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# Analyzing the Underlying Dimensions of Firm Profitability

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**In this paper we decompose a traditional measure for firm's performance, return on sales, into four components that capture the impact of productivity, price recovery, product mix and capacity utilization, respectively, on a firm's profitability. The new measures are used as an illustration to explain changes in the performance of firms in the US telecommunications industry following deregulation. Changes in the overall profitability margin of these firms are explained by substantial but offsetting changes in their productivity, price recovery ability, product-mix maximization and capacity utilization, that have occurred as a consequence of deregulation. The new measures enable us not only to illustrate relative differences between firms in a given cross-section but also to shed light on how changes take place over time in the different components that underlie firms' profitability.**

## INTRODUCTION

The Dupont ROI formula has long been used to measure the financial performance of firms. The return on investment (ROI) is sub-analyzed into a ratio of profitability (return on sales) and an asset turnover ratio. By the very way in which the profitability ratio is constructed, however, it provides only a gross aggregate measure and does not easily shed light on or capture the impact that the micro-attributes of the operations of firms have on profitability. To obviate such a lacuna, new frameworks and tools have been developed recently. For instance, the American Productivity Center (APC) formula disaggregates changes in a firm's profitability into two components capturing changes in its productivity and its price recovery ability (APC, 1981; Banker *et al.*, 1989; Kendrick, 1984; Miller, 1984; van Loggerenberg and Cucchiari, 1981–2).

In this paper we extend such micro-level performance measurement methodologies further. We describe a multiperiod, multiproduct model that integrates profitability ratio analysis, as noted above, with an extension of the APC method. The model we describe disentangles further the sources of changes in a firm's profitability. It enables those

interested in the performance evaluation of firms to link a firm's operating or strategic decisions, or exogenous and endogenous events, to such underlying components of its profitability. Thereby, the model also supports decision making for operational and strategic purposes.

We use the model in an illustrative manner to analyze the performance of the US telecommunications industry during the period of transition following deregulation. This has been a time of considerable change for the industry. A major assumption underlying deregulation is that firm performance on various dimensions will improve. We show how our highly integrated approach yields rich insights into the performance of firms within the industry, of the industry as a whole, and thus enables us to evaluate the detailed outcomes of public policy decisions such as deregulation.

Profitability can be affected by many factors such as the productivity of firms and the price-recovery ability that they possess. These factors can be first gauged by calculating the APC ratios, and then linking them to the Dupont ROI formula via a profitability ratio. While the APC method has received considerable attention and acceptance, its measures of productivity and price-recovery

change can be confounded by changes in the product mix and capacity utilization of firms. Therefore, we use the APC method as a point of departure. Extending previous work (Banker *et al.*, 1989; Banker and Johnston, 1989), we describe in the next section an alternative set of ratios to quantify the impacts that changes in a firm's overall productivity, price recovery, product mix and capacity utilization have on the changes in a firm's overall profitability. In the third section these ratios are applied to explain changes in the performance of firms in the US telecommunications industry following deregulation. In the fourth section we analyze our findings and the final section contains a summary and conclusions.

## FORMULAE FOR PROFITABILITY RATIO ANALYSIS

### Antecedents

The Dupont ROI formula decomposes the return on investment of a firm into two ratios. The first is a ratio of profits to sales and the second a ratio of asset turnover. The first ratio measures a firm's ability to generate profits related to its sales revenue attainments. The second is a measure of the extent to which the firm has been able to generate revenues with its assets. The Dupont formula has been traditionally expressed as follows:

$$\begin{aligned} \text{ROI} &= \text{profits/assets} \\ &= (\text{profits/revenues}) \times (\text{revenues/assets}) \quad (1) \\ &= (1 - \pi^{-1}) \times (\text{revenues/assets}) \end{aligned}$$

where  $\pi^{-1}$  is the reciprocal of the profitability margin. The profitability margin for a period  $t$  is computed as revenues divided by costs and can be defined as:

$$\pi^t = \sum_m p_m^t y_m^t / (\sum_v w_v^t x_v^t + \sum_f w_f^t x_f^t) \quad (2)$$

where

$y_m^t$  = actual quantities of outputs during period  $t$ ; there can be multiple products factored into the analysis as denoted by  $m = 1, 2, \dots, M$ . There can be multiple time periods over which analysis can be undertaken as given by  $t = 1, 2, \dots, T$ ;  
 $p_m^t$  = price per unit of output  $m$  during period  $t$ ;  
 $x_v^t$  = actual quantity of variable input  $v$  during

period  $t$ ; there can be several categories of variable inputs as given by  $v = 1, 2, \dots, V$ . Variable inputs are those that vary in proportion to output level;

$w_v^t$  = price per unit of variable input  $v$  during period  $t$ ;

$x_f^t$  = actual quantity of fixed input  $f$ ; again there may be several categories of fixed inputs as given by  $f = 1, 2, \dots, F$ , used during period  $t$ . Fixed inputs are invariant with respect to output level changes;

$w_f^t$  = price per unit of fixed input  $f$  during period  $t$ .

To conduct a multiperiod analysis of profitability, a profitability change ratio may be defined as a ratio of ratios: the ratio of profitability for the period  $t$  to the profitability ratio for a base level 0. It can be expressed as:

$$\begin{aligned} \text{Profitability (PFTBLT)} &= \frac{\pi^t}{\pi^0} \\ &= \frac{\sum_m p_m^t y_m^t / (\sum_v w_v^t x_v^t + \sum_f w_f^t x_f^t)}{\sum_m p_m^0 y_m^0 / (\sum_v w_v^0 x_v^0 + \sum_f w_f^0 x_f^0)} \quad (3) \end{aligned}$$

Depending on the purpose of the analysis, the base level 0 may be defined as either the firm's own performance during some earlier base period, as some prior technically determined standard, as the profitability performance of another firm, or as the average performance of the industry as a whole over a given time period.

### APC Ratios

The profitability change ratio as developed in Eqn (3) can be decomposed further into two measures of changes in productivity and price recovery. The APC productivity change ratio (*APRDT*) is the ratio of the values of current period outputs to base period outputs, divided by the ratio of the values of current period inputs to base period inputs. It is expressed thus:

$$\begin{aligned} \text{APRDT} &= \frac{\sum_m p_m^0 y_m^t / \sum_m p_m^0 y_m^0}{(\sum_v w_v^t x_v^t + \sum_f w_f^t x_f^t) / (\sum_v w_v^0 x_v^0 + \sum_f w_f^0 x_f^0)} \quad (4) \end{aligned}$$

The above ratio holds output prices constant at base period levels while capturing changes in output quantities, and holds input prices constant at current period levels while capturing changes in input quantities.

The APC price recovery ratio (*APRCR*) is the ratio of the value of outputs at current period prices to the value at base level prices, divided by the ratio of the value of inputs at current period prices to the value at base level prices. It is expressed thus:

*APRCR*

$$= \frac{\sum_m p_m^t y_m^t / \sum_m p_m^0 y_m^0}{(\sum_v w_v^t x_v^t + \sum_f w_f^t x_f^t) / (\sum_v w_v^0 x_v^0 + \sum_f w_f^0 x_f^0)} \quad (5)$$

This ratio holds output constant at current period levels while output prices are allowed to vary, and inputs are held constant at base period levels while input prices vary.

The ratio in Eqn (4) can be influenced by changes in product mix and volume, and thereby signal productivity changes when there are really none (Banker *et al.*, 1989). Additionally, capacity utilization can further impact the productivity ratio, and this will not be discernable as standard input and resource consumption patterns are not factored into the ratios in Eqns (4) and (5).

To address these problems, we describe an alternative set of ratios, based on previous work on the subject (Banker, 1988; Banker *et al.*, 1989; Banker and Johnston, 1989). These incorporate technical standards, to enable us to gain insights into what is technically feasible versus what is really attained. The ratio in Eqn (3) is decomposed into a set of four ratios that reflect not only changes in productivity and price recovery, as the APC formulation enables us to do, but, additionally, impacts on profitability due to changes in the product mix and capacity utilization of firms. Thereby, we gain a richer understanding of the different components of a firm's profitability.

### Assumptions Underlying Proposed Ratios

In this sub-section we describe the preliminary assumptions about technical standards that need to be defined, for computation of our proposed ratios. The ratios comprise:

- (1) *A productivity change ratio*, which compares actual input usage to standard input requirements given actual outputs and output capacities;
- (2) *A price-recovery change ratio*, which compares the values of outputs and inputs at current and base level prices, while holding both outputs and inputs constant at base levels;
- (3) *A product-mix change ratio*, which captures the

- profitability impact of changes in the mix of actual outputs and output capacities of the products or services dealt with by the firm; and
- (4) *A capacity-utilization change ratio*, which captures the profitability impact of deviations in current period capacity utilization from standard levels of capacity utilization.

The proposed ratios, when multiplied together, yield the profitability change ratio in Eqn (3).

To operationalize the ratios we need to first define standard quantities. The standard quantity  $z_v^t$  of variable input  $v$  needed in period  $t$ , based on the standard input requirement  $\alpha_{mv}$  per unit of actual output of product  $m$ , is defined as:

$$z_v^t = \sum_m \alpha_{mv} y_m^t \quad (6)$$

where  $\alpha_{mv} > 0$  and  $y_m^t \geq 0$ .

The standard quantity  $z_f^t$  of fixed input needed in period  $t$ , based on the standard input requirement  $\beta_f$  per unit of actual output capacity, is defined as:

$$z_f^t = \beta_f k^t \quad (7)$$

where  $k^t$  denotes the actual quantum of physical plant capacity provided during period  $t$  for producing the various outputs. We estimate standard input requirements  $\alpha_{mv}$  and  $\beta_f$  by regressing each input on outputs or capacity for our pooled sample of observations over multiple firms and time periods.

The base period can be defined in many ways. Therefore, the standard industry load factor is also subject to definition in many ways. We choose to define the base period in terms of the average output and capacity over all firms and time periods.

The standard quantity of plant capacity in period  $t$  is defined to be

$$u^t = \Psi^0 \sum_m y_m^t \quad (8)$$

where  $\Psi^0$  is the inverse of the standard industry load factor  $\Omega^0$ . We estimate the standard industry load factor  $\Omega^0$  by dividing the sum of the base period outputs ( $\sum_m y_m^0$ ) by the base period capacity available ( $k^0$ ). That is,

$$\Omega^0 = \frac{\sum_m y_m^0}{k^0} \quad (9)$$

The standard quantity  $q_f^t$  of fixed input  $f$  required in period  $t$ , based on the input requirement  $\beta_f$  per standard unit of output capacity provided in general, is then defined as:

$$q_f^t = \beta_f u^t = \beta_f \Psi^0 \sum_m y_m^t \quad (10)$$

The base output and capacity quantities are calculated as averages over all firms and all time periods, as:

$$y_m^0 = \frac{\sum_n \sum_t y_m^t}{NT} \quad (11)$$

$$k^0 = \frac{\sum_n \sum_t k_m^t}{NT} \quad (12)$$

where  $n = 1, 2, \dots, N$  denotes individual firms and  $t = 1, 2, \dots, T$  denotes time periods. The base actual and standard input quantities are then calculated using the estimated standard inputs, the estimated standard industry load factor, and the base actual output and output capacity, as follows:

$$x_v^0 = z_v^0 = \sum_m \alpha_{mv} y_m^0 \quad (13)$$

$$x_f^0 = z_f^0 = \beta_f k^0 \quad (14)$$

$$= \beta_f \Psi^0 (\sum_m y_m^0) = q_f^0$$

The base output and input prices are calculated as weighted averages over all time periods, as:

$$p_m^0 = \frac{\sum_n \sum_t p_m^t y_m^t}{\sum_n \sum_t y_m^t} \quad (15)$$

$$w_v^0 = \frac{\sum_n \sum_t w_v^t x_v^t}{\sum_n \sum_t x_v^t} \quad (16)$$

$$w_f^0 = \frac{\sum_n \sum_t w_f^t x_f^t}{\sum_n \sum_t x_f^t} \quad (17)$$

### Specification of the Ratios

We now use the above definitions of standard quantities and prices to specify the set of four ratios that we referred to in the beginning of the previous sub-section. The productivity ratio for period  $t$  is defined as the ratio of standard to actual quantities:

$$PRDTV T = \frac{\sum_v w_v^t z_v^t + \sum_f w_f^t z_f^t}{\sum_v w_v^t x_v^t + \sum_f w_f^t x_f^t} \quad (18)$$

The productivity change ratio can next be defined as the ratio of the raw productivity ratio for period  $t$  to the corresponding ratio for a base period 0, as described below:

*PRDTV T*

$$= \frac{\sum_v w_v^t z_v^t + \sum_f w_f^t z_f^t}{\sum_v w_v^t x_v^t + \sum_f w_f^t x_f^t} \bigg/ \frac{\sum_v w_v^0 z_v^0 + \sum_f w_f^0 z_f^0}{\sum_v w_v^0 x_v^0 + \sum_f w_f^0 x_f^0} \quad (19)$$

The ratio captures deviations between actual and standard usages, and in doing so provides a purer

measure of change in productivity for the period. Because of the normalization in Eqn (13), the divisor in Eqn (18) equals one and the ratio reflects only deviations between current period actual usage of inputs *vis-à-vis* the standard usage of inputs, based on the actual output of the current period. The definition of the *PRDTV T* ratio in Eqn (19) is the identical to that in Eqn (18).

The price recovery change ratio also incorporates standard input requirements, given current period outputs and capacities:

*PRCREC*

$$= \frac{\sum_m p_m^t y_m^t}{\sum_v w_v^t z_v^t + \sum_f w_f^t z_f^t} \bigg/ \frac{\sum_m p_m^0 y_m^0}{\sum_v w_v^0 z_v^0 + \sum_f w_f^0 z_f^0} \quad (20)$$

Since  $z_v^t$  and  $z_f^t$  are functions of  $y^t$ , *PRCREC* is driven only by difference in prices, and shows the composite ability of firms to maximize output prices relative to input prices.

The product-mix change ratio incorporates the same standard inputs for variable inputs as do the preceding ratios described. But, to disentangle the effects of change in product mix from changes in capacity utilization, for fixed inputs the standard inputs given actual outputs and standard capacity factors are also incorporated:

*PRODMIX*

$$= \frac{\sum_m p_m^0 y_m^t}{\sum_v w_v^0 z_v^t + \sum_f w_f^0 q_f^t} \bigg/ \frac{\sum_m p_m^0 y_m^0}{\sum_v w_v^0 z_v^0 + \sum_f w_f^0 q_f^0} \quad (21)$$

These same standard inputs, given actual outputs and the standard capacity factors for fixed inputs, are incorporated into the dividend, while the standard inputs for fixed inputs are used in the divisor as shown below:

*CAPUTIL*

$$= \frac{\sum_v w_v^0 z_v^t + \sum_f w_f^0 q_f^t}{\sum_v w_v^0 z_v^0 + \sum_f w_f^0 q_f^0} \bigg/ \frac{\sum_v w_v^0 z_v^t + \sum_f w_f^0 z_f^t}{\sum_v w_v^0 z_v^0 + \sum_f w_f^0 z_f^0} \quad (22)$$

As a result of the normalization in Eqn (12),  $q_f^0 = z_f^0$  and therefore:

$$CAPUTIL = \frac{\sum_v w_v^0 z_v^t + \sum_f w_f^0 q_f^t}{\sum_v w_v^0 z_v^0 + \sum_f w_f^0 z_f^0} \quad (23)$$

Thus, the capacity utilization change ratio reflects current period deviations between  $q_f^t$  and  $z_f^t$ , that is, between the input requirements given the standard capacity factor as given by  $q_f^t$  and input requirements given actual capacities as given by  $z_f^t$ . Theoretical considerations, and the relevant math-

ematical assumptions, underlying the derivation of these ratios are described in Banker (1988).<sup>1</sup>

## EMPIRICAL ILLUSTRATION

### The Telecommunications Industry

We illustrate the application of the ratios with an analysis of the performance of firms in the US telecommunications services industry before and after deregulation. In this industry a series of experiments have been undertaken in regulating it, and this has opened up the market to competition. Such competition was expected to influence the behavior and performance of firms, and the industry thus provides an apposite setting for the use of our profitability ratios in illustrating changes in a firm's performance.

We undertake our analysis with observations from three specific time windows: 1981, 1984 and 1987. We choose 1981 as it represents the time when moves to deregulate the industry began, with the revival of the anti-trust suit against AT&T (American Telephone and Telegraph Company). Prior to this, the firms had operated in a fully regulated environment. Between 1981 and 1984 several steps to deregulate the industry were undertaken, and in 1984 a reorganization plan for the industry was put into effect. The year 1984 was a period of major change for the industry, as the operating companies owned by AT&T were divested to newly established regional holding companies (RHCs). Since 1984 competition has also been made gradually permissible in many sub-sectors of the local exchange market, particularly regarding the provision of services to business customers, in the intra-state long-distance market, and in several of the critical inter-state long-distance markets. Thus, the years 1981, 1984 and 1987 capture the operations of firms in this industry in three dissimilar time periods. The ratios that we calculate thus reflect the performance of firms in regulated, transitory and deregulated environments, respectively.

### Performance Expectations After Deregulation

Deregulation, and the steady influence of an increasingly competitive environment, is expected to have several impacts on the performance of firms in general, with pressures on firms to be simultan-

ously efficient and innovative. The lowering of entry barriers is expected to increase the number of competitors. While existing firms may show short-term gains in profitability margins by being first movers on the emerging market scene, exploiting newly opened-up opportunities and improving efficiency, overall profit margins are expected to decline in the long term with the advent of more competitors seeking the same customers (Kahn, 1988; Spence, 1986).

Under deregulation productivity is likely to increase, since higher costs caused by inefficient operations can no longer be passed on to consumers, and wastage and slack in input utilization is no longer tolerable (Crew *et al.*, 1971; Leibenstein, 1975, 1978; Selten, 1986; Stevenson, 1982). Similarly, deregulation-induced decreases in monopoly power and new product introductions lead to increases in the price elasticity of demand for existing customers who have more product substitutes from which to choose, which thereby leads to a reduction in the ability of existing firms to recover premium prices. Thus, over time the price recovery ratio is expected to decline (Bailey, 1986; Perl, 1988; Shepherd, 1983).

While price recovery declines, cream-skimming and cross-subsidization is also no longer possible in a deregulated milieu and, therefore, firms have to adopt focused strategic behavior, concentrating their resources and attention on that mix of products that have the highest margins (Porter, 1980; Smith and Grimm, 1987). Concomitantly, the existing resource base of firms has to be better utilized, resulting in a higher-capacity utilization ratio, because rate-base padding, once feasible in a regulated environment, can no longer occur in a deregulated environment (Averch and Johnson, 1962; Bailey *et al.*, 1985; Courville, 1974; Morrison and Winston, 1985; Primeaux, 1978; Spann, 1978).

### Description of the Data

There are approximately 50 local operating companies in the US telecommunications industry that had annual revenues in 1987 of \$100 million or more. Hence, these are large firms and many of them belong in the *Fortune 100* list. We evaluate the performance of 39 of these companies. The others are not used in the sample because of missing data problems. Prior to deregulation in 1984 these companies were part of either Bell operating system or other telecommunications groups such as

GTE, Central Telecommunications (CENTEL), United Telecommunications and Continental Telephone (CONTEL), or were independent firms such as Southern New England Telephone, Rochester Telephone or Cincinnati Bell. After 1984 the Bell operating companies were split into seven regional groups: Ameritech, Bell Atlantic, Bell South, Nynex, Pacific Telesis, Southwestern Bell and US West. Our calculations include all former Bell operating companies, all the independent companies such as Cincinnati Bell, Rochester Telephone Company and Southern New England Telephone (SNET), and a majority of the operating companies belonging to the other groups.

The production and delivery of telecommunications services is characterized by several varieties of costs, two principal types of physical outputs and two principal physical inputs. Our physical input measures are employees and total number of access lines. We obtained data, by each company for each year, from an annual publicly available publication of the Federal Communications Commission titled *Statistics of Communications Common Carriers*. Our physical output measures are the total minutes of local and toll calls for each firm in each time period. We obtained these data from a publicly available *ad hoc* FCC survey. While past studies have looked at physical outputs and physical inputs of telecommunication systems, none have used the accounting framework of fixed or variable costs, or evaluated price-recovery ratios, and hence a precedent does not exist for classifying costs into such categories. Our choice of physical inputs and outputs is consistent with other past studies of the industry, as comprehensively documented and evaluated in Courville *et al.*, (1981) and Waverman (1989), and is more fine grained.

We identify four input costs as being variable. These are traffic, commercial, general office, and other miscellaneous expenses. These expenses vary more or less directly with the volume of actual revenue-generating outputs. Two input cost categories are defined as fixed, that is, they vary with plant capacity which is fixed in the short run. They are maintenance costs and depreciation costs. Again, the data on costs for each firm in each time period are obtained from the FCC Common Carrier Statistics.

Telecommunication service firms earn revenues by providing two basic types of output: local calls and toll calls within defined intra-state areas of operation, to both business and residential users.

Variable cost inputs are a function of the volume of these categories of outputs. There is only one category of physical plant capacity, namely access lines in service, which are used to generate both of these revenue outputs. Hence, fixed inputs are a function of the available plant capacity as measured by access lines.

Physical outputs and inputs yield only physical productivity measures. Recall our interest in generating richer measures of changes in profitability. Therefore, to calculate performance changes due to price recovery and overall product-mix changes we need to derive the output and input prices, which we do in the following manner. To obtain output prices we divide the annual dollar revenues for each output category (deflated by the implicit price deflator for GNP) by the total minutes of calls for that category. To obtain input prices we divide the variable costs for each category (deflated by the implicit price deflator for GNP) and the maintenance cost (deflated by the producer price index for electrical plant and machinery) by the number of employees, to obtain a measure of price per unit for these cost elements. To obtain a measure of price per unit of capital consumption, we divide the deflated depreciation amount (again deflated by the producer price index for electrical plant and machinery) by the total number of access lines.

## FINDINGS ON FIRM PERFORMANCE

To illustrate what insights might be obtained from our analysis we focus on the performance of four firms from the sample of 39. These are GTE Northwest (officially called General Telephone of the Northwest), Pacific Telephone (which in 1983 changed its name to Pacific Bell), Southern New England Telephone (SNET) and United Indiana. Each of these belongs to a different ownership group, and is thus also representative of how differences in ownership may have an impact on firm performance.

First, we discuss some general findings as presented in Fig. 1. The profitability of firms increases with deregulation in 1984, but either stays at the same level or generally declines with the advent of further competition in 1987. Though the profitability change curve may itself look flat for some companies or display a decline in the post-deregulation

period for others, the underlying components of profitability have each moved spectacularly.

We expected productivity to increase across the board; as can be seen from Fig. 2, however, it increases significantly for only one company. Pacific Telephone, rises and then declines for GTE

Northwest, and declines for the other two firms. The average for the 39 firms, that make up the bulk of the local exchange telecommunications industry, as a whole does, however, show an increasing trend. It is an issue that we tackle subsequently. This figure reveals the wide divergences in the adaptive

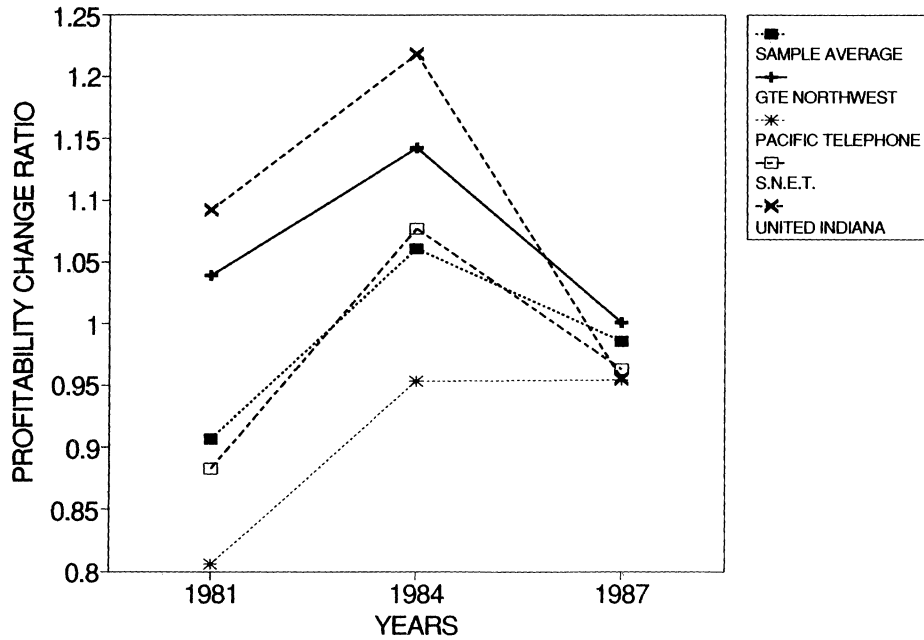


Figure 1. Ratio trends: individual firms.

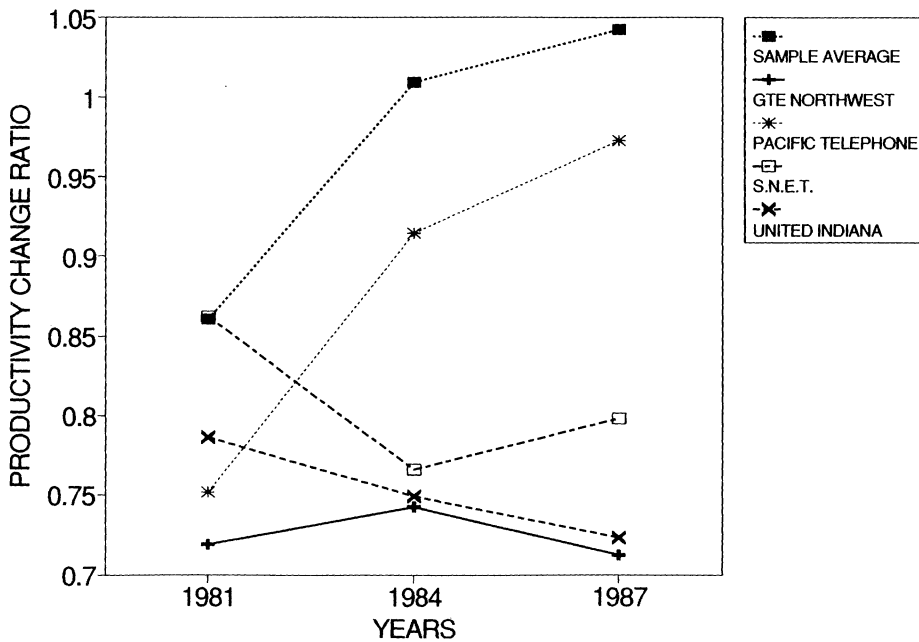


Figure 2. Ratio trends: individual firms.

responses of firms to an environment where efficiency concerns are of much importance. Some of the firms seemingly, do not have the wherewithal to change internal systems immediately to improve productivity.

If productivity changes are not entirely as expected for the individual firms we look at, what are the changes in the other components like? Price recovery falls very steeply from 1981 to 1984, and less steeply from 1984 to 1987. This is consistent with our contention that firms in a deregulated environment can no longer charge former monopoly prices. This trend is noted for all the four firms in our sample, as can be seen from Fig. 3.

If the price-recovery ability decreases as a result of competition, then firms have to undertake steps to counteract such a factor, otherwise this may lead to an overall profitability decline. We see that the product-mix performance ratio improves from 1981 to 1984. It does rise again from 1984 to 1987, but less steeply so than between 1981 and 1984, as can be seen from Fig. 4. This is consistent with our contention that, with the advent of a more competitive environment, firms will concentrate on their more profitable products.

Finally, we expected capacity utilization to improve, as, with the onset of deregulation, firms would be motivated to be efficient in the utilization

of their assets. Figure 5 shows that this ratio does improve for all four companies; the change is large from 1981 to 1984 but only marginally positive between 1984 to 1987.

Based on all the companies in the sample we also calculated a simple average of all five ratios for each of the three years, to examine the overall industry trend in performance. Figure 6 shows this trend for each ratio. It can be seen that while profitability rises and then falls, productivity and product-mix ratios rise monotonically as expected, and capacity utilization ratios improve in the period between 1981 and 1984 but stabilize and drop marginally thereafter. As we also noted in the cases of the four individual firms we looked at, the price-recovery ratio has fallen monotonically in the period after deregulation.

Next, we consider the overall pattern of changes in the individual firms' ratios. Table 1 shows how the various performance ratios changed from 1981 to 1987 for the four firms and also for the industry as a whole. The overall profitability for GTE Northwest declines between 1981 and 1987, a principal factor underlying such a trend being the decline in its price-recovery ability, though its productivity also declines. To offset these partially, there is improvement in both the product-mix ratio and in capacity utilization.

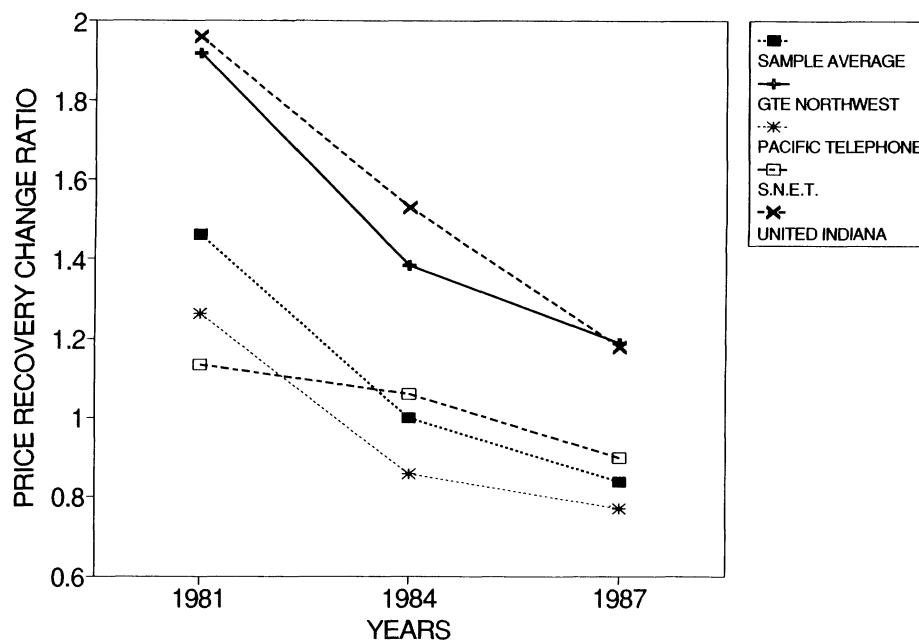


Figure 3. Ratio trends: individual firms.

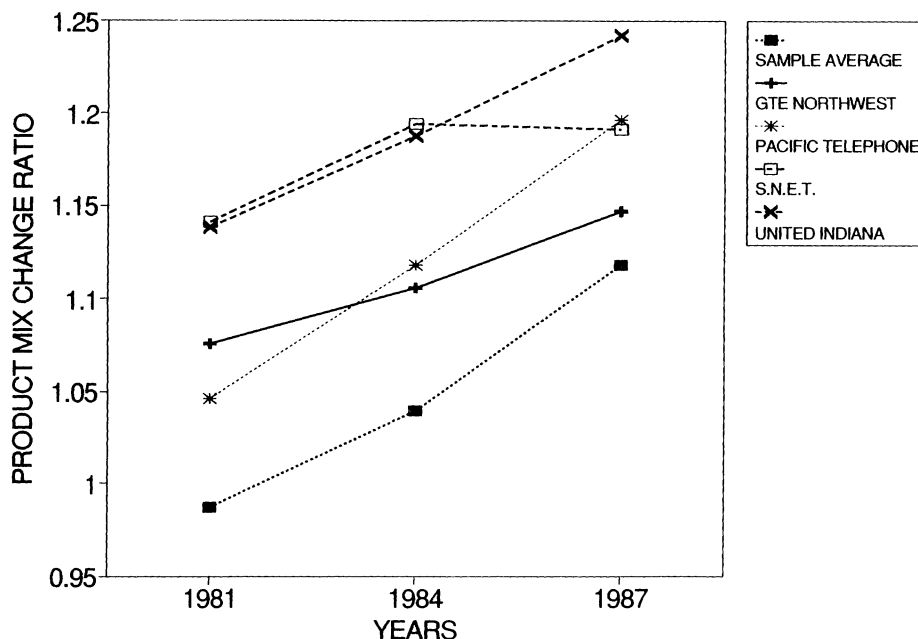


Figure 4. Ratio trends: individual firms.

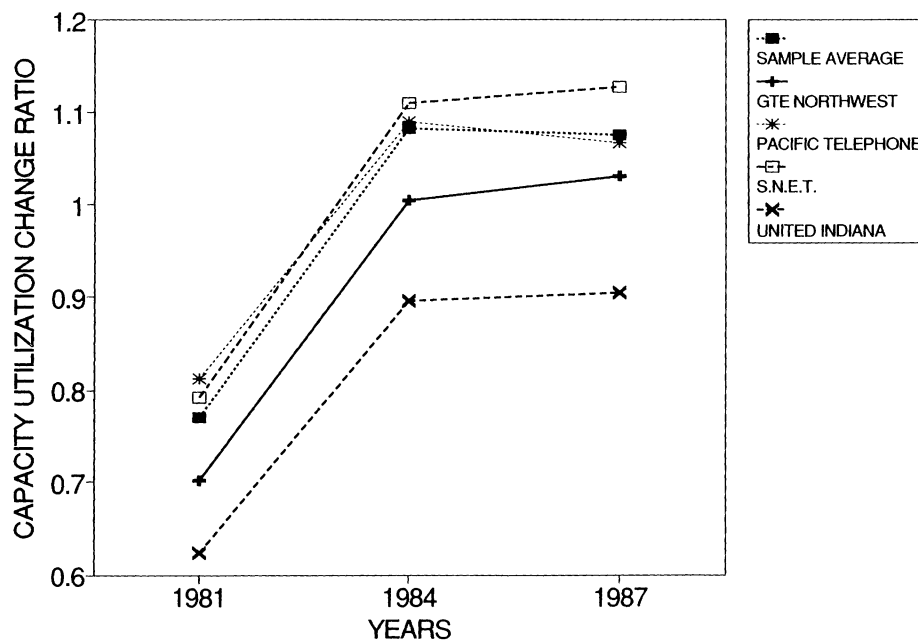


Figure 5. Ratio trends: individual firms.

Pacific Telephone's overall profitability increases in the 1981-87 period. Contributing to such an overall increase are rises not only in its productivity but also in product mix and capacity utilization, which more than offset the decline in the price recovery that it suffers.

For Southern New England Telephone there is also an improvement in overall profitability between 1981 and 1987. There is, however, a decline in both its productivity and price recovery, and only a marginal increase in the product-mix ratio. Therefore, the major source of improvement in

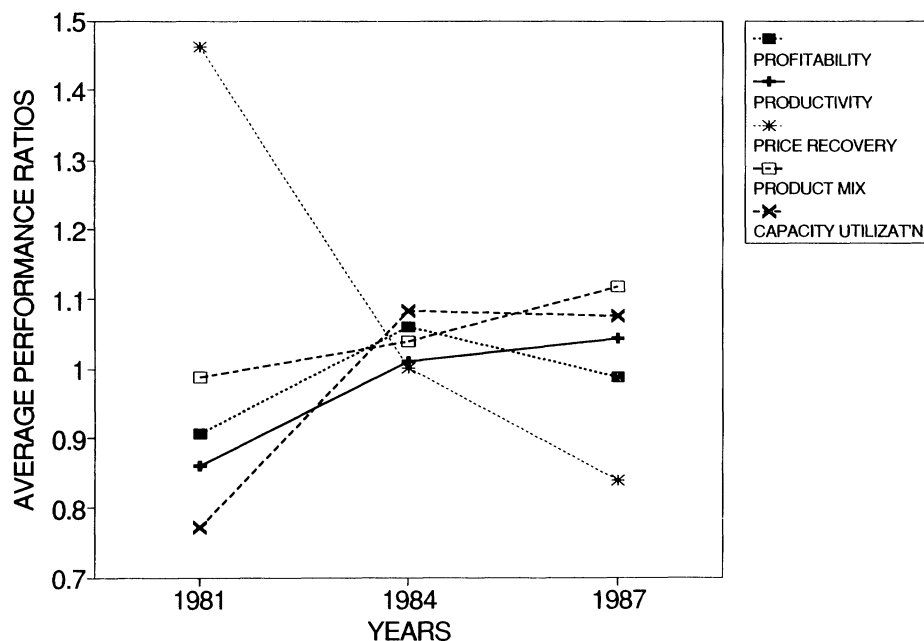


Figure 6. Average performance ratios: all firms.

Table 1. Direction of Changes in the Performance Ratios between 1981 and 1987

	GTE Northwest	Pacific Telephone	Southern New England Telephone	United Indiana	Average for 39 firms
Profitability- change ratio	-	+	+	-	+
Productivity- change ratio	-	+	-	-	+
Price-recovery change ratio	-	-	-	-	-
Product-mix change ratio	+	+	+	+	+
Capacity-utilization change ratio	+	+	+	+	+

profitability has been the improvement in capacity utilization during the period.

The case of United Indiana is similar to GTE Northwest. Overall profitability declined between 1981 and 1987, and two of its key components, namely productivity and price recovery, also decline. While the product-mix ratio and the capacity utilization improve, these improvements are not enough to offset either the decline in price recovery or productivity.

Unlike Pacific Telephone and Southern New

England Telephone, both GTE Northwest and United Indiana are not either part of the Bell grouping or Bell affiliates. We can surmise that the trauma of deregulation and divestiture are not as severe for GTE and United companies as it has been for the Bell operating companies and affiliates. As a result, these companies have not been as strongly induced to improve their performance, and with the advent of a more competitive environment they find themselves declining in overall profitability. These surmises, however, can be tested in

more micro-level studies, the foundations of which can be the changes in profitability and other ratios serving as variables to be explained.

## SUMMARY AND CONCLUSIONS

Finding useful components of performance measures is a relevant area for research. A major difficulty has been in defining the appropriate components and showing whether the interpretations that result are reasonable and applicable elsewhere. Based on such considerations, in this paper we illustrate a multi-period, multi-product method to measure changes in the performance of firms. This method extends the profitability ratio analysis of the APC method. The profitability component (profit to revenues ratio) of the Dupont ROI formula provides a starting point for performance analysis of firms. When combined with the APC method, the resultant ratios allow more micro-analytic details of performance to be evaluated. We, however, go further. In an effort to disentangle micro-analytic components that impact a firm's profitability, we analyze changes in productivity, price recovery, product mix and capacity utilization to examine how each contributes to changes in a firm's profitability.

These ratios can be further decomposed to facilitate performance evaluation. For example, the price-recovery change ratio may be further decomposed into measures of changes in both input and output prices. Similarly, the productivity change ratio can be further decomposed into partial productivity change measures for each input. Why is such fine-grained decomposition useful? First, it gives decision makers a clear sense of where strategic decisions are impacting, and how they might need to make micro adjustments to operational areas within the firm. Second, a gross measure is certainly useful for relative comparison among firms. Why some firms are continuously better than others and can sustain such excellence in performance can be identified only through the use of decomposed ratios. Thus, implications for external parties who do evaluations as to whether profit performance of some firms is merely because of chance or whether there are strong micro-economic and organizational factors underlying a firm's performance can be ascertained.

From a contextually driven, empirical perspect-

ive, our method enables us to examine the impact of deregulation on the performance of US telecommunications firms. Overall profitability increased immediately, but thereafter started declining as competition grew. Productivity in general has shown a slightly increasing trend as a result of deregulation. Declines in price recovery suggest that competitive market forces have decreased the possibility of monopoly rent extraction, and the allocative efficiency of price-setting mechanisms seems to be increasing. To counter the forces described above, firms have had to concentrate their resources on the more profitable product lines, and also improve the utilization of their fixed capital resources. The social welfare consequences of such results are evidently positive, and thus support the view that public policy decisions, such as deregulation, are likely to have a positive impact.

Nevertheless, while overall impacts have been positive, our analysis also shows different dynamics at work at the firm level. Some firms seem to have had difficulty adjusting to a deregulated environment and improving their profitability and productivity in a sustained manner, while others are consistent in the patterns of improvement of the various components of their performance.

The existence of such inter-firm patterns suggests that firm and ownership-group-specific factors are also likely determinants of profitability, a point to which we have already alluded. Given our framework for analyzing profitability ratios into their components, it is apparent that great potential exists for firm-level studies that can identify the endogenous and exogenous forces impacting various attributes of performance, by using the ratios as dependent variables in a regression where explanatory variables are measures capturing these forces.

Second, we looked at three discrete points in time (1981, 1984 and 1987) in analyzing trends in firm performance. It is entirely conceivable that performance trends of the firms reviewed may have changed considerably as a result of further market-liberalization measures taken since 1987. A richer study, then, will involve a continuous study of all years in, say, a ten-year period 1981 to 1990 to truly understand the temporal dynamics of how telecommunications firms have behaved in what has been a very turbulent decade for them. Thereby, the foundations can be laid for a rich stream of empirical performance analysis, applicable to many contexts resulting from market-liberalization measures being taken in various places around the world.

## NOTE

1. Copies of this paper are available from the first author.

## REFERENCES

- American Productivity Center (1981). *Total Productivity Measurement*, Houston, TX.
- H. Averch and L. L. Johnson (1962). Behavior of the firm under regulatory constraint. *American Economic Review* **52**, 1052–69.
- E. E. Bailey (1986). Price and productivity change following deregulation: The U.S. experience. *Economic Journal* **96**, March, 1–17.
- E. E. Bailey, D. R. Graham and D. P. Kaplan (1985). *Deregulating the Airlines*, Cambridge, MA: The MIT Press.
- R. D. Banker (1988). Productivity and profitability ratio analysis. *Research Note*, Carnegie-Mellon University, Pittsburgh, PA.
- R. D. Banker and H. H. Johnston (1989). Strategic profitability ratio analysis: an application to the U.S. airline industry following deregulation. *Working Paper*, Carnegie-Mellon University, Pittsburgh, PA.
- R. D. Banker, S. M. Datar and R. S. Kaplan (1989). Productivity measurement and management accounting. *Journal of Accounting, Auditing and Finance*, Fall, 528–54.
- L. Courville (1974). Regulation and efficiency in the electric utility industry. *Bell Journal of Economics and Management Sciences* **5**, Spring, 53–74.
- L. Courville, A. de Fontenay and R. Dobell (eds) (1983). *Economic Analysis of Telecommunications: Theory and Applications*, Amsterdam: North-Holland.
- M. A. Crew, M. W. Jones-Lee and C. K. Rowley (1971). X-Theory versus management discretion theory. *Southern Economic Journal* **38**, October, 173–84.
- Federal Communications Commission (annual). *Statistics of Communications Common Carriers*, Washington, DC.
- Federal Communications Commission (1988). *Monitoring Report: Docket No. 87–339*, Washington, DC.
- A. E. Kahn (1988). *The Economics of Regulation: Principles and Institutions*, Cambridge, MA: The MIT Press.
- J. W. Kendrick (1984). Improving Company Productivity: Handbook with Case Studies, in collaboration with the American Productivity Center, Baltimore, MD: Johns Hopkins University Press.
- H. Leibenstein (1975). Aspects of the X-efficiency theory of the firm. *Bell Journal of Economics and Management Science* **6**, Autumn, 580–606.
- H. Leibenstein (1978). On the basic proposition of X-efficiency theory. *American Economic Review* **68**, 2, May, 328–32.
- D. M. Miller (1984). Profitability = productivity + price recovery. *Harvard Business Review* **3**, May–June, 145–53.
- S. Morrison and C. Winston (1985). *The Economic Effects of Airline Deregulation*, Washington, DC: The Brookings Institution.
- L. J. Perl (1988). Economic consequences of competition in telecommunications. Paper presented at the International Telecommunications Society, Seventh Bi-Annual Conference, Cambridge, MA.
- M. E. Porter (1980). *Competitive Strategy*, New York: The Free Press.
- W. Primeaux (1978). The impact of competition of capacity utilization in the electric utility industry. *Economic Inquiry* **16**, April, 237–48.
- R. Selten (1986). Elementary theory of slack ridden competition. In *New Developments in the Analysis of Market Structure* (edited by J. E. Stiglitz and G. F. Mathewson), Cambridge, MA: The MIT Press, pp. 293–310.
- W. G. Shepherd (1983). Concepts of competition and efficient policy in the telecommunications sector. In *Telecommunications Regulation: Today and Tomorrow* (edited by E. M. Noam), New York: Harcourt Brace Jovanovich, pp. 79–120.
- K. G. Smith and C. M. Grimm (1987). Environmental variation, strategic change and firm performance: a study of railroad deregulation. *Strategic Management Journal* **8**, 363–76.
- R. M. Spann (1974). Rate of return regulation and efficiency in production: an empirical test of the Averch–Johnson thesis. *Bell Journal of Economics and Management Science* **5**, Spring, 38–52.
- A. M. Spence (1986). Cost reduction, competition and industry performance. In *New Developments in the Analysis of Market Structures* (edited by J. E. Stiglitz and G. F. Mathewson), Cambridge, MA: The MIT Press, pp. 475–515.
- R. Stevenson (1982). X-Inefficiency and interfirm rivalry: evidence from the electric utility industry. *Land Economics* **51**, 1 February, 52–64.
- B. J. van Loggerenberg and S. J. Cucchiaro (1981–2). Productivity measurement and the bottom line. *National Productivity Review*, Winter, 87–99.
- L. Waverman (1989). U.S. inter-exchange competition. In *Changing the Rules: Technological Change, International Competition and Regulation in Communications* (edited by R. W. Crandall and K. Flamm), Washington, DC: The Brookings Institution, pp. 62–113.