The Persistence of Price, Volume, Cost and Productivity Effects:

Industry-Level Analysis

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ABSTRACT

We investigate the persistence of year-over-year changes in the components of operating profit. Using industry-level data, we find that changes in the volume of output exhibit a more persistent effect on profitability than changes in output prices, labor cost, labor productivity, intermediate input cost, and intermediate input productivity. Furthermore, we show that industry growth is the main driver of persistence. Industry concentration and barriers to entry, price stickiness, and cost stickiness also affect the degree of persistence. One implication of these results is that the documented higher persistence of revenue shocks, as compared to expense shocks, is likely due to the volume effect rather than the price effect of revenue.

Keywords: Profitability, Earnings Persistence, Market Structure

JEL Classifications: M41

1. Introduction

Prior research examines the persistence of earnings (e.g. Kormendi and Lipe 1987) and a wide variety of earnings components, such as cash flows versus accruals (e.g. Sloan 1996), operating versus non-operating items (e.g. Fairfield et al. 1996), or profit margins versus assets turnover (e.g., Nissim and Penman 2001; Fairfield and Yohn 2001; Soliman 2008). We compute the annual change in operating profit attributed to price, volume, cost-inflation and productivity (efficiency), and investigate the persistence of each one of these components. We study how current components explain future operating profit growth and also future components of operating profit growth. Through a contextual analysis, we analyze the determinants of persistence related to market structure: concentration, capital intensity, economies of scale, unionization, and industry growth.

The importance of differentiating among price, volume, cost and productivity effects is well recognized in managerial accounting (see, e.g., Horngren et al. 2010).[1] The objective typically is to identify areas that require particular attention, take corrective actions, evaluate performance of managers or business units, and determine realistic financial performance targets for the next period. Anecdotally, it seems that many companies use some form of this analysis.[2] However, firms generally do not provide a systematic disaggregation in publicly available financial reports.[3] In the MD&A section of the annual report, many companies provide a decomposition of revenue growth rates into price, volume, structural changes (acquisitions and dispositions of businesses), translation, and product/geographic-mix effects, but disclosures regarding cost-related variation analysis components are uncommon. Over time, some companies have disclosed in the MD&A or investor presentations variation analysis information that includes cost components, but these disclosures typically contain little discussion, if any, of the methodology used to quantify the different effects (examples include General Electric, J.P. Morgan, Honeywell, Exxon-Mobil, and Sony).[4]

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[1] Our analysis differs from Variance Analysis in the benchmark. Whereas Variance Analysis studies the factors that caused the difference between the budgeted standards and the actual results, our analysis compares last year results with current results. Besides the typical Variance Analysis, Horngren et al. (2010) also performs a disaggregation of year-over-year changes in operating profit under the name of "Strategic Profitability Analysis".

[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.

[4] For example, the MD&A section of General Electric's 2011 10-k contains the following disclosure for its healthcare business (similar disclosures are provided for the other major business units): "Segment profit of $2.8 billion in 2011 increased 2%, or $0.1 billion, reflecting increased productivity ($0.3 billion), higher volume ($0.2 billion) and the weaker U.S. dollar ($0.1 billion), partially offset by lower prices ($0.3 billion) and higher inflation ($0.1 billion), primarily non-material related."

In fact, the Securities and Exchange Commission (SEC) explicitly requires that the MD&A section include a discussion of any change in volume or price that either explains material increases in revenues or alters significantly the relationship between revenues and costs,[5] though no specific methodology has been established to do so. This requirement has been reiterated in successive interpretive guidance regarding the disclosure of the MD&A section.[6]

While firm-specific price, volume, cost-inflation and productivity effects are occasionally publicly available, the incompleteness and lack of uniformity of these disclosures makes it difficult to evaluate their informativeness. Presumably for this reason, empirical research on this issue is limited. We circumvent the lack of consistent firm-specific data by using industry-level metrics, obtained from the National Bureau of Economic Research and U.S. Census Bureau's Center for Economic Studies Manufacturing Productivity Database. Using these data, we construct proxies for elements of this disaggregation and examine their usefulness in predicting industry-level growth in operating profit. We find that the components of this analysis are consistently useful in predicting changes in operating profit. Volume is by far the most persistent effect, followed by output price, materials cost, materials productivity, labor productivity and labor cost. Next, we map how current components of operating profit growth persist in future operating profit growth by running regressions of each future component on current components. This analysis helps us to confirm that industry growth is the major driving force of persistence. An increase in current operating profit due to volume, persists in future operating profit also through a positive future volume effect. This future increase in volume will have an impact on other simultaneous effects such as productivity. Our findings also suggest an influence of cost stickiness (Anderson et al. 2003) and price stickiness (Blinder et al. 1998) in the persistence of certain components.

We then examine the market structure determinants of persistence. In more competitive industries (i.e. low concentration and low barriers to entry) we expect lower persistence of the components of operating profit growth. We run regressions of future operating profit growth on components of current operating profit growth interacted with industry concentration, capital intensity, economies of scale, unionization and growth. We find that, at the industry

[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 with sales."

level, the persistence of price, volume, cost and productivity will exhibit a higher persistent in less competitive environments. Again, growth seems to be the strongest determinant.

A primary stated objective of financial reporting is to provide information useful for predicting 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.[7] 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 to be used in providing the variations disclosures it has been advocating.[8]

In addition to potential policy implications, our analysis and findings are also relevant for investors, financial intermediaries, managers, academics, and other parties who are interested in predicting operating profitability and evaluating the causes and implications of changes in operating profitability. One interesting finding, in particular, 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; Ertimur et al. 2003) may be due to the volume rather than the price effect of revenue. We find that, at least at the industry level, the volume effect is highly persistent while the price effect is significantly less persistent.[9] Our results also support the view held by some investors, such as Warren Buffett, that prefers a mediocre business in a buoyant industry, than a good business in a stagnating industry. This popular notion has long been supported by academic research that argues that industry membership is a fundamental determinant of firm performance (e.g., King 1966, Schmalensee 1985).

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

[8] Although the MD&A section is unaudited, it is part of the 10-K form and/or other SEC filings that Sarbanes-Oxley Act of 2002 requires some CEOs and CFOs to be certify. Misleading MD&A reports were at the heart of relatively 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)

[9] 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.

While our primary interest in variation analysis is at the firm level and we use industry level data due to data limitations, implementing variation analysis at the industry level has its own merit. To the extent that variation analysis helps predict aggregate earnings, it may be useful in contexts that require such forecasts. Indeed, a recent strand of accounting research focuses on the modeling and prediction of aggregate earnings (e.g., Kothari et al. 2006; Sadka 2007; Ball et al. 2009). Moreover, firm-specific forecasts are often derived by first obtaining industry level estimates and then applying industry share factors to those forecasts.

2. Methodology

Operating Profit Variation Analysis

In Appendix A, we derive a quantitative approach for decomposing operating profit changes into different key effects. This method is based on the traditional variance analysis taught in managerial accounting courses and developed in a vast normative literature since the 1930's.[10] As shown in the appendix, the annual change in operating profit (ΔOP) can be decomposed as follows:

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

$$- \sum_{j=1}^{J}(\Delta C_j / C_{j,-1}) \times VC_{j,-1} - \sum_{j=1}^{J}\sum_{k=1}^{K}(\Delta iProd_{\mathrm{j,k}} / iProd_{\mathrm{j,k,-1}}) \times VC_{j,k,-1} - \sum_{h=1}^{H}\Delta FC_h + residual \qquad (1)$$

Where the subscript "-1" denotes prior period values, and

P_k = Average (over the period) price per output unit of type k, k = 1,2,…,K

Q_k = Quantity of output units sold of type k, k =1,2,…,K

$REV_k = Q_k \times P_k$, that is, revenue from selling units of type k, k =1,2,…,K

C_j = Average cost per input unit of type j, j = 1,2,…,J

$iProd_{j,k}$ = Average number of input units of type j, j = 1,2,…,J, required to produce the quantity of output units sold of type k, k = 1,2,…,K.[11]

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[10] Shank and Churchill (1977) review variance analysis. Horngren et al. (2010) discuss variations analysis for a single product setting; their operating profit decomposition is conceptually similar to ours.

[11] $iProd_{j,k}$ denotes the inverse productivity of factor j in producing output k. We define $iProd_{j,k}$ as the number of input units per output unit in order to obtain a more parsimonious expression. The analysis is similar (but more cumbersome) if instead we define *Prod* as the number of output units per input unit. Another modeling choice related to *iProd* is that we use output sold, without any adjustments for changes in inventory (at current cost), rather than output produced.

$VC_{j,k} = C_j \times Q_k \times iProd_{j,k}$, that is, (variable) cost of type j, j = 1,2,…,J, required to produce the quantity of output units sold of type k, k = 1,2,…,K.

VC_j = (variable) cost of type j, j = 1,2,…,J, required to produce all units sold

$CM_k = REV_k$ minus the total of all variable costs required to produce the quantity of output units sold of type k, k = 1,2,…,K.

FC_h = Total amount of fixed operating expenses of type h, h = 1,2,…,H.[12]

Residual = the total of five joint variances

The right hand side terms of equation (1) can be labeled as follows:

ΔOP = price effect + revenue volume effect + expense volume effect + cost inflation effects + productivity effects + fixed cost effect + residual

respectively. These components are explained in detail below.

The price effect measures the impact of changes in output prices on operating profit. All else equal[13], the price effect for a type *k* output is equal to the product of the percentage change in price ($\Delta P_k/P_{k,-1}$) and the amount of prior period revenue ($REV_{k,-1}$).

The volume effect measures the impact of changes in the quantity of output sold on operating profit. 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 $(\Delta Q_k / Q_{k,-1}) \times CM_{k,-1}$. In our analysis we break down the effect in two components: the revenue volume effect $(\Delta Q_k / Q_{k,-1}) \times REV_{k,-1}$ and the expense volume effect $-(\Delta Q_k / Q_{k,-1}) \times EXP_{k,-1}$.

The cost inflation effect represents the impact of changes in input prices on operating profit. All else equal, a rise in the cost of input *j* increases the related variable operating expense by the same percentage. Therefore, the cost

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 2011, and JP Morgan in 1999).

[12] 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.

[13] By "all else equal" we refer to the pure price effect on current operating profit growth, without considering the impact of the price effect on other simultaneous effects such as volume. The assumption is not crucial for our empirical results, as running the regressions with the joint variances (i.e. interactions of effects) does not change our estimates. The same comment applies to the rest of effects.

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 effect reflects the impact of changes in the productivity of inputs on operating profit. An increase in $iProd_{j,k}$ means more units of input are used per unit of output, which implies less productivity, more cost and lower operating profits. So for each input, the productivity effect will be the negative of expression $(\Delta iProd_{j,kj}/iProd_{j,k,-1})\times VC_{j,k,-1}$ aggregated over all output units. The first element in the product measures the percentage increase 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 simple—cost increases reduce operating profit dollar-for-dollar. By definition, the fixed cost effect does not vary with the level of activity, and thus, appears unrelated to the number of output units. Some textbooks refer to this component as the *spending variance*.

We choose not to include the joint variances from equation A7 in equation (1) because we believe these effects will be less important than the main effects in that equation. Joint variances are products of changes by changes. They could have been incorporated in the analysis either by selectively assigning them to 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. 2010 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 nine additional variables to our regressions. In our robustness checks we find that including the second-order effects does not alter our results. In fact, these joint effects are generally insignificant. Because we do not include the join effects either as separate variables in (1) or allocate the joint effects to the main effects, these join effects can be considered the residual in (1).[15]

[APPENDIX A HERE]

[14] Horngren et al. (2010) 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] We are thankful to one of the referees for helping us clarify this paragraph.

Measurement

As discussed below, we use a database that provides industry-wide estimates of all the variables in equation (1), with three exceptions. First, the amounts are not provided by output (k), but rather by indices and dollar aggregates. This means that the product mix effects are intermingled with the price and volume effects. Second, the database only provides the cost of materials and production labor as described below. We therefore focus on an operating profit measure which excludes the cost of fixed assets and treat all included costs as variable (i.e., $EXP_j = VC_j$ and $OP = CM$).[16] Third, $\Delta iProd_j/iProd_{j,-1}$ is not given explicitly. Fortunately, this latter variable can be derived using available information. By definition, $iProd_j = I_j / Q$, where I_j is the number of input units j required to produce Q, and so

$$
\begin{aligned}
\Delta iProd_j/iProd_{j,-1} &= (I_j / Q - I_{j,-1} / Q_{-1}) / (I_{j,-1} / Q_{-1}) = (I_j \times Q_{-1} - I_{j,-1} \times Q) / (I_{j,-1} \times Q) \\
&= [(I_{j,-1} + \Delta I_j) \times Q_{-1} - I_{j,-1} \times (Q_{-1} + \Delta Q)] / (I_{j,-1} \times Q_{-1} + \Delta Q \times I_{j,-1}) \\
&= (\Delta I_j / I_{j,-1} - \Delta Q / Q_{-1}) / (1 + \Delta Q / Q_{-1})
\end{aligned}
$$

We thus use input and quantity indexes to measure productivity.

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

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

$VolumeEffect_{REV} = (\Delta Q/Q_{-1}) \times REV_{-1}$

$VolumeEffect_{EXP} = -(\Delta Q/Q_{-1}) \times EXP_{-1}$

$CostEffect_j = -(\Delta C_j/C_{j,-1}) \times EXP_{j,-1}$, j = *Intermediate Inputs, Labor*.

$ProdEffect_j = -[(\Delta I_j/I_{j,-1} - \Delta Q/Q_{-1}) / (1 + \Delta Q/Q_{-1})] \times EXP_{j,-1}$, j = *Intermediate Inputs, Labor.*

The total of these components may not equal the change in operating profit for several reasons. As discussed above (section 2.1), the above 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:

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[16] Our definition of operating expenses includes primarily materials and production worker 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 includes some fixed costs, the volume effect will be underestimated (overestimated) when quantity percentages increase (decrease). Our results in Section 6 (see below) suggest that any such bias is relatively small because the revenue and expense volume effects have similar significant coefficients.

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

where *Unexplained* measures that portion of the actual change in operating profit which is not accounted for by the first-order effects used in the analysis.

Ideally we would use firm-specific data to measure the 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 National Bureau of Economic Research and U.S. Census Bureau's Center for Economic Studies Manufacturing Productivity Database (NBER-CES).[17] As of December 2013, the most recent data available from this source cover all 4-digit SIC and 6-digit NAICS manufacturing industries from 1958 through 2009. The SIC version includes 459 industries, while the NAICS codes cover 473 industries. We provide results for the SIC version because most variables in our contextual analysis are available only for SIC industries. The database includes by-industry estimates of output, intermediate inputs, compensation of employees, number of employees, price indexes of output and intermediate inputs, and other data. Bartelsman and Gray (1996) provide a full description of the database and its original sources that we briefly summarize in Appendix B. We next discuss the definitions of the variables.

Revenues. We measure operating revenue (*REV*) as "value of industry shipments" (NBER-CES item *VSHIP*). These are based on net selling values, f.o.b. plant, after discounts and allowances.

Operating Expenses. We measure operating expenses (*EXP*) as the total of "production worker wages" (NBER-CES item *PRODW*) and "cost of materials" (NBER-CES item *MATCOST*). *MATCOST* includes raw materials, parts, and supplies put into production or used for repair and maintenance, along with purchased electric energy and fuels. The measure of operating expenses we use generally excludes depreciation, amortization and overhead costs. Accordingly, our measure of operating profit is a close proxy for the contribution margin.

Operating Profit. We measure operating profit as the difference between operating revenues and operating expenses:

$$OP = REV - EXP$$

[17] http://www.nber.org/nberces

Price Change. We measure $\Delta P/P_{-1}$ as the annual change in the "price deflator for value shipments" (NBER-CES item *PISHIP*), divided by the value of this deflator in the prior year:[18]

$$\Delta P/P_{-1} = \frac{\Delta PISHIP}{PISHIP_{-1}}$$

Quantity Change. We measure $\Delta Q/Q_{-1}$ as the annual change in *VSHIP* deflated by *PISHIP*, divided by the value of deflated *VSHIP* in the prior year:

$$\Delta Q/Q_{-1} = \frac{\Delta(VSHIP\,/\,PISHIP)}{VSHIP_{-1}\,/\,PISHIP_{-1}}$$

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 "production worker wages" (NBER-CES item *PRODW*) to the "number of production workers" (NBER-CES item *PRODE*):

$$CompPerEmp = \frac{PRODW}{PRODE}$$

Intermediate input inflation. $\Delta C_{II}/C_{II,-1}$ is measured as the annual change in the "price deflator for materials" (NBER-CES item *PIMAT*), divided by the value of this deflator in the prior year:

$$\Delta C_{II}/C_{II,-1} = \frac{\Delta PIMAT}{PIMAT_{-1}}$$

Change in labor input. $\Delta I_{Labor}/I_{Labor,-1}$ is measured as the annual change in the "number of production workers" (NBER-CES item *PRODE*), divided by the value of this number in the prior year:

$$\Delta I_{Labor}/I_{Labor,-1} = \frac{\Delta PRODE}{PRODE_{-1}}$$

Change in intermediate inputs. $\Delta I_{II}/I_{II,-1}$ is measured as the annual change in *MATCOST* deflated by *PIMAT*, divided by the value of deflated *MATCOST* in the prior year:

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[18] 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 B for a detailed calculation of a "chain-type index."

$$\Delta I_{II}/I_{II,-1} = \frac{\Delta(MATCOST / PIMAT)}{MATCOST_{-1} / PIMAT_{-1}}$$

[APPENDIX B HERE]

3. Sample and Descriptive Statistics

As mentioned above, the NBER-CES data covers the years 1958-2009. However, since the data required to measure the explanatory variables (dependent variable) include previous year (next year) values of some quantities, the sample covers 50 base years: 1959-2008. Industry observations are either based on the 6-digit NAICS classification, ranging from 311111 to 339999 (manufacturing industries), or on the 4-digit SIC classification, ranging from 2011 to 3999. Table 1 presents examples of NAICS industries included in the sample. The total number of industry-year observations with all the operating profit variation analysis components available is 23,221 for the NAICS version and 22,841 for the SIC version. To mitigate the effects of outliers, all analysis variables are winsorized at the top and bottom 0.5% of their distributions.

[TABLE 1 HERE]

Table 2 presents descriptive statistics for the variables in the SIC database. The mean annual percentage change in both output prices and intermediate input costs across all industry-year observations are very similar, 3.2% and 3.4% respectively. In contrast, the mean annual percentage increase in compensation per production worker is 4.6%. In addition, the number of industry-year observations with negative changes in compensation per employee is substantially smaller than the number of industry-years exhibiting decline in output prices or input costs. In comparison, the average percentage change in the Consumer Price Index (CPI)[19] for the same period is 4%. These statistics suggest that inflation in the prices of manufactured products and materials was on average lower than inflation in service prices and labor costs. This later result is consistent with the fact that inflation is commonly used as a benchmark for adjusting employee compensation.

[19] As a measure of inflation we take the commonly used Consumer Price Index (CPI) provided by the Bureau of Labor Statistics (ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt). The base year of the index is 1983. Note that the CPI is different from the output price index. The former is a weighted average of only consumer product prices; the latter is an equally weighted index of the output prices for all the manufacturing industries.

The mean percentage increase in the quantity of units sold is 2.7%, whereas the number of production workers decreased a 0.4%. Accordingly, the mean improvement in labor productivity is 2.3% (2.7% - (-0.4%)). In contrast, the productivity of intermediate inputs remained the same during the sample period.

On average, variable operating expenses account for about 63.7% of revenue, implying a contribution margin of 36.3%. Intermediate inputs constitute the majority of variable operating expenses, totaling 50% of revenues.

The final set of variables in Table 2 gives the distributions of the change in operating profit and the variation analysis components. To hold size constant, all variables are deflated by lagged revenue. The change in operating profit as a percentage of lagged revenue has a mean of 0.023%, but it exhibits significant variation over time and across industries. The two effects that contribute most to the variation in operating profitability are the price effect and the revenue volume effect. In fact, the variability in the volume effects is larger than that of the total change in operating profit, indicating that at least some effects tend to offset each other. The high variability of the volume effect does not mean that it has low persistence, however. Persistence is an attribute of the relation 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 effects under study by examining their relation with future changes in operating profit.[20]

The mean unexplained change in operating profit is nearly zero and its standard deviation is small compared to those of the current operating profit growth 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 errors due to changes in output and input mixes.

[TABLE 2 HERE]

Table 3 presents correlations among the main variables of this study. Obviously, price and revenue volume effects are positively correlated to current and future change in operating profit. Expense volume, cost, and productivity effects are defined with a negative sign in front, so they should be also positively correlated with current

[20] As described below, we measure the persistence of changes in operating profit using the slope coefficient from a regression of the one-year ahead change in operating profit on the current change in operating profit. We then decompose the current change in operating profit into the variation analysis components and compare the slope coefficients of the different components.

and future change in operating profit. Yet, that is not the case for the cost and expense volume effects, making necessary a multivariate analysis for a better understanding. For example, an increase in the expense volume effect (i.e. increase in current operating profit due to lower volume generating lower expenses) should lead to an increase in current and future operating profit. However, the decrease in volume could be in itself a sign of crisis and thus, current and future operating profit can decline through other effects. Overall, correlations in table 3 start shedding light on the importance of industry volume growth, as it strongly correlates with many other variables.

[TABLE 3 HERE]

4. Explaining Future Operating Profit Growth and its Components

Specifications and Hypotheses

If price, volume, cost and productivity effects had differential persistence, they should be useful for predicting future operating profit. To test this hypothesis, we start by specifying an auto-regressive model for changes in operating profit:[21]

$$\Delta OP_{t+1} = \alpha_{industry} + \alpha_{year} + \beta_1 \, \Delta OP_t + e_{1,t+1} \qquad (2)$$

Where both the dependent and independent variables—as well as all the components of ΔOP_t in expressions (3) and (4) below—are deflated by lagged revenue (i.e., REV_{t-1}). This adjustment mitigates potential scale effects of the highly size-heterogeneous sample used in this study.[22]

Model (2) uses the current change in operating profit ($\Delta OP_t = OP_t - OP_{t-1}$) as a starting point for predicting next year's change in operating profit ($\Delta OP_{t+1} = OP_{t+1} - OP_t$). In other words, the model explains future economic shocks based on current shocks. The coefficient β_1 captures the persistence of changes in *OP*.

We next use expression (1) to break down ΔOP_t into its key components. As stated earlier, we omit the joint variance effects, treat all costs as variable, and deflate all variables by lagged revenues (i.e., REV_{t-1}). We also introduce

[21] As an alternative, we also considered a model with levels of operating profit. However, its empirical implementation is problematic. The variable *OP* is non-stationary, i.e., its mean, variance and/or covariance changes over time. This is a frequent problem in the time-series of macroeconomic variables. Running regressions on non-stationary data can result in spurious values of R^2 and t statistics. Unlike the usual datasets employed in accounting research, our panel data has a large number of years (T=50) relative to the number of industries (N=459). As a consequence, the usual fixed-T large-N asymptotics may not apply and we need to consider the effect of possible time-series unit root processes (Wooldridge 2002, p. 175). We ran the Dickey-Fuller test (Dickey and Fuller 1979) with one lag in *OP* and found that we cannot reject the random walk hypothesis (stochastic trend) for most of the industries. Our current changes model does not suffer from this problem. For the variable ΔOP we can reject the random walk and deterministic trend hypothesis.

[22] As a robustness check, we included the variable $1/REV_{t-1}$ in the specification. Results were not affected.

fixed-effects to control for industry and time-specific omitted correlated variables. We do the disaggregation in two steps:

$$\Delta OP_{t+1} = \alpha_{industry} + \alpha_{year} + \beta_2\, \Delta REV_t + \beta_3\, \Delta EXP_t + e_{2,t+1} \quad (3)$$

$$\Delta OP_{t+1} = \alpha_{industry} + \alpha_{year} + \beta_4\, PriceEffect_t + \beta_5\, VolumeEffect_{REVt} + \beta_6\, VolumeEffect_{EXPt} + \beta_7\, CostEffect_{LABOR,t} + \beta_8\, CostEffect_{II,t} + \beta_9\, ProdEffect_{LABOR,t} + \beta_{10}\, ProdEffect_{II,t} + e_{3,t+1} \quad (4)$$

In equation (3), ΔREV is the change in revenue during the year and ΔEXP is the negative change in variable costs, including intermediate inputs and compensation, so that $\Delta REV+\Delta EXP=\Delta OP$. Equation (4) represents our primary model. In addition to the regression of ΔOP_{t+1} on the components of ΔOP_t , we regress each component of ΔOP_{t+1} on the components of ΔOP_t . These additional seven equations, (5) to (11), will help us develop hypotheses on how current components predict future operating profit growth.

Prior research demonstrates that the persistence of revenue surprises are larger than those of expense surprises (e.g., Lipe 1986; Swaminathan and Weintrop 1991; Ertimur et al. 2003). We run regression (3) to test the following hypothesis for our industry level data:

H1: Shocks in revenues are more persistent than shocks in expenses ($\beta_2>\beta_3$).

Predicting the persistence of current components in equation (4) is an open empirical question. On the one hand, prior research consistently documents mean reversion in firm performance (e.g. Freeman et al. 1982; Fama and French 2000; Nissim and Penman 2001), predicting low persistence of current components. On the other hand, industry secular growth could be a major driving force of profitability, increasing the persistence of current components. If we observe a positive volume effect in an industry at its growing life-stage, chances are that volume will keep growing in the following year. If the offer is not enough to serve the demand, prices will also increase. Higher volume can simultaneously generate positive productivity effects in the presence of economies of scale. On the contrary, if we observe a negative volume effect because an industry is in decay, the situation will only get worse. In stagnant industries the only way existing firms can grow is by taking share away from the other players, creating price wars (Palepu and Healy 2012). Moreover, the cost stickiness literature (Anderson et al. 2003) suggests that when the level of activity decreases, resources (here intermediate inputs and labor) are not adjusted immediately, generating negative productivity effects.

In addition to real volume growth, nominal growth can also enhance the persistence of current components. Empirical research in macroeconomics shows that wages and prices adjust slowly to macroeconomic events, that is, they are sticky (see Blinder et al. 1998 for a review). *Price stickiness* predicts that current output price, input cost, and labor cost effects will persist one-year ahead, contributing to the overall persistence of operating profit growth.

The degree of mean reversion and the ability of industry growth to translate into operating profit growth will depend on competition forces. The more competitive is an industry, the higher is the mean reversion and the lower the translation of industry growth into profitability (the contextual analysis section studies how market structure variables affect persistence). The tensions generated by the four major forces described above (i.e. competition, industry growth, cost stickiness and price stickiness) preclude us from formulating directional predictions about the persistence of price, volume, cost and productivity effects.

Results

Table 4 presents estimates of models (2) through (11) for our sample of SIC industries with nominal dollars measurements.[23] We run regressions with industry and year cluster-adjusted errors.[24] Estimating model (2), we find that the coefficient of ΔOP_t is slightly negative and not significant. The level of significance increases when we use constant dollars (t=1.82) (not reported). It seems as if overall changes in operating profit do not exhibit substantial persistence or reversal.

Estimation of equation (3) shows that revenue shocks are significantly more persistent than expenses shocks (β_2=-0.069 vs. β_3=-0.154). Hence, we cannot reject hypothesis 1, consistent with prior research. Estimation of equation (4) in Table 3 shows that disaggregating ΔOP_t into our key components is informative about future changes in operating profit. The R^2 measures of model (4) are significantly higher than those of model (2) (recall that the regressions include many explanatory variables—the fixed year and industry effects—so the magnitude of the changes

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[23] Using a sample with NAICS industry classification and constant dollars would not change our results. Inflation adjusting (using constant dollar) does not matter much, mainly because the span of time between measurement of the independent and dependent variables is not very large and inflation has been traditionally low.

[24] This approach allows for correlations among different industries in the same year and among different years for the same industry (see, e.g., Petersen 2009; Gow et al. 2010). Cross-sectional correlation could be an issue because some industries are suppliers or customers of others, or provide substitute or complementary products to those provided by other industries. Fixed effects, in addition to mitigating the omitted correlated variables problem, partially reduce the correlation across disturbances. However, fixed effects only allow for a uniform correlation among errors in a cluster. Using cluster adjusted errors allows for less restrictive correlation structures.

in R^2 are relatively small in spite of being significant).[25] The coefficients are negative and significant for all the current components with the exception of the volume effects. Both, the revenue volume effect and the expense volume effect have a very similar positive and significant coefficient. This suggests that the common practice of identifying only one volume effect as $(\Delta Q/Q_{-1}) \times OP_{-1}$ is empirically correct (e.g. Shank and Churchill 1977; Horngren et al. 2010). It seems that, at the industry level, the persistence of the revenue effect is driven by volume more than by price. Adjusting for inflation has a very small effect on the estimates, indicating that the differences in persistence across the operating profit components are not driven by inflation (not reported).[26]

The interpretation of the coefficients is straightforward. For example, in specification (4) of Table 4 , for each \$1 increase in current operating profit due to price, we expect next year's operating profit to decrease by \$0.065 (i.e., an increase of \$0.935 compared to operating profit two years ago). Note that the cost and productivity effect variables are negatively defined. Therefore, an increase of \$1 in current operating profit due to the change in the cost of intermediate inputs (i.e., a decrease of \$1 in the cost) would result in a decrease in operating profit of \$0.173 next year (i.e., an increase of \$0.827 compared to operating profit two years ago). In general, any coefficient higher than -1.0 implies some persistence in the level of operating profit. For example, a coefficient of -0.9 implies that of a \$1 increase in the level of operating profit, \$0.1 will persist in next period's operating profit.

Regressions (5) to (11) of one-year ahead components on current components form a system in which disturbances are most likely related. However, in the particular case of Seemingly Unrelated Regressions where regressors are identical we can estimate each regression separately using regular ordinary least squares. The estimated coefficients shed new light about the prevailing forces in explaining the persistence of each component.

- Price Effect ($PriceEffect_{t}$): a \$1 increase in current operating profit due to price will result in a \$0.225 increase in one-year ahead operating profit due to price. This positive and significant coefficient is consistent with price stickiness. An increase in current price is also related to a decrease in one-year ahead volume, consistent with competition forces. The decrease in volume is reflected in the price effect

[25] Models (2) and (4) are non-nested because of the unexplained variation. For this reason, we compare the R^2 by means of a Vuong test (Dechow 1994). The Z statistic is 1.18, equivalent to a p-value of 0.88.

[26] To adjust for inflation, we deflate the "building blocks" variables VSHIP, PRODW, MATCOST, PISHIP, and PIMAT by the general inflation index (CPI as defined in footnote 17), standardizing the amounts to the same base year. Deflating by inflation has the additional benefit of removing any trends left in the data due to inflation. In that sense, this analysis constitutes a robustness check.

coefficients of -0.206 and 0.104 explaining the one-year ahead revenue volume and expense volume effects, respectively. Finally, the decrease in future volume due to the current increase in price, seems to generate negative productivity effects (-0.042 for labor and -0.189 for intermediate inputs). Because of cost stickiness, inputs might not be adjusted to the decrease in outputs, decreasing productivity and operating profit.

- Revenue Volume Effect *(VolumeEffect$_{Rev\ t}$)*: the overall persistence of revenue volume effects in one-year ahead operating profit (β_5=0.111) seems to come mainly from secular growth. Current positive revenue volume effects persist in future volume effects (coefficient of 0.306). At a lower scale, volume might be increasing negotiating power as reflected by the significant positive intermediate input cost effect (0.042).
- Expense Volume Effect (*VolumeEffect$_{Exp\ t}$*): interestingly, the persistence of expense volume effects in one-year ahead operating profit (β_6=0.126) does not come from secular growth, but from a large reversal in volume. A $1 increase in current operating profit due to the expense volume effect (i.e. current decrease in volume) predicts a future increase in operating profit due to the revenue volume effect (i.e. future increase in volume). This explanation is consistent with the significant negative price effect (-0.240) generated by the current decrease in volume. The current crisis leads an industry to decrease prices in order to increase volume again.
- Labor Cost Effect (*LaborCostEffect$_t$*): this is the least persistent component (-0.573). Unlike prices, labor costs do not exhibit price stickiness. On the contrary, a $1 dollar increase in current operating profit due to lower labor cost results in a decrease of $0.159 in future operating profit due to labor cost. A plausible explanation becomes apparent when observing the significant future decrease in volume (see coefficients of -0.841 and 0.544 when explaining revenue and expenses volume effects, respectively). Current decreases in labor costs tend to happen in stagnant industries that have been downsizing their operations. The labor offer is higher than demand and so labor costs diminish. In the next period, the process will repeat: less volume, more downsizing, less labor costs.
- Intermediate Inputs Cost Effect (*IICostEffect$_t$*): a $1 dollar increase in current operating profit due to lower inputs cost predicts a decrease of $0.226 in future operating profit due to lower output prices. A possible reason is that cost savings are passed on to the customers due to competition. Similar to the

labor cost effect, a spiral of volume decreases also appear. As an industry decreases, demand for intermediate inputs decreases and their prices drop. This rationale is consistent with the coefficients that explain the future revenue volume effect (-0.353), expense volume effect (0.204), labor cost effect (-0.013), and price effect (-0.226). The significant persistence of current input costs on future input costs (0.257) might be a sign of price stickiness.

- Labor Productivity Effect ($LaborProdEffect_t$): the low persistence of current productivity effects in future operating profit (-0.361) seems to be driven by a future decrease in volume. Due to cost stickiness, the future decrease in volume might drive the lower future productivity effects for both labor and intermediate inputs (-0.101 and -0.133, respectively).
- Intermediate Input Productivity Effect ($IIProdEffect_t$): here we observe the same results as for labor productivity effect. Given a $1 increase in current operating profit due to an improvement in productivity (i.e. fewer input units per output units), we expect a decrease of $0.181 in future operating profit. Again, the result seems explained by a future decrease in volume and cost stickiness.

In summary, industry growth seems to be the underlying story in many of the findings described above. Increases in volume tend to persist and at the same time affect productivity through cost stickiness. The nominal phenomenon of price stickiness is also present in the data. Still, for most effects, we still find certain degree of mean reversion in operating profit growth, with significant negative coefficients.

[TABLE 4 HERE]

5. Contextual analysis: Market Structure Determinants

The extent to which mean reversion and industry growth are translated into profitability will likely depend on the level of competition. Prior work in the field of Industrial Organization has evaluated 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). In accounting research, some studies have documented the effect of economic determinants on the persistence of earnings (e.g. Lev 1995; Baginski et al. 1999). This type of analysis may prove useful in the interpretation of our results.

We identify five market structure variables from prior literature that explain the persistence of profitability:

- Concentration (Stigler 1968, Porter 1980, Waring 1996): industries in which a few firms control a large market share experience less rivalry. We expect the components of current change in operating profit to be more persistent in highly concentrated industries. We measure concentration with the four-firm concentration ratio (C4), computed as the percentage share of sales accounted by the 4 largest companies in the industry. We create a dummy variable that takes value 1 if the concentration ratio is above the median of all industries in a particular year, and otherwise 0. Data on concentration for SIC industries expanding from 1958 to 1996 is obtained from the Economic Census Bureau.

- Capital intensity (Porter 1980, Eaton and Lipsey 1981, Lev 1983, Baginski et al. 1999): Eaton and Lipsey (1981) find that high capital intensity is positively associated with industry profitability, as large investments generate barriers to entry. However, Lev (1983) argue that high capital intensity induces more volatility of earnings because of operating leverage, decreasing the persistence of profitability. The effect of capital intensity on the persistence of ΔOP_t components is an open empirical question. We measure capital intensity as the ratio of real capital stock (i.e. plant and equipment investments) on sales and then create a dummy variable that takes value 1 if capital intensity is above the median of all industries in a particular year, and otherwise 0. The NBER-CES Productivity Database provides the time series for our full SIC sample.
- Economies of scale (Scherer 1980, Schmalensee 1981, Waring 1996): we expect economies of scale to be positively related to the persistence of operating profit components. In growing industries with persistence of volume effects, economies of scale will mean lower costs and more productivity. In stagnating industries the effect will be the opposite, aggravated by cost stickiness. Economies of scale are proxied with the average size of the firm in each industry (sales / number of firms). We generate a dummy variable that takes value 1 if the average size is above the median of all industries, and otherwise 0. Data on the number of firms in SIC industries expanding from 1958 to 1996 is obtained from the Economic Census Bureau.
- Unionization (Ghemawat 1991, Waring 1996): The effect of unionization is unclear. On the one hand, unionization raises total expropriation by labor, leading to low persistence of profitability. In particular, we would expect the labor cost effect to be less persistent in highly unionized industries. On the other hand, unionization reduces differential expropriation by labor because an effect of unions is to maintain pay differences within the industry (Waring 1996). Unionization is computed as the percentage of workers affiliated to unions in each industry. We create a dummy variable that takes value 1 if

unionization is above the median of all industries, and otherwise 0. We use data from the Current Population Survey (see Hirsch and Macpherson 2003 for a detailed description of this data).

- Growth (Stigler 1968, Porter 1980, Waring 1996): industry growth reduces rivalry, as firms do not have to fight for the same pie. We expect that higher growth will lead to higher persistence of components, muting the mean reversion effect of other competition forces. We measure growth as one-year ahead sales growth and generate a dummy that takes value 1 if growth is above the median of all industries, and otherwise 0. Obviously, here we are going to have a look-ahead bias, but in this case we are not trying to predict. We only want to document that growth is a major force driving persistence.

We interact the dummy variables defined above with each one of the components of current change in operating profit and estimate the following specification:

$$\begin{aligned}\Delta OP_{t+1} &= \alpha_{industry} + \alpha_{year} + \delta + \gamma_1\, PriceEffect_t + \gamma_2\, \delta\, PriceEffect_t + \gamma_3\, VolumeEffect_{REVt} \\ &+ \gamma_4\, \delta\, VolumeEffect_{REVt} + \gamma_5\, VolumeEffect_{EXPt} + \gamma_6\, \delta\, VolumeEffect_{EXPt} + \gamma_7 CostEffect_{LABOR.t} \\ &+ \gamma_8 \delta\, CostEffect_{LABOR.t} + \gamma_9 CostEffect_{II.t} + \gamma_{10} \delta\, CostEffect_{II.t} + \gamma_{11}\, ProdEffect_{LABOR.t} \\ &+ \gamma_{12}\, \delta\, ProdEffect_{LABOR.t} + \gamma_{13} ProdEffect_{II.t} + \gamma_{14} \delta\, ProdEffect_{II.t} + \varepsilon_{1,t+1} \qquad \text{(12) to (16)}\end{aligned}$$

where δ represents one of the industry structure dummies described above for each equation.

Table 5 presents the coefficients and t-stats from estimating equations (12) through (16). As expected, higher concentration is positively associated with higher persistence of the profitability components. All the coefficients in the interactions are positive, albeit only the interaction with the price effect is significant (t=1.94). Current increases in prices are more persistent in future operating profit when industries are concentrated. In our robustness analysis we have used alternative measures of concentration (C8, C20, C50 and the Herfindhal Index) and results hold.

Capital intensity is also positively associated with persistence, supporting the view that capital intensity generates barriers to entry. Again, all the interacted variables exhibit positive coefficients, although the level of significance is also low. Results remain similar if we measure capital intensity as the ratio of capital expenditures on sales, instead of real capital stock on sales.

Higher economies of scale are linked to higher persistence of the components. The coefficients of all the interacted variables are positive and significant with the exception of labor cost which is negative but not significant. Using alternative measures such as the ratio of real capital stock to number of companies, and the number of employees to the number of companies does not alter our findings substantially.

Results from our unionization regression are weak. The coefficient of the interaction between unionization and labor cost effect is positive, suggesting no expropriation by labor in unionized industries, but the result is insignificant. The lack of results might be related to the limitations of our data. The unionization measure we use is given at the NAICS four-digit level classification. However, in our main sample NAICS industries are defined at a six-digit level. Thus we lose some industry specific information in the matching process.

As expected, future growth has a positive association with the persistence of current components. All the coefficients of the interactions are positive and highly significant. Again, the goal of this particular regression is not to establish causality or predictive power, but just to test a correlation that reflects the overwhelming power of industry secular growth.

Taken as a whole, our results support the view that industry growth is a major driver of the persistence of current operating profit growth components in future operating profit growth, beyond the limitations of competition forces that induce mean reversion.

[TABLE 5 HERE]

7. Conclusion

This study investigates the persistence of price, volume, cost and productivity components of current change in operating profit. Using industry-level data, we show that these components have differential persistence and might therefore be useful for predicting changes in operating profit. Our regressions of components on components allows us to map the dynamics by which current components persist in future operating profit. The findings in the contextual analysis confirm the role industry structure variables play on the persistence of profitability. These findings suggest that differentiating price, volume, cost and productivity components 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 findings highlight the significance of each of the current operating profit growth effects in explaining future growth in operating profit, thereby providing important insights. One implication is that the higher persistence of revenue shocks compared to expense shocks, which has been documented by prior studies (e.g., Lipe 1986; Swaminathan and Weintrop 1991; Ertimur et al. 2003), is likely driven by volume, not price effects. Another implication relates to the structure of the analysis. In the managerial accounting domain, some have recommended combining the price and inflation effects into a summary variable referred to as Price Recovery (see e.g., Horngren et al. 2010; Hayzen and Reeve 2000). Our results imply that focusing on the price recovery effect may not be desirable as the predictive power of the two components—changes in output prices and changes in input prices—may differ significantly. Last but not least, the higher persistence of volume in future operating profit, and specifically in future volume effects, suggests that industry growth is a major driving force of persistence. An investor would do well in choosing carefully the industry before choosing a firm. Warren Buffett argued that his worse mistake was buying in the wrong industry, referring to Berkshire Hathaway.

Prior work in the field of Industrial Organization has evaluated the association between measures of market structure, such as concentration, barriers to entry and unionization, with profitability, prices and other performance variables (e.g. Waring 1996). In accounting research, some studies have documented the effect of economic determinants on the persistence of earnings (e.g. Lev 1995; Baginski et al. 1999). This study goes one step beyond by examining the effect of market structure variables on the persistence of different components of profitability. Our findings highlight some underlying stories (e.g. growth, competition forces, cost stickiness, price stickiness) in persistence that open the door to more detailed future research.

We conclude with two caveats. First, 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. While firm-level data are generally not available from public sources, they may be available in some industries for some activities.[27] An important extension of this research, therefore, is to conduct a firm-level analysis.

The second caveat also relates to the generalizability of the results. Our sample includes only manufacturing industries. The homogeneity of these industries implies that the estimated coefficients likely measure the underlying effects with reasonable precision. However, it also suggests that these coefficients and related inferences cannot be applied to service industries. In fact, *a priori* arguments would suggest that the results likely differ for service industries. For service companies, output and intermediate input units are typically not physical and not well-defined, which could cause the related effects to have different persistence rates than those documented for manufacturing

[27] For example, banks disclose volume and rate analysis of net interest income.

industries. This is an important caveat because service industries have become increasingly important, particularly in the U.S.

Appendix A

Operating Profit Variation Analysis

Ignoring any 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 (that is, the inverse productivity of factor j in producing output k or $iProd_{j,k}$).
- Total amount of fixed operating expenses of type h, h = 1,2,…,H (FC_h).

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:

$$REV = \sum_{k=1}^{K} REV_k = \sum_{k=1}^{K} P_k \times Q_k \quad \text{(A1)}$$

$$VC = \sum_{j=1}^{J}\sum_{k=1}^{K} VC_{j,k} = \sum_{j=1}^{J}\sum_{k=1}^{K} C_j \times Q_k \times iProd_{j,k} \quad \text{(A2)}$$

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

$$CM = \sum_{k=1}^{K} CM_k = \sum_{k=1}^{K} REV_k - \sum_{j=1}^{J}\sum_{k=1}^{K} VC_{j,k} = \sum_{k=1}^{K} P_k \times Q_k - \sum_{j=1}^{J}\sum_{k=1}^{K} C_j \times Q_k \times iProd_{j,k} \quad \text{(A3)}$$

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

The annual change in revenues can be calculated as

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

$$\sum_{k=1}^{K} [(P_k - P_{k,-1}) \times Q_{k,-1} + P_k \times Q_k - P_k \times Q_{k,-1}] = \sum_{k=1}^{K} (\Delta P_k \times Q_{k,-1} + P_k \times \Delta Q_k) \quad \text{(A4)}$$

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

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

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

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

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

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

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

$$\sum_{j=1}^{J}\Big(\sum_{k=1}^{K} C_j \times (\Delta Q \times iProd_{j,k,-1} + Q_k \times \Delta iProd_{j,k})$$

$$+\sum_{k=1}^{K} \Delta C_j \times Q_{k,-1} \times iProd_{j,k,-1} \Big) + \sum_{h=1}^{H} \Delta FC_h \qquad \text{(A5)}$$

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

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

$$-\sum_{j=1}^{J}\Big(\sum_{k=1}^{K} C_j \times (\Delta Q \times iProd_{j,k,-1} + Q_k \times \Delta iProd_{j,k})$$

$$+\sum_{k=1}^{K} \Delta C_j \times Q_{k,-1} \times iProd_{j,k,-1} \Big) - \sum_{h=1}^{H} \Delta FC_h \qquad \text{(A6)}$$

Substituting relations (1) through (3) into equation (6) and simplifying, we get

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

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

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

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

$$-\sum_{j=1}^{J}\sum_{k=1}^{K} (\Delta Q_k / Q_{k,-1}) \times (\Delta \mathrm{C}_j / \mathrm{C}_{j,-1}) \times VC_{j,k,-1}$$

$$-\sum_{j=1}^{J}\sum_{k=1}^{K} (\Delta Q_k / Q_{k,-1}) \times (\Delta \mathrm{C}_j / \mathrm{C}_{j,-1}) \times (\Delta iProd_{\text{j,k}} / iProd_{\text{j,k,-1}}) \times VC_{j,k,-1}$$

$$-\sum_{j=1}^{J}\sum_{k=1}^{K} (\Delta iProd_{\text{j,k}} / iProd_{\text{j,k,-1}}) \times (\Delta \mathrm{C}_j / \mathrm{C}_{j,-1}) \times VC_{j,k,-1} \qquad \text{(A7)}$$

This equation is the starting point for the discussion in Section 2 (equation (1) is the same as equation (A7), with the five joint variance referred to as *residual*).

Appendix B
Data Sources and Calculation of Chain-Type Indexes

Most of the variables in the NBER-CES Database come from the Annual Survey of Manufactures (ASM), a sample of around 60,000 manufacturing establishments, carried out by the Census Bureau. This basic information covers 11 of the 18 variables in the data set: number of workers, total payroll, number of production workers, number of production worker hours, total production workers wages, value of shipments, value added, end-of-year inventories, new capital investment, expenditure on energy, and expenditure on materials (including energy).

Price deflator variables come from the Bureau of Economic Analysis (BEA). BEA publishes annual current-dollar estimates of an industry's gross output and intermediate inputs. With the help of raw price indexes, BEA derives the chain-type quantity and price indexes that we explain in the next paragraph. The raw 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. For other sectors, the data sources vary. For a comprehensive list of original sources see Lum et al. (2000).

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, this change in output mix 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.

Sources: Bartelsman and Gray (1996); U.S. Census Bureau; and U.S. Bureau of Economic Analysis

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Table 1
Industry Composition of Sample (NAICS)

31-33	**Manufacturing**
311	**Food Manufacturing**
3111	Animal Food Manufacturing
31111	Animal Food Manufacturing
311111	Dog and Cat Food Manufacturing
311119	Other Animal Food Manufacturing
3112	Grain and Oilseed Milling
31121	Flour Milling and Malt Manufacturing
311211	Flour Milling
311212	Rice Milling
311213	Malt Manufacturing
31122	Starch and Vegetable Fats and Oils Manuf.
311221	Wet Corn Milling
311222	Soybean Processing
311223	Other Oilseed Processing
311225	Fats and Oils Refining and Blending
31123	Breakfast Cereal Manufacturing
3113	Sugar and Confectionery Product Manufacturing
31131	Sugar Manufacturing
311311	Sugarcane Mills
311312	Cane Sugar Refining
311313	Beet Sugar Manufacturing
31132	Chocolate and Confectionery Manuf from Cacao Beans
31133	Confectionery Manufacturing from Purchased Chocolate
31134	Nonchocolate Confectionery Manufacturing
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321	**Wood Product Manufacturing**
3211	Sawmills and Wood Preservation
32111	Sawmills and Wood Preservation
321113	Sawmills
321114	Wood Preservation
3212	Veneer, Plywood, and Engineered Wood Product Manuf.
32121	Veneer, Plywood, and Engineered Wood Product Manuf.
321211	Hardwood Veneer and Plywood Manufacturing
321212	Softwood Veneer and Plywood Manufacturing
321213	Engineered Wood Member (except Truss) Manuf.
321214	Truss Manufacturing
321219	Reconstituted Wood Product Manufacturing
3219	Other Wood Product Manufacturing
32191	Millwork
321911	Wood Window and Door Manufacturing
321912	Cut Stock, Resawing Lumber, and Planing
321918	Other Millwork (including Flooring)
32192	Wood Container and Pallet Manufacturing
32199	All Other Wood Product Manufacturing
321991	Manufactured Home (Mobile Home) Manufacturing
321992	Prefabricated Wood Building Manufacturing
321999	All Other Miscellaneous Wood Product Manufacturing
322	**Paper Manufacturing**
3221	Pulp, Paper, and Paperboard Mills
32211	Pulp Mills
32212	Paper Mills
322121	Paper (except Newsprint) Mills
322122	Newsprint Mills
32213	Paperboard Mills
3222	Converted Paper Product Manufacturing
32221	Paperboard Container Manufacturing
322211	Corrugated and Solid Fiber Box Manufacturing
322212	Folding Paperboard Box Manufacturing
322213	Setup Paperboard Box Manufacturing
322214	Fiber Can, Tube, Drum, and Similar Products Manuf.
322215	Nonfolding Sanitary Food Container Manufacturing
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331	**Primary Metal Manufacturing**
3311	Iron and Steel Mills and Ferroalloy Manuf.
33111	Iron and Steel Mills and Ferroalloy Manuf.
331111	Iron and Steel Mills
331112	Electrometallurgical Ferroalloy Product Manuf.
3312	Steel Product Manuf. from Purchased Steel
33121	Iron and Steel Pipe & Tube Manuf. from Purchased Steel
33122	Rolling and Drawing of Purchased Steel
331221	Rolled Steel Shape Manufacturing
331222	Steel Wire Drawing
3313	Alumina and Aluminum Production and Processing
33131	Alumina and Aluminum Production and Processing
331311	Alumina Refining
331312	Primary Aluminum Production
331314	Secondary Smelting and Alloying of Aluminum
331315	Aluminum Sheet, Plate, and Foil Manuf.
331316	Aluminum Extruded Product Manufacturing
331319	Other Aluminum Rolling and Drawing
3314	Nonferrous Metal (except Aluminum) Production and Processing
33141	Nonferrous Metal (except Aluminum) Smelting and Refining
331411	Primary Smelting and Refining of Copper
331419	Primary Smelting and Refining of Nonferrous Metal (except Copper and Aluminum)
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This table provides a short selection of the NAICS-coded industries used in our sample. The sample period covers the base years 1959-2008 and 473 industries at the NAICS 6-digit level. When an industry is defined only at the 5-digit level (e.g. 31123 Breakfast Cereal Manufacturing) that industry has no subgroups and is included in the sample adding a zero at the end (e.g. 311230). The NBER-CES Database is also available using the 1987 SIC code at the 4-digit level. In this case, the period covered is the same and the total number of industries is 459. In many regressions we have used SIC data because most market structure variables in the contextual analysis follow this classification. Results are the same under both classifications.

Table 2
Summary Statistics

	Mean	St. Dev.	P5	Q1	Median	Q3	P95
$\Delta P/P_{-1}$	0.032	0.066	-0.035	0.004	0.021	0.049	0.132
$\Delta Q/Q_{-1}$	0.027	0.135	-0.157	-0.037	0.022	0.083	0.216
$\Delta C_{Labor}/C_{Labor-1}$	0.046	0.054	-0.033	0.016	0.044	0.074	0.130
$\Delta C_{II}/C_{II-1}$	0.034	0.062	-0.026	0.003	0.022	0.050	0.133
$\Delta I_{Labor}/I_{Labor.-1}$	-0.004	0.107	-0.162	-0.059	0.000	0.047	0.155
$\Delta I_{II}/I_{II.-1}$	0.027	0.151	-0.173	-0.044	0.020	0.088	0.238
$\Delta Prod_{Labor}/Prod_{Labor.-1}$	0.023	0.093	-0.104	-0.016	0.025	0.067	0.151
$\Delta Prod_{II}/Prod_{II.-1}$	-0.001	0.073	-0.108	-0.033	0.001	0.034	0.103
EXP/REV	0.637	0.110	0.453	0.571	0.640	0.709	0.808
$COMP/REV$	0.136	0.065	0.040	0.090	0.131	0.176	0.246
II/REV	0.501	0.125	0.311	0.419	0.490	0.573	0.724
OP/REV	0.363	0.110	0.192	0.291	0.360	0.429	0.547
$\Delta OP/REV_{-1}$	0.023	0.067	-0.061	-0.007	0.020	0.049	0.110
$PriceEffect/REV_{-1}$	0.032	0.057	-0.035	0.004	0.021	0.049	0.132
$VolumeEffect_{Rev}/REV_{-1}$	0.027	0.135	-0.157	-0.037	0.022	0.083	0.216
$VolumeEffect_{Exp}/REV_{-1}$	-0.017	0.087	-0.141	-0.053	-0.014	0.023	0.101
$LaborCostEffect/REV_{-1}$	-0.006	0.008	-0.021	-0.010	-0.005	-0.002	0.004
$IICostEffect/REV_{-1}$	-0.017	0.030	-0.072	-0.024	-0.010	-0.002	0.014
$LaborProdEffect/REV_{-1}$	0.003	0.011	-0.013	-0.002	0.003	0.008	0.022
$IIProdEffect/REV_{-1}$	0.001	0.034	-0.051	-0.016	0.000	0.017	0.054
$Unexplained/REV_{-1}$	0.001	0.015	-0.007	-0.001	0.000	0.002	0.009

The sample period covers the base years 1959-2008 and 459 industries at the 4-digit level using SIC 1987 code. The total number of industry-year observations is 22,841. The top/bottom 0.5% of each variable has been winsorized. $\Delta P/P$ is the annual rate of change in the "price deflator for value shipments." $\Delta Q/Q_{-1}$ is the annual rate of change in "value of shipments deflated by the price index." $\Delta C_{Labor}/C_{Labor.-1}$ is the annual rate of change in compensation per employee (ratio of "production worker wages" to "number of production workers"). $\Delta C_{II}/C_{II.-1}$ is the annual rate of change in the "price deflator for materials." $\Delta I_{Labor}/I_{Labor,-1}$ is the annual rate of change in "number of production workers." $\Delta I_{II}/I_{II,-1}$ is the annual rate of change in the "cost of materials deflated by the materials price index." $\Delta Prod/Prod_{-1} = (\Delta I_j/I_{j,-1} - \Delta Q/Q_{-1}) / (1+\Delta Q/Q_{-1})$ for j = Labor, II. EXP is the total of "production worker wages" and "cost of materials." REV is "value of shipments." $OP = REV - EXP$. $PriceEffect = (\Delta P/P_{-1}) \times REV_{-1}$. $VolumeEffect_{Rev} = (\Delta Q/Q_{-1}) \times REV_{-1}$. $VolumeEffect_{Exp} = -(\Delta Q/Q_{-1}) \times EXP_{-1}$. $CostEffect_j = -(\Delta C_j/C_{j.-1}) \times EXP_{j,-1}$, for j = Labor, II. $ProdEffect_j = -((\Delta I_j/I_{j,-1} - \Delta Q/Q_{-1}) / (1+\Delta Q/Q_{-1})) \times EXP_{j,-1}$, for j = Labor, II. $Unexplained = \Delta OP - PriceEffect - VolumeEffect - \sum CostEffect_j - \sum ProdEffect_j$.

Table 3
Spearman Correlations

	ΔOP_{t+1}	ΔOP_t	*Price* $Effect_t$	*Volume* $Effect_{Rev\ t}$	*Volume* $Effect_{Exp\ t}$	*Labor* $CostEffect_t$	*II* $CostEffect_t$	*Labor* $ProdEffect_t$	*II* $ProdEffect_t$
ΔOP_{t+1}	1.000								
ΔOP_t	0.074	1.000							
$PriceEffect_t$	0.060	0.152	1.000						
$VolumeEffect_{Rev\ t}$	0.110	0.757	-0.211	1.000					
$VolumeEffect_{Exp\ t}$	-0.095	-0.711	0.213	-0.983	1.000				
$LaborCostEffect_t$	-0.103	-0.122	-0.163	-0.110	0.110	1.000			
$IICostEffect_t$	-0.044	-0.099	-0.693	0.087	-0.090	0.131	1.000		
$LaborProdEffect_t$	0.017	0.366	-0.286	0.454	-0.452	-0.388	0.137	1.000	
$IIProdEffect_t$	-0.061	0.267	-0.360	0.100	-0.104	-0.011	-0.078	0.134	1.000

All the Spearman correlations above are significant at the 1% level, except the one between $IIProdEffect_t$ and $LaborCostEffect_t$. The sample period covers the base years 1959-2008 and 459 industries at the 4-digit level using SIC 1987 code. The total number of industry-year observations is 22,841. The top/bottom 0.5% of each variable has been winsorized. $OP = REV - EXP$. $PriceEffect = (\Delta P/P_{-1}) \times REV_{-1}$. $VolumeEffect_{Rev} = (\Delta Q/Q_{-1}) \times REV_{-1}$. $VolumeEffect_{Exp} = -(\Delta Q/Q_{-1}) \times EXP_{-1}$. $CostEffect_j = -(\Delta C_j/C_{j,-1}) \times EXP_{j,-1}$, for j = Labor, II. $ProdEffect_j = -((\Delta I_j/I_{j,-1} - \Delta Q/Q_{-1}) / (1+\Delta Q/Q_{-1})) \times EXP_{j,-1}$, for j = Labor, II. All variables are deflated by REV_{-1}. $\Delta P/P$ is the annual rate of change in the "price deflator for value shipments." $\Delta Q/Q_{-1}$ is the annual rate of change in "value of shipments deflated by the price index." $\Delta C_{Labor}/C_{Labor,-1}$ is the annual rate of change in compensation per employee (ratio of "production worker wages" to "number of production workers"). $\Delta C_{II}/C_{II,-1}$ is the annual rate of change in the "price deflator for materials." $\Delta I_{Labor}/I_{Labor,-1}$ is the annual rate of change in "number of production workers." $\Delta I_{II}/I_{II,-1}$ is the annual rate of change in the "cost of materials deflated by the materials price index." $\Delta Prod/Prod_{-1} = (\Delta I_j/I_{j,-1} - \Delta Q/Q_{-1}) / (1+\Delta Q/Q_{-1})$ for j = Labor, II. *EXP* is the total of "production worker wages" and "cost of materials." *REV* is "value of shipments."

Table 4
Regressions of Next Year's Change in Operating Profit and its Components on Current Change in Operating Profit and its Components

(2) $\Delta OP_{t+1} = \alpha_{industry} + \alpha_{year} + \beta_1 \Delta OP_t + e_{1,t+1}$
(3) $\Delta OP_{t+1} = \alpha_{industry} + \alpha_{year} + \beta_2 \Delta REV_t + \beta_3 \Delta REV_t + e_{1,t+1}$
(4) $\Delta OP_{t+1} = \alpha_{industry} + \alpha_{year} + \beta_4 PriceEffect_t + \beta_5 VolumeEffect_{REVt} + \beta_6 VolumeEffect_{EXPt} + \beta_7 CostEffect_{LABOR.t} + \beta_8 CostEffect_{II.t} + \beta_9 ProdEffect_{LABOR.t} + \beta_{10} ProdEffect_{II.t} + e_{2,t+1}$
(5) to (11) are the same as (4) but substituting the dependent variable ΔOP_{t+1} by each one of its components

	(2) ΔOP_{t+1}	(3) ΔOP_{t+1}	(4) ΔOP_{t+1}	(5) Price $Effect_{t+1}$	(6) Volume $Effect_{Rev\ t+1}$	(7) Volume $Effect_{Exp\ t+1}$	(8) LaborCost $Effect_{t+1}$	(9) IICost $Effect_{t+1}$	(10) LaborProd $Effect_{t+1}$	(11) IIProd $Effect_{t+1}$
ΔOP_t	-0.007									
	-0.41									
ΔREV_t		-0.069								
		-4.21								
ΔEXP_t		-0.154								
		-7.03								
$PriceEffect_t$			-0.065	0.225	-0.206	0.104	-0.010	0.020	-0.042	-0.189
			-2.61	4.09	-3.26	2.69	-4.06	0.89	-3.46	-6.48
$VolumeEffect_{Rev\ t}$			0.111	-0.114	0.306	-0.105	-0.004	0.042	0.011	0.063
			2.96	-1.83	1.78	-1.02	-1.34	2.37	0.48	1.49
$VolumeEffect_{Exp\ t}$			0.126	-0.240	0.471	-0.148	-0.003	0.086	0.038	0.101
			2.36	-2.52	1.84	-0.95	-0.45	2.90	0.97	1.78
$LaborCostEffect_t$			-0.573	-0.149	-0.841	0.544	-0.159	-0.004	-0.007	-0.047
			-6.36	-1.68	-4.54	4.39	-5.00	-0.09	-0.24	-0.68
$IICostEffect_t$			-0.173	-0.226	-0.353	0.204	-0.013	0.257	-0.032	-0.100
			-3.15	-1.97	-1.91	1.66	-2.25	3.10	-2.17	-1.95
$LaborProdEffect_t$			-0.361	0.100	-0.389	0.255	0.001	-0.057	-0.101	-0.133
			-5.52	0.99	-2.14	2.08	0.09	-1.03	-3.28	-2.30
$IIProdEffect_t$			-0.181	0.110	-0.339	0.212	-0.006	0.045	-0.032	-0.234
			-6.82	3.35	-4.47	4.56	-1.72	2.14	-2.48	-8.47
R Squared	0.15	0.17	0.17	0.33	0.17	0.16	0.27	0.42	0.09	0.07

The top row of the table contains the independent variables. Each column includes the coefficients of an OLS regression with industry and time fixed effects. The t-stats shown below each coefficient are based on industry and year cluster adjusted errors. All variables are deflated by REV_{t-1} and winsorized at the top/bottom 0.5%. The sample includes 22,841 SIC industry-year observations (1959-2008). Regressions (5) to (11) are estimated separately as a special case of Seemingly Unrelated Regressions where all the independent variables are the same.
$OP = REV - EXP$. $PriceEffect = (\Delta P/P_{-1}) \times REV_{-1}$. $VolumeEffect_{Rev} = (\Delta Q/Q_{-1}) \times REV_{-1}$. $VolumeEffect_{Exp} = -(\Delta Q/Q_{-1}) \times EXP_{-1}$. $CostEffect_j = -(\Delta C_j/C_{j,-1}) \times EXP_{j,-1}$, for j = Labor, II. $ProdEffect_j = -((\Delta I_j/I_{j,-1} - \Delta Q/Q_{-1}) / (1+\Delta Q/Q_{-1})) \times EXP_{j,-1}$, for j = Labor, II. $\Delta P/P$ is the annual rate of change in the "price deflator for value shipments." $\Delta Q/Q_{-1}$ is the annual rate of change in "value of shipments deflated by the price index." $\Delta C_{Labor}/C_{Labor,-1}$ is the annual rate of change in compensation per employee (ratio of "production worker wages" to "number of production workers"). $\Delta C_{II}/C_{II,-1}$ is the annual rate of change in the "price deflator for materials." $\Delta I_{Labor}/I_{Labor,-1}$ is the annual rate of change in "number of production workers." $\Delta I_{II}/I_{II,-1}$ is the annual rate of change in the "cost of materials deflated by the materials price index." $\Delta Prod/Prod_{-1} = (\Delta I_j/I_{j,-1} - \Delta Q/Q_{-1}) / (1+\Delta Q/Q_{-1})$ for j = Labor, II. EXP is the total of "production worker wages" and "cost of materials." REV is "value of shipments."

Table 5
Contextual Analysis: Regressions of Next Year's Change in Operating Profit on Current Components Interacted with Market Structure Variables

(12) to (16) $\Delta OP_{t+1} = \alpha_{industry} + \alpha_{year} + \delta + \gamma_1\, PriceEffect_t + \gamma_2\, \delta\, PriceEffect_t + \gamma_3\, VolumeEffect_t + \gamma_4\, \delta\, VolumeEffect_t + \gamma_5\, VolumeEffect_t + \gamma_6\, \delta\, VolumeEffect_t + \gamma_7 CostEffect_{LABOR,t} + \gamma_8 \delta\, CostEffect_{LABOR,t} + \gamma_9 CostEffect_{II,t} + \gamma_{10} \delta\, CostEffect_{II,t} + \gamma_{11}\, ProdEffect_{LABOR,t} + \gamma_{12}\, \delta\, ProdEffect_{LABOR,t} + \gamma_{13} ProdEffect_{II,t} + \gamma_{14} \delta\, ProdEffect_{II,t} + \varepsilon_{1,t+1}$

	Concentration C4	*Capital Intensity*	*Economies of Scale*	*Unionization*	*Growth*
δ	-0.002	0.004	-0.004	0.000	0.058
	-0.71	1.81	-1.59	0.01	18.19
$PriceEffect_t$	-0.125	-0.086	-0.159	-0.019	-0.169
	-4.06	-2.89	-4.26	-0.38	-6.45
δ* $PriceEffect_t$	0.054	0.042	0.114	-0.037	0.217
	1.94	1.07	2.56	-0.71	6.70
$VolumeEffect_{Rev\ t}$	0.086	0.076	0.062	0.109	0.002
	1.33	1.73	1.48	1.80	0.06
δ* $VolumeEff_{Rev\ t}$	0.096	0.078	0.117	-0.063	0.184
	1.49	1.32	2.65	-0.55	4.50
$VolumeEffect_{Exp\ t}$	0.098	0.077	0.068	0.176	0.008
	1.14	1.24	1.16	1.87	0.17
δ* $VolumeEff_{Exp\ t}$	0.127	0.098	0.163	-0.140	0.200
	1.40	1.12	2.29	-0.86	3.11
$LaborCostEffect_t$	-0.681	-0.684	-0.581	-0.563	-0.503
	-6.11	-4.90	-5.23	-2.70	-4.73
δ* $LaborCostEff_t$	0.104	0.197	-0.219	0.105	0.237
	0.80	1.24	-1.17	0.35	1.53
$IICostEffect_t$	-0.147	-0.195	-0.209	-0.187	-0.187
	-2.36	-3.70	-2.85	-2.29	-3.15
δ* $IICostEffect_t$	0.01	0.03	0.13	-0.14	0.17
	0.13	0.47	1.85	-2.15	2.64
$LaborProdEffect_t$	-0.421	-0.469	-0.498	-0.296	-0.530
	-5.90	-5.44	-6.22	-2.95	-8.10
δ* $LabProdEff_t$	0.063	0.164	0.343	-0.092	0.452
	0.68	1.30	2.29	-0.49	4.21
$IIProdEffect_t$	-0.217	-0.221	-0.270	-0.165	-0.190
	-6.37	-7.31	-6.49	-3.68	-6.70
δ* $IIProdEffect_t$	0.027	0.071	0.123	-0.006	0.077
	0.87	1.74	2.38	-0.12	2.41
R Squared	0.15	0.17	0.15	0.17	0.45
N	17,429	22,841	16,152	11,233	22,841

Each column represents an OLS regression with industry and time fixed effects, using the dummy variable (δ) announced on the top. The top number in each pair represents the estimated coefficient and the bottom number represents the estimated t-statistic corresponding to industry and year cluster-adjusted errors. The

sample period covers the base years 1959-2004 for 4-digit SIC industries. Variables are winsorized at the top/bottom 0.5%. The dummy variables take value 1 when the specific industry structure variable is above the median of all industries, and otherwise 0. The industry structure variables are defined as follows : *Concentration C4* is the percentage share of sales accounted by the 4 largest companies in the industry. *Capital Intensity* is the ratio o real capital stock on sales. *Economies of scale* is the average size of the firm in a given industry. *Unionization* is the percentage of workers affiliated to unions in each industry. *Growth* is the one-year ahead sales growth. All other variables are defined in Table 2.
$PriceEffect = (\Delta P/P_{-1}) \times REV_{-1}$. $VolumeEffect_{Rev} = (\Delta Q/Q_{-1}) \times REV_{-1}$. $VolumeEffect_{Exp} = -(\Delta Q/Q_{-1}) \times EXP_{-1}$. $CostEffect_j = -(\Delta C_j/C_{j,-1}) \times EXP_{j,-1}$, for j = Labor, II. $ProdEffect_j = -((\Delta I_j/I_{j,-1} - \Delta Q/Q_{-1}) / (1+\Delta Q/Q_{-1})) \times EXP_{j,-1}$, for j = Labor, II. $\Delta P/P$ is the annual rate of change in the "price deflator for value shipments." $\Delta Q/Q_{-1}$ is the annual rate of change in "value of shipments deflated by the price index." $\Delta C_{Labor}/C_{Labor,-1}$ is the annual rate of change in compensation per employee (ratio of "production worker wages" to "number of production workers"). $\Delta C_{II}/C_{II,-1}$ is the annual rate of change in the "price deflator for materials." $\Delta I_{Labor}/I_{Labor,-1}$ is the annual rate of change in "number of production workers." $\Delta I_{II}/I_{II,-1}$ is the annual rate of change in the "cost of materials deflated by the materials price index." $\Delta Prod/Prod_{-1} = (\Delta I_j/I_{j,-1} - \Delta Q/Q_{-1}) / (1+\Delta Q/Q_{-1})$ for j = Labor, II. *EXP* is the total of "production worker wages" and "cost of materials." *REV* is "value of shipments."