Profitability = productivity + price recovery

David M. Miller

"Our plant manager has just announced a 10% increase in labor productivity. Does this also mean a 10% increase in our gross profit?"

"How can I know if we're gaining or losing as we try to get more total bang for the buck in our manufacturing department?"

"How can I present productivity data in a way my CEO will understand?"

"How can I distinguish productivity-improvement contributions in the P&L statement from other factors such as price increases?"

"How can I gauge the effect of my sales pricing strategies on profit growth?"

The measurement procedure described in this article answers these questions through a series of easily understood mathematical formulas that have been tested and applied in a variety of corporate settings. The procedure analyzes productivity changes in terms of their contribution to profit growth. It also gives management a way to measure the effectiveness of its pricing strategies. These findings are couched in familiar financial language so that they are accessible to managers whatever their functional responsibilities.

Both companies and profit centers have used this procedure to identify areas in which resources can be better employed or prices better set. Trend charts developed from the author's method have also proved to be an excellent medium for communication between executives and operations managers.

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Schemes for manipulating and analyzing outputs and inputs also vary. Some approaches focus on developing indices that compare the ratios of composite outputs to composite inputs in given periods with the values of those same ratios in base periods. These indices represent the degree to which productivity has changed since the base periods.

Other approaches carry productivity-performance assessment one step further—to the profit level. In profit-oriented approaches, such as the "net income and productivity analysis" system used by AT&T; the principal statistic is not a ratio or an index but rather the dollar impact of productivity performance on profit growth or shortfall. Such approaches are based on quantifying the period-to-period change in the following relationship: profitability = productivity + price recovery, where price recovery represents the net effect on profits of changes in sales prices and input-resource prices (that is, inflation). In essence, this relationship dissects the period-to-period change in the profit margin into a component due to price actions and a component due to relative volumes (that is, output quantities versus input quantities).

The key to using such approaches lies in inflation accounting, which identifies the portions of the changes in revenues and costs that reflect price increases only. Properly implemented, these profit-linked productivity measurement approaches are powerful tools for analyzing the performance of profit centers of all sizes, from entire corporations to single product lines.

The American Productivity Center deserves credit for its pioneering work in profit-oriented, multifactor productivity measurement. However, the APC approach suffers from the fact that its results are developed through indices and ratios rather than through common financial terms and relationships. Consequently, its ultimate users, who are managers accustomed to reacting to financial data and dealing with balance-sheet relationships, may have difficulty understanding and accepting its findings. The procedure described here was designed to overcome these difficulties.

A brass tacks approach

Management needs to know the reasons for good and bad profit changes so that it can decide whether to concentrate its attention on productivity improvements or on pricing strategies, both of which directly affect profitability. The "profitability = productivity + price recovery" procedure generates this information first by measuring changes in profits beyond what they would be if a given profitability standard or goal were realized. The procedure then dissects this change into two contributing amounts—one that results from changes in productivity performance and a second that measures the net price recovery (the net increase in sales prices over increases in the price of labor, raw materials, energy, and other resources).

As an illustration, consider the case of a manufacturing company that I shall call the Silica Corporation. From 1982 to 1983, this company's gross profits rose by $8 million. [Exhibit I shows two years of representative P&L data.] Was this a good increase? Should it have been greater? Given the criterion of achieving profitability of at least the 1982 level, the increase was acceptable because the profit margin rose from 20.4% to 22.7%. Had Silica's profit margin remained at the 1982 level, it would have earned a gross profit of only $34.9 million (20.4% of $171.2 million) on its 1983 sales. In other words, the company was $3.9 million ($38.8 million - $34.9 million) better off in 1983 than it would have been if its profitability performance had not improved from its 1982 level.

Earnings in 1983 could have been even better, however, if productivity performance had kept pace with management's pricing strategy. But, hidden from the view of the accounting system, productivity declined from 1982 to 1983, costing Silica $1.8 million in lost profits. Silica's management was able to compensate for this loss, however, through large sales price increases. Management's pricing actions contributed $5.7 million to profits beyond those anticipated at the 1982 profitability level. The net effect of this good price recovery with the poor productivity performance was the $3.9 million ($5.7 million + ($3.9 million)) growth in profit.

The profitability measurement procedure develops dollar-impact information like this by analyzing profit growth or shortfall in terms of its sources in productivity and pricing. [The flow chart in Exhibit II gives a schematic view of these contributing factors.] As the exhibit indicates, productivity increases obtained from more efficient use of individual manufacturing resources such as materials and energy affect the company's overall productivity. In turn, these

3 For a classic model that uses unit prices as relative weights, see Charles E. Craig and R. Clark Harris, "Total Productivity Measurement at the Firm Level," Sloan Management Review, Spring 1973, p. 13.
4 For an example of an approach that uses weights more subjectively, much as judges in a beauty contest do, see the Oregon Productivity Center, "Matrix Measurement Focuses on Gains," The Productivity Primer, no. 11 (Corvallis, Oregon: Oregon State University, November 1981).
changes directly affect its ability to generate profits at a level equal to or better than what it would earn by maintaining some standard or goal. By the same token, increases in sales prices can compensate for rising resource costs due to inflation. The extent to which such price recovery occurs directly affects the company’s ability to maintain profitability and profits.

The need for new profit strategies can become evident when managers transfer year-to-year findings to a profitability trend chart. For example, both the glass and the ceramics divisions at Silica increased their gross profit margins and thereby showed positive profitability growth from 1976 to 1983. (See Exhibit III and Exhibit IV) The reasons for this growth, however, differed significantly. Whereas the glass division achieved excellent price-recovery results but poor productivity performance, the ceramics division was able to make productivity improvements that more than offset serious inflation-related pricing problems. To continue profit growth, management clearly had to develop a distinctive strategy for each division.

The profitability = productivity + price recovery procedure can be structured in several ways. For instance, we can define profitability as gross profit margin, net income margin, or return on capital employed. Similarly, we can devise various schemes to apportion the dollar impact of profitability changes to productivity and price recovery.

In the approach developed here, the actual gross profit realized in a period is compared with the gross profit that would have been realized had the company’s profit margin (its gross profit divided by its net sales revenue) remained unchanged. This difference or increment represents the dollar impact of margin growth on the bottom line. The profit anticipated at the base period’s margin constitutes a standard that is used to judge how well income has grown. The following equation, where \( t \) = the time period under analysis and \( B \) = the base period, shows this comparison:

\[
\text{Profit change} = \text{actual profit} - \text{anticipated profit},
\]

or

\[
\text{Profit change in period } t = (\text{sales}_t) (\text{margin}_t - \text{margin}_B)
\]

In other words, the incremental profit shown as the profitability change in Exhibit III and Exhibit IV is the dollar impact of converting the variance between the actual gross profit margin and the margin goal into absolute dollar terms. Customarily, the margin in a base period supplies this margin goal, but any figure—for example, a 5% improvement over the average margin in the last three years—could be used.

To illustrate these calculations, recall Silica’s P&L data. If we take the 1982 margin of 20.4% as the target, or base, the company’s profitability grew in 1983, as the increase in margin indicates. The impact of this increase was as follows:

\[
\text{Profitability change in 1983} = (\$171.2 \text{ million}) \times (0.227 - 0.204) = \$3.9 \text{ million}
\]

How much of the $3.9 million reflects productivity changes, and how much price recovery, is still uncertain.

### Measuring productivity’s contribution to profits

Removing all price changes from the calculation of gross profit margin leaves a deflated, or a constant, dollar margin. This deflated margin constitutes a multifactor measure of the company’s overall productivity. Therefore, simply by converting the deflated margin variance into dollars, we can calculate the impact that a change in the productivity ratio from one period to another has on profits. That is:

\[
\text{Productivity contribution in period } t = (\text{sales}_t^D) (\text{margin}_t^D - \text{margin}_B),
\]

where

- “sales\(_t^D\)” represents the deflated net sales in period \( t \), and
- “margin\(_t^D\)” the deflated gross profit margin in period \( t \).

“Deflated sales” refers to the net sales that would result if unit sales prices remained constant.
from one period to the next. Likewise, "deflated margin" refers to the margin obtained by subtracting a deflated or a constant-price cost of sales from the deflated net sales and then dividing by deflated net sales. Because this constant cost-of-sales figure incorporates the costs that would result if raw materials prices, labor pay rates, utility prices, rents, taxes, and so forth did not change, the effects of inflation do not appear. As a result, the deflated margin reflects changes in relative volumes, the quantity of sales (or output) relative to the quantity of inputs.

For illustration of these calculations, consider Silica once again. The annual price change indices for this company are shown in Exhibit V. The index for net sales represents the weighted average percentage by which prices increased for all products sold, while the indices for the various cost-of-goods-sold elements represent the specific inflation rate embedded in each. (For example, the average utility rate went up 12.56% in 1983.) Taking a weighted average of the increases in various cost elements gives us the overall inflation rate in Silica's total cost of goods sold (see the Appendix). For 1983 this amounted to an index of 1.033. Therefore, the deflated margin (margin $D$) can be calculated as follows:

$$\text{Margin}^D_{1983} = \frac{\text{sales}^D \cdot \text{cost}^D}{\text{sales}^D} = \frac{\frac{($171,200,000)}{1.078} - \frac{($132,400,000)}{1.033}}{($171,200,000) - ($132,400,000)} = 19.3\%$$

In other words, on a margin basis the productivity, or efficiency, of the equivalent of each unit of product made and sold in 1983 was 19.3%. This figure is a volume, or a physical efficiency, measure since it excludes all price effects.

Comparing this 1983 deflated margin with Silica's goal (the reported margin in 1982) deter-
**Exhibit III**  
**Trends in profit contribution at Silica Corporation’s glass division**

<table>
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<th>Year</th>
<th>Price recovery</th>
<th>Profitability</th>
<th>Productivity</th>
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Profit change: $30 million

**Exhibit IV**  
**Trends in profit contribution at Silica Corporation’s ceramics division**

<table>
<thead>
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<th>Year</th>
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Profit change: $15 million
mines the impact of productivity changes on profit growth:

\[
\text{Productivity contribution in 1983} = \left( \frac{171.2 \text{ million}}{1.078} \right) \cdot (1.93 - 0.204) = \$1.8 \text{ million}
\]

Because its productivity declined from the 1982 level, the company lost the opportunity to earn $1.8 million more in profit. The 1983 P&L statement would have shown profits of $40.6 million had the drop not occurred.

Both executives and operations managers find this type of information extremely valuable. It provides quantitative evidence that productivity-improvement campaigns and cost-reduction efforts have or have not paid off. And the evidence appears not in financially abstruse terms such as pounds per man-hour but in terms that have a common meaning such as changes in gross profit. Consequently, this information serves as a useful trigger for executive action. Management might decide, for example, to grant bonus pay to plant managers to reward their good productivity performance, to initiate follow-up studies on the reasons for good or bad productivity changes, and to set future productivity-performance goals in terms of their impact on the P&L statement.

### Assessing price recovery

We can use a similar procedure to develop a "price margin" that reflects the impact of inflation and sales prices on profitability growth. In this equation the revenue generated by unit sales price changes constitutes sales (as opposed to the volume sold), while the dollars generated by inflation in labor rates, energy prices, and so forth make up the cost portion. Using this approach, we can calculate the efficiency with which sales price increases recover the effects of inflation and contribute to profits. This efficiency is the price margin. We can use it to determine the impact price recovery has on anticipated profit growth:

\[
\text{Price recovery contribution in period } t = \text{sales}^{\text{PR}_t} \cdot (\text{margin}^{\text{PR}_t} - \text{margin}_0),
\]

where "sales" is the price-generated revenue in period t, and "margin" is the price margin that equals the difference between price-generated revenue and inflation-generated cost divided by price-generated revenue.

For example, Silica’s 1983 price-generated sales amounted to $171.2 million - ($171.2 million/1.078), or $12.38 million, while the inflation-generated cost was $132.4 million - ($132.4 million/1.033), or $4.22 million. Therefore, the price-generated margin was ($12.38 million - $4.22 million)/$12.38 million = 65.9%. That is, sales prices so far outpaced inflation that they produced a margin of 65.9%. (The large gap between the sales price index of 1.078 and the overall inflation index of 1.033 in the total cost of goods sold mirrors this margin.)

The impact of this large margin on profit growth is calculated as follows:

\[
\text{Price recovery contribution in 1983} = \text{($12.38 million)} \cdot (0.659 - 0.204)
\]

\[
= $5.7 \text{ million}
\]

That is, the efficiency with which price-generated sales dollars produced profits exceeded the goal of maintaining 1982’s efficiency, or margin, of 20.4% by $5.7 million. Unfortunately, some $1.8 million of this contribution never reached the bottom line because it was needed to offset the losses caused by productivity declines.

Price-impact information like this provides top management with a useful profit-related gauge of its sales-pricing strategies. It indicates whether the company’s prices do their part in counteracting inflation and maintaining gross profit margin, and it triggers corrective actions such as marketing strategy reviews and renegotiations with vendors and customers.

### Refining productivity measurement

In the examples given so far, productivity and price recovery have been analyzed at a macro-
economic level, where results appear in terms of their composite effects—the end results regardless of the causes. These analyses are useful for monitoring a division's overall inflation-adjusted performance and for quantifying the bottom-line impact of corporate productivity-improvement programs. But their usefulness is limited because they do not discriminate among the factors that constitute productivity. Changes in productivity almost always reflect a combination of factors, including product mix, employee satisfaction, sales volume, and the quality of raw materials.

Addressing this problem requires supplementary analyses that refine productivity's contribution to profits. Otherwise, management would be unable to pinpoint specific improvement opportunities so that the necessary operational changes could be made. A wide variety of such analyses spin off the basic profitability = productivity + price recovery chart. These include a portrayal of the percentage change in the productivity levels of each major resource (labor, capital, energy, and materials), the dollar impact of changes in these levels, the growth in overall sales volume in which each product's contribution is weighted by its base year price, and a picture of how sales price increases have matched various elements of inflation.

One of the more useful supplemental analyses involves examining the influence of volume changes on productivity measurement. Recall the situation at Silica Corporation's glass division. As the trend chart in Exhibit III indicates, its productivity declined from 1976 to 1980. When the division's managers were asked why, they initially blamed falling sales—not the inefficient use of resources. In reality, resource usage was the culprit, but demonstrating this fact took further analysis of the division's operations. Such supplementary analysis helps to explain the relationships delineated in the basic procedure so that management can make the necessary operational changes.

Most manufacturing processes usually consume a certain amount of resources regardless of the volume produced. Consequently, the level of sales, or volume, will influence the productivity of those resources as measured by standard output-input ratios. Thus, if a company's sales volume declined from one quarter to the next, its labor productivity ratio would also decline if technological constraints kept management from reducing its labor force proportionally. This decline would occur however efficiently the employees worked.

Charts such as the one shown in Exhibit VI are useful tools for assessing this influence of volume on observed productivity changes. To develop a volume-influence chart, we first divide the resources that have been consumed into two categories—fixed and variable. For instance, in process industries a relatively large proportion of a plant's direct labor force is needed to operate reactors and other equipment regardless of the volume flowing through these facilities. In this case, as much as 90% to 95% of wages and benefits might be unavoidable without major process changes and would therefore figure as a fixed resource.

All resource inputs (or their deflated costs) can then be grouped as either fixed or variable resource elements, and the dollar impact on profit growth or shortfall calculated for each group. The effect of this calculation is to split the overall productivity contribution into two mutually exclusive causal areas—one due to volume influences (that is, changes in the productivity ratio of fixed resource elements) and the other due to volume-independent or variable elements.

Productivity data from Silica's glass division illustrate the value of this volume analysis. (Trend lines for fixed and variable element groups as well as a plot of the deflated sales volume appear in Exhibit VI.) Note that in several years the trend of fixed-elements productivity does not match the volume trend. This mismatch implies that the division was incurring true efficiency gains and losses in the use of fixed resources such as salaried manpower. For example, we remember that the division's management initially attributed the large drop in the 1980 productivity to declining volume. As Exhibit VI indicates, however, the decline in fixed-resources productivity so far exceeded the drop in volume that it alone could not explain the degradation of profit. Inefficiencies embedded in the use of salaried labor, wage roll employees, energy, and other fixed resources were the more critical factors.

Dollars & cents rewards

The assumption behind the profitability = productivity + price recovery approach is that every dollar of revenue carries the burden of earning profit at the same margin goal or standard. Dollars generated by sales-price increases are expected to be just as profitable—to earn just the same margin—as dollars attributable to increases in the number of units sold. Therefore, management must raise its sales prices not merely enough to recover inflation on a dollar-for-dollar basis but enough to maintain the company's profit margin.

Managers who accept this assumption will find the measurement procedure outlined here extremely useful. It establishes a way of showing the results of productivity-improvement efforts in terms of their impact on profits. It also gives management an opportunity to assess its pricing strategy by quantifying the impact of sales price actions and indicating whether prices are recovering inflation costs and contributing to profitability.
Meeting the challenge of a constant-margin goal, however, can be difficult. During a recession, for example, management may be unable to set prices that will both maintain the desired profit margin and recover inflation-related costs. At such times the practical advantages of a profit-linked productivity measurement system prove especially relevant.

Managements in various industries, including plastics, aluminum, and industrial chemicals, have already applied the simplicity = productivity + price recovery analysis to their operations. It has been used internally at the corporate, division, plant, and product-line level and externally to analyze a company’s relations with a major customer.

The procedure has been most widely used to develop historical profitability trend charts and to forecast trends in upcoming budget years. In addition, it is a useful method for analyzing candidates for business acquisition and profit centers’ long-range plans.

The benefits derived from these practical applications have varied. At times the results have simply confirmed what management has known intuitively. In other cases, however, they have revealed unsuspected problem areas and improvement possibilities. For example, one group of managers was surprised to learn that the price-escalation formulas written into its customer sales contracts were eroding product-line profitability. Because the formulas were constructed to pass cost reductions on to customers through process- utilization updates, sizable productivity gains never reached the bottom line. Improving productivity only lowered prices and diminished profits.

Several general conclusions arise from these applications, including the following:

**Productivity and price recovery are interrelated.** Sales price strategies affect a company’s ability to obtain volume. In turn, volume has a direct as well as an indirect effect on productivity. Specifically, through the output figure, volume changes enter the output-input measures of productivity directly, while indirectly, increased volume allows otherwise uneconomical productivity-improvement projects to become justifiable. Conversely, productivity improvements allow managers to strengthen their pricing position with respect to their competitors. A productive company can weather economic storms and be an effective price leader in its industry.

As an illustration of the connection between volume and price recovery, consider what happened in one company that manufactures components for retail products. Originally the company assembled a major component manually, and the product was therefore costly and uncompetitive. Thanks to an aggressive campaign to obtain volume through low price increases, the company obtained large sales contracts and gradually built up its production volume. With this additional volume, investment in a new, highly productive assembly machine became economically justifiable on the basis of ROI and payback. In turn, the new machine lowered unit costs and raised profitability. It also aided management’s ability to obtain price increases and enhance price recovery. (The Japanese have long recognized this productivity-price
recovery connection and have used it to capture many international markets.)

**Management often overlooks the effect of pricing strategies on the bottom line.** While most executives understand the immediate relationship between unit sales prices and revenues, they often fail to consider the impact that pricing actions have on profit growth. The profitability = productivity + price recovery procedure corrects this oversight. Because the analysis is based on the expectation that price increases will recover the negative effects of inflation and maintain the profit margin goal, it establishes a target or a base with which to monitor the performance of a profit center's pricing actions.

The benefits of such monitoring can be impressive. With it, one product manager learned that his pricing strategy was incompatible with his operation's profit goals. Although the $.10 per unit sales price increase covered the $.08 rise in raw materials costs, the resulting gross profit margin was below the 25% level of the previous period. This discovery led him to reexamine the operation's marketing strategies and its basic goals. To his dismay, he found that he and other managers had keyed their price changes to raw materials only. They had failed to consider other sources of inflation.

**Management often overstates the influence of volume and product mix on productivity.** When a productivity measure drops, managers customarily cite falling sales or shifts in the product mix. While these are common causes, they tend to be overused and frequently appear as scapegoats. Often the real cause is the reluctance to respond to declining sales by reducing consumption of resources thought to be fixed.

In addition to the benefits that flow from these conclusions, using the procedure brings additional practical rewards. For example, several managers found that it enabled them to explain variations in price-recovery performance that were linked to some products' unique attributes (or to their absence). The ability to achieve substantial price increases affects a product's profitability growth through the price recovery side and, indirectly, through the productivity side as well. Through this ability hinges on many factors, the presence of unique product or delivery attributes often gives the competitive edge sales managers need to "sell" higher prices to their customers. By giving management detailed information about the effect of its pricing policies, the analysis points up this primary relationship between a product's unique characteristics and its profitability.

Finally, the profitability analysis improves corporate communications. Manufacturing managers often have difficulty talking effectively about productivity issues with marketing managers because they lack common ground. The former are accustomed to speak about changes in their plants' ratios of pounds produced per man-hour, while the latter think in terms of cutting prices to beat the competition. By concentrating on the bottom line, this analysis emphasizes their common goal. Thus, it fosters effective dialogue about productivity and pricing among managers at different levels and in different functional areas. In the last analysis, this dialogue may be the most valuable benefit of all.

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**Appendix:** Method of deflating (D) the reported cost of sales in a given year (t) back to a base year

\[ D_t = \frac{\text{Cost deflator for year } t - 1}{\text{Cost deflator for year } t - 2} \times \frac{\text{Cost deflator for year } t - 1}{\text{Cost deflator for year } t} \times \ldots \times \frac{\text{Cost deflator for year } t - 1}{\text{Cost deflator for year } t} \times \frac{\text{Cost deflator for year } t}{\text{Cost deflator for year } t} \]

where

\[ D_t = \frac{\text{Deflated value of raw materials, expressed in prior-year (t-1) dollars}}{\text{Deflated value of salaries, expressed in prior-year dollars}} + \ldots \]

**Reported total cost of sales in year t**

**Implied total cost deflator for year t**

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