		0.122	0.067		0.130	0.101
		2.0	2.5		3.1	5.2
R-squared	0.475	0.519	0.516	0.613	0.642	0.614
Obs.	778	769	1,072	778	769	1,072

The dependent variable in each regression is stock return volatility calculated over five years subsequent to the reporting of the profit margin and asset turnover, year t. For each independent variable (listed in the first column of each table), the first (second) row reports the time-series mean (t-statistic) of the annual cross-sectional coefficients from the corresponding regression. The t-statistics are calculated using Newey-West corrected standard errors allowing for 5 lags. The variables are defined in Table 1. The sample for the implied volatility regressions spans fiscal years 1995 to 2011 (implied volatility measured on April 1996 through April 2012). For the other regressions, the sample spans base years 1968 to 2007 (future volatility through 2012).

Table 7
Summary statistics from cross-sectional regressions of alternative measures of future operating volatility on historical operating volatility, operating profit margin and components of operating asset turnover

Panel A: Explaining future values of the degree of operating leverage (*DOL*)

	OLS			Industry fixed effects		
Intercept	1.459	1.612	1.709			
	28.8	27.2	19.9			
PP&E_OA	0.046	-0.134	-0.057	0.327	0.289	0.324
	0.7	-1.9	-1.0	3.1	2.5	2.9
OPM	-2.341	-2.522	-2.845	-2.656	-2.815	-2.977
	-6.5	-7.2	-6.4	-5.5	-6.2	-5.9
DOL	0.019	0.021	0.022	0.003	0.005	0.006
	1.5	1.7	1.8	0.3	0.4	0.5
PP&ET		-0.012	0.003		-0.002	0.005
		-2.6	0.8		-0.8	1.6
OAT			-0.124			-0.074
			-3.2			-1.7
R-squared	0.016	0.018	0.021	0.159	0.162	0.165
Obs.	1,036	989	978	1036	989	978

Panel B: Explaining future values of the de-trended degree of operating leverage (*DOL_DeTr*)

	OLS			Industry fixed effects		
Intercept	1.791	1.889	1.825			
	18.9	11.9	11.4			
PP&E_OA	0.321	0.254	0.336	1.063	1.234	1.300
	2.4	1.2	1.6	8.1	8.8	8.5
OPM	-2.465	-2.732	-2.829	-2.123	-2.329	-2.446
	-6.7	-6.1	-5.0	-5.1	-5.6	-4.8
DOL_DeTr	0.066	0.064	0.063	0.052	0.049	0.048
	8.3	7.9	8.2	5.1	4.9	5.0
PP&ET		-0.007	-0.002		0.008	0.012
		-0.8	-0.2		1.7	1.0
OAT			0.015			-0.017
			0.2			-0.2
R-squared	0.011	0.013	0.015	0.147	0.150	0.153
Obs.	1,023	978	967	1,023	978	967

Panel C: Explaining future values of sales volatility (*Volat_Sales*)

	OLS			Industry fixed effects		
Intercept	0.139	0.132	0.143			
	23.5	13.7	14.6			
PP&E_OA	0.006	0.022	0.030	-0.020	-0.002	0.008
	0.5	1.4	2.0	-2.0	-0.2	0.7
OPM	0.167	0.159	0.120	0.132	0.132	0.117
	3.3	2.9	2.3	2.6	2.3	2.3
Volat_Sales	0.192	0.188	0.188	0.156	0.153	0.154
	7.8	7.7	7.5	7.8	7.7	7.6
PP&ET		0.000	0.002		0.000	0.001
		0.4	3.1		0.9	4.4
OAT			-0.013			-0.007
			-4.2			-2.2
R-squared	0.082	0.085	0.089	0.256	0.258	0.260
Obs.	1,072	1,026	1,014	1,072	1,026	1,014

Panel D: Explaining future values of the volatility of de-trended sales (*Volat_Sales_DeTr*)

	OLS			Industry fixed effects		
Intercept	0.064	0.068	0.073			
	35.6	19.4	19.3			
PP&E_OA	0.007	0.007	0.013	-0.022	-0.020	-0.015
	1.5	0.8	1.8	-7.1	-2.8	-2.9
OPM	0.047	0.028	0.009	0.017	0.006	0.003
	4.9	3.4	0.8	1.2	0.4	0.3
Volat_Sales_DeTr	0.206	0.203	0.194	0.136	0.134	0.133
	12.9	13.9	13.0	12.4	12.5	12.6
PP&ET		-0.000	0.001		-0.000	0.000
		-1.5	2.6		-0.6	1.2
OAT			-0.007			-0.002
			-3.4			-1.2
R-squared	0.062	0.061	0.066	0.243	0.243	0.244
Obs.	1,070	1,024	1,012	1,070	1,024	1,012

Panel E: Explaining future values of the volatility of net operating profit after tax (*Volat_NOPAT*)

	OLS			Industry fixed effects		
Intercept	0.345	0.368	0.400			
	29.0	28.5	21.5			
PP&E_OA	0.048	0.033	0.065	0.021	0.021	0.055
	3.8	1.2	3.2	1.3	0.9	2.7
OPM	-0.455	-0.539	-0.661	-0.606	-0.665	-0.728
	-7.2	-8.6	-7.1	-7.7	-9.0	-7.9
Volat_NOPAT	0.243	0.245	0.239	0.175	0.173	0.172
	24.4	26.4	26.0	40.5	39.8	38.9
PP&ET		-0.002	0.003		-0.001	0.003
		-1.5	3.0		-1.5	2.7
OAT			-0.040			-0.030
			-4.6			-3.0
R-squared	0.073	0.080	0.088	0.236	0.244	0.249
Obs.	1,070	1,024	1,012	1,070	1,024	1,012

Panel F: Explaining future values of the volatility of de-trended NOPAT (*Volat_NOPAT_DeTr*)

	OLS			Industry fixed effects		
Intercept	0.241	0.259	0.278			
	15.5	15.7	15.4			
PP&E_OA	0.042	0.032	0.055	0.002	-0.003	0.019
	3.3	1.2	2.4	0.2	-0.1	1.2
OPM	-0.301	-0.372	-0.446	-0.434	-0.495	-0.528
	-6.1	-7.5	-7.5	-7.9	-8.9	-8.5
Volat_NOPAT_DeTr	0.253	0.253	0.245	0.180	0.177	0.175
	12.5	12.5	12.3	12.2	11.9	12.1
PP&ET		-0.001	0.002		-0.001	0.001
		-1.3	1.7		-1.5	1.8
OAT			-0.026			-0.018
			-4.4			-3.5
R-squared	0.073	0.079	0.083	0.234	0.241	0.244
Obs.	1,070	1,022	1,010	1,070	1,022	1,010

In each panel, the dependent variable is an alternative volatility measure calculated over the five years subsequent to the year in which the independent variables are measured. For each independent variable (listed in the first column of each table), the first (second) row reports the time-series mean (t-statistic) of the annual cross-sectional coefficients from the corresponding regression. The t-statistics are calculated using Newey-West corrected standard errors allowing for 5 lags. The variables are defined in Table 1. The sample spans base years 1968 to 2007 (future volatility through 2012).