Operating Profit Variation Analysis:
Implications for Future Earnings and Equity Values

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ABSTRACT

This study investigates the information content of variation analysis—that is, analysis of year-over-year changes in the components of operating profit. Using industry-level data, we find that the effects on profitability of changes in the prices of output products and costs of intermediate inputs are more persistent than the effects of changes in output volume, labor cost, labor productivity, and intermediate input productivity. We further show that this information is priced by investors. One implication of these results is that the documented higher persistence of revenue shocks compared to expense shocks is likely due to price rather than volume effects.

1. Introduction

We investigate the ability of variation analysis to predict future operating profit and the pricing of this information. Variation analysis, or analysis of changes in operating profit, is a modification of the standard variance analysis where variances are measured relative to prior period amounts instead of relative to budgets.[1] In a typical variance analysis, deviations of operating profits from budgeted amounts are attributed to price, volume, cost-inflation and productivity (efficiency) effects. This information is used to identify areas that require particular attention, take corrective actions, evaluate performance of managers or business units, or make other business decisions. The key components of variation analysis are similar to those of variance analysis. The objective typically is to identify the root causes of the changes in operating profit year-over-year and guide business decisions. The analysis is especially helpful to determine realistic financial performance targets for the next period.

The importance of analyzing variances/variations is well recognized in managerial accounting (see, e.g., Horngren et al. 2006). Anecdotally, it seems that many companies use some form of variations analysis in analyzing their performance and developing their plans for next period[2]. However, firms generally do not provide systematic variance or variation analysis in publicly available financial reports[3]. Over time, some companies have disclosed selected variations analysis information in their MD&A section or in their annual investor presentations, but there is little discussion, if any, of the methodology used to quantify the effects of the different variables disclosed (examples include General Electric, J.P. Morgan, Honeywell,

[1] A variance is the difference between planned, budgeted or standard cost or revenue and actual cost or revenue. Variance analysis is an analysis of the factors that have caused the difference between the pre-determined standards and the actual results.

[2] Several surveys corroborate this assertion (e.g. Drury and Tales [1994], Mouritsen [1996], Guilding et al. [1998]).

[3] One exception is the banking industry, where firms often provide volume/rate analysis that explains changes in net interest income.

Exxon-Mobil, and Sony).[4] In fact, the SEC explicitly requires that the MD&A section includes a discussion of changes in volume and prices that either explain material increases in revenues or alter significantly the relationship between revenues and costs[5], although no specific methodology is established. This requirement has been reiterated in successive interpretive guidance regarding the disclosure of the MD&A section.[6] However, the lack of uniformity in disclosures makes it difficult to evaluate the informativeness of variation analysis using firm-specific publicly available data. In this paper we use industry-level data, obtained from the Industry Economic Accounts (IEA) web page of the Bureau of Economic Analysis (BEA), to construct proxies for elements of variation analysis. We then use the estimated components to examine the usefulness of variation analysis in predicting industry level future operating profit. We find that some elements of variation analysis are consistently useful in predicting operating profits while others are not. In particular, the price effect and the intermediate inputs cost effect are consistently significant in predicting future operating profit after controlling for current operating profit. In contrast, the volume, labor cost, labor productivity and intermediate inputs productivity effects are significant only for selected sectors.[7]

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[4] For example, the MD&A section of General Electric's 2005 Annual Report contains the following disclosure for its Healthcare business (similar disclosures are provided for the other major business units): "[In 2005] operating profit of $2.7 billion was 17% higher than in 2004 as **productivity** ($0.5 billion) and **higher volume** ($0.4 billion) more than offset **lower prices** ($0.4 billion) and **higher labor and other costs** ($0.1 billion)."

[5] Management's Discussion and Analysis of Financial Condition and Results of Operations, Paragraphs (a)(3)(ii), (iii), and (iv) in Item 303 of Regulation S-K. SEC Rules and Regulations.

[6] The most recent interpretive guidance is dated December 2003 (Release Nos. 33-8350; 34-48960; FR-72). A particularly explicit interpretive guidance was the one published in May 1989 (Release Nos. 33-6835; 34-26831; IC-16961; FR-36) as a result of the SEC's review of the MD&A disclosures of 650 firms. The SEC developed an MD&A quality score that has been used in subsequent research (see, e.g., Barron et al. [1996]). One of the components in this quality measure is the "disclosure of the relation of price, volume or new products on sales."

[7] This result is far form obvious. In fact, a priori, one might argue that productivity effect is likely to be more persistent because it is much less affected by competitors' actions than price or volume.

We then examine the pricing of this information, substituting contemporaneous and next year's industry stock returns for next year's operating profit as the dependent variables. We find that, at the industry level, components of variation analysis are priced in an efficient way: the signs and significance of the coefficients from the contemporaneous stock returns and future operating profit regressions are generally similar. In contrast, none of the variation analysis components is significant when predicting future stock returns.

This study makes contributions to both financial and managerial accounting research. A primary objective of financial reporting is to provide information useful for the prediction of future earnings (Statement of Financial Accounting Concepts (SFAC) No. 1). Thus, by demonstrating that variation analysis informs on future operating profit, this study suggests that the FASB may improve the usefulness of financial reports by requiring firms to disclose summary information on prices, costs, and quantities of output and input units[8]. This suggestion could be similarly applicable to the current SEC requirement mentioned above. The SEC may find it desirable to be more specific about the methodology and analysis necessary to provide the variations disclosures it has been advocating[9]. A related implication of this study is that managers may be better able to predict profitability by conducting variation analysis. In their review of empirical research in managerial accounting, Ittner and Larcker (2001) point out the potential contribution of this line of research:

> A final observation from our review is the lack of integration between financial and managerial accounting research. With the possible exception of compensation studies, accounting researchers have treated these fields as independent, even though it is likely that these choices do not stand alone. For example, the value-based management

[8] We acknowledge that there are potential costs associated with the disclosure of this information, especially, given its proprietary nature. Yet, for firms with a considerable market and product diversification, this concern could be relatively moot.

[9] Although the MD&A section is not audited, it is part of the documents filed to the SEC that must be certified by the CEO and the CFO under Sarbanes-Oxley. Misleading MD&A reports were at the heart of recent cases the SEC brought against firms such as Kmart, Coca-Cola and Global Crossing (see "The SEC: Cracking Down on Spin", Business Week, September 26th, 2005)

> literature argues that the value driver analysis should not only influence the choice of action plans and the design of control systems, but should also affect external disclosure requirements …. This claim is consistent with calls in the financial accounting community for greater disclosure of information on key value drivers …. Without greater integration of financial and managerial accounting research, our understanding of the choice and performance implications of internal and external accounting and control systems is far from complete.

Indeed, one of the most interesting findings of this study has immediate implications for financial accounting research. Our results suggest that the previously documented higher persistence of revenue shocks compared to expense shocks (see, e.g., Lipe [1986], Swaminathan and Weintrop [1991], and Ertimur et al. [2003]), might be due to price rather than volume effect. In fact, we find that while the price effect is highly persistent, the volume effect is less persistent than most other drivers of operating profit, at least at the industry level.[10]

The study proceeds as follows. The methodology is developed in Section 2. Section 3 discusses the data. Section 4 examines the information content of variation analysis regarding future operating profit, and Section 5 investigates the pricing of this information. Section 6 decomposes the volume effect, and Section 7 presents results by sectors. Section 8 concludes.

[10] This result could also have implications for equity valuation. A common practice among many analysts is to forecast sales starting with industry data, specially considering that they do not have the same access to firm-level information as managers do (see Piotroski and Roulstone [2004]). Recognizing the different persistence of the different sales components could improve the accuracy of the prediction.

2. Methodology

2.1 Operating Profit Variation Analysis

In this section we develop a quantitative framework for decomposing operating profit changes into different key effects. Our model is based on the traditional variance analysis taught in managerial accounting courses and developed in a vast normative literature since the 30's.[11]

Assuming a negligible foreign exchange effect, the annual change in operating profit is due to changes in:

- Average (over the period) price per output unit of type k, k = 1,2,…,K (P_k).
- Average cost per input unit of type j, j = 1,2,…,J (C_j).
- Quantity of output units sold of type k, k =1,2,…,K (Q_k).
- Average number of input units of type j, j = 1,2,…,J, per output unit sold of type k, k = 1,2,…,K (productivity of factor j in producing output k or $Prod_{j,k}$).[12]
- Total amount of fixed operating expenses of type h, h = 1,2,…,H (FC_h).[13]

These quantities can be used to express revenue (*REV*), variable operating expenses (*VC*), total operating expenses (*EXP*), contribution margin (*CM*) and operating profit (*OP*) as follows:

$$REV = \sum_{k=1}^{K} REV_k = \sum_{k=1}^{K} P_k \times Q_k \qquad (1)$$

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[11] Shank and Churchill (1977) review variance analysis. Banker et al. (1989) study productivity variance measurements in the context of a variance analysis system. Horngren et al. (2006) discuss variations analysis for a single product setting; their operating profit decomposition, referred to as "Strategic Profitability Analysis", is conceptually similar to ours.

[12] We define $Prod_{j,k}$ as the number of input units per output unit in order to obtain a more parsimonious expression. The analysis is similar (but more cumbersome) when *Prod* is defined as the number of output units per input unit. Another modeling choice related to *Prod* is that we use output sold adjusted for changes in inventory (at current cost) rather than output produced. This is due primarily to data availability considerations. We note that some companies that disclose productivity results similarly define productivity based on sales rather than production (see for example the annual reports of General Electric from 2000 to 2005, and JP Morgan in 1999).

[13] Both variable and fixed costs can be further classified as direct versus indirect. However, this distinction would make the notation unnecessarily cumbersome as it has no implications for our analysis.

$$VC = \sum_{j=1}^{J}\sum_{k=1}^{K} VC_{j,k} = \sum_{j=1}^{J}\sum_{k=1}^{K} C_j \times Q_k \times Prod_{j,k} \tag{2}$$

$$EXP = VC + FC = \sum_{j=1}^{J}\sum_{k=1}^{K} VC_{j,k} + \sum_{h=1}^{H} FC_h = \sum_{j=1}^{J}\sum_{k=1}^{K} C_j \times Q_k \times Prod_{j,k} + \sum_{h=1}^{H} FC_h$$

$$CM = \sum_{k=1}^{K} CM_k = \sum_{k=1}^{K} REV_k - \sum_{j=1}^{J}\sum_{k=1}^{K} VC_{j,k} = \sum_{k=1}^{K} P_k \times Q_k - \sum_{j=1}^{J}\sum_{k=1}^{K} C_j \times Q_k \times Prod_{j,k} \tag{3}$$

$$OP = REV - EXP = \sum_{k=1}^{K} P_k \times Q_k - \sum_{j=1}^{J}\sum_{k=1}^{K} C_j \times Q_k \times Prod_{j,k} - \sum_{h=1}^{H} FC_h$$

The annual change in revenues can be calculated as

$$\Delta REV = REV - REV_{-1} = \sum_{k=1}^{K} (P_k \times Q_k - P_{k,-1} \times Q_{k,-1}) =$$

$$= \sum_{k=1}^{K} [(P_k - P_{k,-1}) \times Q_{k,-1} + P_k \times Q_k - P_k \times Q_{k,-1}] = \sum_{k=1}^{K} (\Delta P_k \times Q_{k,-1} + P_k \times \Delta Q_k) \tag{4}$$

where the subscript "-1" denotes prior period values. Similarly, we can derive the annual change in expenses:

$$\Delta EXP = EXP - EXP_{-1} = \sum_{j=1}^{J}\Big(\sum_{k=1}^{K} VC_{j,k} - \sum_{k=1}^{K} VC_{j,k,-1} \Big) + \sum_{h=1}^{H} FC_h - \sum_{h=1}^{H} FC_{h,-1} =$$

$$= \sum_{j=1}^{J}\Big(\sum_{k=1}^{K} C_j \times Q_k \times Prod_{j,k} - \sum_{k=1}^{K} C_{j,-1} \times Q_{k,-1} \times Prod_{j,k,-1} \Big) + \sum_{h=1}^{H} \Delta FC_h =$$

$$= \sum_{j=1}^{J}\Big(\sum_{k=1}^{K} C_j \times Q_k \times Prod_{j,k} - \sum_{k=1}^{K} C_j \times Q_{k,-1} \times Prod_{j,k,-1}$$

$$+ \sum_{k=1}^{K} C_j \times Q_{k,-1} \times Prod_{j,k,-1} - \sum_{k=1}^{K} C_{j,-1} \times Q_{k,-1} \times Prod_{j,k,-1} \Big) + \sum_{h=1}^{H} \Delta FC_h =$$

$$= \sum_{j=1}^{J}\Big(\sum_{k=1}^{K} C_j \times (Q_k \times Prod_{j,k} - Q_{k,-1} \times Prod_{j,k,-1})$$

$$+ \sum_{k=1}^{K} (C_j - C_{j,-1}) \times Q_{k,-1} \times Prod_{j,k,-1} \Big) + \sum_{h=1}^{H} \Delta FC_h =$$

$$= \sum_{j=1}^{J}\Big(\sum_{k=1}^{K} C_j \times (\Delta Q \times Prod_{j,k,-1} + Q_k \times \Delta Prod_{j,k}) + \sum_{k=1}^{K} \Delta C_j \times Q_{k,-1} \times Prod_{j,k,-1} \Big) + \sum_{h=1}^{H} \Delta FC_h \tag{5}$$

Combining expressions (4) and (5), the annual change in operating profit (*ΔOP*) is:

$$\Delta OP = \Delta REV - \Delta EXP = \sum_{k=1}^{K} (\Delta P_k \times Q_{k,-1} + P_k \times \Delta Q_k)$$

$$- \sum_{j=1}^{J} \Big(\sum_{k=1}^{K} C_j \times (\Delta Q \times Prod_{j,k,-1} + Q_k \times \Delta Prod_{j,k}) + \sum_{k=1}^{K} \Delta C_j \times Q_{k,-1} \times Prod_{j,k,-1} \Big) - \sum_{h=1}^{H} \Delta FC_h \quad (6)$$

Substituting relationships (1) through (3) into equation (6), we obtain (see appendix 1 for details):

$$\Delta OP = \sum_{k=1}^{K} (\Delta P_k / P_{k,-1}) \times REV_{k,-1} + \sum_{k=1}^{K} (\Delta Q_k / Q_{k,-1}) \times CM_{k,-1} - \sum_{j=1}^{J} (\Delta C_j / C_{j,-1}) \times VC_{j,-1}$$
$$- \sum_{j=1}^{J} \sum_{k=1}^{K} (\Delta Prod_{j,k} / Prod_{j,k,-1}) \times VC_{j,k,-1} - \sum_{h=1}^{H} (\Delta FC_h / FC_{h,-1}) \times FC_{h,-1}$$
$$+ \sum_{k=1}^{K} (\Delta Q_k / Q_{k,-1}) \times (\Delta P_k / P_{k,-1}) \times REV_{k,-1}$$
$$- \sum_{j=1}^{J} \sum_{k=1}^{K} (\Delta Q_k / Q_{k,-1}) \times (\Delta Prod_{j,k} / Prod_{j,k,-1}) \times VC_{j,k,-1}$$
$$- \sum_{j=1}^{J} \sum_{k=1}^{K} (\Delta Q_k / Q_{k,-1}) \times (\Delta C_j / C_{j,-1}) \times VC_{j,k,-1}$$
$$- \sum_{j=1}^{J} \sum_{k=1}^{K} (\Delta Q_k / Q_{k,-1}) \times (\Delta C_j / C_{j,-1}) \times (\Delta Prod_{j,k} / Prod_{j,k,-1}) \times VC_{j,k,-1}$$
$$- \sum_{j=1}^{J} \sum_{k=1}^{K} (\Delta Prod_{j,k} / Prod_{j,k,-1}) \times (\Delta C_j / C_{j,-1}) \times VC_{j,k,-1} \quad (7)$$

or

ΔOP = price effect + volume effect + cost inflation effects + productivity effects

+ fixed cost effect + 5 joint effects

respectively.

The price effect represents the effect on operating profitability of changes in output prices. All else equal, the price effect is equal to the summation of the percentage change in each output price ($\Delta P_k/P_{k,-1}$) times the amount of prior period revenue from each output ($REV_{k,-1}$).

The volume effect measures the impact of changes in the quantity of output sold on operating profitability. Since quantity affects both revenues and variable expenses, the volume effect is proportional to the prior period contribution margin: holding constant the contribution margin per unit, a rise in volume increases the contribution margin by the same percentage. Accordingly, the volume effect is equal to the aggregate over all outputs of $(\Delta Q_k / Q_{k,-1}) \times CM_{k,-1}$.

The cost inflation effects represent the impact of changes in input prices on operating profits. All else equal, a rise in the cost of input *j* increases the related variable operating expense by the same percentage. Therefore, the cost inflation effect for input *j* is equal to the negative of the product of the percentage change in the cost per unit ($\Delta C_j / C_{j,-1}$) and the related variable operating expense in the prior period ($VC_{j,-1}$).

The productivity effects reflect the impact of changes in the productivity of inputs on operating profits. For each input, we measure the contribution of productivity improvements to operating profits by aggregating the expression $(-\Delta Prod_{j,kj}/Prod_{j,k,-1}) \times VC_{j,k,-1}$ over all output units. The first element in the product measures the percentage reduction in the number of input units of type *j* required to produce a given number of output units *k*. The second term measures the cost of the required input units prior to the improvement in productivity.

The impact of fixed costs is clear—cost increases reduce operating profit dollar-for-dollar. By definition, the fixed cost effect is not related to the number of output units, input units or the cost of inputs. Some textbooks refer to this component as the spending variance.

The joint variances are second-order effects, that is, products of changes by changes. These terms can be incorporated in the analysis either by arbitrarily assigning them to the first order effects, or by including them in the analysis in a similar fashion to the first order effects. The first option is suggested in textbooks and used by practitioners (for example, Horngren et al.

[2006] assign the joint price-quantity variance to the price effect).[14] However, using this approach would hinder our ability to interpret the coefficients of the first order effects. The second alternative requires adding five additional variables to our regressions, substantially decreasing the power of the tests. Moreover, as we show below, at least for our sample (industry-year observations), the joint effects are negligible compared to the first order effects. We therefore selected to exclude these terms from the regressions.

2.2 Measurement

As discussed below, we use a database that provides industry-wide estimates of all the quantities of equation (7), with three exceptions. First, the amounts are not provided by output (*k*) but rather using indices and dollar aggregates. This means that the product mix effects are intermingled with the price and volume effects. Second, the database does not make the distinction between fixed and variable costs, and provides limited data on the cost of fixed assets. We therefore focus on an earnings measure which excludes the cost of fixed assets and treat all included costs as variable (i.e., $EXP_j = VC_j$ and $OP = CM$).[15] Third, $\Delta Prod_j/Prod_{j,-1}$ is not given explicitly. Fortunately, this latter quantity can be derived using available information. By definition, $Prod_j = I_j / Q$, where I_j is the number of input units j required to produce Q, and so

$$\Delta Prod_j/Prod_{j,-1} \quad = (I_j / Q - I_{j,-1} / Q_{-1}) / (I_{j,-1} / Q_{-1}) = (I_j \times Q_{-1} - I_{j,-1} \times Q) / (I_{j,-1} \times Q)$$

[14] Horngren et al. (2006) refer to our price effect as "Revenue Effect of Price Recovery" and, according to our notation and assuming a single product setting, define it as follows:
Price effect = $(\Delta P/P_{-1}) \times REV_{-1} + (\Delta Q/Q_{-1}) \times (\Delta P/P_{-1}) \times REV_{-1} = (\Delta P/P_{-1}) \times (P_{-1} \times Q_{-1}) \times [1+(\Delta Q/Q_{-1})] = (P - P_{-1}) \times Q$

[15] Our definition of operating expenses includes primarily materials and compensation. A survey by NAA Tokyo Affiliate (1988) suggests that most US manufacturing companies classify these expenses as variable. To the extent that our definition of operating expenses include some fixed costs, we are going to underestimate (overestimate) the quantity effect when there is a quantity percentage increase (decrease). In section 6, we show that this does not affect our results because both, the volume effect for revenues and the volume effect for expenses, exhibit similar significant coefficients.

$$= [(I_{j,-1} + \Delta I_j) \times Q_{-1} - I_{j,-1} \times (Q_{-1} + \Delta Q)]/(I_{j,-1} \times Q_{-1} + \Delta Q \times I_{j,-1})$$
$$= (\Delta I_j / I_{j,-1} - \Delta Q / Q_{-1})/(1 + \Delta Q / Q_{-1})$$

We thus use input and quantity indexes to measure productivity.

To summarize, the components of the variance analysis are calculated as follows:

$PriceEffect = (\Delta P/P_{-1}) \times REV_{-1}$

$VolumeEffect = (\Delta Q/Q_{-1}) \times OP_{-1}$

$CostEffect_j = -(\Delta C_j/C_{j,-1}) \times EXP_{j,-1}$, j = 1,2,…,J

$ProdEffect_j = [(\Delta Q/Q_{-1} - \Delta I_j/I_{j,-1}) / (1 + \Delta Q/Q_{-1})] \times EXP_{j,-1}$, j = 1,2,…,J.

As discussed above, these terms have been derived assuming that the joint effects are negligible. In addition, changes in product and input mixes, and measurement errors in the variables, possibly add significant noise to the estimated effects. Therefore, to evaluate the accuracy of the above decomposition, we define and examine the magnitude of the following term:

$$Unexplained = \Delta OP - PriceEffect - VolumeEffect - \sum_{j=1}^{J} CostEffect_j - \sum_{j=1}^{J} ProdEffect_j.$$

where *Unexplained* measures that portion of the actual change in operating profit which is not accounted for by the variation analysis components.

Ideally we would use firm-specific data to measure the variance analysis components and then analyze their information content. Unfortunately, such data are not publicly available. Instead, we use industry-level data that we extract from the Industry Economic Accounts (IEA) web page of the Bureau of Economic Analysis (BEA).[16] These data cover several categories and have alternative formats. The data required for our analysis are included in the "GDP by Industry" files. We use the SIC version of these files since that version covers a substantially

[16] http://www.bea.gov/bea/dn2/home/annual_industry.htm.

longer time period compared to the alternative NAICS version (1977-1997 vs. 1998-2005).[17] The files include by-industry estimates of gross output (sales or receipts and other operating income, commodity taxes, and inventory change), intermediate inputs (energy, raw materials, semi-finished goods, and purchased services), compensation of employees, number of employees, chain-type price and quantity indexes of gross output and intermediate inputs, and other data. We next discuss the definitions of the variables we use.

Revenue. We measure operating revenue (*REV*) as "gross output" (IEA item *GO*).

Operating Expenses. Input factors include labor, capital, and intermediate purchases such as raw materials, energy, and services purchased from other companies. We measure operating expenses (*EXP*) as the total of "compensation of employees" (IEA item *COMP*) and "intermediate inputs" (IEA item *II*). As mentioned earlier, this measure of operating expenses excludes depreciation and amortization (referred to as "capital consumption" in IEA reports). Accordingly, our measure of operating profits is similar to Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA).[18]

Operating Profits. We measure operating profits as the difference between operating revenues and operating expenses:

$$OP = REV - EXP$$

Price Change. We measure $\Delta P/P_{-1}$ as the annual change in "chain-type price indexes for gross output" (IEA item *GOPI*), divided by the value of this index in the prior year:[19]

[17] IEA also provides a "historic" version of the data by NAICS, but this version does not include all the required variables.

[18] Moulton and Seskin (2003), in a BEA methodology paper, mention that the Gross Operating Surplus (GOS) in the National Income and Product Accounts is analogous to EBITDA in financial accounting. The difference between our estimation of EBITDA and GOS is only the amount of Taxes on Production and Imports, less subsidies (TXPIX), which on average represents less than 4% of Gross Output (Revenues).

$$\Delta P/P_{-1} = \frac{\Delta GOPI}{GOPI_{-1}}$$

Quantity Change. We measure $\Delta Q/Q_{-1}$ as the annual change in "chain-type quantity indexes for gross output" (IEA item *GOQI*), divided by the value of this index in the prior year:

$$\Delta Q/Q_{-1} = \frac{\Delta GOQI}{GOQI_{-1}}$$

Labor Cost Inflation. $\Delta C_{Labor}/C_{Labor,-1}$ is measured as the annual change in compensation per employee (*CompPerEmp*), divided by the prior year value of this variable:

$$\Delta C_{Labor}/C_{Labor,-1} = \frac{\Delta CompPerEmp}{CompPerEmp_{-1}}$$

where *CompPerEmp* is measured as the ratio of "compensation of employees" (IEA item *COMP*) to the number of "full-time equivalent employees" (IEA item *FTE*):

$$CompPerEmp = \frac{COMP}{FTE}$$

Intermediate input inflation. $\Delta C_{II}/C_{II,-1}$ is measured as the annual change in "chain-type price indexes for intermediate inputs" (IEA item *IIPI*), divided by the value of this index in the prior year:

$$\Delta C_{II}/C_{II,-1} = \frac{\Delta IIPI}{IIPI_{-1}}$$

Change in labor input. $\Delta I_{Labor}/I_{Labor,-1}$ is measured as the annual change in "full-time equivalent employees" (IEA item *FTE*), divided by the value of this index in the prior year:

$$\Delta I_{Labor}/I_{Labor,-1} = \frac{\Delta FTE}{FTE_{-1}}$$

[19] A chain-type annual-weighted price index is calculated for a particular year as the geometric average (that is, the square root of the product) of two price indexes: one uses the previous year as the base period, and the other uses the particular year as the base period. The resulting values are then "chained" to form a time series that in effect uses weights that change each year. See appendix 2 for a detailed calculation of a "chain-type index".

Change in intermediate inputs. $\Delta I_{II}/I_{II,-1}$ is measured as the annual change in "chain-type quantity indexes for intermediate inputs" (IEA item *IIQI*), divided by the value of this index in the prior year:

$$\Delta I_{II}/I_{II,-1} = \frac{\Delta IIQI}{IIQI_{-1}}$$

3. Sample and Descriptive Statistics

As discussed above, the SIC version of the IEA data covers the years 1977-1997. However, since the data required to measure the explanatory variables (dependent variable) include previous year (next year) values of some quantities, the sample covers 19 base years: 1978-1996. The industry observations are generally based on the 2-digit SIC classification, although some industries are based on three-digits SIC. Table 1 presents the industry composition of the sample. For most of the 60 industries, data are available for all 19 years, and for most of the remaining industries, data are available for the nine years 1988-1996[20]. The total number of industry-year observations is 997.

Table 2 presents descriptive statistics for the distribution of the variables. The mean annual percentage change in both output prices and intermediate input costs is 3.8% across all industry-year observations. In contrast, the mean annual percentage increase in compensation per full-time employees is 5.3%. In addition, the number of industry-year observations with negative change in compensation per employee is substantially smaller than the number of industry-years with declines in output prices or intermediate input costs. These data suggest that during our sample period real wages increased by approximately 1.5% per year (5.3% − 3.8%).

[20] The reason for the missing industry-year observations is the accommodation of changes in the SIC. For example, the industries with only 9 observations correspond to redefined industries after the 1987 SIC implementation. In this way, BEA makes sure that the industries time series are consistent.

The mean percentage increase in the quantity of units produced is 2.8%, which is significantly larger than the 1% increase in the number of full time employees. Accordingly, the mean improvement in labor productivity is 1.8% (2.8% − 1%). Thus, increases in labor productivity were slightly larger than increases in real wages. In contrast, the productivity of intermediate inputs has slightly declined during the sample period.

On average, operating expenses account for about 80% of total revenue, implying a pre-tax and depreciation profit margin of 20%. Intermediate inputs constitute the majority of operating expenses, totaling 50% of revenues.

The final set of variables in Table 2 gives the distributions of the change in operating profits and its variation analysis components. The change in operating profit has a mean of 1.1%, but it exhibits significant variation over time and across industries. The three effects that contribute most to the variation in operating profitability are intermediate input productivity, intermediate input cost and, most of all, the price effect. In fact, the variability in the price effect is larger than that of the total change in operating profitability, indicating that at least some effects tend to offset each other. The high variability of the price effect does not mean that it has low persistence, however. Persistence is an attribute of the relationship between the *average* future value of a variable and its current value. A highly volatile variable can be persistent as long as, on average, its future value is related to the current value. In the next section we effectively compare the persistence of the variation analysis components by examining their relationship with future operating profit[21].

[21] Earnings persistence indicates how sustainable or recurrent earnings are. We measure it as the slope coefficient of one-year ahead operating profit on current operating profit. By decomposing the change in current operating profit into different components and allowing for different coefficients, we want to test whether we can add information to this mapping process of current operating profit on future operating profit.

The mean unexplained change in operating profit is zero and its standard deviation is negligible compared to those of the variation analysis components. Thus, the effects of (1) approximation errors due to the omission of joint variations, (2) changes in output and input mixes, and (3) measurement error in the variables, all appear rather limited for our sample. This is likely due to the aggregate nature of the data (industry-level as opposed to firm-specific) and to the use of chain-type indexes which mitigate measurement error due to changes in output and input mixes. Nonetheless, we acknowledge that in a full equilibrium setting there might be some interdependences among the different effects that an aggregate unexplained change in operating profit might disguise.

4. Variation Analysis and Future Operating Profits

If components of the variation analysis have differential persistence, they should be useful for predicting future operating profits. To test this hypothesis, we start by specifying an auto-regressive model for operating profit:

$$OP_{t+1} = \alpha + \beta\, OP_t + e_{1,t+1} \tag{8}$$

This model uses the current level of operating profit (OP_t) as a starting point for predicting next year's operating profit (OP_{t+1}) and, by specifying a free coefficient for OP_t, it allows for mean reversion in operating profit (e.g., Brooks and Buckmaster 1976).

We next allow the slope coefficient to vary with the relative magnitudes of the variation analysis components:[22]

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[22] Technically, the components should be deflated by their sum (i.e. ΔOP_t), which is essentially the change in operating profit. This latter variable, however, is negative for many observations. Moreover, since we focus on the persistence of operating profit, and the variation analysis components are part of operating profit, it is reasonable to measure their relative magnitude compared to operating profit.

$$\beta = \beta_1 + \beta_2\, PriceEffect_t / OP_t + \beta_3\, VolumeEffect_t / OP_t + \beta_4\, CostEffect_{LABOR,t} / OP_t + \beta_5\, CostEffect_{II,t} / OP_t + \beta_6\, ProdEffect_{LABOR,t} / OP_t + \beta_7\, ProdEffect_{II,t} / OP_t + e_{2,t+1} \quad (9)$$

Since the level and persistence of operating profit is likely to vary across industries and over time, we substitute industry and year fixed-effects for the intercepts of equations (8) and (9); that is, we substitute $\alpha_{industry} + \alpha_{year}$ for α, and $\beta_{industry} + \beta_{year}$ for β_1. Finally, we substitute equation (9) into equation (8), which yields

$$OP_{t+1} = \alpha_{industry} + \alpha_{year} + \beta_{industry}\, OP_t + \beta_{year}\, OP_t + \beta_2\, PriceEffect_t + \beta_3\, VolumeEffect_t + \beta_4\, CostEffect_{LABOR,t} + \beta_5\, CostEffect_{II,t} + \beta_6\, ProdEffect_{LABOR,t} + \beta_7\, ProdEffect_{II,t} + e_{3,t+1} \quad (10)$$

This equation represents our primary model. Note that the procedure to obtain this specification is analogous to the one followed in the Earnings Response Coefficients literature (see Kothari [2001] for a review). The differences are in the dependent variable (future operating profit vs. stock returns) and in the information set (industry-level vs. firm-level). In part 5 we also use stock returns as the dependent variable.

Table 3 presents estimates from three alternative regressions of model (10): to mitigate the effects of heteroscedasticity, we use a weighted least square estimation with two alternative weight variables, $1/REV_t$ and $1/EXP_t$, in addition to OLS.[23] In each of the three regressions, the coefficients on the price and cost of intermediate inputs are positive and highly significant. In contrast, the coefficients on the volume effect are negative and marginally significant, and the coefficients on labor productivity are positive and marginally significant. The remaining two effects—labor cost and intermediate input productivity—are insignificant. The adjusted R-

[23] Using the inverse of revenue or expenses as a weight assumes that the variance of the error term is proportional to revenue or expenses, respectively. An alternative assumption is that the variance of the error term is proportional to revenue squared or expenses squared, which would require the use of the inverse of these quantities as deflator. To select the weight variable, we regressed the squared residual from OLS estimation of equation (10) on revenue, expenses, revenue squared and expensed squared, and found that revenue and expenses are substantially more significant than their squared counterparts.

squared are very high, reflecting the strong auto-correlation in operating profit and the large differences in operating profits across industries.

Note that the negative coefficient on the volume effect does not imply that a current increase in volume has a negative impact on next year's operating profit. In fact, combined, the estimates suggest that an increase in current operating profit due to a volume effect has a positive impact on next year's operating profit. This follows because the impact of volume is included in two of the explanatory variables—$VolumeEffect_t$ and OP_t. Thus, the impact of the volume effect on next year's operating profit should be measured as the sum of these two coefficients, which is generally positive (the OP coefficient, which is industry-year specific, has a mean of about 0.75).

One possible explanation for the positive coefficient of the price effect and the negative coefficient of the volume effect is as follows. Let us distinguish between industries operating under capacity and industries operating at capacity. When there is a positive shock in demand, industries that operate under capacity will in general increase production volume and raise prices. But for industries at capacity, the only short term response possible is a price increase. Later in time, if the demand shock is persistent, the level of capacity is likely to be adapted and we will observe volume increases[24]. That is, for these firms the price effect predicts future earnings while the volume effect reflects past shocks. This suggests that, on average, the persistence of the price effect is likely to be higher than that of volume.

5. The Pricing of Variation Analysis Components

Given that the variation analysis is informative about future operating profits, this information should either be fully reflected in current stock prices (efficient pricing), or predict

[24] This argument is in line with prior research documenting a positive association between capacity utilization and inflation (see Corrado and Mattey 1997 for a review). Relatedly, the Federal Reserve often uses capacity utilization rates as indicators of inflationary pressures.

subsequent stock returns. Accordingly, we next examine the relationship between the variation analysis components and contemporaneous and next year's industry stock returns. Specifically, we run the following model:

$$R = \alpha_{industry} + \alpha_{year} + \beta_{industry}\, OP_t + \beta_{year}\, OP_t + \beta_2\, PriceEffect_t + \beta_3\, VolumeEffect_t + \beta_4\, CostEffect_{LABOR,t} + \beta_5\, CostEffect_{II,t} + \beta_6\, ProdEffect_{LABOR,t} + \beta_7\, ProdEffect_{II,t} + \beta_8\, R_{t-1} + e_{4,t+1} \quad (11)$$

where R is the total annual dollar return earned on all outstanding shares of firms that have the industry SIC classification and are included in CRSP.[25]

To evaluate the timeliness of the market's response to the variation analysis information, we measure the dependent variable over two alternative return periods: the current year and the next year. We include the lag industry return (R_{t-1}) as an explanatory variable to control for the predictable portion of the variation analysis components, since stock returns reflect investors' response to *new* information. To the extent that the variation analysis components are predictable, the estimated coefficients will be biased downward. By controlling for past stock return we effectively undo the expected portion from the variation analysis components, since including past stock return in the regression is equivalent to orthogonalizing all the regression variables with respect to this variable (see, e.g., Greene 2003). That is, we effectively remove from the components of the variation analysis information that the market has already reacted to in year *t-1*.

Before reporting the results, we note several potential issues. First, stock return information is available only for public companies while the explanatory variables measure all business activities, including those conducted by private companies and unincorporated

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[25] $R_t = \sum_{i=1}^{I} r_{i,t} \times MV_{i,t-1}$, where r_i is the annual stock return for firm *i* in period *t*, $MV_{i,t-1}$ is the market value of firm *i* at the beginning of time *t*, and *I* is the total number of firms in a given industry.

enterprises. Second, many firms operate in multiple industries and it is not clear whether the BEA classifies firms to SIC industries the same way that CRSP does[26]. Third, market prices reflect the values of all assets that are held by the firm, including those not used for operating activities and not generating operating profit. Analogously, stock returns do not reflect that portion of the operating profit which accrues to debt-holders. Finally, as discussed above, the variation analysis components should be correlated with stock returns only to the extent that they contain unexpected information. For these reasons, the estimates of equation (11) may be different from those of equation (10) not only in magnitude but also in sign and significance.

Panel A of Table 4 reports the estimates of model (11) for each of the two return periods and three weighting schemes. In spite of the issues discussed above, the results of the contemporaneous return are largely consistent with the future operating profit regressions: the price, intermediate input cost and labor productivity effects are positive and significant, the labor cost effect is insignificant, intermediate input productivity is positive and marginally significant, and the volume effect is insignificant. In contrast, the coefficients of the next year's return regressions, with the exception of the volume effect, are insignificant. Thus, it appears that investors react in a rather timely manner to the variation analysis information, at least at the industry level.

While financial information required for the estimation of the explanatory variables of equation (11) becomes available during the calendar year, the final numbers (and in particular fourth quarter accounting information) are disseminated a few months after the end of the year.[27]

[26] CRSP always classifies industries at the company level, whereas BEA can report some series at the establishment level (e.g. compensation for employees). Establishments are economic units, generally at a single physical location, where business is conducted or where services or industrial operations are performed. Companies consist of one or more establishments.

[27] During the period of our study quarterly "advance" estimates on GNP, National Income, Corporate Profits and net interest were released two months after each quarter. The preliminary and final estimates were released 3 and 4

It is therefore likely that the contemporaneous calendar return variable does not fully reflect the market reaction to the variation analysis information. In addition, the relationship between next year's return and the volume effect may be due to lag in the dissemination of fourth quarter information rather than to market inefficiency. To test these conjectures, we re-estimate the regressions measuring returns from April 1 of each year through March 31 of the following year. As shown in Panel B of Table 4, the sign and significance of all the explanatory variables from the contemporaneous return regressions are now similar to those in Table 3 which deals with prediction of operating profit. In addition, all the explanatory variables in the next year's regressions are now insignificant. These results provide strong support for the findings from the future operating profit regressions, and also indicate the investors are cognizant of the variation analysis information, at least at the industry level.

One of the weaknesses of the Earnings Response Coefficients literature is the lack of out-of-sample evidence (see e.g. Kothari [2001]). We rerun the regressions in part 4 and 5 using data from 1998 to 2005 that follows the NAICS classification. Despite the much lower power of the test, the results are significant and support our original findings.

6. Analysis of the Volume Effect

Prior research demonstrates that the persistence of revenue surprises and their market reaction are larger than those of expense surprises (e.g., Lipe [1986], Swaminathan and Weintrop [1991], Ertimur et al. [2003]). To test whether this result holds for our industry-level data, we run regressions of the following model:

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months after each quarter, respectively. For the 4^{th} quarter, all these releases were done one month later. Annual revisions were carried out each July. For more information see "A Look at How BEA Presents the NIPA's" (Survey of Current Business, Feb. 1994).

$$OP_{t+1} = \alpha_{industry} + \alpha_{year} + \beta_{industry}\, OP_t + \beta_{year}\, OP_t + \beta_2\, \Delta REV_t + \beta_3\, \Delta COMP_t + \beta_4\, \Delta II_t + e_{5,t+1} \qquad (12)$$

where ΔREV is the change in revenue during the year, $\Delta COMP$ is the change in compensation cost, and ΔII is the change in the cost of intermediate inputs. Estimation results, reported in Table 5, confirm that revenue shocks are more persistent than expense shocks. Specifically, changes in expense items have the same persistence as the overall level of operating profit (the coefficients on $\Delta COMP$ and ΔII are insignificant), while changes in revenue have higher persistence (the coefficients on ΔREV are positive and significant).

To the extent that components of the variation analysis mix revenue and expense items, Table 5's results suggest that a decomposition of the variation components may yield further insights. With the exception of the volume effect, all other components of the variation analysis focus on either revenue or expense items. The volume effect, in contrast, is measured as the product of the rate of change in quantity and the prior year operating profit. That is, this effect implicitly assumes that revenues and expenses, which determine operating profit, have the same persistence. Since revenues and expenses have differential persistence, we decompose the volume effect as follows:

$$\begin{aligned} VolumeEffect &= (\Delta Q/Q_{-1}) \times OP_{-1} = (\Delta Q/Q_{-1}) \times (REV_{-1} - COMP_{-1} - II_{-1}) \\ &= (\Delta Q/Q_{-1}) \times REV_{-1} + (\Delta Q/Q_{-1}) \times (-COMP_{-1}) + (\Delta Q/Q_{-1}) \times (-II_{-1}) \\ &= VolumeEffect_{REV} + VolumeEffect_{COMP} + VolumeEffect_{II} \end{aligned}$$

and substitute the three components for the volume effect in equation (10), which yields:

$$\begin{aligned} OP_{t+1} = {} & \alpha_{industry} + \alpha_{year} + \beta_{industry}\, OP_t + \beta_{year}\, OP_t + \beta_2\, PriceEffect_t \\ & + \beta_3\, VolumeEffect_{REV,t} + \beta_4\, VolumeEffect_{COMP,t} + \beta_5\, VolumeEffect_{II,t} \\ & + \beta_6\, CostEffect_{LABOR,t} + \beta_7\, CostEffect_{II,t} + \beta_8\, ProdEffect_{LABOR,t} \\ & + \beta_9\, ProdEffect_{II,t} + e_{6,t+1} \qquad (13) \end{aligned}$$

Table 6 presents estimation results for equation (13). Each of the three volume effects, including the volume-revenue effect, is negative. This result implies that the higher persistence of revenue compared to expense surprises is driven by price rather than quantity effects. Interestingly, each of the coefficients on the volume effects is substantially larger in magnitude and more significant than the coefficient on the total volume effect in Table 3. Also, after decomposing the volume effect, the labor productivity effect is no longer significant. The coefficients on the other effects remain essentially unchanged. The change in the adjusted R-squared is almost imperceptible, an expected result given the high adjusted R-squares and the fact that by decomposing the volume effect we are just adding two additional parameters to the previous 164.

7. Results by Sector

Thus far we estimated the regressions using all industries. This choice is due primarily to the relatively small number of observations. Yet, the differential persistence of the variation analysis components may vary across industries. Therefore, we next estimate equation (10) for three sectors: manufacturing, service, and all other (Agriculture, forestry, and fishing; Mining; Construction; Transportation and public utilities; Wholesale trade; and Retail trade). We note, however, that these results should be interpreted with caution since they are based on relatively small numbers of observations. For this same reason, we are reluctant to perform further partitions based on industry characteristics and macroeconomic variables.

Table 7 presents the estimates. For parsimony, we report only the results using 1/REV as the weighting variable, but the 1/EXP and OLS results are similar. As shown, for each of the three sectors, the price and intermediate input cost effects are positive and significant. In contrast, the other effects have coefficients which vary across sectors. In particular, the volume effect is positive for manufacturing but negative or insignificant for other sectors. The labor cost effect is negative for service, insignificant for manufacturing and positive for other sectors. The productivity of labor is negative for service, insignificant for manufacturing, and positive for other sectors. Finally, the productivity of intermediate inputs is positive for service and manufacturing, and insignificant for other sectors.

8. Conclusion

This study investigates the information content of variation analysis. Using industry-level data, we show that components of variation analysis have differential persistence and are therefore useful for predicting operating profit. We further show that, at the industry level, this information is priced by investors. These findings suggest that conducting variation analysis may help managers and other parties with access to managerial accounting information to predict future operating profit. In addition, since a primary objective of financial reporting is to provide information useful for the prediction of future earnings (SFAC No. 1), the evidence provided here suggests that the FASB may improve the usefulness of financial reports by requiring firms to disclose summary information, consistently produced, on key drivers of changes in operating performance.

Our strongest finding is the significance of the price and intermediate input cost effects. This result is consistent with evidence provided by prior studies (e.g., Lipe [1986], Swaminathan and Weintrop [1991], Ertimur et al. [2003]), which indicates that revenue shocks are more persistent than expense shocks. Our study suggests that the higher persistence of revenue shocks may be driven by price, not volume effects. The significance of the intermediate input cost effect might be a reflection of the same phenomenon (cost of intermediate input for one firm are selling prices for another).

In the managerial accounting domain, some have recommended combining the price and inflation effects into a summary variable referred to as Price Recovery (see for example Horngren et al. [2006], Banker et al. [1989], and Hayzen et al. [2000]). Our results imply that focusing on the price recovery effect may not be desirable as the valuation implications and predictive power of the two components—changes in output prices and changes in input prices—may differ greatly.

A natural extension for our paper is to perform an industry contextual analysis. Prior work in the field of Industrial Organization has studied the association between measures of market structure such as concentration, barriers to entry and unionization with profitability, prices and other performance variables (see Carlton and Perloff [2005] for a review). This type of analysis could be useful for the interpretation of our results. The limited number of observations in our study precludes us from performing further sample partitions based on industry characteristics and macroeconomic variables.

We conclude with a caveat. Because of the lack of firm specific data, we focused our attention on industry level variation analysis. However, industry-level findings may not generalize to firm-specific contexts. For example, changes in relative prices within industries may not have the same persistence as industry-wide changes. Moreover, market efficiency with respect to firm-specific variation analysis may be lower than the efficiency with respect to industry-wide analysis. While firm-level data are generally not available from public sources, they may be available in some industries for some activities.[28] An important extension of this research will be to conduct a firm-level analysis.

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[28] E.g., volume and rate analysis of net interest income disclosed by financial institutions, oil and gas extraction activities.

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Appendix 1
Derivation of expression (7)

$$\Delta \boldsymbol{OP} = \Delta REV - \Delta EXP = \sum_{k=1}^{K} (\Delta P_k \times Q_{k,-1} + P_k \times \Delta Q_k)$$

$$- \sum_{j=1}^{J} \Big(\sum_{k=1}^{K} C_j \times (\Delta Q \times Prod_{j,k,-1} + Q_k \times \Delta Prod_{j,k}) + \sum_{k=1}^{K} \Delta C_j \times Q_{k,-1} \times Prod_{j,k,-1} \Big) - \sum_{h=1}^{H} \Delta FC_h =$$

$$= \sum_{k=1}^{K} [(\Delta P_k / P_{k,-1}) \times P_{k,-1} \times Q_{k,-1} + P_k \times Q_{k,-1} \times (\Delta Q_k / Q_{k,-1})] - \sum_{j=1}^{J} \sum_{k=1}^{K} C_j \times (\Delta Q_k / Q_{k,-1}) \times Q_{k,-1} \times Prod_{j,k,-1}$$

$$- \sum_{j=1}^{J} \sum_{k=1}^{K} C_j \times Q_k \times Prod_{j,k,-1} \times (\Delta Prod_{j,k} / Prod_{j,k,-1}) - \sum_{j=1}^{J} \sum_{k=1}^{K} (\Delta C_j / C_{j,-1}) \times C_{j,-1} \times Q_{k,-1} \times Prod_{j,k,-1} - \sum_{h=1}^{H} \Delta FC_h =$$

$$= \sum_{k=1}^{K} (\Delta P_k / P_{k,-1}) \times REV_{k,-1} + \sum_{k=1}^{K} (\Delta Q_k / Q_{k,-1}) \times (P_k \times Q_{k,-1} - \sum_{j=1}^{J} C_j \times Q_{k,-1} \times Prod_{j,k,-1})$$

$$- \sum_{j=1}^{J} \sum_{k=1}^{K} C_j \times Q_k \times Prod_{j,k,-1} \times (\Delta Prod_{j,k} / Prod_{j,k,-1}) - \sum_{j=1}^{J} \sum_{k=1}^{K} (\Delta C_j / C_{j,-1}) \times VC_{j,k,-1} - \sum_{h=1}^{H} \Delta FC_h =$$

$$= \sum_{k=1}^{K} (\Delta P_k / P_{k,-1}) \times REV_{k,-1} + \sum_{k=1}^{K} (\Delta Q_k / Q_{k,-1}) \times [P_{k,-1} \times Q_{k,-1} + \Delta P_k \times Q_{k,-1} - \sum_{j=1}^{J} (C_{j,-1} + \Delta C_j)$$

$$\times Q_{k,-1} \times Prod_{j,k,-1}] - \sum_{j=1}^{J} \sum_{k=1}^{K} (\Delta Prod_{j,k} / Prod_{j,k,-1}) \times (C_{j,-1} + \Delta C_j) \times (Q_{k,-1} + \Delta Q_k) \times Prod_{j,k,-1}$$

$$- \sum_{j=1}^{J} (\Delta C_j / C_{j,-1}) \times VC_{j,-1} - \sum_{h=1}^{H} \Delta FC_h =$$

$$= \sum_{k=1}^{K} (\Delta P_k / P_{k,-1}) \times REV_{k,-1} + \sum_{k=1}^{K} (\Delta Q_k / Q_{k,-1}) \times (REV_{k,-1} + (\Delta P_k / P_{k,-1}) \times REV_{k,-1} - \sum_{j=1}^{J} VC_{j,k,-1}$$

$$- \sum_{j=1}^{J} (\Delta C_j / C_{j,-1}) \times VC_{j,k,-1}) - \sum_{j=1}^{J} \sum_{k=1}^{K} (\Delta Prod_{j,k} / Prod_{j,k,-1}) \times (VC_{j,k,-1} + C_{j,-1} \times \Delta Q_k \times Prod_{j,k,-1}$$

$$+ \Delta C_j \times Q_{k,-1} \times Prod_{j,k,-1} + \Delta C_j \times \Delta Q_k \times Prod_{j,k,-1}) - \sum_{j=1}^{J} (\Delta C_j / C_{j,-1}) \times VC_{j,-1} - \sum_{h=1}^{H} \Delta FC_h =$$

$$= \sum_{k=1}^{K} (\Delta P_k / P_{k,-1}) \times REV_{k,-1} + \sum_{k=1}^{K} (\Delta Q_k / Q_{k,-1}) \times CM_{k,-1} - \sum_{j=1}^{J} (\Delta C_j / C_{j,-1}) \times VC_{j,-1}$$

$$- \sum_{j=1}^{J} \sum_{k=1}^{K} (\Delta Prod_{j,k} / Prod_{j,k,-1}) \times VC_{j,k,-1} + \sum_{k=1}^{K} (\Delta Q_k / Q_{k,-1}) \times (\Delta P_k / P_{k,-1}) \times REV_{k,-1}$$

$$- \sum_{j=1}^{J} \sum_{k=1}^{K} (\Delta Q_k / Q_{k,-1}) \times (\Delta C_j / C_{j,-1}) \times VC_{j,k,-1} - \sum_{j=1}^{J} \sum_{k=1}^{K} (\Delta Q_k / Q_{k,-1}) \times (\Delta Prod_{j,k} / Prod_{j,k,-1}) \times VC_{j,k,-1}$$

$$- \sum_{j=1}^{J} \sum_{k=1}^{K} (\Delta C_j / C_{j,-1}) \times (\Delta Prod_{j,k} / Prod_{j,k,-1}) \times VC_{j,k,-1}$$

$$- \sum_{j=1}^{J} \sum_{k=1}^{K} (\Delta C_j / C_{j,-1}) \times (\Delta Prod_{j,k} / Prod_{j,k,-1}) \times (\Delta Q_k / Q_{k,-1}) \times VC_{j,k,-1} - \sum_{h=1}^{H} (\Delta FC_h / FC_{h,-1}) \times FC_{h,-1}$$

Appendix 2
Calculation of Chain-Type Indexes

The estimation of Gross Output and Intermediate Inputs by industry consists of two broad computational stages:

(1) The estimation of the current-dollar values: these amounts are primarily obtained from annual surveys by the Bureau of the Census. Data on the input composition by industry are obtained from BEA's input-output accounts.

(2) The separation of the current-dollar values into a price-change element and a quantity-change element: the price indexes for manufacturing, wholesale trade and retail trade are mainly producer price indexes (PPI's) and consumer price indexes (CPI's) from the Bureau of Labor Statistics (BLS). For other sectors, the data sources vary. For a comprehensive list of original sources see Lum et al. (2000). From the current-dollar amounts and the price indexes, BEA derives the chain-type quantity and price indexes. For some commoditized industries the volume is observed directly or obtained through extrapolation.

Price and quantity indexes that take the same base year for all the estimations suffer from "substitution bias". When two or more items experience a change of price relative to each other, consumers will purchase more of the now comparatively inexpensive good and less of the more expensive good. Hence, there is a change in output mix that understates the price index, which assumes the same mix over each period of time. Since we measure the changes in prices and quantities relative to a base year, after (before) the base period, as one moves further, growth of real amounts is overstated (understated) because the price indexes are understated (overstated). A way to alleviate this bias is using chain-type measures. The methodology to calculate a chain-type quantity index consists of chaining Fisher quantity indexes, that is, multiply each annual index by the previous year's index, with the base year (2000) set equal to 100. The Fisher quantity and price indexes are computed as follows:

$$P_t^F = \sqrt{\frac{\sum (p_t q_{t-1})}{\sum (p_{t-1} q_{t-1})} \times \frac{\sum (p_t q_t)}{\sum (p_{t-1} q_t)}} \qquad Q_t^F = \sqrt{\frac{\sum (p_{t-1} q_t)}{\sum (p_{t-1} q_{t-1})} \times \frac{\sum (p_t q_t)}{\sum (p_t q_{t-1})}}$$

$$P_t = P_{t-1} \times P_t^F \qquad Q_t = Q_{t-1} \times Q_t^F$$

where P_t and Q_t refer to the Fisher chain-type price and quantity indexes at time t, respectively; P^F and Q^F refer to the Fisher price and quantity indexes at time t, respectively; and p and q refer to detailed prices and quantities for each product.

Source: Bureau of Economic Analysis

Table 1
Industry Composition of Sample

Industry	SIC	Obs	Industry	SIC	Obs
Farms	1-2	19	Trucking and warehousing	42	19
Agricultural services, forestry, and fishing	7-9	19	Water transportation	44	9
Metal mining	10	19	Transportation by air	45	19
Coal mining	12	19	Pipelines, except natural gas	46	13
Oil and gas extraction	13	19	Transportation services	47	9
Nonmetallic minerals, except fuels	14	19	Telephone and telegraph	481-482,489	19
Construction	15-17	19	Radio and television	483-484	19
Lumber and wood products	24	19	Electric, gas, and sanitary services	49	19
Furniture and fixtures	25	19	Wholesale trade	50-51	19
Stone, clay, and glass products	32	19	Retail trade	52-59	19
Primary metal industries	33	19	Depository institutions	60	9
Fabricated metal products	34	19	Nondepository credit institutions	61	9
Industrial machinery and equipment	35	19	Security and commodity brokers	62	19
Electronic and other electric equipment	36	9	Insurance carriers	63	19
Motor vehicles and equipment	371	19	Insurance agents, brokers, and service	64	19
Other transportation equipment	372-379	19	Real Estate	65	9
Instruments and related products	38	9	Holding and other investment offices	67	9
Miscellaneous manufacturing industries	39	19	Hotels and other lodging places	70	19
Food and kindred products	20	19	Personal services	72	19
Tobacco products	21	19	Business services	73	9
Textile mill products	22	19	Auto repair, services, and parking	75	19
Apparel and other textile products	23	19	Miscellaneous repair services	76	16
Paper and allied products	26	19	Motion pictures	78	19
Printing and publishing	27	19	Amusement and recreational services	79	19
Chemicals and allied products	28	19	Health services	80	19
Petroleum and coal products	29	19	Legal services	81	12
Rubber and miscellaneous plastics products	30	19	Educational services	82	19
Leather and leather products	31	19	Social services	83	9
Railroad transportation	40	19	Membership organizations	86	9
Local and interurban passenger transit	41	12	Other services	84,87,89	9
					997

The sample period covers the base years 1978-1996 and there are 60 industries.

Table 2
Summary Statistics

	Mean	St. Dev.	P5	Q1	Median	Q3	P95
$\Delta P/P_{-1}$	0.038	0.055	-0.035	0.012	0.032	0.060	0.116
$\Delta Q/Q_{-1}$	0.028	0.066	-0.067	-0.005	0.028	0.058	0.133
$\Delta C_{Labor}/C_{Labor-1}$	0.053	0.037	0.003	0.030	0.049	0.073	0.114
$\Delta C_{II}/C_{II-1}$	0.038	0.052	-0.016	0.014	0.030	0.052	0.128
$\Delta I_{Labor}/I_{Labor,-1}$	0.010	0.056	-0.076	-0.015	0.011	0.038	0.082
$\Delta I_{II}/I_{II,-1}$	0.036	0.118	-0.125	-0.017	0.028	0.078	0.228
$\Delta Prod_{Labor}/Prod_{Labor,-1}$	0.018	0.059	-0.065	-0.012	0.015	0.046	0.115
$\Delta Prod_{II}/Prod_{II,-1}$	-0.008	0.090	-0.138	-0.035	-0.001	0.027	0.112
EXP/REV	0.799	0.131	0.559	0.727	0.825	0.898	0.964
COMP/REV	0.304	0.117	0.077	0.239	0.305	0.368	0.514
II/REV	0.495	0.144	0.276	0.381	0.489	0.605	0.716
OP/REV	0.201	0.131	0.036	0.102	0.175	0.273	0.441
ΔOP/REV	0.011	0.040	-0.036	-0.002	0.010	0.026	0.059
PriceEffect/REV	0.034	0.052	-0.036	0.011	0.030	0.055	0.106
VolumeEffect/REV	0.005	0.016	-0.013	-0.001	0.003	0.011	0.027
LaborCostEffect/REV	-0.015	0.013	-0.037	-0.021	-0.013	-0.007	-0.001
IICostEffect/REV	-0.017	0.032	-0.061	-0.023	-0.012	-0.006	0.009
LaborProdEffect/REV	0.005	0.019	-0.016	-0.003	0.003	0.012	0.032
IIProdEffect/REV	-0.001	0.030	-0.048	-0.015	-0.001	0.013	0.042
Unexplained/REV	0.000	0.004	-0.003	-0.001	0.000	0.001	0.003

The sample period covers the base years 1978-1996. The total number of industry-year observations is 997. $\Delta P/P$ is the annual rate of change in "chain-type price indexes for gross output." $\Delta Q/Q_{-1}$ is the annual rate of change in "chain-type quantity indexes for gross output." $\Delta C_{Labor}/C_{Labor,-1}$ is the annual rate of change in compensation per employee (the ratio of "compensation of employees" to "full-time equivalent employees"). $\Delta C_{II}/C_{II,-1}$ is the annual rate of change in "chain-type price indexes for intermediate inputs." $\Delta I_{Labor}/I_{Labor,-1}$ is the annual rate of change in "full-time equivalent employees." $\Delta I_{II}/I_{II,-1}$ is the annual rate of change in "chain-type quantity indexes for intermediate inputs." $\Delta Prod/Prod_{-1} = (\Delta I_j/I_{j,-1} - \Delta Q/Q_{-1}) / (1+\Delta Q/Q_{-1})$ for j = Labor, II. *EXP* is the total of "compensation of employees" and "intermediate inputs." *REV* is "gross output." $OP = REV - EXP$. $PriceEffect = (\Delta P/P_{-1}) \times REV_{-1}$. $VolumeEffect = (\Delta Q/Q_{-1}) \times OP_{-1}$. $CostEffect_j = -(\Delta C_j/C_{j,-1}) \times EXP_{j-1}$, j = Labor, II. $ProdEffect_j = -((\Delta I_j/I_{j,-1} - \Delta Q/Q_{-1}) / (1+\Delta Q/Q_{-1})) \times EXP_{j,-1}$, j = Labor, II. $Unexplained = \Delta OP - PriceEffect - VolumeEffect - \sum CostEffect_j - \sum ProdEffect_j$.

Table 3
Regressions of Future Operating Profit
on Current Operating Profit and Components of Variation Analysis

$$OP_{t+1} = \alpha_{industry} + \alpha_{year} + \beta_{industry}\, OP_t + \beta_{year}\, OP_t + \beta_2\, PriceEffect_t + \beta_3\, VolumeEffect_t + \beta_4\, CostEffect_{LABOR,t} + \beta_5\, CostEffect_{II,t} + \beta_6\, ProdEffect_{LABOR,t} + \beta_7\, ProdEffect_{II,t} + e_{3,t+1}$$

	W=1/REV	W=1/EXP	OLS
PriceEffect	0.256	0.263	0.283
	6.2	6.7	6.8
VolumeEffect	-0.193	-0.256	-0.119
	-1.6	-2.1	-1.1
$CostEffect_{LABOR}$	-0.042	-0.008	0.147
	-0.3	-0.1	1.2
$CostEffect_{II}$	0.251	0.266	0.286
	4.8	4.9	5.5
$ProdEffect_{LABOR}$	0.128	0.136	0.256
	1.2	1.2	2.5
$ProdEffect_{II}$	-0.023	-0.049	0.002
	-0.5	-1.0	0.1
Adjusted R^2	0.987	0.992	0.997

Each column represents a regression. The regressions differ with respect to the weight variable, which is identified in the headings of the columns. The top number in each pair represents the estimated coefficient and the bottom number represents the estimated t-statistic. The sample period covers the base years 1978-1996. The total number of industry-year observations is 997. All variables are defined in Table 2.

Table 4
Regressions of Stock Returns
on Current Operating Profit and Components of Variation Analysis

$$R = \alpha_{industry} + \alpha_{year} + \beta_{industry}\, OP_t + \beta_{year}\, OP_t + \beta_2\, PriceEffect_t + \beta_3\, VolumeEffect_t + \beta_4\, CostEffect_{LABOR,t} + \beta_5\, CostEffect_{II,t} + \beta_6\, ProdEffect_{LABOR,t} + \beta_7\, ProdEffect_{II,t} + \beta_8\, R_{t-1} + e_{4,t+1}$$

Panel A: Calendar year returns

	R = Contemporaneous Return			R = Next year's Return		
	W=1/REV	W=1/EXP	OLS	W=1/REV	W=1/EXP	OLS
PriceEffect	0.937	0.875	0.544	0.098	0.165	0.088
	4.5	5.0	3.1	0.4	0.8	0.4
VolumeEffect	-0.745	-0.360	0.087	-2.195	-2.192	-2.280
	-1.2	-0.7	0.2	-3.4	-3.7	-4.1
$CostEffect_{LABOR}$	-0.471	-0.481	-0.534	-0.171	-0.001	-0.044
	-0.7	-0.7	-1.0	-0.2	0.0	-0.1
$CostEffect_{II}$	0.776	0.719	0.414	0.220	0.259	0.265
	3.0	3.0	1.9	0.8	1.0	1.0
$ProdEffect_{LABOR}$	2.239	1.786	0.920	0.115	0.236	0.891
	4.3	3.6	2.2	0.2	0.4	1.8
$ProdEffect_{II}$	0.461	0.347	0.218	-0.028	0.110	0.194
	2.0	1.6	1.2	-0.1	0.5	0.9
R_{-1}	-0.104	-0.122	-0.059	0.066	0.062	0.119
	-2.9	-3.4	-1.7	1.7	1.5	2.9
Adjusted R^2	0.457	0.447	0.545	0.595	0.556	0.637

Panel B: Returns measured from April 1 through March 31 of the following year

	R = Contemporaneous Return			R = Next year's Return		
	W=1/REV	W=1/EXP	OLS	W=1/REV	W=1/EXP	OLS
PriceEffect	0.460	0.431	0.272	-0.280	-0.212	-0.289
	2.8	3.0	1.7	-1.2	-1.0	-1.2
VolumeEffect	-1.934	-1.819	-1.531	-0.562	-0.542	-1.841
	-4.0	-4.1	-3.5	-0.8	-0.9	-2.8
$CostEffect_{LABOR}$	-0.566	-0.441	0.095	0.315	0.456	-0.553
	-1.0	-0.8	0.2	0.4	0.6	-0.8
$CostEffect_{II}$	0.670	0.625	0.452	-0.062	-0.027	0.016
	3.2	3.1	2.3	-0.2	-0.1	0.1
$ProdEffect_{LABOR}$	0.735	0.630	0.223	0.052	0.235	1.007
	1.7	1.5	0.6	0.1	0.4	1.7
$ProdEffect_{II}$	-0.066	-0.059	-0.132	-0.011	0.123	0.142
	-0.3	-0.3	-0.8	0.0	0.5	0.6
R_{-1}	0.058	0.03	0.065	0.228	0.186	0.273
	1.7	0.9	1.9	4.6	3.7	5.1
Adjusted R^2	0.559	0.536	0.588	0.604	0.575	0.656

Each column represents a regression. The regressions differ with respect to the weight variable, which is identified in the headings of the columns. The top number in each pair represents the estimated coefficient and the bottom number represents the estimated t-statistic. The sample period covers the base years 1978-1996. The total number of industry-year observations is 997. R is the total annual dollar return earned on all outstanding shares of firms that have the industry SIC classification and are included in CRSP. All other variables are defined in Table 2.

Table 5
Regressions of Future Operating Profit
on Current Operating Profit and Revenue and Expense Shocks

$$OP_{t+1} = \alpha_{industry} + \alpha_{year} + \beta_{industry}\, OP_t + \beta_{year}\, OP_t + \beta_2\, \Delta REV_t + \beta_3\, \Delta COMP_t + \beta_4\, \Delta II_t + e_{5,t+1}$$

	W=1/REV	W=1/EXP	OLS
ΔREV	0.094	0.102	0.139
	2.7	3.0	3.9
ΔCOMP	0.026	0.002	-0.087
	0.3	0.0	-1.0
ΔII	-0.043	-0.04	-0.072
	-1.0	-1.0	-1.7
Adjusted R^2	0.986	0.992	0.997

Each column represents a regression. The regressions differ with respect to the weight variable, which is identified in the headings of the columns. The top number in each pair represents the estimated coefficient and the bottom number represents the estimated t-statistic. The sample period covers the base years 1978-1996. The total number of industry-year observations is 997. ΔREV is the change in revenue during the year, $\Delta COMP$ is the change in compensation cost, and ΔII is the change in the cost of intermediate inputs. $OP = REV - COMP - II$.

Table 6
Regressions of Future Operating Profit
on Current Operating Profit and Components of the Variation Analysis,
Decomposing the Volume Effect into Revenue and Expense Components

$$OP_{t+1} = \alpha_{industry} + \alpha_{year} + \beta_{industry}\, OP_t + \beta_{year}\, OP_t + \beta_2\, PriceEffect_t + \beta_3\, VolumeEffect_{REV,t} + \beta_4\, VolumeEffect_{COMP.t} + \beta_5\, VolumeEffect_{II,t} + \beta_6\, CostEffect_{LABOR,t} + \beta_7\, CostEffect_{II,t} + \beta_8\, ProdEffect_{LABOR,t} + \beta_9\, ProdEffect_{II,t} + e_{6,t+1}$$

	W=1/REV	W=1/EXP	OLS
PriceEffect	0.254	0.262	0.277
	6.2	6.7	6.7
$VolumeEffect_{REV}$	-0.409	-0.468	-0.357
	-2.9	-3.3	-2.6
$VolumeEffect_{COMP}$	-0.520	-0.595	-0.554
	-2.3	-2.5	-2.7
$VolumeEffect_{II}$	-0.526	-0.591	-0.418
	-3.1	-3.4	-2.4
$CostEffect_{LABOR}$	-0.094	-0.063	0.096
	-0.7	-0.4	0.8
$CostEffect_{II}$	0.241	0.257	0.277
	4.6	4.7	5.3
$ProdEffect_{LABOR}$	-0.014	-0.018	0.114
	-0.1	-0.1	1.0
$ProdEffect_{II}$	-0.036	-0.062	-0.016
	-0.8	-1.3	-0.4
Adjusted R^2	0.988	0.992	0.997

Each column represents a regression. The regressions differ with respect to the weight variable, which is identified in the headings of the columns. The top number in each pair represents the estimated coefficient and the bottom number represents the estimated t-statistic. The sample period covers the base years 1978-1996. The total number of industry-year observations is 997. $VolumeEffect_{REV} = (\Delta Q/Q_{-1}) \times REV_{-1}$, $VolumeEffect_{COMP} = (\Delta Q/Q_{-1}) \times (-\ COMP_{-1})$, and $VolumeEffect_{II} = (\Delta Q/Q_{-1}) \times (-\ II_{-1})$, where *REV* is revenue, *COMP* is compensation cost, and *II* is the cost of intermediate inputs. All other variables are defined in Table 2.

Table 7
By-Sector Regressions of Future Operating Profit on Current Operating Profit and Components of Variation Analysis

$$OP_{t+1} = \alpha_{industry} + \alpha_{year} + \beta_{industry}\, OP_t + \beta_{year}\, OP_t + \beta_2\, PriceEffect_t + \beta_3\, VolumeEffect_t + \beta_4\, CostEffect_{LABOR,t} + \beta_5\, CostEffect_{II,t} + \beta_6\, ProdEffect_{LABOR,t} + \beta_7\, ProdEffect_{II,t} + e_{3,t+1}$$

	All	Manufacturing	Service	All Other
PriceEffect	0.256	0.304	0.353	0.344
	6.2	4.3	2.6	4.9
VolumeEffect	-0.193	0.904	0.076	-0.613
	-1.6	3.5	0.4	-2.8
$CostEffect_{LABOR}$	-0.042	-0.108	-0.366	0.587
	-0.3	-0.5	-2.1	1.5
$CostEffect_{II}$	0.251	0.244	1.198	0.386
	4.8	3.3	2.3	2.1
$ProdEffect_{LABOR}$	0.128	0.041	-0.238	0.607
	1.2	0.2	-1.6	2.5
$ProdEffect_{II}$	-0.023	0.148	0.143	-0.067
	-0.5	2.1	1.8	-0.7
Adjusted R^2	0.987	0.950	0.996	0.975
N	997	379	290	328

Each column represents a regression. The regressions differ with respect to the weight variable, which is identified in the headings of the columns. The top number in each pair represents the estimated coefficient and the bottom number represents the estimated t-statistic. The sample period covers the base years 1978-1996. All variables are defined in Table 2.