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LABOR PRODUCTIVITY: A SEARCH AND CONFIRMATION OF NONTRADITIONAL DETERMINANTS

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LABOR PRODUCTIVITY: A SEARCH AND CONFIRMATION

OF NONTRADITIONAL DETERMINANTS

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> Love is very patient and kind, never jealous or envious, never boastful or proud, never haughty or selfish or rude. Love does not demand its own way. It is not irritable or touchy. It does not hold grudges and will hardly even notice when others do it wrong. It is never glad about injustice, but rejoices whenever truth wins out. (I Corinthians 13:4-6)

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CHAPTER I

INTRODUCTION

Productivity has been regarded as one of the most important measures of performance at the economy-wide, industry, firm and department level. As a result, productivity has now become an everyday word. The impact of increases in the level of productivity on social and economic consideration are, for instance, rapid economic growth, higher standards of living, improvement in the balance of payment, lower inflation and increased leisure time. At the firm level, productivity has been utilized as a goal of future strategy and labor negotiations.

In the United States the earliest studies of productivity were made in the late 19th century by the Bureau of Labor in the Department of the Interior under the direction of Commissioner Carrol D. Wright (Kendrick, 1976 B, p. 425). Kendrick also noted that the next broad studies were made by the National Research Project of Works Progress Administration and the National Bureau of Economic Research in the 1930's. These productivity studies led to published measures of output per man-hour in major industries and sectors of the United States as a regular part of federal government statistical programs in 1940 under the Bureau of Labor Statistics. The main concern of these early studies was to measure the labor-displacing effects of machinery or technology.

Though the first American national productivity organization was not established until 1970, the United States helped European countries and Japan to set up a national productivity center after World War II. In 1955, the European Productivity Agency was established (1) to function as a clearing house for national productivity bodies and other international associations, and (2) to guide European efforts toward greater productivity and to study the social, economic and human consequences of developments in technology (Takeuchi, 1977, p. 5). With comparable objectives, the Japanese Productivity Center was established in 1955 (Lee, 1971, p. 93).

In June 1970 President Nixon set up the National Commission on Productivity to study ways of increasing output in government and private industry (O'Connor, 1977, p. 701). One of its main objectives was to use the trend-rate of productivity advance as a guide to non-inflationary wage increases under the wage-price controls that were in effect from 1971 to 1974. But the United States Congress was disappointed in its performance. Specifically the House Banking and Currency Committee questioned the commission's lack of concentration on matters potentially affecting America's international competitive position and the usefulness of some proposed projects dealing with banking, restaurants and education (Mathiasen, 1975, p. 261).

In 1975, this commission was renamed as the National Commission on Productivity and Work Quality. Besides changing its name, the Congress crystallized its function. It was required to focus its efforts on four areas: worker morale and quality of product, the United States international competitive position, government efficiency and cost of essential consumer goods and services (O'Connor, 1977, p. 701).

In the private domain, 80 corporations founded the American Productivity Center under the leadership of C. Jackson Grayson, formerly of the federal government's Price Commission and former Dean of Southern Methodist University (Business Week, 1977). This private productivity center, founded in 1977, is dedicated to strengthening the free enterprise system by developing programs to improve productivity and the quality of working life. It also provides information and conducts seminars and training programs on productivity.

Reason for Micro Productivity Research

Here, micro means that the special application of the result of productivity studies is to firms, rather than to a national, regional, or local economy. It is also true that whether a study concerns itself with a nation, industry or firm, the implication is not limited to only one level, since each level is interrelated. For instance, if the main purpose of a study is to make a recommendation on how to improve the productivity of a group of firms, the impact of this study will be on an industry and a national economy as well as its preset boundary, a group of firms. Thus, the key issue becomes: what is the "direct" interest of a study?

Why does this study have a micro focus? A micro focus does not imply that a macro study is not important. On the contrary, this study recognizes the significant influence of macro level studies on productivity. The true is that the review of previous research in productivity shows the importance of such studies. In addition, most groundwork in productivity has been conducted at a macro level. Does this imply that micro research is not necessary? Definitely, the answer is "no." To understand productivity, it is essential to study all levels of the economy rather than only certain levels. In other words, like the human body, which requires balanced nutrition for healthy growth, productivity studies also need a balance of micro and macro research. This study concerns a micro level not because a macro level is not important but because a better balance of studies on productivity is needed.

Another reason for the selection of firms is that most data at the macro level are drawn from government publications. These data are obtained mainly for purposes other than productivity analysis, consequently, considerable manipulation of the data is often required to be able to analyze productivity. Such manipulation may create a reliability problem. For instance, when the Bureau of Labor Statistics wants to obtain data on employee manhours for the food retailing industry, they have to collapse two types of data; employee data by the Bureau of Census and their own internal data. Specifically,

> The Bureau of Labor Statistics data for nonsupervisory workers are multiplied by the reported average weekly hours to obtain total manhours for nonsupervisory workers. The number of supervisory workers (total employment less nonsupervisory workers) are multiplied by the established average weekly hours worked for salaried retail food managers derived from data published in the 1960 and 1970 census of population (Bureau of Labor Statistics, 1974, p. 11).

The use of primary data might avoid this kind of problem. But the collection of primary data usually demands a longer period of time and more research funds. The data for this study were not directly collected to study productivity. But, fortunately, the data as they were collected required no manipulation except the creation of new variables by using existing variables in the data base.

Why Study Retailing Productivity?

This section describes why retailing is adopted as the industry to be studied in this research.

Dynamic Changes in Retailing

In the 1970's retailing faced double-digit inflation, rising energy costs, high capital costs, recurring capital shortages and a major recession. This economic situation was different from that of the previous decade which had provided a favorable environment for relatively rapid expansion of retailing. The 1970's developments were unfavorable especially to retailing which operates on relatively slender profit margins. For instance, during this period the average profit ratios for discount department stores and supermarkets were only 1.9 percent and .8 percent, respectively (McCammon, 1981). McCammon said that these ratios are only a little over half of the target profit margins.

In addition to a roller coaster economy, retailing was suddenly confronted by new types of competition. McCammon (1973) classified the new types of competition into four; intra type competition (Thrifty vs. Walgreen), intertype competition (Kroger vs. K-Mart), systems competition (A&P vs. IGA) and free-form competition (Daylin vs. Interco).

A roller coaster economy and intensified competition also contributed to accelerating retail institutional life cycles. McCammon (1973) estimated that the time to reach maturity declined from approximately 100 years, in the case of department stores, to approximately 10 years, in the case of catalog showrooms. As concept companies of the 1960's like McDonald's, Kentucky Fried Chicken, K-mart, and Radio Shack became the dominant competitors in their line of trade in the 1970's, McCammon (1981) predicted that new wave retailers such as Video Concepts, Color Tile, Wallpapers To Go, Standard Brands Paint, Toys 'R" Us and Mervyn's, will enjoy high competitive edges over existing firms in the future.

Productivity is not the sole answer to meet this challenge, but productivity will draw special attention as a tool of survival.

Low Productivity in the Service Sector

The service sector of the United States economy has been receiving increased attention. Presently the share of total employees in the service sector is 64 million, or 62 percent of the total civilian labor force (Bureau of Labor Statistics, 1981). Several studies have attempted to determine why the large increase in total employment occurred. For instance, Fuchs (1968) considers three hypotheses: (1) a more rapid growth in the demand for services by consumers, (2) a relatively slow increase in the demand for services by consumer, (3) a relatively slow increase in output per manhour in the service industry. These hypotheses respond to the dramatic shift of employment toward services from approximately 40 percent in 1929 to over 60 percent in 1963. Among these three hypotheses, he argued that the last hypothesis explains the majority of such changes. In other words, the main explanation was that output per manhour grew much more slowly in the service industries. These industries are inherently less subject to technological change than the rest of the economy. He rejected the first hypothesis, since the share of GNP by the service sector has not changed much. He also rejected the second hypothesis since it accounted for only 10 percent of such change.

But the conclusions of Fuchs bring about several criticisms. The service sector is so diverse that all industries in the service sector cannot be regarded and analyzed as one. The service sector includes transportation, public utilities, wholesale and retail trade, government, hospital and doctor's service, finance, insurance, real estate and a variety of other services. Among these industries, growth rates in output per manhour in the air transportation and the gas and electric utilities industries were actually at the top of 44 selected industries studied by the Bureau of Labor Statistics for the period from 1947-1973.

One of the many reasons for the drag in productivity in the service sector is the inclusion of the state and local government sector. During this period, this sector made almost no effort to measure productivity. The state and local government sector provided only 6.3 percent of all job opportunities in 1947. Its share has since increased to over 15 percent in 1980 (Bureau of Labor Statistics, 1981). This second reason shows that productivity in retailing must be studied separately from the service sector. This is the case because the service sector includes such diverse industries that it is difficult to draw meaningful conclusions from studies that are highly aggregated.

Declining Service in Retailing

The third reason is the possibility that all or most of the gains in retailing productivity were largely the result of a decline in service. This hypothesis is based on the work of Schwartzman (1971) which revealed that all increases in transaction size are attributed to service reduction. Bucklin (1978, p. 65) said that Schwartzman's estimates are likely to be sharply exaggerated. And he continues:

> Although productivity gains from this source doubtless have been enjoyed, there is neither evidence nor theory to support the contention that a given increase in transaction size (even where only higher quality is involved) translated into proportionate reductions in labor.

This controversy leads to another reason to further investigate productivity in retailing.

Marketing Functions of Retailing

The fourth reason to select retailing is that the distributive trades including retailing are typically involved in performing only marketing functions. Ingene and Lusch (1980, p. 2) state that:

> In contrast, manufacturers perform both production and marketing functions: this makes it difficult to empirically isolate marketing inputs and outputs from those of production. More importantly however is the fact that most marketing activities occur in the distributive trades.

Thus, this fourth reason, not the least important, is more likely a methodological consideration.

Why Study Labor Productivity?

This section discusses why labor productivity is adopted for the purpose of this study.

Short-Run Controllability

When labor and capital are compared, the commitment to labor is relatively shorter than to capital. As a result, the first indication of a depression is a high unemployment rate due to layoffs. This evidence shows that labor is more controllable and flexible than other types of inputs.

Easy Execution

The section on labor productivity versus total factor productivity will reveal that total factor productivity is more desirable and ideal as a performance measure than a single factor productivity measure. This is because it usually considers labor, capital and material together as inputs. But the concept and measurement of total factor productivity are relatively primitive, and therefore its adoption might be misleading. The main cause of confusion lies in the characteristics of total factor productivity which requires the development of an input index. In order to obtain an index, some type of weighting system is needed. But such systems usually are based on subjective criteria. Besides the problem of an index, total factor productivity provides a less meaningful conclusion to managers than labor productivity, especially in the study of determinants. For instance, if a study finds that total factor productivity, which considers labor, capital and material as its input, is related with a store location, this finding can be interpreted that all three types of input are associated with a store location, though, in reality a store location may make more of a contribution to labor than the other types of input. Thus the relative importance of different types of input responding to various determinants cannot be found. The above argument can be supported by a small number of empirical studies on total factor productivity, even though most of them belong to case studies in which statistical techniques are difficult to apply.

Close Relationship with Profitability

Profitability, which is distinct from productivity, is a commonly used performance measure. As a measure, several studies have been conducted to investigate the relationship between profitability and productivity. For instance, Lundberg (1972, p. 475) found in Swedish pulp mills that labor productivity for the highest gross profit margin group was 1.9 times the average, mills with the lowest labor productivity showed either near zero or negative gross margins. Another study (Takeuchi, 1977) claims that in the supermarket industry approximately 55 percent of the variance in profits among the stores could be explained by labor productivity. The above findings show that the adoption of labor productivity does not ignore an important dimension of performance, profitability.

Labor Productivity Across Industries

Table I-1 shows a substantial difference in labor productivity among various industries. Between 1968 and 1978, the average growth rate for all industries was 1.41 percent. Among five examined industries, manufacturing achieved the highest growth rate, 2.34 percent, during ten years, while mining lost productivity by 2.29 percent. Wholesale trade gained a little over the average growth rate for all industries and the growth for retail trade was only half of that for all industries.

TABLE I-1

GROWTH RATES FOR TRADE AND PRODUCTION INDUSTRIES IN THE UNITED STATES (1968-1978)

Industry	Output (%)	Labor Input (%)	Labor Productivity (%)
All Industries	2.89	1.47	1.41
Agriculture, Forestry and Fishing	1.80	1.11	0.68
Mining	1.40	3.78	-2.29
Manufacturing	2.44	0.10	2.34
Wholesale Trade	3.97	2.30	1.63
Retail Trade	3.06	2.28	0.76

Source: U.S. Department of Commerce/Bureau of Industrial Economics, 1981 U.S. Industrial Outlook for 200 Industries with Projections for 1985, Washington, D.C.: U.S. Government Printing Office, 1981.

Not only does there exist a difference in labor productivity among different industries, but also within retailing there exists differences. Among selected retail outlets, gasoline service stations obtained the highest annual growth rate of labor productivity between 1973 and 1978 (see Table I-2). Easting and drinking places got the lowest annual growth rate of labor productivity, -1.5 percent. The existence of differences among industries and within the retail trades provides another indicator that labor productivity is worthy of study.

TABLE I-2

LABOR PRODUCTIVITY IN DIFFERENT LINES OF RETAIL TRADE

Line of Retail Trade	Average Annual Growth Rates of Labor Productivity, 1973-78
Retail Food Stores	-0.2%
Franchised New Car Dealers	2.3
Gasoline Service Stations	4.9
Eating and Drinking Places	-1.5
Hotels, Motels and Tourist Courts	0.6
Laundry and Cleaning Services	1.1

Source: Bureau of Labor Statistics, Productivity Indexes for Selected Industries, 1979, Edition, Washington, D.C.: U.S. Government Printing Office, 1979, p. 6.

High Labor Cost

According to a study by Progressive Grocer (1980, pp. 90-109), the leading concern for retailers is labor since its cost is more than 50 percent of total oparating expenses. For wholesalers, in 1970, labor was most frequently mentioned as their biggest problem. But in 1980, their opinion was changed to profit. However, the labor cost including employee benefits still accounts for more than 50 percent of their total operating expenses. This finding confirms the fact that labor is a far more important input than any other input.

Reason for Hardware Industry

The focus of this study is on analyzing labor productivity at the micro level within the retail hardware industry. Three major reasons for selecting hardware retailing as the subject of this analysis can be cited: (1) the data are available, (2) few attempts have been made to study labor productivity in the hardware industry, and (3) the desire to improve productivity in this particular industry is high.

In conducting research, it is necessary to obtain a balance between research objectives and time and money constraints. Ideally the researcher will collect the data which fits the developed objective of the study. But in this case the study requires considerable time and money to collect the data. The second option, which is less desirable than the first option, is to try to find an existing data base which requires relatively little manipulation and is also suitable for the objectives of the study. The final option is that the researcher obtains data and then constructs a model to fit the data. Among these three options, the second option is adopted for this study. The data used in this study, which is collected by the National Retail Hardware Association, are suitable for the purpose of this study.

The second reason for the selection of the retail hardware industry is that most previous productivity studies at the firm level were concerned with food related industries. As a result, the findings in these industries can hardly be generalized. This study can provide an added dimension to micro productivity studies, since the hardware industry seldom has been the subject of labor productivity research.

The hardware industry is not an exception to the common practice which emphasizes profitability while paying scant attention to productivity. But recently this industry raised its interest in productivity by communicating two simple productivity axioms to its members (Vereen, 1978, pp. 54-57):

1. Without identifying productivity, it is not possible to improve it.

2. Merely by beginning to measure productivity, one can improve it even without instituting new systems, new techniques or new processes.

Is it enough simply to measure productivity for the improvement of its performance? Definitely the answer is no. Measuring productivity is the first step to improve productivity. It must be accompanied by two other steps: identify determinants of productivity and develop and implement a strategy to improve productivity. Unfortunately little attempt has been made at the second and third steps. Thus another reason for choosing this industry is to help this industry develop strategies for improving productivity.

Objective of This Study

The general purpose of this study is to make a contribution to the future study of productivity. Before the specific objectives of the research are discussed, it is necessary to briefly review the main characteristics of previous studies. Such a review provides a sound foundation for this study.

The main characteristics of prior productivity studies can be summarized as:

1. The majority of previous studies have adopted labor productivity as their measurement of productivity. Thus total factor productivity needs more attention in the future.

2. The food industry has been the most popular area of study. As a result diversification is needed in research to draw general conclusions regarding productivity.

3. As mentioned earlier, there exists an imbalance in productivity studies. Productivity research started at the macro level and dominance is still seen at this level.

4. At a macro level, sample size has seldom been a problem since most studies utilize government data. But at a micro level, with few exceptions, many studies are concerned with case studies. Thus, the application of statistical tools is difficult, especially in total factor productivity studies.

5. In searching for productivity determinants, exogenous variables of a firm, such as per-capita income and the rate of population growth, have been used extensively. The emphasis on these types of variables brings about little attention to endogenous variables of a firm, especially decision making variables.

The above statements show the most urgent needs for future research. These are displayed in Table I-3.

This study does not attempt to bridge all of the gaps in existing productivity studies. However, it does try to cover several shortages of prior studies, which, in turn, will serve as a useful basis for future studies. Specifically this research attempts to answer the following issues.

TABLE I-3

SURPLUS AND SHORTAGE OF PRODUCTIVITY STUDIES

Dimension	Surplus	Shortage
Measurement	Single Factor	Total Factor
Level	Macro	Micro
Industry	Food	Other than Food
Variables	Exogenous	Endogenous

(1) What is productivity and why is it important at a micro level and a macro level?

Good research must have a sound conceptual basis. The development of concept can never end. And healthy empirical research must go along with healthy conceptual development. Thus one of the major objectives of this research is to review the basic concept of productivity which will in turn be utilized as a basis for the empirical research.

The importance of productivity is highly recognized. Whenever some social problems such as inflation, labor disputes, or a balance of payment arise, productivity has been a key issue. Actually the impact of productivity is not limited to the industry involved but to the whole society. Thus another reason for this study is to discuss why productivity is important at a micro level and a macro level.

(2) How should productivity be measured?

The basic concept of productivity is the ratio of output to input. But there is no consensus on how to measure productivity. Another objective of this research is to compare and confirm some of the most commonly used measurements for input and output.

(3) What relation does productivity have with its explanatory variables?

Most previous studies assume that the relationship between productivity and its independent variable is either linear or log. Conceptual clarification of such relationships is needed, but, at the same time, it is also necessary to empirically verify such relationships. Thus another reason for this study is to find the functional relationship between labor productivity and its determinants.

(4) What is the influence of marketing mix decision variables on productivity?

Unlike the previous studies, this study considers the marketing mix variables, price, product, promotion and place. This study also considers other variables besides the mix variables such as labor related variables, organization structure variables and business health variables. Why does this research include the mix variables? First, in marketing, there have been only limited efforts to find the impact of marketing mix decisions on performance. Few attempts belong to experimental studies. Experimental studies, by their nature, deliberately manipulate one or more variables and assume that other variables are controllable. The consequence of this manipulation and assumption is that the design is not the actual situation. Therefore the findings under an experimental study require extra precaution in making meaningful inferences. Second, even in experimental approaches, the considered variables are very limited, such as the impact of the fluctuation of price or the impact of different promotional methods.

(5) Can the developed productivity model be confirmed?

Another objective of this study is to develop a productivity model based on prior research. In conjunction with this model, several hypotheses are developed to be tested empirically. The data of 1976 is used to explore a preliminary model of productivity and the next two years' data are utilized to confirm the developed and tested model. This approach is unique from the previous studies, since few of them have attempted to confirm their models by utilizing different data. The specific objectives of this research are summarized in Table I-4.

TABLE I-4

OBJECTIVES OF THIS STUDY

Conceptual	(1) What is productivity?
	(2) Why is it important?
Measurement	How to measure input and output?
Function	Linear vs. Log
Variables	Marketing Mix Variables
Confirmation	1976 vs. 1977 and 1978

Limitation of This Study

This study makes a compromise between "ideal research" and reality. Consequently, this study has numerous limitations. The following items are only a sample of such limitations.

(1) Is it worthwhile to construct a productivity model and empirically test it?

It is true that productivity determinants are so complex that no model can consider all the possible factors at the same time. One of the leading scholars in this field, Kendrick (1976, p. 12) states that no credible productivity model exists. But is it still worthwhile to attempt to develop a productivity model? Yes, it is, since at least it is better to try than not to try. In addition, the basic assumption of this study is the existence of causality. If this fundamental assumption is incorrect, the effort of this study is null. Fortunately, or unfortunately, the discussion of causality has a long history and such discussion will go on, possibly as long as human beings exist in this world.

(2) Is labor productivity a good measurement of productivity?

Many prior studies used labor productivity as their productivity measure. This study also presents several reasons to adopt labor productivity over total factor productivity. At the same time, this study admits that the ultimate goal for the measurement of productivity must be total factor productivity.

(3) Are the adopted measures for input, output and independent variables valid?

This issue leaves a lot of room for dispute, since this study considers that it is "impossible" to measure the true value of any variable. It is commonly acceptable that the true value of a variable consists of an observed value and error term. Thus all measures in this study can be considered as surrogate measures.

Structure of This Study

This chapter points out why this study selects a micro level, retailing, labor productivity and hardware industry as the scope of inquiry. In addition, this chapter presents the objectives of this study and its limitations.

Chapter II reviews the basic concept of productivity and relates it to similar concepts such as profitability and effectiveness. Chapter II also focuses on the importance of productivity at a micro and macro level. Chapter III analyses how to measure productivity and shows what kind of alternatives exist. Chapter IV discusses the determinants of productivity based on the previous studies in this field and formulates a productivity model to provide a basis for an empirical test.

Chapter V describes the research methodoloty. Chapter VI presents the statistical analysis and findings. Chapter VII concludes the thesis by summarizing the findings and presenting several suggestions for the future study of productivity.

CHAPTER II

THE CONCEPT OF PRODUCTIVITY

This chapter covers seven sections. First, it presents various definitions of productivity and describes the basic concept of productivity. Second, it contrasts labor productivity with total factor productivity. Labor productivity has enjoyed a dominant position in productivity studies since the concept evolved, but recently many experts have argued that total factor productivity is superior to labor productivity when measuring productivity. The next two sections discuss the main differences between productivity and its similar terms, such as profitability and effectiveness. This chapter also reviews the concept of a production function. The last two sections of this chapter state why productivity is important at both a macro level and a micro level.

Basic Concept of Productivity

The term productivity is a familiar one and it is used in various ways. In spite of this wide recognition and usage of productivity, different authors use different definitions of productivity. A handful of examples of different definitions of productivity are:

> In the present context, marketing productivity refers to the ratio of sales or net profit (effect produced) to marketing cost (energy expended) for a specific segment of the business (Sevin, 1965, p. 9).

> Productivity is an expression of the physical or real volume of goods and services related to the physical or real quantities of input (Mark, 1971, p. 7).

> Productivity measures are statistics designed to measure only the real change in the flow of goods and resources required to produce them (Bucklin, 1978, p. IV).

The main thrust of the above definitions is the ratio of output to input. The basic concept can be illustrated mathematically as:

$$\text{PRODUCTIVITY} = \text{OUTPUT}/\text{INPUT}$$

And there are at least two distinct types of productivity ratios, total factor productivity and single (or partial) factor productivity. Single factor productivity ratios are those which evaluate the efficiency of but one of the inputs. Total factor productivity is an aggregate measure reflecting all inputs.

Single factor productivity, in the case of labor productivity, is illustrated in the following equation:

$$O/L = At\ f(L,K,M)$$

where,

O = Output

At = The technology that is employed at the time

L = Labor (full time equivalent employees or manhours)

K = Land and capital

M = Material and partially processed goods

With the same notation, the equation of total factors productivity follows:

$$O/(L+K+M) = At/(L+K+M)\,f(L,K,M)$$

The main distinction between these two types of ratios is the number of inputs considered.

Labor Productivity versus Total Factor Productivity

As mentioned in the previous section, there are two broad classes of productivity; single factor productivity and total factor productivity. In regard to single factor productivity, many alternative measures of productivity are possible, such as labor, capital and energy. But whether for a firm, an industry or the entire economy, the most frequently developed and used productivity measure is labor productivity. Thus this section discusses why labor productivity has been most frequently used.

Craig and Harris (1973, p. 14) argue that the use of labor productivity can lead to serious misunderstanding about a productivity index. They provide an example of the fallacies of partial productivity measures:

> Assume a company procures a higher quality raw material that significantly reduces the man-hours necessary for processing. The output per man-hour index would naturally rise since a worker now can produce more of the same product in less time. However, suppose that the improved raw material is more costly. To simplify the example, assume that the increase in material cost is equal to the savings from reduced processing man-hours. Using the labor productivity index as a guide, labor and stockholders would note an increase in productivity. Either group could take action to distribute this gain. Labor could bargain for increased wages, and stockholders could expect increased dividends or at least a growth in profits. Customers might expect a price reduction. However, there has been no real gain to the corporation. The apparent increase in labor productivity has already been distributed to the raw material supplier; there is nothing available for distribution to labor, stockholders or customers. Gains indicated by increased labor productivity may not actually be gains at all. The cost of generating the increased labor productivity must be considered.

This type of fallacy exists in all single factor productivity studies and as a result, this provides a rationale for considering total factor productivity. But at present, total factor productivity studies carry practical shortcomings in terms of conceptualization and operationalization.

Regarding this type of problem, the Bureau of Labor Statistics (1974, p. III) justifies the use of single factor productivity as:

> Although the measures relate output to employment and man-hours, they do not measure the specific contributions of labor, capital, or any other factor of production. Rather, they reflect the joint effect of a number of interrelated influences, such as changes in technology, capital investment per worker, changes in the level of output, utilization of capacity, layout and flow of material, managerial skill and effort of the work force.

In addition, several authors manifest different reasons for the usage of labor productivity. First, labor is almost universally required for all types of production though the degree varies (Mark, 1971, p. 7). Second, as a practical matter, it is perhaps a more measurable input than other factors, such as capital, particularly when the measurement of labor is based on a head-count or on statistics of hours workerd, ignoring differences in skill and rates of pay (Eilon and Soesan, 1976, p. 3; Mark, 1971, p. 7). Also, Takeuchi (1977, p. 162) states that labor productivity is a more empirically stable measure of productivity as compared to total factor prodsctivity, since total factor productivity is nested with measurement problems.

Third, when labor productivity is adopted as a measure of productivity, the analytical comparison of findings with other studies is much easier than in the case of total factor productivity (Stein, 1971, p. 1). The main reason for this easy comparison is that the measurement of labor productivity is relatively well established, although there is still a lot of room to improve methodology.

The fourth reason for labor productivity being so prominent is that productivity adjustments have become central in many wage negotiations. Eilon and Soesan (1976, p. 3) elaborate on this point:

> This reflects the desire of labour unions to ensure that improvement in performance of an industrial enterprise is coupled with improved wages and working conditions and it also reflects the parallel concern of management to achieve improvements in performance in order to help offset the cost of higher payment of labour.

Last, Bucklin (1978, p. 19) illustrates the major problems facing total factor productivity as:

> The units of each are quite different, creating a severe "apple and orange" problem. This may be avoided by forming indices for each of the different inputs and then summing. However, this, in turn, opens up a new issue with respect to how the sum is to be made. Equal weighting of the subindices is not appropriate, because it seldom reflects actual resource proportions. Weighting by relative input use for some given base year, as is typically done, means that, over time, the weights for one year may become inappropriate to conditions in the others. Choice of a base year affects the estimate of the quantity of inputs used and, through this, the level of productivity change. Thus adjustment must be made to all productivity indices to reflect variations in the compositions of resource use.

The current trend in productivity is that if the research interest is capital intensive industries, then total factor productivity is adopted; on the other hand, labor intensive industries such as retailing, wholesalers, and service industries focus on labor productivity. Thus this observation justifies that the criteria for this issue lies in the characteristics of the industry being studied. But it is also true that total factor productivity has recently attracted high interest, as a result, many research endeavors have been conducted in this area.

Productivity versus Profitability

Several empirical researchers (Lundberg, 1972, p. 475; Takeuchi, 1977, p. 145) indicate that there exists a close correlation between productivity and profitability. But, though these terms are often used interchangeably, they carry different characteristics and it is desirable to distinguish between them.

Bucklin (1976, pp. 2-5) explained these two terms by using the following equation:

$$S/C = O/I \times Po/Pi$$

where:

S is a pecuniary measure of sales

C is a pecuniary measure of resource costs

Po is a price index for output

Pi is a price index for input

O is a measure of output

I is a measure of input

He viewed the ratio of sales to costs as the level of profitability of the economic unit. The profitability in this equation is influenced by two elements, productivity and "the terms of trade." The terms of trade represent the ratio of the prices at which an organization sells and buys. As a result, theoretically productivity is unaffected by the price level at which goods are bought and sold, since productivity is concerned with physical efficiency. On the other hand, profitability is influenced by the price level and consequently the results can be inflated or deflated depending on the time period of the research.

Productivity versus Effectiveness

This section discusses the difference between productivity and effectiveness. These terms have much in common, however, they are also distinct. They are both similar because they both are measures of performance. Furthermore they both are similar in that they consider relationships between inputs and outputs. On the other hand they differ because productivity is concerned with getting the highest possible output given the inputs available, whereas, effectiveness is concerned with getting the best output given the inputs. Best output means the quality of output derived, while highest output means the quantity of output. Therefore a person can be productive but not effective and vice versa.

An example may help to clarify this distinction. If an auto dealership is interested in salesforce productivity, a measure of salesforce productivity may be the number of cars sold per salesperson per month. Whereas effectiveness may be measured by the number of satisfied customers created per salesperson per month. Productivity only concerns itself with quantity of output, but effectiveness is concerned with the quality of output.

Production Function

This section discusses the production function since the concept of productivity is deduced either from an explicitly defined production function or from a distribution theory where the production is implicit (Nadiri, 1970, pp. 1140).

Under known technology, the theory of production holds that specific sets of such basic inputs as labor, land, capital and materials may be joined to produce a defined quantity of output. When the two factors, labor and capital are considered, algebraically, this function may be set forth as follows:

$$0 = At\ f(L,K)$$

where:

0 = the quanity of output

At = the technology that is employed at the time

L = labor

K = a combination of land, capital, materials and processed goods

This simplified production function has two major assumptions. First, it assumes that a homogeneous aggregate production function exists. The second assumption is that technical change is autonomous, neutral or growing at a constant rate.

The importance of the first assumption is that without proper aggregation the interpretation of the properties of a production function is misleading. For instance, labor and capital are basically heterogeneous with divergent characteristics; they differ in their longevity, impermanence, quality and mobility. The necessary and sufficient conditions for grouping these two types of input are: (a) that the rate of substitution between capital and labor must be independent, and (b) that the marginal rate of substitution between different inputs must be constant, for instance, the two types of input are perfect substitutes (Nadiri, 1970, p. 1144). The first condition stems from Leontief's functional separability theorem. Green (1964, p. 2) said that "the marginal rate of substitution between any two variables in that group shall be a function only of the variables in the group, and therefore, independent in any other group." The second condition is required for the aggregate to be a simple sum of different elements in the group. But in reality, labor and capital, are complementary, therefore they are not perfect substitutes as required by the condition, neither are they independent. Regarding the assumption of aggreagation, Nadiri (1970, pp. 1145-6) made the following comments:

> Aggregation is a serious problem affecting the magnitude, the stability, and the dynamic changes of total factor productivity. We need to be cautious in interpreting the results that depend on the existence and specification of an aggregate production function. Aggregation may not be "necessarily bad" nor is it necessarily good. That the use of the aggregate production function gives reasonably good estimates of factor productivity is due mainly to the narrow range of movement of aggregate data, rather than the solid foundation of the function.

Relating to the second assumption, the constant change of technology gives rise to several important questions:

1. What determines the stock of pure knowledge in a society?

2. How and when does part of this knowledge take the form of innovations?

3. Which industries are likely to initiate adoption of the new techniques?

4. What are the characteristics of the transmission mechanism that determine the diffusion of new technology throughout an economy?

5. What are the external economies (diseconomies) of employing the new techniques?

The attempt to answer these questions is beyond this study, but at least they imply that the second assumption is also as difficult to make as the first one.

The Importance of Productivity at a Macro Level

The importance of productivity at a macro level can be reviewed on several different dimensions. These dimensions are interrelated, thus these dimensions are not separable but complementary. For the purpose of description, its importance at a macro level is reviewed in regard to inflation, labor relations, international competition and economic growth.

Inflation

One reason for being concerned about low productivity is that a number of studies have shown that there is a statistically significant inverse relationship between changes in productivity and changes in various price indices that are used to measure inflation. Renshaw (1976, pp. 47-48) illustrates the relationship between low productivity and high inflation as:

> The rather severe slump in the growth of output per employed hour from 3.6 percent in 1966 to rates of 2.0, 2.7, 0.1 and 1.1 percent for the years 1967 through 1970 - more than any other single factor - was probably responsible for the accelerated rate of increase in prices and wages which eventually forced President Nixon to impose a wage-price freeze in August 1971.

He (Renshaw, 1976, p. 48) continues to explain how high productivity deters high inflation:

> There was a 3.7 percent surge in labor productivity in 1971 and another robust increase of 3.2 percent in 1972. These increases helped to reduce the rate of inflation in the consumer price index from 5.5 percent in 1970 to only 3.4 percent in 1972.

Fabricant (1969, pp. 116-117) also argues that output per unit of labor and capital has clearly been inversely related to prices. He states:

> At the top of the list, arranged in order of increase in output per unit of labor and capital, are electric light and power, manufactured gas and rubber products, all industries in which selling prices declined not only relatively but even absolutely. At the other end, among the industries in which productivity lagged, are lumber products and coal mining, industries in which prices have, since the opening of the century, risen far more than did the general level of prices.

Bloom (1972, p. 2) explains this inverse relationship in terms of labor cost. According to him, since labor is the most important cost element, unless there are equivalent gains in productivity, it is obvious that an acceleration in the rate of increase in unit costs can be transmitted into a spiraling price inflation of increasingly serious dimensions. In the same token, Doutt (1976, p. 29) commented that if labor productivity levels fall, then labor costs increase even further, so that the net effect is a sharp increase in unit labor costs.

The above statements clarify the existence of an inverse relationship between productivity and inflation. The next logical question is that if such a relation exists, to what extent does productivity influence the level of inflation. Fabricant (1969, p. 119) states that:

> In industries in which relative output per manhour doubled, relative prices tended to fall by a third rather than a half.

Labor Relations

Productivity has been an important issue in labor negotiation. The union is concerned with high productivity, because it can reduce the number of employees, while others argue that high productivity means an increase in job opportunity. The logic underlying the positive impact of high productivity on employment is that high productivity reduces the price of a product and, in turn, under the assumption of elastic demand, lower price creates higher sales volume which expand the job opportunity or the number of manhours. History confirms the second argument about the positive impact of productivity on the size of the labor force. Fabricant (1969) states that, in the long run, industries where the rate of labor productivity increase was greater than for the entire economy, the level of employment has increased by a larger percentage than did industry in general.

Another significant topic in regard to labor is the share of increased value added that labor deserves in correspondent to higher productivity. This contrasts the parallel opinions of management and labor. The union desires that an improvement in performance is coupled with improved wages and working conditions, while management is concerned with the achievement of improvement in performance in order to help offset the costs of higher payments to labor.

In order to avoid this type of dispute between management and labor, the National Board for Prices and Incomes in the United Kingdom (1967, p. 45) developed several guidelines for management, unions and the Ministry of Labour. Their guidelines are:

1. It should be shown that workers are making a direct contribution towards increasing productivity by accepting more exacting work or a major change in working practices.

2. Forecasts of increased productivity should be derived by the application of proper work standards.

3. An accurate calculation of the gains and the cost should normally show that the total cost per unit of output, taking into account the effect on capital, will be reduced.

4. The scheme should contain effective controls to ensure that the projected increase in productivity is achieved, and that the payment is made only as productivity increased or as changes in working practice takes place.

5. The undertaking should readily show clear benefits to the consumer through a contribution to stable prices.

6. An agreement covering part of an undertaking should bear the cost of consequential increases elsewhere in the same undertaking, if any have to be granted.

7. In all cases negotiators should beware of setting extravagant levels of pay which would provoke resentment outside.

The above statements make an attempt to distinguish between productivity of labor and other factors, but they failed to answer how they can be measured.

Economic Growth

Productivity has a close association with economic growth and, in turn, a higher economic growth has made a great contribution to an increased standard of living. Kendrick (1976, p. 1) states that for more than half a century productivity advances accounted for more than half of the growth in real gross national product in the United States. The rest was due to increases in inputs of resources--labor, capital and natural resources. Therefore it is of the utmost importance to pay special attention to productivity in analyzing past economic growth and in assessing prospects for the future.

Stein (1971, p. 2) analyzes an association between productivity and real income. He says that the slowdown of productivity deteriorated the real income gains which workers have come to expect with rising wages. Thus an increase in productivity can help to increase the rate of gain in average real income. The National Commission on Productivity stresses that continued productivity gains are the key to maintaining or improving the benefits achieved to data and to achieving the increased quality of life the nation demands, including health, safety, a clean environment, and quality of opportunity (Mathiasen, 1975, p. 261).

Doutt (1976, pp. 31-32) explains its relationship with the standard of living as:

> To increase the overall standard of living, there must be an increase in output in relation to population. Such an increase could result from a larger workforce, longer hours per worker, or increased productivity. Of these only the last is practically or politically feasible.

The premise of this view is based on the assumption that quality of life requires massive revenue flows and thus is dependent upon continuing economic development as reflected in productivity growth.

Another dimension relating to the standard of living is that high productivity means a maximum utilization of limited resources. Preston (1969, p. 2) states:

> It is generally agreed that the time, money, buildings, and managerial and creative skill devoted to marketing activities could be used in other productive ways and, therefore, that individual firms and industries and society at large, will generally be made better off if marketing tasks are accomplished as efficiently as possible.

The Importance of Productivity at a Micro Level

The importance of productivity is not limited to a macro level. As a distinctive measurement of performance, productivity can make a significant contribution to any firm if it is properly utilized. For instance without an enormous investment or organizational change, merely informing labor that productivity is being measured can improve its performance substantially (Vereen, 1978, p. 54).

Takeuchi (1977, pp. 167-68) argues that two types of productivity indices, a cross-sectional index and a time-series index can be used as management tools. Specifically he states that a cross-sectional index of productivity can be utilized through comparison, control and prediction by managers. Specifically he said:

> The cross-sectional index enables the user to compare productivity levels across stores or with competitors and the industry at one point in time. It also enables the user to test hypotheses regarding the relationship of certain factors to productivity for a new store given the data base of existing stores.

According to him, another type of productivity index, the time-series index, provides a similar management tool, such as comparison, planning and experimentation. He (Takeuchi, 1977, pp. 167-68) states these basic tools in detail as:

> The time-series index, on the other hand, allows the user to compare a present index with past indices. A declining growth. rate may signal trouble and a diminishing increase in the growth rate over a given period may indicate caution. At the same time, the analysis of productivity trends enables management to set goals to be achieved over the next year say, at 5%, can help to motivate store employees to achieve that goal if the goal itself is realistic and also if some form of incentive is awarded. The time-series index is also conducive to hypotheses-testing. Because changes over time and across stores are traced, it opens up the possibility of running experiments. An experimental factor can be introduced in some stores but not in others to investigate the impact of that factor towards productivity change.

In sum, productivity can play an important role in analyzing, planning, implementing and controlling an organization.

The managerial significance of productivity cannot be overemphasized, however, most productivity analyses have involved levels of aggregation such as national, industries or sectors beyond the firm itself. As a result more attention must be given to micro level studies. Managers can combine this additional information from a firm level with the existing knowledge at a macro level to establish a comprehensive plan for higher productivity.

Kendrick and Creamer (1965, pp. 6-7) elaborate on the importance of productivity in terms of the adaptive survival ability of a firm as:

> If a company's productivity increases more and thus unit real costs decline more than the average of the industry, profit margin should improve relative to the industry average. Conversely, if the management of a firm has a below-average record in improving productive efficiency, relative profit margins will decline. If an unfavorable productivity trend is not corrected, the firm may become one of the casualties of the impersonal forces of competitive markets.

In addition, if the proposition that "spending is no more merit in the United States economy" is acceptable, productivity is getting more important than ever. Regarding the effective use of resources, Preston (1970, p. 30) notes that:

> (1) marketing functions will be performed by individual enterprises in combinations that lead to the lowest minimum costs for the entire collection of functions, and (2) marketing activities in the economy as a whole will be performed by the appropriate number of enterprises, each with the appropriate combination functions, so as to lead to least-cost results for the marketing sector as a whole.

Eilon and Soesan (1976, p. 6) offer several reasons why productivity should be measured and how to utilize it at a firm level:

1. For strategic purposes, in order to compare the performance of the firm with that of its competitors or related firms,

both in terms of aggregate results and in terms of major components of performance;

2. For tactical purposes, to enable management to control the performance of the firm by identifying the comparative performance of individual sectors of the firm, either by function or by product;

3. For planning purposes, to compare the relative benefits accruing from the use of different inputs, or varying proportions of the same inputs, currently and over longer periods, as the basis for considering alternative adjustments over future periods; and

4. For other management purposes, such as collective bargaining with trade unions, assessing the effects of prospective governmental restrictions, etc.

Summary

This chapter presents seven sections relating to the concept of productivity. The review of prior studies in productivity reveals that productivity is defined as the ratio of output to input. When the concept of labor productivity is compared with total factor productivity, labor productivity provides several advantages over total factor productivity. They are:

(1) Labor is almost universally required for all types of production.

(2) Labor is a more measurable input than other inputs.

(3) Labor productivity is a more empirically stable measure of productivity as compared to total factor productivity.

(4) It is easier to compare the results of labor productivity with other studies.

(5) Labor productivity has become one of the most important factors for wage negotiation.

In spite of these distinctive advantages of labor productivity, total factor productivity draws an increasing attention especially in capital intensive industries. This is because total factor productivity represents the efficient use of all resources employed.

As a measure of performance, profitability and effectiveness are often used. The main distinction between productivity and profitability lies in the fact that theoretically productivity is unaffected by the price level at which goods are bought and sold. In relation to effectiveness, productivity is preferred to effectiveness, because the former is more powerful and objective than the latter.

This chapter also reviews the importance of productivity at both a macro level and a micro level. At a macro level its importance is found in four related areas: inflation, labor relations, international competition and economic growth. At a micro level the potential use of productivity as a management tool is endless. But since the number of studies at a micro level is relatively small, more attention is needed at this level.

CHAPTER III

PRODUCTIVITY MEASUREMENT

The main purpose of this chapter is not to select any particular measures for input and output but to stress that all measures have their advantages and disadvantages depending upon the area of inquiry. In other words, different measures can be justified for different purposes under different circumstances.

But the major problem with the prior statement is that it becomes difficult to compare studies and draw general conclusions. Thus it is reasonable to state that different measures can be used, but for the purpose of comparison, a uniform measure is recommendable. For instance, if value added per employee is accepted as a uniform measure of labor productivity, then it is recommended that the research show the result of value added per employee as well as that of different measures such as transaction per manhour or sales per dollar of wages, or whatever the researcher thinks reasonable. Greenberg (1973, p. 1) agrees with this view and states:

> What is productivity? It serves no useful purpose to rely on the old chiché that it is whatever the compiler, or reader, or user wishes it to be. Standardization of concepts and a common understanding of what they signify are very important if we are to have a system of information by means of which firms can compare themselves with each other, with the industry and with other industries.

Before various alternatives for input and output measurement are reviewed, general problems in productivity measurement are also discussed.

Problems in Productivity Measurement

The main purpose of this section is to discuss problems in productivity measurement which concern both input and output measures. In general, such problems can be classified into four areas: data, service industries, pecuniary measures and quality.

Data

As mentioned earlier, most studies have adopted secondary data. As a result, there often exists an inconsistency between the data and the developed concept of a study. Mark (1971, p. 9) elaborates on this type of problem:

> Since most data are collected for purposes other than productivity measurement, definitions already established and procedures for reporting information on production and factor input must be used; these may or may not be consistent with concepts appropriate for productivity measurement.

The major concern with this practice is that the conclusion drawn may not be valid. This is the case because the adopted measures which affect the conclusion are a function of existing data.

Service Industries

Service industries are regarded as more troublesome in terms of productivity measurement than other sectors of the United States economy. Hirshhorn and Geehan (1977, p. 211) state that:

> Our understanding of the service producing sector of the economy is seriously constrained by the inadequacy of measures of real

> output for the major service industries. Analyses of industry growth and productivity are only as good as the industry output measures on which they are based; and for many service industries (especially finance, insurance, government administration, health services and education) the real output measures that are generally adopted are poor indeed. In some cases production in the service sector, as measured in the national accounts, is no more than an index of labor input, with the result that the calculation of productivity change is essentially a tautological exercise. In almost all cases economists have had to reconcile themselves to the fact that at least part of the disparity in productivity growth between the service and goods producing industries is a statistical illusion resulting from the inadequacy of existing data and techniques of measurement.

Service sectors, in a broad sense, embody government, construction and other services (including business and personal services, and finance, insurance and real estate). Among these subsectors, measuring productivity in government is the most difficult, because there is a lack of directly quantifiable entry which describes a unit of service. In addition, there is a lack of attempts to measure productivity at government levels. Mark (1971, p. 9) illustrates the major problem facing the measurement of productivity at the government level as:

> In the absence of market valuation of the service of general government agencies, the practice in national income accounting is to value government output in terms of the wages and salaries of government employees. The deflated, or constant dollar, measure in derived from changes in employment. Such an output measure results in no statistical change in productivity. This measure of government output may be increasingly difficult to continue in view of the reported increases in output per man-hour in certain government operations which are subject to measurement. Based on these data the trend of output per man-hour for the national economy would be biased downward. As a consequence, the available measures of productivity are limited to the private economy.

An interesting note in his comment is that if government service can be measured by market valuation, the problem in measuring productivity at this level disappears. But this creates another measurement problem since measures of productivity could be devoid of their pecuniary content (Bucklin, 1978, p. 2). Thus if pecuniary measures of service sectors can be found, this is not the end of measurement problems but the starting point.

The above illustrations exhibit that in service sectors it is harder to measure productivity than in production sectors. But Bucklin (1978, p. X) argues that the problems of measuring productivity in marketing, a subsection of service sectors, are not significantly different than measuring productivity in production. He says:

> The value provided in marketing are hard enough to define, let alone to measure. However, what is less obvious is that the output of manufacturing industries is subject to a similar set of measurement conditions. The automobile of one year is not the same as the better quality model of the next. New dress shirts may be easily washed at home and require little in the way of special ironing or other care to look fresh. Physical products, therefore, may also be seen as a bundle of services equally as difficult to measure as those of marketing.

Pecuniary Measures

Most productivity studies (Mark, 1971; Bucklin, 1978; and Ingene and Lusch, 1980) argue that physical or real volume as a measure of productivity is preferred to pecuniary measures. Bucklin (1978, p. 2) states that measures of productivity should be devoid of their pecuniary content if they are to be reliable. Specifically, he says:

> The nub of the issue is that when an economic statistic is expressed in terms of monetary units, two phenomena, the quantity of units sold and the average price of those units, are being measured - not just one. Either may vary when making comparisons, but it is not clear which will. Hence, to measure something defined as "the ratio of effect produced to energy expended" by means of such pecuniary data is to introduce bias directly into the intended statistic. This bias may be great or small, depending upon individual circumstances, but it can never be considered insignificant.

Thus Ingene and Lusch (1980, p. 4) recommend that if a researcher cannot avoid pecuniary measures as measures of input and output, it must take special precautions in strictly interpreting the empirical results.

Quality

Another common problem in the measurement of productivity is quality. Most studies assume that both output and input are additive and homogeneous. The underlying reason for this assumption is that the quality of output and input is constant over time and across industries. For instance, in the case of output, a particular brand of 1981 car is seldom equivalent in quality to the corresponding 1980 model. One way to consider differences in the quality of output is pecuniary measures under the assumption that prices reflect proportional quality. But this alternative does not overcome the previously mentioned problems of pecuniary measures and the fact that high prices do not always mean higher quality. Thus Doutt (1976, p. 64) implies his pessimistic view and states that there are no procedures at present to take quality changes into account in any direct manner.

The issue of quality is also related to the measurement of input. For instance total man-hours as a measure of labor input usually ignores the qualitative aspect of an hour worked by different individuals. An ideal measure for labor input must consider not only quantitative aspects but also qualitative. Mark (1971, p. 9) suggests two alternatives to measure quality of labor. Though these options are proper conceptually, practically the collection of such information will be met with numerous difficulties. His suggested methods are:

One way which has been utilized is to combine the man-hours of various employees in terms of pay differentials. The man-hours of higher paid workers are given more weight than lower paid. This assumes that differences in earnings reflect differences in education, experience, skill and their contribution to output (except to the extent that regional or similar wage differentials affect average hourly earnings). Another method is to adjust the data to take into account changes in volcational training, length of schooling or type of education, etc., of the work force, assuming there is a close relationship between qualification and quality. When adjustments are made for changes in the quality of labor input, the resultant productivity measure will not reflect changes in the composition of the work force as a productivity change but rather as a change in factor input.

Input Measurement

In principle, there exist many different types of input, for example, labor, capital, material and energy. Among these inputs, only labor and capital are selected to be reviewed, since prior studies reveal that these are the most frequently used inputs.

Labor Input

There are at least three alternatives to measure labor input; man-hours, full time equivalents and wages. The first two measures are physical ones and the last measure is monetary. Before further details of these measures are discussed, it is necessary to consider what the term "labor" means in relation to productivity, in other words, what types of labor must be included in the labor input calculation.

Ingene and Lusch (1980, p. 4) state that labor inputs should be broken into managerial vs. non-managerial personnel and order getting vs. order filling personnel. These classifications may be desirable for management analysis purposes and further subdivision may also be useful. But if the main purpose of a study is a comparison of productivity among firms or industrial levels, it is recommended that all employment in labor input whether man-hours, full-time equivalents or wages be adopted. Greenberg (1973, p. 8) provides two reasons why total employment must enter into the labor input calculation. First, all employees make some contribution, direct or indirect, to the firm's output, and the man-hours and the wages of all employees must be a part of the calculation of costs and ultimately of price. Second, this approach gives a more meaningful result when making comparisons with other firms or with the industry as a whole. Because of differences in technology, in management concepts, or other reasons, some firms have a different proportion of production or direct workers to total employment.

Man-hours. The major question about man-hours as an indicator of labor input is the meaning of man-hours. Two types of man-hours measures might be used to measure a firm's productivity; man-hours worked or man-hours paid.

Man-hours paid usually includes all hours worked by employees plus hours not worked but paid for, including vacations, holidays, sick leave, jury duty, and other paid leave. Three advantages for this measure are illustrated by Greenberg (1973, p. 8):

1. It is a measure of the total man-hours a firm must pay for in order to obtain a given volume of output at any given time.

2. Data on hours paid for may be more readily available from the personnel and payroll record system currently used by the firm; these records often do not provide an accounting for paid absences, particularly for workers paid on an annual, rather than an hourly basis.

3. Most of the published information on hourly earnings is based on hours paid for. If the productivity index is to be compared with average earnings, it should be conceptually compatible, i.e., also based on man-hours paid for.

According to Greenberg, the main disadvantage of this measure is that it is affected by differences in work and leave practice. For instance, if the workweek is increased by overtime or decreased by a reduction in the scheduled hours of work, the weekly and annual hours paid will be increased or decreased in proportion.

On the other hand, man-hours worked reflects all changes in leave practice in the same way. For example, if hours at work are reduced by a shorter week, by vacations, or by more holidays, the annual hours at work will reflect all three types of reduction. Here a more precise term of man-hours worked is "plant hours" which includes coffee breaks, rest periods, downtime and other times within the scheduled hours whether employees are actually "working" or not, but excluding all leaves, whether paid or unpaid (Greenberg, 1973, p. 9).

Several authors (Mark, 1971, p. 0; Greenberg, 1973, p. 8; Cocks, 1974, p. 9; Takeuchi, 1977, p. 150; Bucklin, 1978, p. 32) indicate that man-hours worked is the most suitable unit of measure for labor input. But the utilization of this measure requires overcoming several problems. The first problem of this measure is the availability of data. Fundamentally some personnel departments do not keep track of working hours, for instance, proprietors, professional, executives and full time salesmen (Doutt, 1976, p. 66). One possible solution for this issue is that estimates of those hours may be made by adjusting scheduled hours on the basis of known practices or of the trends in average hours of those whose records are kept (Greenberg, 1973, p. 10). Another possibility for this problem is the use of full-time equivalents. As a measure of productivity Hall and others (1966) used sales per person engaged which included not only paid employees but also proprietors and unpaid family members.

Another major problem of man-hours is that no consideration is given to quality or skill. Basically there are two ways of obtaining a measure which reflects the change in the quality of employment. Greenberg (1973, p. 47) suggests an approach which assigns the occupational classification a weight, usually the wage rate for the base period. In computing changes, the man-hours in the base period in each occupational class (e.g., laborer, machine operator and machinist) are multiplied by the weight for that class, and the weighted figures are summed. The man-hours for the next and subsequent periods are multiplied by those same weights and so on. Another approach is suggested by Denison (1962). His method is based on the classification of workers by age, sex and education in each period and the assignment of a base-year value to each category for use as weights.

Full-time equivalents. The calculation of full time equivalents is another alternative to reflect labor input. The major advantage of this measure is that it is not necessary to estimate the number of hours worked or paid for by those who do not use time cards. In addition, such data as the number of employees are more readily available.

One question regarding this measure is how to treat part-time employees. One possible solution for this case is the calculation of the actual proportion of part-time to full-time based on a sample of an interested industry or a firm. If the result shows that the average part-time employees work only one-third of full-time employees, three part-time employees must be treated as one full-time employee.

Several authors discuss the usefulness of using part-time employees. During cyclically fluctuating demand part-time employees provide labor flexibility to management. Hall, *et al*. (1962, p. 54) state:

> The problem of the peak-load is particularly acute in retailing because people want to shop at much the same time. In these circumstances, the use of part-time labor may increase the retailer's efficiency, if he can supplement his normal labor force at times of peak demand; it should also be economic from the social point of view if the displacement cost of the part-time laborers, as it probably is, very low. There are undoubtedly difficulties in making suitable arrangements. . . . But imaginative managements have usually overcome these.

McNair (1959, p. 5) shares their view and comments:

> The resulting irregularity of shop hours forces utilization of an increasing number of part-time employees. But this development is by no means a disadvantage since there is evidence that by the careful planning of hours for part-time employees, a considerable increase in employee productivity is possible.

Wages. Unlike the previous two measures, wages are the pecuniary indicator of labor input. Several authors (Mark, 1971, p. 7; Bucklin, 1978, p. 2; Ingene and Lusch, 1980, p. 5) argue that such pecuniary measures must be avoided since they produce unrealiable results. And they prefer physical measures to pecuniary measures of input.

Empirical studies show that there is virtually no distinction in measuring input using physical measures such as man-hours and pecuniary measures such as wages. For instance, Takeuchi (1977, p. 150) found that the correlation coefficient of the two indicators (i.e., manhours worked and salary) is 0.997. Along with this argument Lusch and Ingene (1979, p. 333) discovered that monetary input measures provide accurate estimates as long as value added is used as a measure of output. The findings of these empirical studies suggest that the theoretical argument for physical measures is not a proven approach.

The major advantage of wages, as monetary measures, is that the measure itself reflects the quality of labor. This statement is based on the assumption that wage rates disclose the quality of labor.

The above discussion shows that each measure of input has both pros and cons. But for the purpose of this empirical study, full-time equivalents are adopted as an indicator of input, since its definition is generally agreed upon and it is more valid than others.

Capital Input

The empirical part of this study does not consider capital input which is one major input of total factor productivity. Since the importance of capital input in productivity studies is growing rapidly, especially in the area of capital intensive industries, this section reviews different measurement approaches for capital input.

Different authors (Mark, 1971, p. 19; Craig and Harris, 1974, p. 13; Cocks, 1974, p, 10; Takeuchi, 1977, p. 151; Bucklin, 1978, p. 32) adopt different categories of capital and, consequently different measures of capital input are created. In general, capital input includes only fixed capital such as equipment, which are depreciable in accounting procedures, and land. Other possible components of capital input are current asset, research and development (R&D), advertising and materials. The adopted criteria of what to include in capital input depends on the characteristics of a study and its data availability rather than the generally agreed guideline if it is available.

Cocks (1974) capitalized R&D in his study of Eli Lilly & Company and found that the capitalized research costs exceeded the company's entire investment in plant and equipment. For example, in 1972 the total stock for buildings and equipment was 421 million dollars while the total stock of research and development was 620 million dollars. The result of his study indicates how important it it to include R&D in capital input, especially for research intensive organizations.

Not all advertising expenses need to be capitalized. One possible criteria is the objective of advertising. If its objective is to build a favorable image of a firm through institutional advertising, it has enough support to amortize its expenses over several years. On the other hand, if its main objective is to promote daily sales, for example, Sunday supplements for grocery products, it can be reasonably treated as current expenses. But Bucklin (1978, p. 36) argues that it has a special merit to treat advertising as capital input.

> Whether advertising is capitalized or expensed currently, it may nevertheless be advantageous to treat it as an element of the capital account, rather than as a material purchase of services from advertising agencies and media. In the form of dollar outlay, advertising is a method of capital substitution for more traditional ways of delivering marketing services. It represents the same type of substitution of capital for labor in marketing that automation does in production.

There are basically four methods to measure capital input; stock, replacement, lease and flow. The stock concept of capital is derived by adjusting the value of existing plant and equipment for new investment and the retirement of old assets. Under this concept, capital input is estimated by two methods; gross and net. Net stock estimates are derived by depreciating assets, while gross stock estimates are derived by retaining assets at their full value until they are retired from use (Mark, 1971, p. 9). Since these are physical measures, the value of capital stock requires the adjustment for price changes.

Cocks (1974, p. 10) illustrates these two concepts with the following equations:

$$\sum_{t=1}^{n} GSit = \sum_{t=1}^{n} [(GIit - Rit)/Pit], \quad t=1,2...n$$

$$\sum_{t=1}^{n} NSit = \sum_{t=1}^{n} [(GSit - Dit)/Pit], \quad t=1,2...n$$

where,

GSit = Gross stocks of class i of equipment or structures in year t

GIit = Gross investment of class i of equipment or structures in year t

Rit = Retirement of class i of equipment or structures in year t

Pit = Price deflator associated with class i of equipment or structures in year t

NSit = Net stock of class i of equipment or structures in year t

Dit = Net stock of class i of equipment or structures in year t

The major shortcoming of this approach is that net book value does not identify whether the capital was utilized in the production process or not.

A replacement cost concept reflects the current value of capital, since it considers the cost of capital if it has to be replaced at that time. This method considers the most current cost of capital but it fails to account for differences in the intensity of use over time.

A lease concept represents the service value gained from utilizing capital, and the leased capital value is derived as an annuity of capital. Takeuchi (1977, p. 102) illustrates this concept as:

> Firm A has a leasing subsidiary which buys the land, buildings and equipment and leases them to Firm A with an expectation that the subsidiary would earn a return on the investment. The capital input term, then, is the payment made by Firm A to the leasing subsidiary. The payment (or annuity) depends on (a) the cost of the asset to the subsidiary, (b) the productive life of the asset, and (c) the desired rate of return by the subsidiary.

Takeuchi (1977, p. 103) prefers a lease concept to other methods as it is a more realistic representation of capital. But like the previous two methods, this method also fails to account for the use of the intensity of capital. This concept is equivalent to man-hours paid in labor input, since it includes all costs whether the capital has been used several shifts during a business expansion or it is idle during construction. In reality, a large part of existing capital capacity may be standby or employed only during periods when the economy is operating at very high rates.

The flow concept reflects the amount of capital employed to produce current output. Ideally it is derived by aggregating the capital hours used weighted by the rental value of each type of structure and piece of equipment (Mark, 1971, p. 9). But a commonly used flow of capital service measure is depreciation due to the difficulty of obtaining the necessary data. This surrogate measure of the capital flow, depreciation, approximates actual consumption of capital for a given period. But, if it adopts depreciation as a measure of the capital flow, it becomes too sensitive to methods of calculation which often reflect current income tax regulations rather than the actual amount of capital used for current production. Another source of bias is that different types of capital require different methods of depreciation and at an aggregate level different firms apply different types of depreciation.

Output Measurement

In order to measure productivity, it is necessary not only to calculate input but also output. This section will discuss several measures of output which have been used in the study of productivity.

Previous studies have mentioned at least six measures of output: transactions, unit sales, dollar sales, gross margin, value added and man-hour equivalent. The details of each measure will be reviewed.

There are several characteristics which all measures must share. First, they are concerned with the results of activity, not activity itself (Mark, 1971, p. 8). Thus output measurement differs from work measurement. Work measurement generally refers to the analysis of the stages of activity and requirements at each of these stages. The second characteristic to be kept in mind in developing an output measure is that the value of the units should be conceptually equivalent to each other in a way which meets the basic objective of developing an output measure to be used for productivity ratios (Greenberg, 1973, p. 16).

Transactions

The number of transactions can be considered as a measurement analogous to the physical unit in production, since each is composed of a bundle of attributes that yields services of value (Bucklin, 1978, p. 21). Also, this measure is appealing since marketing has often been defined in terms of the exchange process and exchange results in a transaction. But Ingene and Lusch (1980, p. 3) raised a question in regard to the validity of this measure. Specifically they state that the major problem of transactions as a measure of output lies in the requirement that all transactions are equal. This assumption does not hold up in reality, since a transaction for an automobile requires more labor and capital inputs than that for a bag of groceries. But if the main purpose of a study is a comparison of productivity among stores which requires almost the same services and whose size of transactions and whose products are similar, the number of transactions will be a useful indicator of output. The fast food industry is one of several industries where the number of transactions can be applied as a measure of output.

Unit Sales

Units sold is another alternative measure of output. Ingene and Lusch (1980, p. 3) argue that the application of this measure to marketing creates two basic unknown biases. They are:

> First, marketers not only sell products but also provide services. Some marketing institutions are self service, cash and carry, whereas others provide high levels of sales assistance, credit and delivery. By ignoring the level of services provided per unit sold, an unknown bias is induced. Second, many if not most

> marketing organizations sell a variety of products. It takes more capital and labor inputs to sell televisions versus shoelaces; however a department store may sell each. By summing such diverse units to obtain total unit sales would bias the measure of output.

The above statement indicates that the basic requirement for the use of units sold or produced as an output measure is the homogeneity of unit prices, unit quality and the required service level. In a situation which meets this requirement, this measure can be preferred to others, as long as one is favorable to physical measurements over monetary measurements in productivity.

Dollar Sales

Another alternative for an output measure is dollar sales which is derived by taking the number of units sold multiplied by the unit selling price. The major reason for the use of this measure lies in its convenience, since it requires less time and trouble for respondents to provide sales information. In addition, there is less disagreement in defining this term. The second reason belongs to the possibility of aggregating different products with a common denominator, dollars. The third reason is that it includes a monetary value for service provided (Ingene and Lusch, 1980, p. 4).

There are several limitations to this approach. Ingene and Lusch (1980, p. 4) state that the use of dollar sales could have a biasing effect, since it includes the contribution of production processes. Takeuchi (1977, p. 120) says that another major problem with this measure is unrealistic assumptions. Specifically, he argues:

> Measuring output by sales assumes either one of two things: (a) that there is a more or less standard bundle of services associated with each dollar of sales, or (b) that the unit selling price somehow reflects the amount of services embodied in each

> product. These assumptions, of course, are unrealstic under actual market conditions and must be discarded since: (1) the proportion of services in each dollar is not constant across products; and (2) unit selling price reflects, among other things, the general supply and demand situation as well as specific considerations for competition, level of sales, promotion and costs.

Like other measures, dollar sales has its own pros and cons. Thus as long as research utilizes this measure under the proper circumstances, it is a useful indicator of output. Hall and others (1962, p. 43) elaborate on this:

> The more homogeneous the comparison, the more meaningful it is, and, as an added advantage, the less is the problem of choice of indicator. For a sufficiently homogeneous sector, all the possible indicators will most likely be closely related and the most easily accessible of them (such as value of sales) can be used.

Gross Margin

Another measure of output is gross margin. Before the concept of gross margin is discussed, it is necessary to consider how to obtain gross margin and value added, since both methods are similar and are often confused. The formulas to calculate these methods are:

Gross margin = net sales - cost of goods sold

Value added = net sales - cost of goods sold - total operating expenses + wages

The above formulas indicate that though gross margin is better than dollar sales since it excludes some of the contributions made by other institutions, this method fails to exclude all of the contribution made by other institutions. But value added, by definition, includes only the value of services rendered by the organization, thus, it is a net measure of output.

Several authors criticize the usage of gross margin as a measure of output. Schwartzman (1971, p. 23) says that gross margin is the best measure of output available but fails to capture the change in the quantity of service per dollar of sales. Douglas (1975, p. 679) recognizes its limitations and warns that "the only situations in which margins should be compared in productivity analysis are those between two establishments, two firms, or two points in time in which the same marketing functions are being performed and the same inputs result in comparable productivity potentials." Takeuchi (1977, p. 126) indicates that this measure is acceptable but imperfect:

> Two stores could differ in gross margin if one store enjoys monopoly profits and the other does not. Competitive forces may also force a disparity in gross margin across stores. But since such weights assume that the services provided for each product category or in each department are comparable across stores, they may not accurately measure the service component of output. In a more practical realm, compiling and maintaining a data file would require a substantial amount of investment (computer time and man hours) since gross margin data for all the product categories in all the stores over time need to be recorded and stored.

Value Added

Several authors (Harison and Handy, 1973, p. 23; Doutt, 1976, p. 70; Lusch and Ingene, 1979) argue that value added as a measure of output is not free of weakness but it has distinct advantages over other measures. Ingene and Lusch (1980, p. 4) explain its advantages in terms of its relationship with unit sales, transaction and dollar sales. They say:

> Although value added is not an ideal measure, we believe that it is superior to each of the preceding, since it is functionally related to each of them. That is, value added will rise as: (1) unit sales rise, (2) transactions increase in number and (3) dollar sales increase.

Empirically the same authors (1979, p. 333) demonstrate that value added is the best measure of output if one must select from unit sales, number of transactions, dollar sales or value added. Value added is adopted as a measure of output for the empirical part of this study, since it indicates only the value of services provided by a firm, though it contains the problem of monetary measurement.

Man-Hour Equivalent

Man-hour equivalent is another approach to measure output. This measure is based on the principle of equating all products in accordance with the number of man-hours required to make each product at a certain time (Greenberg, 1973, p. 19). According to him, the main advantage of this method is that it is not affected by shifts in the proportions of goods manufactured, by differences in the market value of products, or by changes in prices. This advantage is valid only when man-hours are the appropriate unit for developing a measure of the physical output of the firm. Does one hour of steel equal one hour of a sweater? If the pay scales of both industries are the same, then possibly both hours can be considered equal. But unfortunately, different industries have different pay scales and even in the same industry pay scales are different. Consequently, the question in regard to the validity of man-hour as a measure of output still remains. Also, this measure needs detailed information of man-hour requirements of each product which are often unavailable. The treatments of new products or specification changes of products may induce undesirable bias.

Summary

This chapter reviews various measures of input and output. Before different measures are discussed, several general problems in input and output measurements are analyzed. These problems belong to four areas: data, service industries, pecuniary measures and quality.

On the input side both labor and capital measurements are considered. Labor input measures include two physical and one monetary measure. The two physical measures are man-hours and full time equivalent employees and the one monetary measure is wages. Among these three alternatives full time equivalent employees is adopted for the empirical part of this study. When this is done it is not necessary to estimate the number of hours worked or paid for.

Four different methods to measure capital input are conceptually examined. The four measures are stock, replacement, lease and flow.

Six measures of output are discussed. They are transactions, unit sales, dollar sales, gross margin, value added and man-hour equivalent. Value added is adopted as a measure of output for the empirical part of this study, since it indicates only the value of services provided by a firm, though it does contain the problem of monetary measurement.

CHAPTER IV

PRODUCTIVITY MODEL

The purpose of this chapter is to develop a productivity model which will provide a theoretical background for the empirical research. The first section of this chapter will briefly introduce major findings of several significant studies in the field. These studies will be interrelated with the hypotheses derived from the model.

Even a brief discussion of the previous studies requires a framework. The possible frameworks are: macro vs. micro, single factor productivity vs. total factor productivity, time series vs. cross sections, etc. The main problem in the adoption of one of these frameworks is that most studies belong to more than one category. Thus this section will use the following classifications: productivity trend, service industry, international comparison and market structure.

Productivity Trend

Barger (1955) reports on the changing role of distribution in the United States. This study focuses on the distributive trades for goods purchased by the final consumer from 1869 to 1949.

His three leading findings are in the following discussion. First, as Table IV-1 indicates, between 1930 and 1950 the fraction of the labor force engaged in retailing and wholesaling rose from one worker in eight to one worker in six; between the same dates, persons engaged in production underwent a relative decline from one-half of the labor force to two workers in five.

TABLE IV-1

EMPLOYMENT IN DISTRIBUTION AND OTHER INDUSTRIES, 1930, 1940, AND 1950

	1930	1940	1950
		(thousands of persons)	
All industries	43,725	48,088	58,795
Commodity-producing industries	19,183	19,895	22,958
Agriculture, forestry, fisheries	8,804	7,918	6,884
Mining	956	965	966
Manufacturing	9,423	11,012	15,108
Distribution	7,437	8,646	11,225
		(percent)	
Employment in distribution:			
As percent of all employees	17.0	18.0	19.1
As percent of employee in production and distribution combined	27.9	30.3	32.8
		(persons)	
Per thousand in production	388	435	489

Source: Barger, Harold. Distribution's Place in the American Economy Since 1869. New York: National Bureau of Economic Research and Princeton University Press, 1955, p. 8.

His second finding is that productivity in production grows more rapidly than that in distribution (Barger, 1955, p. 38). Output per person engaged in the commodity producing industries rose nearly five fold and in distribution increased about 80 percent, between 1869 and 1949. He also indicates that output per man-hour multiplied six times in the commodity industries, and about two and a half times in distribution. In addition, labor productivity increased somewhat more than twice as fast in the production of commodities as it did in their distribution during the same period.

His third main finding is related to distribution cost. Table IV-2 shows that distribution cost, measured as a fraction of the retail value of commodities, remained remarkably stable.

TABLE IV-2

MEASURES OF DISTRIBUTION COST, 1929-1948
(percent of retail value)

	1929	1939	1948
All commodities retailed:			
Value added by			
Wholesalers	8.0	7.6	7.7
Retailers	28.6	29.7	29.7
Distribution, total	36.6	37.3	37.4

Source: Barger (1955, p. 60).

In 1961 Kendrick undertook a reworking and extension of Barger's study (1955). His main objective was to describe United States productivity trends and to indicate some of the interrelationship between productivity change and changes in economic aggregates and the economic structure.

There are several major findings in his study. First, as Table IV-3 shows, between 1889 and 1957 total factor productivity in the private domestic economy grew at an average annual rate of 1.7 percent. There is some variability in the rate of change in total productivity from one decade to the next. For instance, between 1889 and 1919, the growth rate was only 0.6 percent which was far lower than the 2.6 percent growth rate of total factor productivity between 1919 and 1953.

TABLE IV-3

GROWTH RATES IN OUTPUT AND PRODUCTIVITY RATIOS, 1889-1953

	Output	Output per Unit		
		Total Factor Input	Labor Input	Capital Input
1889-1953	3.2	1.7	1.9	1.0
1889-1919	3.1	0.6	0.8	0.1
1919-1953	3.2	2.6	2.8	1.9

Source: Kendrick, John W. Productivity Trends in the United States. New York: National Bureau of Economic Research and the Princeton University Press, 1961, p. 70.

In 1973, Kendrick updated the estimates and analyses contained in his earlier work (1961). There are several conclusions he drew from this study. First, he found no significant acceleration in the trend rate of growth in total factor productivity since World War II. Table IV-4 also indicates that the rate of advance in labor productivity has shown further acceleration since World War II. This was due to a much faster rate of increase in capital per unit of labor input than prevailed during the other war period.

Second, he argued that the chief determinant of the rate of growth in total factor productivity is the rate of growth in the real stocks of intangible capital embodied in the tangible factors. He also considered several other possible causes of productivity changes including changes in economic efficiency, scale, the inherent quality of resources and rates of capital utilization.

TABLE IV-4

AVERAGE ANNUAL PERCENTAGE RATES OF CHANGE IN PRODUCTIVITY RATIOS

	1889-1919	1919-1948	1948-1966
Labor productivity	2.0	2.2	3.4
Capital productivity	0.5	1.6	0.4
Total factor productivity	1.3	1.8	2.5
Capital-labor input ratio	1.1	0.3	2.5

Source: Kendrick, John W. Postwar Productivity Trends in the United States, 1948-1968. New York: National Bureau of Economic Research and the Columbia University Press, 1973.

Third, he said that, in looking at changes in productivity of more than thirty industry groups, the degree of dispersion is considerable for the post-1948 period, but no greater than in earlier periods of comparable length. Fourth, he confirmed the previous finding (Kendrick, 1961; Fuchs, 1969) that there is a significant positive correlation between relative industry changes in productivity and in output within broadly similar sectors. Specifically he (p. 111) said:

Our results for the period 1948-66 are broadly in line with the results of the earlier studies. The regression between average annual percentage rates of change in output and total factor productivity for thirty-two industry groups yields a coefficient of correlation of 0.55. With rates of change in output related to output per man-hour for thirty-six industry groups, the coefficient is 0.60. Finally, the correlation between rates of change in output and capital productivity for thirty-two groups is 0.54. All these correlations are significant at the 0.01 level. Confining the analysis to manufacturing, for the twenty-one two digit industry groups the coefficient of correlation between rates of change in output and total factor productivity is higher than in the industry segment including trade: 0.65; using rates of changes in output labor productivity, the coefficient is 0.54.

Service Industries

Fuchs (1968) examined differential trends in productivity across eighteen service industries from 1939 to 1963. The underlying reasons for this study lie in the recognition of the growing importance of the service sector and the general belief that productivity in services has not improved as rapidly as in goods-producing industries. In the service sector he includes wholesale and retail trade; finance, insurance and real estate; general government; and the service proprietors such as personal services, professional services, business services and repair services. But he admitted that this definition is somewhat arbitrary, since some workers employed in goods industries produce services and some in service industries produce goods.

His first major finding is related to average annual rates of change of labor productivity in the service sector. Table IV-5 shows several interesting patterns. First, sixteen of the eighteen industries show positive rates of change of labor productivity. Second, the rate of increase for the service sectors was not as rapid as for manufacturing or the total economy. Third in one-third of the cases, labor

TABLE IV-5

AVERAGE ANNUAL PERCENTAGE RATES OF CHANGE, LABOR PRODUCTIVITY, 18 SELECTED SERVICE INDUSTRIES, 1939-1963

Industry	Labor Productivity (%)
Services	
Auto repair	3.32
Barber shops	.60
Beauty shops	1.69
Dry cleaning	2.47
Hotels and motels	.49
Laundries	1.42
Motion picture theaters	-2.83
Shoe repair	1.16
Retail Trade	
Apparel stores	.99
Automobile dealers	2.09
Drug stores	2.68
Eating and drinking places	- .18
Food stores	2.44
Furniture and appliances	2.88
Gasoline stations	3.25
General merchandise	1.40
Lumber dealers	1.21
Other	2.09
Service Industries Total	1.45
Manufacturing Total	2.26
Total Economy	2.23

Source: Fuchs, Victor R. The Service Economy. New York: National Bureau of Economic Research and Columbia University Press, pp. 15-16.

productivity actually grew more rapidly than in the total economy. Fourth, the range of variation from labor productivity of service indusrries is very great from 3.32 to -2.83 percent annually.

His second main finding is concerned with the relationship between industry rates of growth and labor productivity across seventeen service industries. The previous studies (Fabricant, 1942; Kendrick, 1961; Salter, 1960) reviewed this relationship mainly in manufacturing industries. Thus this study tested this relationship in the service sector. The finding supports the hypothesis that there is a positive correlation between growth and productivity.

Wilburn (1967) focused on the disparate performance of two apparently similar industries--barber shops and beauty shops. These two industries are commonly treated as one industry since they share several common characteristics (Fuchs and Wilburn, 1967, pp. 55-56). First, their function is essentially similar, both being engaged primarily in grooming the hair. Second, the size of establishment in both cases is referred to as typically small. Third, both businesses are heavily labor-intensive. But from the standpoint of productivity the differences between the two are more noteworthy than the likenesses. Table IV-6 reflects clearly their divergent performance. The more rapidly rising prices of barber services--which increased from an index of 52.6 in 1939 to 183.9 in 1963, as contrasted with 54.6 in 1939 to 136.6 in 1963 for beauticians--suggest a lower increase in productivity in that industry. This study found that increases in capital per worker and economies of scale are of little importance in these two industries, while changes in the quality of the labor force, changes in technology and increasing percentages of part-time employees offer an explanation for differences in productivity. That is, these factors made a contribution to the increase in productivity in the beauty industry but not in the barber industry. Another result of this study is the two-sided nature of the relationship between productivity and growth trend. Technological change stimulates growth through decreases in price and improvements in quality. And, in turn, the growth of demand stimulates productivity through increases in the size of transactions and decreases in idle time.

TABLE IV-6

INDICES OF PRICES AND PRODUCTIVITY IN BARBER SHOPS AND BEAUTY SHOPS (1948 = 100)

Year	Prices		Labor Productivity	
	Barbers	Beauticians	Barbers	Beauticians
1939	52.6	54.6	91.5	90.6
1948	100.0	100.0	100.0	100.0
1963	183.9	136.6	106.4	129.0

Source: Fuchs, Victor R. and Jean A. Wilburn. Productivity Differences within the Service Sector. New York: National Bureau of Economic Research, 1967.

Schwartzman (1971) provided an interesting observation in regard to labor productivity in retail trade. Unlike the previous studies, this one (pp. 133-166) implied that there was a reduction in efficiency in retailing, since the service quality losses were even greater than the measured productivity. Bucklin (1978) raised several questions about the validity of this finding. Specifically, he (pp. 55-56) said:

> While the conceptual framework behind the model is highly ingenious, there is some doubt that it really does indicate an annual service decline of the 0.3 percent suggested. First, there appears to be a strong possibility of some double-counting in the denominator. . . . Further, data errors are likely. Schwartzman's measure for service station gross margin was not corrected for changes in the product mix. If any proportion of this shift was due to an increased proportion of repair work and the sale of other automotive products, where margins are likely to be larger, then the change in gross margin reflects real gain in output. Adjustment ought to be made accordingly. Finally, the analysis assumes away the possibility that service per transaction might well have increased in gasoline stations over the period, for example, in the form of longer station hours to provide greater convenience to motorists. . . . Consequently, Swartzman's model, rather than suggesting that service has deteriorated, indicates that it may well have been quite stable over the period.

International Comparison

Hall, Knapp and Winsten (1961) compared the relative levels of productivity achieved in the retail trades in Great Britain, Canada and the United States. They found four determinants for the different levels of productivity--as measured by sales per employee. The primary causes were per capita income, population density, rate of population growth, and age of settlement.

George (1966) attempted a cross section study of sales, employment and productivity in British retailing, based on the 1961 census of distribution. He measured productivity in each town by weighting sales per full-time equivalent employee in each of seven retail types. He expected that there would be positive associations between productivity and each of the following predictors; town size, per capita income, availability of labor, the presence of chain stores, and the size of the individual store. But the result of his study showed that there exists such relationships except by the size of town.

Specifically, in the multiple regression equation, the four variables, the tightness of the labor market, the average sales size of the shop, the percentage of multiple shops and per-capita income, jointly accounted for 82 percent of the variance in productivity among the 160 towns.

George and Ward (1973) updated George's previous study to explore the mechanism of labor market, sales growth and labor productivity by utilizing both the 1961 and 1966 census of distribution. They found that both sustained labor shortages and rapid sales growth tend to have a favorable impact on productivity in the retail sector. Their explanation for this tendency is that this occurs in part due to the inducement of the more efficient use of labor and in part due to the elimination of marginal shop effects. The main implication of this finding is that an increase in the real cost of labor will tend to accelerate productivity growth in the retail sector.

One interesting note of this study can be found in their argument that higher income per capita may also lead to the purchase of more luxurious items in smaller stores that provide the kind of service associated with such items (pp. 43-44). They attempted to identify both the transaction and luxury effect by taking differences in performance between the years 1961 and 1966 for forty-two towns through the following equation:

$$Y = 19.5 + 2.89L + 0.167S + 0.379\ Y/H - 0.037\ Y/K \qquad R^2 = 0.60$$

where: Y = the percent change in the volume of sales per person engaged

L = the percent change in labor market tightness

S = the percent change in sales per shop

Y/H = the percent change in income per head of the population 1959-1960, 1964-1965

Y/K = income per head in 1959-1960

This equation indicates that the change in income per capita retains the positive association, indicating a transaction effect, though the level of income at the starting point turns negative. This is presumably to reflect the luxury element of the effect.

Takeuchi and Bucklin (1977) explored several forces that affect one element of retail structure, the number of retail establishments per capita. This element was found to be an important determinant of retail productivity in the United States and Japan. The general paradigm for retail structure had three sets of forces: the personal wealth of the society, the level of technology employed by the retail sector, and the degree of competition among the retailers. Based on this paradigm, they developed six independent variables which influence the retailing structure: income, automotive ownership, department store sales, price of labor, density-urbanity of population and change in population. Among these variables, they hypothesized that income and automotive ownership have a positive association with retail structure and others have negative associations with their dependent variable. Based on the secondary data collected for two years, 1964 and 1968 for Japan and 1963 and 1967 for the United States, linear regression analysis showed that nine of the twelve specified variables were statistically significant at the level of 0.05.

Bucklin (1978, pp. 75-79) studied productivity in distributive activities in the United States and Japan. Unlike the towns used in the studies of George (1966) and Ward (1973), he employed the mainland states of the United States and the forty-two prefectures of Japan. In retailing he examined seven factors affecting productivity in retailing: the role of scale in retailing, the importance of department stores, the price of labor, per capita income, population growth and the force of time. After all variables were transformed to logarithms, he found that the degree of explanation was superior in the case of Japan with R^2 of 0.96 compared with but 0.63 for the United States. In this study sales per full-time employee was used as a measure of labor productivity in both the United States and Japan.

The number of stores per capita was used as a measure of the first variable, retail store size. He argued that the number of stores per capita is a better measure than average store sales, since this measure can eliminate the chance of spurious association that might arise from the use of sales on both sides of the equation. But Ingene and Lusch (1980, pp. 12-13) state that his use of stores per capita as a surrogate for average store size is not valid. Specifically they said:

> Although this approach to measuring store size avoids the problem of having sales on both sides of the regression equation it does induce a bias of another form. Number of stores per capita is only an accurate reflection of store size if and only if the number of square feet of floor space per capita is equal across the geographical units being investigated.

In regard to this variable, in Japan every 1 percent decline in the number of stores per capita causes labor productivity to increase by 0.5 percent; a rather substantial change compared to the 0.1 percent increase for the United States. He ascribed this cause to the smaller scale of stores in Japan.

The second variable, department store sales as a percentage of all retail sales had a negative relation with its dependent variable in the United States. In Japan the coefficient was positive but insignificant. Therefore it appears that there is less distinction among service outputs with respect to department stores in Japan than in the United States.

The third variable, trade wages had a positive association with labor productivity in the case of both the United States and Japan, although the relationship was more powerful in the former. The underlying reason for this result is that where trade wages were relatively high, retailers would make great efforts to improve productivity, and high quality employees can be recruited.

The fourth variable, income per capita, was intended to capture the influences of transaction size and expenditure volume on retail stores. He found this effect on both countries, but the impact was substantial only in Japan.

The fifth variable was urban density which was designed to reflect any indication of stern competition that might be associated with the heavily populated areas as compared to the rural. This variable was insignificant in the United States and significant but negative in Japan. The result indicates two implications. First, in the United States, the pervasive use of the automobiles may have all but eliminated the barrier of distance to competition. Second, in Japan, where population density is much greater, changes in the structure of cities to accommodate the new retail forms may be more difficult. The next variable, population growth had only a negligible effect on both countries. The final variable, time indicated that in the United States, there was indeed a rate of technological change during the period. The specific figures of each variable can be found on Table IV-7.

Arndt and Olsen (1975) analyzed the impact of labor and capital on output by utilizing a production function. The data was collected from Oslo food stores by mail questionnaire. They adopted gross margin dollars for each store as their measure of output and number of persons engaged per store and the square footage of the store space as inputs. They also divided the stores into two groups, small and large stores. They assumed that the relationship is nonlinear and found the following lorarithmic regression equations:

$$O_g = -.34 + 1.34\ Lg + .18\ Sg \qquad R^2 = .85$$

$$O_s = .81 + .91\ Ls + .04\ Ss \qquad R^2 = .83$$

Where,

O = output

L = labor

S = scale

g = large stores

s = small stores

Based on these equations they concluded that there appear to be economies of scale in food retailing for small stores but that these either greatly diminish or disappear altogether for larger establishments.

Ofer (1974) conducted a study of several retail store types in Israel. The selected types of stores were food, furniture and clothing. He used value added as a measure of output and persons employed as a measure of input. His two capital variables were floor space and

TABLE IV-7

A COMPARISON OF LOG-LINEAR REGRESSION COEFFICIENTS ON LABOR PRODUCTIVITY IN RETAILING IN JAPAN AND THE UNITED STATES

	Constant	Retail Establishment per Capita	Department Store[a]	Trade Wage	Income per Capita	Urban Density	Population Growth	Time	R^2
Japan									
1963 and 1967	2.33	-.53[b]	.02[b]	.25[b]	.65[b]	-.3[b]	.01	-.06	,96
	(.39)	(.08)	(.01)	(.07)	(.09)	(.01)	(.01)	(.06)	
United States									
1964 and 1968	-1.02	-.11[b]	-.08[b]	.40[b]	.07[b]	.00	.00	.02	.63
	(.48)	(.04)	(.02)	(.08)	(.04)	(.00)	(.01)	(.01)	

[a] Department store sales as a percentage of all retail sales.

[b] $p \geq .95$, one tail test.

Source: Bucklin, Louis P. Productivity in Marketing. Chicago: American Marketing Association, 1978, p. 76.

inventory. In his study, he found that the benefit from larger scales were probably retained even for larger stores. This finding is somewhat different from the result of Arndt and Olsen's study (1975). After comparing these two studies, Bucklin (1978, pp. 93-100) explained this difference in terms of different cultures which influence the operation of stores in disparate ways.

Arndt (1977) was interested in explaining differences in performance between industry groups within Norwegian retailing. He explained the theory behind his study as (p. 238):

> On the basis of the logic of the structure-conduct-performance scheme, a high degree of seller concentration in an industry group was expected to make for less emphasis on low prices in the marketing mix and more emphasis on nonprice variables as service. Next, such market conduct was believed to result in less efficiency in the industry. Hence, more seller concentration in an industry group was hypothesized to result in a poorer economic performance from a societal point of view (in this case reflected in higher percentage gross margin and lower increases in labor producivity). In turn, performance was expected to have a feedback effect on structure, in that high margins and smaller pressures for increasing labor productivity would, in the absence of high barriers to entry, attract new establishments into the industry group and/or decrease store maturity.

He recognized that a frequently used measure of structure is the market concentration ratio or the percentage of total industry sales made by the leading four or eight firms. But the adopted data did not contain such information, he used an indirect measure of market structure, the estimated share of the population living in population clusters large enough to provide room for enough retail establishments to meet the criteria for low concentration. The performance measures used were percentage gross margin and the relative change in sales per person engaged. He measured the future market structure in terms of the relative change in number of establishments in the various industry groups. Though the result of this study shows some linkage between the degree of concentration in industry groups in retailing and performance, and between performance and future structure, the tendencies uncovered were not consistently strong. As the author acknowledge, there are two main reasons for this disappointing result. First, the adopted data are not adequate to conduct this study, as a result, he had to choose less proper measures of each variable. Second, the model he adopted is too simplistic or naive to explain the complex relationship between market structure and performance.

Ingene and Lusch (1980) examined the variation of labor productivity in grocery stores in terms of competitive variables and demand variables. Their unit of analysis was the retail market (i.e., some geographic area such as SMSA). They considered six variables under competitive dimension and four variables under demand dimension. The competitive variables considered were average store size, retail space saturation, capital intensity, population growth, retail wage rate and competitiveness. And the demand variables were income, household size, availability of private transportation and traffic congestion. Except for household size they found that the rest of the nine independent variables were statistically significant in the hypothesized direction. Overall the ten independent variables accounted for 82 percent of the variance of labor productivity across the examined 209 SMSAs.

Productivity Model

In order to develop a productivity model, several basic propositions in regard to productivity are stated.

Proposition 1: Productivity is based on rational behavior rather than random behavior.

If the main concern of productivity is to eliminate waste and inefficiency in human behavior, human behavior must be rational or reasonable and based on the norms of society. The simple reason for the requirement of rational behavior is that people must do what they know best for them and for the society if they are to survive.

Under norms of rationality, high productivity is preferred to low productivity. High productivity usually demands some cost and, as a result, not all members of the society welcome high productivity. The costs of high productivity, for instance, are ecological problems and a possible change of national priority. The lessening pollution standard for American auto industry may increase its productivity, but such action eventually deteriorates the environment. The aid to a sick industry may improve its productivity, but such action as revitalization of an industry may require the shift of national priority from social programs to a revitalization fund. These examples can be easily found in society. Then why does this society prefer high productivity to low productivity? Perhaps the majority in society believe that the benefit of high productivity is worth the cost. Or, maybe, a small number of this society inspire the majority of us to believe such. Thus the starting point of this model is that productivity is based on rational behavior and, in turn, such rational behavior provides a reason for the preference of high productivity to low productivity.

Proposition 2: Productivity is better measured and explained under the assumption that cause and effect are clearly related.

Why is causality a prerequisite for a better understanding of productivity? The main reason belongs to the fact that the lack of causality creates an unknown consequence of an action, as a result, the relationship of input and output is not known. At the same time, when such causality is not clear, other methods which are less strict than productivity are advisable to use as a method of assessment of performance. Thompson (1967, pp. 83-100) suggests that when causality does not exist, under norms of rationality, instrumental tests or social tests are preferred over a productivity test.

Proposition 3: One of the major roles of management is to buffer the influence of the environment into a group of people. As a result, management behavior is influenced by the environment and, in turn, its behavior affects productivity.

One of the most important roles of management is to buffer the influence of the environment on the organization. The role of buffering by management consists of converting fluctuating environments into steady conditions for the organization. Though no organization can avoid totally the impact of the environment, the survival of an organization may depend upon how it handles its task environment. A key reason for management to reduce the influence of its environment is that the more uncertainty the organization has, the less productivity it can create. Therefore, management must try to reduce such effects on its organization in order to achieve high productivity. Here the reduction of such influence does not mean that management itself must avoid such influence but that it must be exposed to its environment to anticipate fluctuating environments and to treat them as constraints on its organization. This exposition can lead the management to prepare for change and, in turn, such preparation should provide a stable environment for its organization. This statement reveals another dimension of the relationship among environment, management and productivity. In order to provide a stable condition for its organization, which is a prerequisite for a high productivity, a plan should be prepared to absorb the impact of its environment. Importantly, management itself must deal with its environment as much as possible. Consequently, management behavior is influenced by the environment and, in turn, its behavior affects productivity.

The prior three propositions provide a foundation for building a productivity model. Under norms of rationality, management decision-making to attain a set of expectations must consider the characteristics of the organization. The environment influences the unique characteristics of each organization. Thus no two organizations in the same kind of business have the same characteristics. For the purpose of this study organizational characteristics are divided into business health and organizational structure. In other words, decision-making requires a careful analysis of the organization in which decisions are made. At the same time, such analyses are not enough without the consideration of the environment as proposition 3 has explained. The relationship is illustrated as Figure 1.

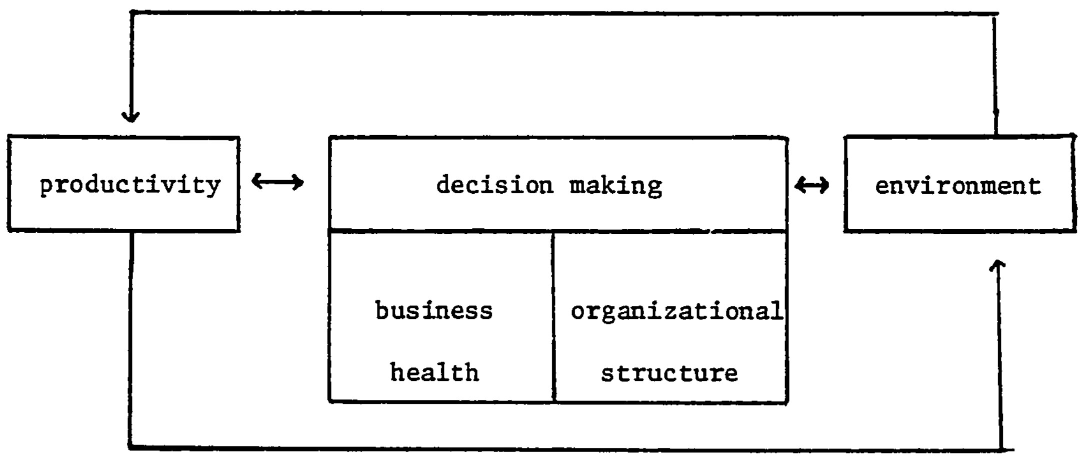

Figure 1

A Productivity Model

In this model, productivity is the outcome of business decisions which are based on the health of the business and its organizational structure. This decision making is influenced by the environment. This model also indicates that the three basic elements are interdependent.

When labor productivity is considered as a measure of productivity, then decision making must include information relating to labor variables. Thus the model adopted for this study, Figure 2, includes labor variables, since this study is interested in the relationship between labor productivity and its determinants. In addition, the new model specifies 4 p's and service levels in decision making variables.

A final note on this model is that without the consideration of environmental variables, the variance of productivity can be explained through the examination of decision making on 4 p's and labor variables, business health, and organizational structure, since management absorbs most of the influence of environment (not all of it).

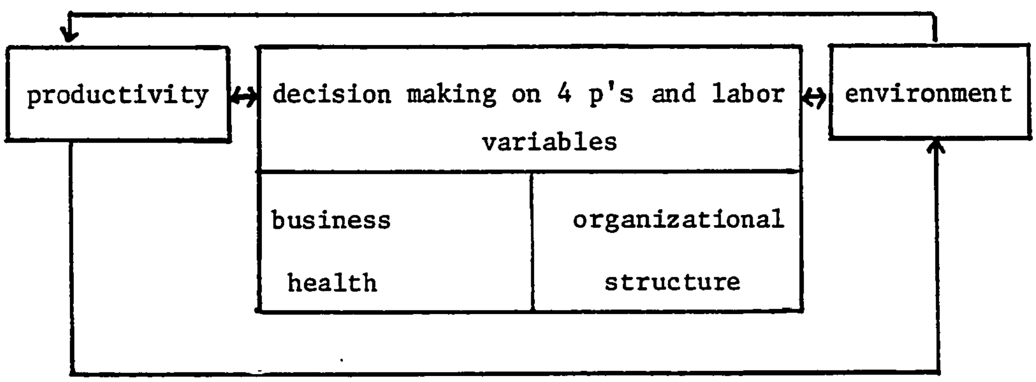

Figure 2

A Revised Productivity Model

Hypotheses

The developed productivity model indicates that without consideration of the environment, productivity can be explained by three blocks of variables. Based on this model, the following hypotheses are developed.

Business Health

Business health can be described in terms of the condition of the financial statements of a firm. Most financial analyses are somewhat static rather than dynamic, since their methods are based on one year. For instance, the current ratio deals with current assets divided by current liabilities in a certain year and at a particular point in time, not across a period of time. The merit of such methods cannot be ignored as an indicator of business health. However, this study adopts the change in sales over last year as a measure of business health. It is hypothesized to have a positive association with labor productivity.

Hypothesis 1.1: The rate of yearly sales increase is positively associated with increases in labor productivity.

Organizational Structure

Another group of determinants of productivity is the organization structure of a firm. The organizational structure is reviewed in terms of three variables; scale, ownership, and type of stores.

Scale. Previous studies (Hall and others, 1961; Bucklin, 1978; George, 1966; Takeuchi, 1977; Doutt, 1977; Greenberg, 1973) indicate the significance of scale in productivity analysis. They also argued that the association between productivity and scale is positive. Takeuchi (1978, pp. 175-76) showed the advantages and disadvantages of economies of scale in retail stores. The first advantage of large store sizes is that as the store size increases there is opportunity for greater specialization of work tasks. Hall and others (1961, p. 73) pointed to the economies associated with labor specialization and said:

> The functions of the different people engaged can become more specialized, with a consequent increase in potential productivity.

Second, assuming that store size was determined to match market potential, the larger stores are expected to serve a more stable clientele. Third, larger stores are less likely to have operational problems resulting from bad store layout or inefficient storage area. Fourth, more efficient use of manpower is made for certain fixed components of labor such as the number of store managers and department managers. Fifth, certain capital investments are indivisible which makes capital resources expanded for these purposes more productively utilized in larger stores.

Takeuchi (1978, pp. 176-77) also argued that a larger store would impose efficiency constraints and said:

> First of all, problems relating to coordination and communication may surface. . . .. Secondly, if the store becomes too large, operational efficiency may drop as a result of having to allocate more time towards in-store travelling and transportation. Thirdly, as store size increases, there is a tendency to install more service oriented departments such as the deli counter, snack bars, gardening, in-store bakery and so forth.

Unlike the above mentioned previous studies, Ingene and Lusch (1980, pp. 14-15) stated that as average store size is increased, labor productivity will actually decline if other factors are held constant. Their focus is on the impact of increasing the average store size in a geographic market rather than the size of a single store in a particular geographic market. The main reason for this hypothesis is the decline of sales in an area. Specifically they said:

> If we have a geographic market in equilibrium and average store size is increased, but retail space saturation is held constant then some stores must exist or leave the market. Now the result of this on the consumer is that s/he will, on average, be a greater distance from a store. . . . It is known that household demand will decline as distance to the store increases and therefore total retail sales must decline.

Douglas (1962) empirically studied the relation between three basic costs of retail operation and the size of firm. The three variables considered were cost of goods sold, total operating costs and cost of capital. One of his major findings based on the analysis of nine types of retail trade is that there are economies to scale in retailing but that in many lines the most efficient size is less than the largest which existed. Other studies (Tilley and Hicks, 1970; Savitt, 1975; and Maller and Haberman, 1975) also supported this finding and the existence of diminishing return on scale.

The above statements imply the relationship between productivity and scale can be positive or negative. Since there is no empirical evidence to support either in the retail hardware industry, the formal hypothesis merely states the existence of such a relationship without an indication of a direction.

The component of scale is measured by square footage.

Hypothesis 2.1: There is a relationship between labor productivity and scale.

Ownership. Another variable to represent the organizational structure is the form of ownership. The different forms of ownership lead to different processes of decision making and different styles of communication. In other words, ownership is a key element to determine the management style of a firm, and, in turn, the management style becomes a key determinant of productivity of a firm. This study uses three different forms of ownership; single proprietorship, partnership and corporation.

Hypothesis 2.2: Different forms of ownership have different levels of labor productivity.

Type of store. The last variable to be considered as representative of organizational structure is type of stores. Different store types have different emphasis on the operation of a firm. In the case of the hardware industry, retailers are classified into three groups; hardware stores, lumber/building material and home center. The National Retail Hardware Association's study shows different performance by three different types of hardware stores (Hardware Retailing, 1976, pp. 90-94). As Table IV-8 indicates, three different types of stores have different levels of sales volume, profit, assets and return on assets. Therefore, it is reasonable to hypothesize that different types of stores have different levels of productivity.

TABLE IV-8

A COMPARISON OF THREE TYPES OF HARDWARE STORES IN 1975

	Hardware Store	Lumber/Building Material	Home Center
Net sales per store	$337,547	$1,004,675	$1,437,131
Net profit before taxes	16,844	41,995	69,413
Total Assets	173,249	444,409	661,300
Return on Assets	9.7%	9.4%	10.5%

Source: Hardware Retailing, 1976, pp. 90-94.

Hypothesis 2.3: Different levels of labor productivity are explained partly by different types of stores.

Labor Variables

The next block of variables in this model is labor related variables. The following three hypotheses are concerned with the impact of these variables.

Wages. Wage rates have been viewed as a determinant of labor productivity by Bucklin (1978, p. 77), Ingene and Lusch (1980, p. 17) and others. The prime reason for this relationship is that where trade wages are relatively high, the firm has more pressure to improve productivity. Thus the more effort it puts forth, the higher the productivity that it can achieve. Ingene and Lusch (1980, pp. 17-18) illustrated the consequences of the high average wage in a geographic area as:

> First, the least productive employees, who were barely worth employing at the old, lower wage, are no longer contributing sufficiently to the firm (relative to their wage) and so are terminated. These people may be replaced by more productive employees of the firm may choose to operate with fewer employees. Second, the employees who are retained at the higher wage will be more closely supervised. Third, the manager will schedule his employees more carefully in order to minimize idleness.

Another aspect of the wage rate reflects the quality of labor. Assuming that wages are a barometer of experience, training and education of employees, higher wage rates can be considered as an indicator of quality of labor. Thus the following hypothesis is developed.

Hypothesis 3.1: Wage rates have a positive relationship with labor productivity.

The number of management versus the number of employees. Another labor related variable is the ratio of the number of management employees over the number of total employees. If wage rates are an indicator of quality of labor, this ratio is an indicator of the efficiency of management. In general, management ability is reflected in all components of productivity. The mark of an excellent manager is to achieve an objective of a firm by extracting all that is possible from a given set of resources under a stable condition through buffering the environment.

As an indicator of management efficiency, the ratio implies that the lower the ratio is, the higher labor productivity is. Thus this relation is formalized in the following hypothesis:

Hypothesis 3.2: The lower the ratio of the number of management employees over that of total employees, the higher labor productivity is.

Capital to labor ratio. The last element in labor related variables is the capital to labor ratio. This ratio reflects a systematic substitution of capital for labor, the degree of capital intensity. Such a ratio depends on the relation between capital and labor. If the cost of capital is higher than that of labor, less capital is used, or vice versa. Since retailing is characterized as a labor intensive industry, productivity rates in retailing are lower than that of product producing industries. Therefore, it is reasonable to assume that a high capital to labor ratio has a positive impact on labor productivity in retailing. To examine this relation, a measure is established based upon the relationship between depreciation and payroll as proxies for capital and labor. Based on these measures, the following hypothesis is stated:

Hypothesis 3.3: The higher the ratio of capital to labor, the higher labor productivity is expected to be.

Marketing Decision Variables

The productivity model emphasizes the importance of marketing decision variables which consist basically of the 4 p's and service levels. This section develops several hypotheses regarding these varaibles.

Service levels. Service level represents the extent to which consumers are provided services ancillary to their purchases of units of output. Basically if services rendered are reduced, there is a positive impact on productivity. The concept of self service supports this proposition, since it changes one form of service to another. For instance, an elimination of delivery or a minimization of sales assistance can contribute to a reduction of prices, which is another form of services to consumers. Guirdham (1972, p. 10) agrees and said:

> The appeal of lower prices has remained important in some form of self service sectors, but it has become clear over the years that many consumers do not see self-service as a reduction in service level and thus only acceptable in exchange for lower prices, but as the substitution of a different kind of services.

The adoption of reduced services needs to be approved cautiously. Unless a decline in services is justified to consumers by reduced prices, consumer resistance may arise, as a result, productivity may not be expected to increase. In sum, it is necessary to increase productivity and the degree of reduced prices must match that of reduced services.

Two measures adopted for service level are the number of employees per square foot and the rate of delivery expenditures to sales. The number of employees per square foot is a surrogate measure of the level of in-store service which indicates the intensity of personal selling and sales assistance. On the other hand, delivery expenditures to sales is a measure of the level of out-store service which shows the strength of adopting "take-home" concept. Based on the proposition that the reduction of services has a positive impact on productivity, the following two hypotheses are developed.

Hypothesis 4.1.1: The level of in-store service has a negative relationship with labor productivity.

Hypothesis 4.1.2: The level of out-store service has a negative relationship with labor productivity.

Place. The first element which deserves consideration as one of the 4 p's in marketing is place. From the aspect of a system, marketing must stress coorindation of 4 p's, thus place is no more or no less important but is equally important with other elements.

Place is more than store location but this study focuses on the general impact of location on productivity. A good location helps to generate high customer traffic, as a result, assuming other factors are constant, the store can achieve good performance with considerably less effort. But if a location has poor vehicular visibility and a accessibility, these weaknesses cannot be easily remedied by providing more service or by spending more for promotional activities. Besides, a store location usually requires a long-term investment which is difficult to change over a short period of time even after the location has been found to be inadequate.

Relating to this issue, Hall and others (1961, p. 98) state that independents generally had to accept inferior locations compared to chains. They said:

> The chains locate themselves in the best places in relation to one another. The independents are left to fill in the gaps, so to speak, either geographically or by serving those customers who do not happen to like chain stores or do not find what they want there.

This study uses six locations in order to find the relationship between labor productivity and location; downtown (central business district), near the edge of downtown, neighborhood shopping center--small, community shopping center--medium to large, free standing--no adjacent stores, and on highway or street several stores nearby. The specific direction of each location relating to labor productivity is hard to find, so the hypothesis simply states the existence of such a relationship.

Hypothesis 4.2: There is a relationship between store location and labor productivity.

Price. Price is one of the variables which the marketing manager can control and, in turn, the price decision determines the firm's revenues. The low price may increase the volume of sales but if the price is too low, it might deteriorate the proper level of profits. On the other hand, if the price is too high, it might contribute to the profits of each product, but it will reduce the sales. Consequently, the price decision making is vital to the survival of business. But few studies in productivity consider it as an explanatory variable of the variance in productivity.

The important point to be considered is that the consumer's perception of price is more important than the actual price. For instance, though the average price of a store is lower than others, the store cannot increase its sales by price incentives if the customers perceive that its prices are higher than others. This occurs when competitors place lower prices on easily recognized items such as national brands and higher prices on others. Though the average price of these competitors is higher, most customers can easily perceive that their prices are lower than the other.

There are several alternatives to measure the price level. First, if the number of products is limited and the quality is reasonably similar, the comparison of price of each product is possible. But, in reality, it is hard to find such a case, especially in retailing, since most types of retailing carry thousands of items. The second alternative is the comparison of sales, if the volume of sales is calculated by multiplying products sold by price. But the subjects of this study have different volume of sales, so it cannot be adopted. The next choice is the ratio of gross margin to net sales. This measure is adopted for this study, since it does not require the previous mentioned unrealistic assumptions and it provides a vehicle to compare different levels of prices with a common denominator. For the purpose of an illustration, assuming that a store bought a pair of shoes for eight dollars and sold it at ten dollars and another store sold it at twelve dollars with the same cost, based on the adopted measures, the price level for the former is one-fifth, while that for the latter is one-third. If consumer's perception goes along with actual prices of these two stores, and the demand for this product is elastic, the former can sell more than the latter. Therefore, it is reasonable to hypothesize that the lower price it is, the higher productivity it is expected to achieve, since lower prices contribute higher sales with a minimum increase of labor forces and value added increases as sales increase when marginal revenue is greater than marginal cost.

Hypothesize 4.3: The price has a negative relationship with labor productivity.

Product. Another control variable to management is product. From the aspect of utility development, wholesalers or retailers as well as manufacturers are producers. The main role of wholesalers or retailers is the identification of the consumer's needs and the attempt to satisfy their needs through a right place, price and product. Here the right product means the correct assortment of merchandise with an appropriate quantity. The right assortment is the proper depth and width of products which a store carries and the appropriate quantity is the inventory of each product to maintain minimal stockouts at an economical level.

Relating to the output side of productivity, these two dimensions have a positive impact. The main assumption underlying this proposition is that a store carrying a right assortment of product can achieve more output than otherwise, while other variables are constant, since consumers will patronize a store which displays what they want.

If a right product has a positive relationship with the output side of productivity, what is the impact on the input side? Under norms of rationality, it is reasonable to assume that the association is constant. A right product decision does not demand an increased labor power, since it demands a quality of management not a quantity of management. It is also true to state that a right product may need more labor force to store, sort and display. But such an increase of manpower should be less than an increment of output from a right product decision. Thus the total impact of a right product on productivity is positive.

It is not easy to measure the quality of a right product decision, but this study adopts the ratio of inventory over per square foot as a surrogate of product assortment. The rationale for this measurement is that a store which has more inventory per square foot may provide more selection to its customers than others, and, consequently, it can enjoy more output than others. Based on this measure, the following hypothesis is developed to be tested empirically.

Hypothesis 4.4: The product assortment has a positive relationship with labor productivity.

Promotion. In general, most promotional activities belong to one of three categories; advertising, sales promotion and personal selling. But promotion is too complicated to make a general implication, saying promotion has a positive relationship with labor productivity or a negative relation. For instance, if the researcher is interested in the impact of advertising, several steps must be taken. First, measurement of the impact in short-term or in long-term must be defined. Second, objectives need to be determined, such as an increase of sales, an improvement of its image and so on. Third, after assuming that the impact is limited to short-run and its focus is an increase of sales, the researcher needs to set up a specific objective on a communication process. For instance, a goal on a target market may be specified as; 90 percent of awareness, 50 percent of interest, 30 percent of comprehension, 10 percent of trier, and 3 percent of repurchase. The purpose of the above statement is to justify the reversion of logic, that is, the relationship between productivity and each promotional campaign will be explained after each promotion measure is introduced, not before.

The ratio of advertising expenses over inventory is adopted to identify the influence of advertising on labor productivity. Advertising expenses are not a true indicator for the performance of advertising campaigns, since they do not consider creativeness of advertising. For example, two firms which have spent one million dollars for advertising usually have different results, because the campaign carries not only different media selections but also different themes. But it is not a dramatically wrong assumption that advertising effectiveness is somewhat proportionally related to advertising expenses if advertising activities are based on rational decisions which is a key proposition for the study of productivity. It is not uncommon to draw an extraordinary result with relatively small amount of money in advertising activities, so recently more attention has been given to creative advertising campaigns. Because few alternatives exist, advertising expenses are regarded as one of two elements to evaluate advertising activities.

Another element must be included with advertising expenses, since it is irrational to compare two firms with different levels of advertising campaigns in conjunction with labor productivity. Comparisons must lie in a common base. For instance, no one expects that one car with a cost of five thousand dollars will provide the same performance of another car costing twenty thousand dollars. Thus inventory is accepted for this purpose with advertising expenses. Another reason for the adoption of inventory as a common denominator of advertising is that advertising is intended to give benefit to the whole inventory in a store rather than only those products sold. If sales is adopted instead of inventory, only the result of advertising is considered and it ignores the cause of advertising.

The next question is what relationship this ratio of advertising expenses over inventory has to labor productivity. As long as the rate of increment of output by increasing promotional campaigns is larger than the increasing rate of campaign, the relationship is positive, otherwise the relationship is negative. Under rational decisions, unless such results are expected, no firm will make such a commitment. Therefore it is reasonable to hypothesize that such a relationship is positive until empirical evidence is provided against such hypothesis. Even though rational behavior provides such a starting point, empirical results may be against this positive association. One of many explanations can be that it is not uncommon to find a case where results are far lower than an expectation, though such an expectation is reasonable. Stochastic variables may be one explanation for unfulfilled expectation. Productivity assumes that the influence of stochastic variables is at a minimum, so the following hypothesis is formalized.

Hypothesis 4.5.1: The impact of advertising on labor productivity is positive.

Another element for marketing promotion to be considered is sales promotion. Sales promotion is defined in terms of the ratio of discount sales over sales. The main reason for the adoption of this instrument is that this ratio indicates the overall sales promotion activities such as quantity discount, seasonal discounts, cash discounts, coupons and so on in relation to the volume of sales.

The same argument about advertising can be applied here to identify the relationship between labor productivity and sales promotion. Without the expectation of an increased output no firm will utilize discounts, therefore the relationship can be defined as positive.

Hypothesis 4.5.2: The impact of sales promotion on labor productivity is positive.

The last element of promotion is personal selling. If advertising attempts to inform and/or persuade the potential buyers to buy a product through mass communications, personal selling attempts such purposes of informing and/or persuading through personal communication.

In retail trade, the importance of the role of personal selling has been decreasing, especially in food related industries and in hardware retailing. But the decreased role of personal selling cannot be applied without restriction. The common phenomena in fast food restaurants and supermarkets is self-service, but high fashion industries or department stores need more high quality salespeople who provide high levels of service, and the customers expect such high quality service with higher prices than self-service stores. Therefore in regard to the role of personal selling, there are plural phenomena; one requires a high quality of personal selling and another attempts to minimize such roles. And it is hard to tell which one is better than the other, since each strategy has achieved a certain level of success. The key issue is how the retailer wants to position itself. The hardware industry which is examined empirically in this study, is going to a self-service strategy rather than to the emphasis of personal selling. Therefore the relationship between personal selling and labor productivity is assumed negative.

The adopted measure of personal selling is the ratio of the number of salespeople to the total number of employees. The rationale for the adoption of this measure is that the more salespeople a store has, the more emphasis a store places on personal selling. The reason to include the number of employees in the measurement of personal selling is to provide a common basis for a comparison.

Hypothesis 4.5.3: There is a negative relationship between personal selling and labor productivity.

Before a summary of hypotheses is introduced, it is necessary to emphasize that marketing must pursue a balance or a coordination of all activities in a system in order to achieve its goal. Though this study hypothesizes each variable relating to labor productivity with the assumption that other variables are constant, the final application must consider all variables together and find the best combination of variables for a firm. Table IV-9 summarizes the hypotheses and the variable measures.

Summary

The main purpose of this chapter was to develop a productivity model. The foundation of this model comes from the review of the prior studies in productivity. The frameworks for this review are: productivity trend, service industry, international comparison and market structure.

The essence of this model is that productivity is the outcome of business decisions which are based on the health of the business and its organizational structure. This decision making is influenced by the environment. This model also indicates that the three basic elements of this model, productivity, decision making variables and environment, are interdependent. Based on this model, 15 hypotheses are specified for the empirical test.

TABLE IV-9

SUMMARY OF HYPOTHESES

	Variables	Measures	Relationship
H 1.1	business health (BH)	an increment of sales over last year's sales	positive
H 2.1	scale (OG)	square feet	-
H 2.2	ownership (O1-O2)	single proprietorship partnership, corporation	-
H 2.3	type of stores (S1-S2)	hardware store, lumber/ building material, home center	-
H 3.1	wage (LA 1)	wage rate	positive
H 3.2	efficiency of management (LA 2)	number of management/ number of employees	negative
H 3.3	capital and labor (LA 3)	depreciation/payroll	positive
H 4.1.1	in-store service (SV 1)	number of employees/ square foot	negative
H 4.1.2	out-store service (SV 2)	delivery expenditures/ net sales	negative
H 4.2	place (L1-L5)	six locations	-
H 4.3	price (PRC)	gross margin/net sales	negative
H 4.4	product (PD)	inventory/square foot	positive
H 4.5.1	advertising (PR1)	advertising expenses/ inventory	positive
H 4.5.2	sales promotion (PR2)	discount/net sales	positive
H 4.5.3	personal selling (PR3)	number of salespeople/ number of employees	negative

CHAPTER V

RESEARCH METHODOLOGY

The purpose of this chapter is to describe the data which are utilized to empirically test the hypotheses and to explain the statistical methods adopted to analyze the data. Usually research methodology discussions allocate a considerable space to sampling and data collection procedures, but this chapter introduces briefly such aspects, since the adopted data came from National Retail Hardware Association (NRHA) and, consequently, sampling and data collection procedures were beyond the control of this author.

Data Description

NRHA provides the data of this study covering 1976, 1977 and 1978. The data of 1976 is used to explore a preliminary model of productivity and the next two years' data are utilized to confirm the developed and tested model. This confirmation procedure is one of the major objectives and contributions of this study, since few previous studies have attempted to go through this procedure. Each year NRHA has sent mail self-administered questionnaires to hardware store operators which include three types of retailers; hardware store, lumber/building material and home center. The collection period was from January to May of each year. NRHA received a total of 1,110 questionnaires for 1976, 1,115 for 1977 and 1,168 for 1978, but the actual sample sizes of three years' period used for final analyses consists of 127, 113 and 112 for 1976, 1977 and 1978 respectively, because the remaining questionnaires contained missing elements.

Statistical Methods

Multiple regression analysis is adopted to test the productivity model. Here labor productivity is measured by value added divided by the number of full time equivalent employees which is conceptually the most sound among the possible measures.

This method will be used to draw three key implications. First each regression coefficient (bi) is used to find the structural or functional relationship between an independent variable and the dependent variable while other independent variables are assumed constant. Under the linear additive functional form, each bi shows the average number of units change in the dependent variable associated with each unit increase of the independent variable. In contrast to the linear form, bi of a log-linear multiplicative form is equivalent to the percentage change in the dependent variable and this is a measure of elasticity. Thus the value of bi may be used by management to make implications concerning how to increase the firm's productivity.

Second, this technique enables the research to test whether the hypothesized relationship of each of the independent variables to the dependent variable as verified, holding all others constant. The null hypothesis states that the parameter value of bi is equal to zero, while the alternative hypothesis states that bi is greater than or smaller than zero, depending on the direction of each hypothesized relationship. The t statistic is used to test the null hypothesis against the alternative.

Third, since the coefficient of multiple determination (R^2) states the percentage of the variance in the dependent variable which can be explained by associated variance in the values of the independent variables, R^2 in conjunction with the F statistic is used to see how well this model as a whole explains different levels of productivity by the introduced determinants of productivity. The F statistic tests the null hypothesis that the coefficient vector is zero.

Like other statistical methods, statistical inference with multiple regression analysis requires several assumptions underlying the probability distribution of the error term as well as the properties of the explanatory variables (Kmenta, 1971, pp. 202-5, 348-350). These assumptions are as follows (subscript k is included; k = 1, 2 . . ., n):

(1) εk is normally distributed (normality)

(2) $E(\varepsilon k) = 0$ (zero mean)

(3) $E(k^2) = \sigma^2$ (homoskedasticity)

(4) $E(\varepsilon k \cdot \varepsilon j) = 0$ $(k = j)$ (nonautoregression)

(5) Each of the explanatory variables is nonstochastic with values fixed in repeated samples and such that, for any sample size, $\sum_{k=1}^{n} (Xki - Xi)^2/n$ is a finite number different in size for every i (nonstochastic x).

(6) The number of observations exceed the number of coefficients to be estimated (sufficient degrees of freedom).

(7) No exact linear relation exists between any of the explanatory variables.

Given the above specification of the multiple regression model, the dependent variable is normally distributed and its mean and variance are given by:

$$E(Y) = a + b1X1 + b2X2 \cdots bn,Xn,$$

$$Var(Y) = E[Y - E(Y)]^2$$

The Basic Model

The developed productivity model needs to be converted to an operational model which can be empirically tested. Within the context of multivariate regression analysis, the basic model gives a linear function form as:

$$\begin{aligned} \text{Labor productivity} = {} & a + b1BH + b2OG + b3O1 + b4O2 + b5S1 + b6S2 \\ & + b7LA1 + b8LA2 + b9LA3 + b10L1 + b11L2 \\ & + b12L3 + b13L4 + b14L5 + b15PRC + b16PD \\ & + b17PR1 + b18PR2 + b19PR3 + b20SV1 + b21SV2 \end{aligned} \qquad (V\text{-}1)$$

In regard to this model, two issues deserve further comments; a functional form and dummy variables. Previous studies in this area indicate that a log form provides a better result than a linear form, so this study compares two forms, linear and log form. Equation (V-1) is converted to a log form equation (V-2) except dummy variables. The variables in equation (V-2) are transformed by taking their natural logarithms so as to linearize the equation (V-3) as follows:

$$\text{Labor productivity} = a \cdot BH^{b1} \cdot OG^{b2} \cdot e^{b3O1} \cdot e^{b4O2} \cdot e^{b5S1} \cdot e^{b6S2}$$
$$LA1^{b7} \cdot LA2^{b8} \cdot LA3^{b9} \cdot e^{b10L1} \cdot e^{b11L2} \cdot e^{b12L3}$$
$$e^{b13L4} \cdot e^{b14L5} \cdot PRC^{b15} \cdot PD^{b16} \cdot PR1^{b17}$$
$$PR2^{b18} \cdot PR3^{b19} \cdot SV1^{b20} \cdot SV2^{b21} \qquad \text{(V-2)}$$

$$\text{Log labor productivity} = a + b1 \log BH + b2 \log OG + b3\ O1 + b4\ O2$$
$$b5\ S1 + b6\ S2 + b7 \log LA1 + b8 \log LA2 +$$
$$b9 \log LA3 + b10\ L1 + b11\ L2 + b12\ L3 +$$
$$b13\ L4 + b14\ L5 + b15 \log PRC + b16 \log PD$$
$$b17 \log PR1 + b18 \log PR2 + b19 \log PR3 +$$
$$b20 \log SV1 + b21 \log SV2 \qquad \text{(V-3)}$$

The next issue is the treatment of dummy variables. In this study, the dummy variables are form of ownership, type of store and type of location. As Rao and Miller (1971, p. 92) suggested, in general, m categories can be distinguished by (m-1) dummy variables, so one category becomes excluded. The matrix below depicts the appropriate coding procedure for form of ownership and the same procedure is applied to the other two variables; type of store and type of location.

Form of ownership	Dummy variable number	
	01	02
Single proprietorship	1	0
Partnership	0	1
Corporation	0	0

Therefore three forms of ownership are coded as 01 and 02, three types of stores as S1 and S2, and six different locations are coded as L1, L2, L3, L4 and L5. The final number of variables after considering dummy variables is 21, though the basic model contains only 15 explanatory variables.

CHAPTER VI

ANALYSIS OF THE DATA

This chapter consists of three main findings from the analyses of the data. First, based on 1976 data, a comparison between a linear and log form is made, since an empirical test provides a clue as to which form must be considered when a conceptual approach does not support either one of them. Second, value added as a measure of output is conceptually superior to other measures, although many previous studies have adopted sales volume as a measure of output. Thus this study attempts to find whether any significant difference exists between these two types of measures. Third, the developed productivity model will be tested in terms of how much variance in productivity can be explained by the determinants of the model, whether the hypothesized relationship between productivity and its determinants can be confirmed, and to what degree productivity can be improved by an increase of one of its determinants.

Linear Versus Log

Table VI-1 is based on a linear form of a multiple regression model, while Table VI-2 is based on a log form. A comparison of these two results indicates that productivity in a log form provides a better explanation of the variance of productivity than a linear form, since

TABLE VI-1

1976 LINEAR MODEL
(Value added divided by full time equivalent employees)

	bi	t value
Intercept	-5098.42	-0.75
BH	12149.59	3.50**
OG	-0.28	-2.57*
O1	- 934.58	-0.69
O2	869.85	0.53
S1	-3837.62	-2.51*
S2	-1641.89	-0.95
LA1	0.00	0.45
LA2	4703.33	1.31
LA3	-36862.76	-3.07**
SV1	-99876.73	-1.11
SV2	-1994968.80	-4.97**
L1	2847.08	1.97
L2	2989.69	1.69
L3	2719.65	1.32
L4	2455.67	0.98
L5	3381.45	2.26*
PRC	-411.55	-0.27
PD	107.06	3.16**
PR1	-10710.53	-1.38
PR2	31294.79	1.14
PR3	-479.82	-0.18
R^2	0.445	
F	4.02**	

*significant at the level of 0.05.

**significant at the level of 0.01.

TABLE VI-2

1976 LOG MODEL
(Value added divided by full time equivalent employees)

	bi	t value
Intercept	0.435	0.65
BH	0.113	0.34
OG	-1.043	-14.36**
01	0.051	0.81
02	0.112	1.49
S1	-0.094	-1.36
S2	-0.043	-0.54
LA1	0.908	13.54**
LA2	0.038	0.98
LA3	-0.020	-0.95
SV1	-0.126	-5.56**
SV2	-1.047	-15.85**
L1	0.063	0.94
L2	0.080	0.99
L3	-.052	0.56
L4	0.075	0.65
L5	0.040	0.58
PRC	-0.002	-0.08
PD	0.029	0.53
PR1	-0.064	-2.47*
PR2	0.023	2.10*
PR3	-0.005	-0.16
R^2	0.810	
F	21.36**	

*significant at the level of 0.05.

**significant at the level of 0.01.

R^2 of a log form is twice as much as that of a linear form, though both have used the same productivity model and data. It is also true to say that R^2 is not the only indication of the appropriateness of a regression model over another. But when R^2 of one model is far better than that of another model, to state that the former is better than the latter is reasonable. Therefore the rest of this chapter will use the log functional form.

Productivity Measurement

Chapter III discussed several different measures of input and output. It also stressed that these measures have some common problems. But they have their own distinctive advantages and disadvantages as measures of productivity. If they are different conceptually, does the adoption of different measures of input and output really make any difference in the calculation of productivity? There are no objective criteria for this issue, but one possible solution is to see how close these measures of input and output are to each other. If, for example, the correlation coefficient for sales volume and value added is one, the adoption of either one will make no difference on productivity.

Six input and output measures are used to test how close they are. The criterion for this selection is the availability of the data. The selected measures for labor input are the number of employees, the number of hours worked and wages. For output, sales volumes, gross margin and value added are used.

Table VI-3 summarizes their relationships over three years, 1976, 1977 and 1978. This table shows all correlation coefficients are relatively high and significant at the level of 0.001. For the data of

TABLE VI-3

PAIRWISE CORRELATION COEFFICIENTS FOR DIFFERENT MEASURES OF PRODUCTIVITY

	SAL	MAR	VAL	EMP	HOU	WAG
			1976			
SAL	1.000					
MAR	0.995	1.000				
VAL	0.982	0.981	1.000			
EMP	0.922	0.878	0.935	1.000		
HOU	0.901	0.836	0.912	0.966	1.000	
WAG	0.972	0.968	0.988	0.962	0.938	1.000
			1977			
SAL	1.000					
MAR	0.950	1.000				
VAL	0.984	0.947	1.000			
EMP	0.896	0.812	0.878	1.000		
HOU	0.949	0.869	0.940	0.931	1.000	
WAG	0.976	0.953	0.985	0.909	0.966	1.000
			1978			
SAL	1.000					
MAR	0.984	1.000				
VAL	0.973	0.955	1.000			
EMP	0.656	0.639	0.668	1.000		
HOU	0.757	0.668	0.781	0.576	1.000	
WAG	0.963	0.944	0.990	0.658	0.866	1.000

All coefficients are significant at the level of 0.001.

SAL = sales volume, MAR = gross margin, VAL = value added, EMP = the number of employees, HOU = the number of hours worked, and WAG = wages.

1976, there is no distinctive difference among three different measures of output since their correlation coefficients are close to one. In other words, different types of output measurement have no influence on productivity. Similar patterns are also found in 1977 and 1978.

The findings of the input side are not different from that of the output side, though the strength of their association is somewhat weaker than the latter, especially in 1978. In 1976 and 1977 all correlation coefficients among different measures of labor input are high.

Table VI-3 also shows that input measurements are closely associated in a linear manner with output measurements, especially among pecuniary measures. If wages are adopted as an input measure, three different measures of output may present almost the same result.

The major implication of this section is that the selected measures of productivity would not provide any significant difference in the calculation of productivity. In practice it is necessary to be consistent and use the same measures of productivity over several periods of time, if a researcher wants to obtain a reliable result. Though this study found that the three measures of output are closely related, it is not recommended that sales volume be used for one year and others for the next year.

In addition, this section also reviews the result of two different measures of output, sales and value added. The regression model shows that both measures have a similar explanatory power of the variance in productivity. Table VI-2 and Table VI-4 indicate that based on sales as a measure of output, the coefficient of multiple determination is 0.823 while based on value added R^2 is 0.810. The model based

TABLE VI-4

1976 LOG MODEL
(Sales divided by full time equivalent employees)

	bi	t value
Intercept	0.520	0.68
BH	0.993	2.63**
OG	-0.862	-10.42**
O1	0.117	1.62
O2	0.176	2.05*
S1	-0.082	-1.04
S2	0.154	1.71*
LA1	0.786	10.30**
LA2	-0.041	-0.95
LA3	0.068	2.74**
SV1	-0.048	-1.89
SV2	-1.112	-14.79**
L1	-0.097	-1.26
L2	0.000	0.00
L3	-0.059	-0.57
L4	0.012	0.09
L5	-0.116	-1.48
PRC	-0.047	-1.09
PD	0.376	5.96**
PR1	0.020	0.70
PR2	0.017	1.70
PR3	0.054	1.32
R^2	0.823	
F	23.26**	

*Significant at the level of 0.05.

**Significant at the level of 0.01.

on sales has eight significant independent variables and the model based on value added has six variables at the level of 0.05 or less. This comparison shows that basically two measures present almost the same results in terms of R^2 and the number of significant variables. Thus value added which is more sound conceptually will be used to test the hypotheses and to confirm that the structural form of the model derived empirically from the 1976 data holds with 1977 and 1978 data.

Test of Hypotheses

The developed hypotheses (pp. 82-100) are under three blocks of determinants of productivity; business health, organizational structure and business decision variables which themselves consist of marketing decision variables and labor related variables. Table VI-2 shows that, out of 15 hypotheses, only six variables are statistically significant. They are: scale, wages, two service levels and two promotional variables.

Business Health

Business health of a firm is measured in terms of an increment of sales over last year and its relationship with productivity is hypothesized as positive (H.1.1). The estimated coefficient of this variable has the correct sign but the coefficient is not significant at the 0.05 level, therefore the hypothesis is not confirmed.

Organizational Structure

Organizational structure is reflected by three variables; scale (H.2.1), form of ownership (H.2.2) and type of store (H.2.3.).

It is assumed that all three variables would make a difference in productivity but no direction of association is specified.

Empirical results show that scale of a store has a negative relationship with labor productivity at the 0.01 significance level. Though this result is different from the majority of the previous studies, it agrees with the result of Ingene and Lusch (1980). When scale of store increases, three impacts are possible relating to labor productivity. First, the rate of increase in output may be greater than that of increase in input, as a result, labor productivity will increase, as scale becomes larger. Second, the rate of increase in output may be less than that of increase in input, thus labor productivity has a negative relationship with scale. Third, when the rate of increase in output and input is similar, there may be no change in labor productivity. The empirical result supports the second choice. In other words, as scale of store increases by one percent, the labor productivity drops by 1.043 percent.

Another explanation for the negative relationship between labor productivity and scale can be found in the model itself. The model attempts to find the impact of scale on labor productivity while other variables are held constant. The specific variables which may influence this relation in the model are management efficiency, capital to labor ratio, and in-store service.

The model artificially assumes that as store size increases the level of management efficiency will remain constant. However, one might expect that as store size increases that management efficiency may increase because the store may add more employees but relatively few if any new managers. Similarly the model assumes that the capital to labor ratio will remain constant. Again this may be unrealistic because as floor space increases, the store may be adding more to capital than to labor. Finally the model assumes that as scale increases that in-store service will remain constant. Many times larger stores use more self-service displays and merchandising methods and therefore the assumption of in-store service being held constant is unrealistic.

The preceding suggests that as store size increases, labor productivity may in reality increase because in-store service may decline, management efficiency rise and the capital to labor ratio increase. The next variable in organizational structure is form of ownership; single proprietorship, partnership and corporation. It is hypothesized that different levels of labor productivity can be explained partly by different form of ownership. The empirical result does not confirm this hypothesis at the 0.05 level of significance. One speculation of this disappointing result is that labor productivity may not be different among different forms of ownership. But this speculation must be rejected, since the 1977 Census of Retail Trade reported that labor productivity for single proprietorship, partnership and corporation were 11.63 dollars, 9.95 dollars and 7.93 dollars, respectively. Its measure for labor productivity is sales divided by payroll. Another speculation is related to the hypothesis itself. Although the hypothesis states that ownership influences management style and, in turn, management style becomes a determinant of labor productivity, the decisive factor for form of ownerwhip may depend on the consideration of the tax law rather than the operating efficiency of a firm.

The last variable considered is type of stores. In this study three types of stores are considered; hardware stores, lumber/building materials and home center. Hypothesis 2.3 indicates that type of stores is one of the key determinants of labor productivity. But the result shows that this relation is not confirmed at the 0.05 significance level. One possible answer for this unconfirmed result is that for this particular variable the employed sample may not represent the population, since another sample in hardware industry indicates different performance by different types of stores. The National Hardware Retail Association found that in 1978 labor productivity for three types of stores--hardware stores, lumber/building materials and home center--were $9,162, $18,134 and $15,649, respectively. Its measure for labor productivity is value added divided by full time equivalent employees.

Labor Related Variables

Labor related variables are wage rates (H.3.1); management efficiency (H.3.2.) and capital to labor ratio (H.3.3). Among three variables, wage rates are found to have a positive relationship with labor productivity at the 0.01 significance level. As wage rates increase by one percent, labor productivity will increase by 0.908 percent when other variables are constant. This finding implies that this industry utilizes its labor at the maximum level, since the marginal cost is almost equal to the marginal revenue when the elasticity is near one. One of the reasons for this maximum use of labor is that the higher wage rates are, the more pressure a store has to increase labor productivity. Another implication lies in the fact that wage rates have significant relationship with quality of labor which can make a great contribution to high labor productivity.

The next hypothesis is concerned with management efficiency. This variable is measured in terms of the ratio of the number of management employees over the number of total employees. Hypothesis 3.2 indicates that this ratio has a negative relationship with labor productivity. The empirical result shows that the hypothesized direction is not correct and this variable is not significant at the 0.05 level. One of the possible reasons for this positive relation lies in the existence of a large number of mom and pop stores in the hardware industry. Both the 1972 and 1977 Census of Retail Trade reported that close to 30 percent of all retail establishments are mom and pop outlets (Ingene and Lusch, 1980, p. 18). The typical characteristic of mom and pop stores is that they operate their own stores based on a rule of thumb from a family tradition rather than rely on high quality of management staff which provide expertise in increasing labor productivity. Consequently mom and pop stores with the lower ratio of the number of management employees over the number of total employees achieve lower level of labor productivity than those stores with a higher ratio of management efficiency. But this speculation must be applied carefully in practice, since a store which hires management staff beyond the optimal level will lose its labor productivity.

The last hypothesis in labor related variables is the degree of capital intensity measured by the ratio of depreciation to payroll. This hypothesis is not confirmed at the 0.05 level and the sign of this variable, being negative, is also incorrect. One of the possible explanations of this unconfirmed result belongs to the problem of the measurement of this variable. The criterion for the adoption of depreciation expenditures is convenience. The information on depreciation expenditures is readily available from the income statement of a firm. But the accuracy of this measure of capital is somewhat doubtful, since most depreciation expenditures are based on the tax law rather than the degree of capital used. A possible alternative for this measure is the adoption of the flow concept as mentioned in the section in capital input, since the concept reflects the actual amount of capital employed to produce current output. This measure is derived by aggregating the capital hours used weighted by the rental value of each type of structure and piece of equipment.

Marketing Decision Variables

Marketing decision variables represent two service levels and the 4 p's. In service levels, in-store service is measured in the context of the number of employees divided by square feet (H.4.1), while out-store service is measured by the delivery expenditures divided by net sales (H.4.2). Both service levels are hypothesized to have a negative relationship with labor productivity, since the concept of self service is dominant in the hardware industry. The result supports both hypotheses at the 0.01 significance level. As a store increases its in-store service by one percent, labor productivity will decrease by 0.126 percent when other variables are constant. Out-store service has the same negative impact on labor productivity, though the impact is deeper than in-store service. As a store increases its out-store level by one percent, its labor productivity will drop by 1.047 percent. Both findings imply that the increase of service levels in the hardware industry is not profitable, especially the out-store service level and, consequently, the hardware industry must seek or expand the concept of self service in order to increase labor productivity.

The first variable considered in conjunction with the 4 p's is location. Hypothesis 4.2 assumes that different locations will provide a partial explanation of different levels of labor productivity. Six different locations in this hypothesis are; downtown (central business district), near the edge of downtown, neighborhood shopping center--small, community shopping center--medium to large, free standing--no adjacent stores, and on highway or street several stores nearby. The empirical analysis does not confirm this hypothesis, but all locations have the same direction sign, positive. One of many possible reasons for this insignificant relation is that the selected six locations may not represent the general impact of place on labor productivity. For instance, a store in the downtown area which is located on the corner of main street could obtain higher visibility and accessibility than another store in the same downtown area which is on a side street or in the middle of main street. The same logic can be applied to the case of a shopping center. Various stores in the same shopping center have different levels of customer traffic. The existence of different levels of rent even in the same shopping center supports this argument. Therefore a future study may consider a more articulate measure of location such as the number of cars passed by per month or the number of customers walking by per month.

The next hypothesis is concerned with price (H.4.3). Price is hypothesized to have a negative relationship with labor productivity. The adopted measure for price is the ratio of gross margin to net sales. Table VI-3 shows that the relationship between price and labor productivity is not confirmed at the 0.05 level, but the hypothesized sign is confirmed.

One speculation for this result lies in the assumption that price is one of the variables which a store manager can control. The price range of products in the hardware industry is relatively narrow, especially in the case of products easily recognized by consumers. When a manager considers the fact that consumers are more price conscious and do more comparative shopping, his price decision must be competitive in the market. A tentative conclusion for this variable is that the manager's control over price is decreasing.

In regard to product, hypothesis 4.4 states that the product assortment has a positive relationship with labor productivity. Table VI-2 shows that this relation is not confirmed at the 0.05 level. But the direction of this hypothesis is correct. The main problem of this insignificant result may stem from the measurement of product. This study recognizes that a correct measure of product must include at least three dimensions of product, the proper depth and width of product, minimal stockout and quality of products. Because of the difficulty of obtaining the measure of the three dimensions, this study adopts the ratio of inventory over per square feet as a surrogate of product assortment. This surrogate measure represents the overall product assortment but it is lacking in the detail of specific product assortment. Thus this study suggests that a future study may develop a more precise measure of product after considering these three chacacteristics of product measurement.

Marketing promotions are reviewed in terms of advertising (H.4.5.1), sales promotion (H.4.5.2) and personal selling (H.4.5.3). Unlike the hypothesis, the result demonstrates that advertising has a negative association with labor productivity at the 0.05 significance level. As the ratio of advertising expenditures to inventory increases by one percent, productivity declines by 0.064 percent.

There are four possible alternative explanations of this negative association between advertising and labor productivity. The first explanation is that the hardware industry is making unprofitable advertising expenditures. But a basic proposition of this study is rational behavior. Therefore this explanation must be eliminated from the consideration of a partial answer, since it is irrational to spend more money on advertising beyond the point of profit maximization.

The second explanation belongs to the long-term effect of advertising. No one denies the fact that all advertising has a certain level of carry-over effect, although the length of such impact varies. The hardware industry, the subject of this study, carries more durable goods than non-durable goods. As a result, the carry-over effect of advertising in this industry is higher than others such as food related industries, due to the characteristics of products. This long-term impact may cause the negative association between advertising and labor productivity. A future study may treat advertising as a capital investment and amortize advertising expenditures over several years.

The third possible explanation is that the amount of advertising expenditures is not equal to the quality of advertising, although in the process of developing the hypothesis such an assumption has been made. Relating to this third speculation, in the hardware industry those who spend relatively small amount on advertising may produce high quality of advertising campaigns while those who have a high level of advertising budget may fail to achieve the expected result.

The last explanation of the found relationship can be found in the sequential effect of advertising. An intensive advertising campaign brings about increased sales and, in turn, increased sales cause high inventory turnovers. The result of high inventory turnovers can be stockouts. A store with a high level of stockouts loses consumer loyalty, since consumers will patronize a store which displays and carries what they want. The loss of loyal customers will bring value added down and the reduced value added creates low labor productivity.

The previous mentioned three alternative explanations, except the first one, are possible sources of the unexpected negative relationship which was found, but there is no precise method to evaluate the individual impact of each explanation. Thus it is reasonable to state that a combination of these three alternatives may cause the negative relationship between advertising and labor productivity.

Sales promotion, another marketing promotion method, was found to have a positive relationship with labor productivity. As a store increases the ratio of discount sales to net sales by one percent, labor productivity increases by 0.023 percent. This hypothesis is confirmed at the 0.05 level.

The last item considered in 4 p's is personal selling. The empirical result does not confirm the hypothesis that there is a negative relationship between the ratio of the number of salespeople to the total number of employees and labor productivity at the 0.05 level. But the direction of this variable is consistent with the hypothesized negative sign. Though the empirical analysis does not confirm this hypothesis, one speculation for this negative direction is that hardware stores can achieve high labor productivity when its emphasis is on the concept of self-service rather than personal selling. This speculation is supported by the confirmed result of in-store service.

Reduced Model over Three Years

The estimation of the full model (Table VI-2) shows that there exist six significant variables: scale, wage, two service levels and two promotional campaigns. These six variables are a basis of the reduced model which will be further explored over three years.

The main concern of this exploration is to check the consistency of the reduced model over three years. If the model holds over three years, a meaningful implication and prediction can be drawn from the model. The reason to adopt the reduced model instead of the full model is the principle of pasrimony which states that it is better to use fewer variables unless the elimination of a variable would result in a substantial sacrifice in the predictive power of the model.

There is no objective method for judging the consistency of a model over several years, but as a rule of thumb, it is acceptable to review four indicators; R^2, bi value, signs of variables and the number of significant variables.

In 1976, when only six variables are considered in the model, R^2 is reduced from 0.810 to 0.766. This reduction is moderate, since the number of variables in the model is drastically reduced. Table VI-5 shows that when these six variables are used as predictors for 1977 and 1978, the resulting R^2's are 0.679 and 0.642, respectively.

TABLE VI-5

A REDUCED MODEL
(Value added divided by full time equivalent employees)

	1976		1977		1978	
	bi	t	bi	t	bi	t
Intercept	-0.084	- 0.18	1.321	2.53*	1.101	1.67
OG	-1.086	-21.58**	-0.901	-14.46**	-1.031	-13.83**
LA1	0.973	21.98**	0.838	16.40**	0.928	15.23**
SV1	-0.091	- 5.54**	-0.066	- 2.52*	-0.054	- 1.94*
SV2	-1.116	-22.24**	-0.907	-15.60**	-1.000	-13.33**
PR1	-0.088	- 4.73**	-0.092	- 3.69**	-0.016	- 0.54
PR2	0.016	1.89*	0.01	1.34	0.016	1.19
R^2	0.766		0.679		0.642	
F	94.70**		50.84**		40.68**	

*Significant at the level of 0.05.

**Significant at the level of 0.01.

Multicollinearity

The presence of multicollinearity raises problems in the use of regression analysis. Multicollinearity is said to be present if there is a linear dependence among the independent variables. The presence of multicollinearity does not imply that the model should be reformulated, but rather that certain precautions concerning the structural interpretation of the model be taken.

Sharma and James (1981, p. 155) summarized the potential problems of multicollinearity as:

1. The parameter estimates are likely to change significantly with negligible changes in the sample.

2. If some type of variable selection procedure is employed, such as stepwise regression, variables may be eliminated from the model incorrectly because of large standard errors, thus resulting in an incorrectly specified model.

3. The parameter estimates are sensitive to the different computer estimation packages.

4. It is not possible to estimate the relative importance or contribution of each variable.

5. The possible wrong signs of the parameter estimates cause difficulty in interpreting the resulting structural coefficients.

Though the problems of multicollinearity are well recognized, there exist only admittedly arbitrary rules of thumb to measure the severity or degree of multicollinearity. For example,

1. Examine zero-order pairwise correlation among the independent variables. If pairwise correlations are greater than .8 or .9, it usually indicates severe multicollinearity (Farrar and Glauber, 1967).

2. Examine the partial correlation coefficients (Johnston, 1972).

3. Examine the coefficient of multiple determination, R^2, between each Xi and the remaining independent variables in the data set (Farrar and Glauber, 1967).

The first examination of multicollinearity, the zero-order pairwise correlation, is found on Table VI-6. The highest pairwise correlation coefficient over three years is 0.675 which is far lower than the suggested level, 0.8 and the rest are around 0.100, in terms of the pairwise correlation analysis.

Klein (1962, p. 101) said that multicollinearity is not necessarily a problem unless it is high relative to the overall degree of multiple correlation. Specifically, multicollinearity is said to be harmful if the zero-order correlation between two independent variables is greater than the multiple correlation between dependent and independent variables. When two tables, Table VI-6 and Table VI-6, are compared, no correlation coefficient is found to be higher than the multiple correlation. Consequently, it is reasonable to say that there is no harmful multicollinearity with respect to the pairwise correlation coefficient test.

The second suggestion is the examination of the partial correlation of independent variables. Table VI-7 shows that the highest partial correlation coefficient is 0.806 which is significant at the 0.01 level. The number of correlation coefficients above 0.5 is two. Therefore this examination also indicates that there exists no harmful multicollinearity in the model.

The third rule of thumb to test the presence of multicollinearity is to examine the coefficient of multiple determination, R^2, between each explanatory variable Xi and the remaining X

TABLE VI-6

ZERO-ORDER PAIRWISE CORRELATION COEFFICIENTS
FOR INDEPENDENT VARIABLES

	OG	LA1	SV1	SV2	PR1	PR2
			1976			
OG	1.000					
LA1	0.419**	1.000				
SV1	-0.118	-0.061	1.000			
SV2	-0.156	0.622	0.123*	1.000		
PR1	0.220**	0.123**	0.125**	-0.045	1.000	
PR2	-0.029	0.118**	0.083	0.147*	-0.058	1.000
			1977			
OG	1.000					
LA1	0.262**	1.000				
SV1	-0.003	-0.058	1.000			
SV2	-0.140*	0.652**	-0.021	1.000		
PR1	-0.038	0.103**	-0.173**	0.049	1.000	
PR2	0.177**	0.043	0.027	-0.037	-0.035	1.000
			1978			
OG	1.000					
LA1	0.301**	1.000				
SV1	-0.064	-0.050	1.000			
SV2	-0.045*	0.675**	0.030	1.000		
PR1	0.089*	0.124**	-0.222**	0.011	1.000	
PR2	0.134*	0.084	0.142*	0.002	-0.110*	1.000

*significant at the level of 0.05.

**significant at the level of 0.01.

TABLE VI-7

PARTIAL CORRELATION COEFFICIENTS FOR INDEPENDENT VARIABLES

	OG	LA1	SV1	SV2	PR1	PR2
			1976			
OG	1.000					
LA1	0.268**	1.000				
SV1	0.113	-0.114	1.000			
SV2	-0.223*	0.604**	-0.061	1.000		
PR1	0.373**	0.629	0.026	-0.114	1.000	
PR2	-0.169*	-0.069	0.056	-0.009	-0.183*	1.000
			1977			
OG	1.000					
LA1	0.375**	1.000				
SV1	-0.029	-0.018	1.000			
SV2	-0.350**	0.319**	-0.083	1.000		
PR1	0.029	0.075	-0.241*	-0.017	1.000	
PR2	0.168*	0.003	-0.053	-0.105	-0.003	1.000
			1978			
OG	1.000					
LA1	0.284**	1.000				
SV1	-0.004	-0.022	1.000			
SV2	-0.154	0.806**	-0.138	1.000		
PR1	0.123	0.072	-0.113	0.054	1.000	
PR2	0.003	-0.135	-0.011	-0.119	-0.195*	1.000

*significant at the level of 0.05.

**significant at the level of 0.01.

variables. Table VI-8 summarizes the coefficients of multiple determination over three years. Out of six variables, three variables produce high R^2's when each is regressed against the remaining independent variables. Farrar and Glauber (1967, p. 98) suggest that if its multiple correlation with other members of the independent variable set is greater than the dependent variables multiple correlation with the entire set, the multicollinearity problem is serious.

TABLE VI-8

R^2 FOR INDEPENDENT VARIABLES

Independent Variables	1976	1977	1978
OG	0.860	0.869	0.857
LA1	0.868	0.835	0.860
SV1	0.119	0.051	0.085
SV2	0.834	0.797	0.811
PR1	0.120	0.070	0.067
PR2	0.057	0.075	0.052

Based on their criteria, the multicollinearity in this model is serious enough that further steps to eliminate it should be taken.

This study utilizes three rules of thumb to find the degree of multicollinearity. The first two methods indicate that there is no problem of multicollinearity in the model. However, the last method indicates that there exists a harmful multicollinearity in the model.

If this study had used only one year of data to predict the coefficients in the model and to explain the structural relationship between a dependent variable and independent variables, then it would be recommendable that additional steps be taken to address the problem of multicollinearity.

The suggested approaches for multicollinearity are (1) dropping one or more variables involved in multicollinearity, (2) artificial orthogonalization of the variables, and (3) replacing ordinary least squares with a biased estimation such as ridge regression or latent root regression (Sharma and James, 1981, p. 155).

As discussed in the previous section, the developed model is consistent over three years. Two of three rules of thumbs to test multicollinearity revealed no existence of multicollinearity problem in the model and that no further step is required to correct it.

Comparison of Mean Square Errors

This section attempts to investigate how consistent the developed model is with the actual data.

The reduced model based on 1976 data (Table VI-5) provides the following equation:

$$\begin{aligned} Lp \;=\; & -0.084 - 1.086{*}\ OG + 0.973{*}\ LA1 \\ & -0.091{*}\ SV1 - 1.116{*}\ SV2 - 0.088{*}\ PR1 \\ & + 0.016{*}\ PR2 \end{aligned} \qquad \text{(VI-1)}$$

This equation is used in 1977 and 1978 data to find the difference between the actual mean square error and the mean square error based on the 1976 model. The mean square error (MSE) indicates the variation in the dependent value which is not explained by the regression line, therefore the lower the value, the better the model explains the variance of the dependent variance. The significance of this test lies in the fact that if the difference between two MSE is small, the 1976 model has almost the same prediction power as the 1977 and 1978 model without any change in coefficients of the 1976 model.

If reliability is considered as the likelihood of obtaining sample estimates that will be reasonably close to the actual parameters, this examination can be viewed as a type of reliability test.

Table VI-9 shows two types of MSE. The actual MSEs for 1977 and 1978 come from the equation with their own coefficients of independent variables, while the predicted MSEs come from the 1976 equation applied to 1977 and 1978. Since there is no substantive difference between two types of MSE, the model may be considered highly reliable.

TABLE VI-9

ANALYSIS OF MEAN SQUARE ERRORS

	1976	1977	1978
N	180	151	143
Actual	0.033	0.054	0.081
Predictor	(0.033)	0.057	0.085

In addition to the analysis of MSE, this section also reviews how accurately the model predicts labor productivity in the future.

Based on equation VI-1 labor productivity is estimated for 1977 and 1978. This relationship can be stated as:

$$ALP = a + b\ ELP \qquad \text{(VI-2)}$$

where:

ALP is actual labor productivity

ELP is estimated labor productivity for 1977 and 1978 based on 1976 coefficients

a is intercept

b is slope

If its prediction is perfect, the intercept (a) will be zero and the slope (b) will be one. The actual data shows the following results for 1977 and 1978.

$$ALP\ (77) = \underset{(0.460)}{1.482^*} + \underset{(0.048)}{0.845^*}\ ELP \qquad \text{(VI-3)}$$

$$ALP\ (78) = \underset{(0.572)}{0.982^*} + \underset{(0.059)}{0.896}\ ELP \qquad \text{(VI-4)}$$

The slopes for 1977 and 1978 are relatively close to one and their standard errors are low. But unfortunately the intercepts are disappointing, since the value of the intercepts are not near to zero and their standard errors are high. When t-test is applied to test the null hypotheses that the intercept is zero and the slope is one for 1977 and 1978 models, only the slope of 1978 model is supported at the 0.05 significant level.

Analysis of Stability

Previous discussion reveals that the reduced model is consistent over three years in terms of R^2, the number of significant variables, the signs of independent variables and the magnitude of each variable. These criteria are rule of thumb tests which are subject to change by different researchers. The main objective in the use of this additional analysis is to find whether the data can be pooled over three years with more objective criteria. If the test shows that the data can be pooled in terms of intercepts and slopes of the model, this finding will confirm the previous tentative conclusion that the model is consistent over different years and, as a result, it can be used as a tool of prediction and as a tool of structural interpretation. Specifically this analysis is used:

(1) to test difference in intercepts (slopes are assumed constant for all periods),

(2) to test differences in all slopes over different periods of time,

(3) to test differences in both intercepts and slopes simultaneously over different periods of time,

(4) to test differences in one slope of one variable over different periods of time, and

(5) to test differences in one slope of one variable and in slopes together over different periods of time.

Based on the reduced model (EQ. VI-1), five basic models, which will be explored further, are introduced.

For 1976 $LP = ao + a1OG + a2LA1 + a3SV1 + a4SV2 + a5PR1 + a6PR2$ (VI-5)

For 1977 $LP = bo + b1OG + b2LA1 + b3SV1 + b4SV2 + b5PR1 + b6PR2$ (VI-6)

For 1978 $LP = co + c1OG + c2LA1 + c3SV1 + c4SV2 + c5PR1 + c6PR2$ (VI-7)

For a combined model for 1976 and 1977

$$LP = do + d1OG + d2LA1 + d3SV1 + d4SV2 + d5PR1 + d6PR2 \qquad \text{(VI-8)}$$

For a combined model for 1976 and 1978

$$LP = eo + e1OG + e2LA1 + e3SV1 + e4SV2 + e5PR1 + e6PR2 \qquad \text{(VI-9)}$$

where:

ao - a6 are coefficients of 1976 model

bo - b6 are coefficients of 1977 model

co - c6 are coefficients of 1978 model

do - d6 are coefficients of a combined model for 1976 and 1977

eo - e6 are coefficients of a combined model for 1976 and 1978

LP is labor productivity

OG is scale

LA1 is wage

SV1 is in-store service

SV2 is out-store service

PR1 is advertising

PR2 is sales promotion

F-test is adopted to answer specific questions. F statistics are calculated as:

$$F(dfr - dfu, dfu) = \frac{(SSEr - SSEu)/(dfr - dfu)}{SSEU/dfu}$$

where

SSEr is sum square errors for a restricted model

SSEu is sum square errors for an unrestricted model dfr is degree of freedom for a restricted model

dfu is degree of freedom for an unrestricted model

<u>1976</u> <u>vs</u>. <u>1977</u>. The first question is whether 1976 and 1977 models have the same intercept while all slopes are assumed constant. The unrestricted model for this question is:

$$LP = do + d1OG + d2LA1 + d3SV1 + d4SV2 + d5PR1 + d6PR2 + d7D \quad (VI-10)$$

where D is 0 for 1976 and 1 for 1977

The restricted model is:

$$LP = do + d1OG + d2LA1 + d3SV1 + d4SV2 + d5PR1 + d6PR2 \quad (VI-11)$$

If 1976 and 1977 models have the same intercept, d7 will be zero. The developed hypothesis is:

$$Ho : d7 = 0 \qquad Ha : d7 \neq 0$$

As Table VI-10 indicates, null hypothesis is not rejected since the calculated F value is less than the tabulated F value at the 0.01 level. In other words, it is reasonable to conclude that 1976 and 1977 models have the same intercept.

The next question is whether both models have the same slopes assuming that the intercept is the same. The unrestricted model is:

$$LP = do + (a1OG + a2LA1 + a3SV1 + a4SV2 + a5PR1 + a6PR2) + (b1OG + b2LA1 + b3SV1 + b4SV2 + b5PR1 + b6PR2) \quad (VI-12)$$

This unrestricted model is tested against the previous restricted model (EQ. VI-11). The specific hypotheses for this concern is:

$$H : ai = bi \qquad Ha : ai \neq bi \text{ for same } i$$

where i = 1, 2, 3, 4, 5, 6

Table VI-10 shows that at 0.01 confidence level there is no strong evidence to reject the null hypothesis. Thus it is concluded that both models have the same slopes and the data may be pooled for estimation purposes.

TABLE VI-10

SUMMARY OF F-TEST FOR 1976 AND 1977

Hypotheses[a]	F Value	Degree of Freedom
d7 = 0	0.482	1,323
ai = bi[b]	0.841	6,318
d7 = 0, ai = bi[b]	1.300	7,317

[a]All hypotheses cannot be rejected at the level of 0.01.

[b]i = 1, 2, 3, 4, 5, 6.

The third question extends from the previous two questions, intercepts and slopes together. The unrestricted model is:

$$LP = (do + d7D) + (a1OG + a2LA1 + a3SV1 + a4SV2 + a5PR1 + a6PR2) + (b1OG + b2LA1 + b3SV1 + b4SV2 + b5PR1 + b6PR2) \qquad (VI-13)$$

If the unrestricted model holds, the relationships are:

For 1976 $LP = do + a1OG + a2LA1 + a3SV1 + a4SV2 + a5PR1 + a6PR2$ (VI-14)

For 1977 $LP = (do + d7) + b1OG + b2LA1 + b3SV1 + b4SV2 + b5PR1 + b6PR2$ (VI-15)

But if the restricted model is held, the relationship is:

For 1976 and 1977

$$LP = do + d1OG + d2LA1 + d3SV1 + d4SV2 + d5PR1 + d6PR2 \qquad (VI\text{-}16)$$

When intercept and slopes are considered simultaneously, the hypothesis is:

$Ho : d7 = 0, ai = bi \qquad Ha : d7 \neq 0, ai \neq bi$ for same i

where $i = 1, 2, 3, 4, 5, 6.$

Table VI-10 shows that no evidence is found to reject the hypothesis.

When all its hypotheses are reviewed, the restricted model holds. That is, the data for 1976 and 1977 may be pooled for estimation purposes. This finding implies that the reduced model for 1976 (EQ VI-1) is consistent over 1977.

If the above tests show significant evidence to reject the null hypothesis that the slopes of 1976 model are equal to those of 1977 model, the following question must be answered: Does each slope in the model have the same slope for a variable of the corresponding model with the same intercept or without it? The purpose of this question is to identify which variable contributes the rejection of the hypothesis. But since the result indicates that there exists a strong evidence to pool the two year data, this further step is not necessary.

1976 vs. 1978. The same logic for 1976 and 1977 applies to the 1976 and 1978 models. The specific models for these two years are summarized on Table VI-11, and the summary of F statistics for 1976 and 1978 appear on Table VI-12. The results for 1976 and 1978 show that 1976 and 1978 data may be pooled together since they share with the same intercept and slopes. In other words, the model for 1976 holds over 1978 as it did over 1977.

TABLE VI-11

SUMMARY OF THE UNRESTRICTED AND RESTRICTED MODELS FOR 1976 AND 1978

Restricted Model

LP = eo + e1OG + e2LA1 + e3SV1 + e4SV2 + e5PR1 + e6PR2

Unrestricted Models

Intercept

LP = eo + e1OG + e2LA1 + e3SV1 + e4SV2 + e5PR1 + e6PR2 + e7D

Slope

LP = eo + (a1OG + a2LA1 + a3SV1 + a4SV2 + a5PR1 + a6PR2) + (c1OG + c2LA1 + c3SV1 + c4SV2 + c5PR1 + c6PR2)

Intercept and Slope

LP = eo + e7D + (a1OG + a2LA1 + a3SV1 + a4SV2 + a5PR1 + a6PR2) + (c1OG + c2LA1 + c3SV1 + c4SV2 + c5PR1 + c6PR2)

TABLE VI-12

SUMMARY OF F-TEST FOR 1976 AND 1978

Hypotheses[a]	F Value	Degree of Freedom
e7 = 0	0.036	1,315
ai = ci[b]	1.248	6,310
e7 = 0, ai = ci[b]	1.387	7,309

[a]All hypotheses cannot be rejected at the level of 0.01.

[b]i = 1, 2, 3, 4, 5, 6.

CHAPTER VII

SUMMARY

This last chapter consists of three sections. It begins by presenting a summary of the empirical findings. Secondly, managerial implications are made with respect to the retailing industry. The last section presents several suggestions for future research.

Summary of Findings

Based on the previous studies in productivity, a productivity model is developed and tested empirically. The main feature of this model is that the variance in labor productivity can be explained by three blocks of determinants; business health, organizational structure and business decision variables which themselves consist of marketing decision variables and labor related variables.

Before the hypotheses are tested, this study analyzes the functional relationship between labor productivity and its associated variables and it also attempts to determine if there is any differences among different measures of input and output.

When two forms, a linear form and log form, are compared, the result indicates that a log form provides a better explanation of the variance of productivity. This finding justifies the previous use of a log form in searching for productivity determinants.

Two separate tests are conducted to investigate the similarity of different measures of productivity. The first test, zero-order pair-wise correlation coefficient test, shows that the examined six measures are not dramatically different. In the second test, the two most commonly used measures of output are further explored. When value added and sales are adopted as a measure of output, the regression model shows that both measures have similar explanatory powers of the variance of productivity.

The productivity model is the foundation of 15 hypotheses. The analysis of 1976 data shows that out of 15 hypotheses, only the hypothesis concerning six variables were supported. They are: scale, wages, two service levels and two promotional variables. The reduced model based on these six variables is further explored to find whether this model is consistent over three years in terms of R^2, bi value, signs of variables and the number of significant variables. The result shows that the model is stable over three years. Besides this rule of thumb, a more objective statistical analysis is conducted.

The main purpose of using this additional statistical analysis is to determine if the data of 1976, 1977 and 1978 can be pooled with respect to intercepts and slopes. The result confirms that over a three year period the reduced model is consistent.

The reduced model based on 1976 data is also used to find how consistent the developed model is with the actual data. The analysis of the mean square error reveals that the mean square error of the model is almost identical with that of the actual data. For this purpose, another analysis, a comparison of the predicted labor productivity with the actual labor productivity, is made. The finding is that the predicted labor productivity is close to the actual labor productivity. But the result is not satisfactory, since the statistical analysis supports only the slope of the 1978 model.

The adopted statistical method, regression analysis, requires precaution regarding structural interpretation of the model, when multicollinearity is present. Thus this study tries to find the existence of multicollinearity in the model by using three rules of thumb. The first two methods, zero-order pairwise correlation and partial correlation, show that the model contains no multicollinearity. But the third method, the examination of the coefficient of multiple determination between each independent variable and the remaining independent variables, shows that there exists multicollinearity. This study does not take a further step to eliminate multicollinearity, since two out of three rules of thumb indicated no presence of multicollinearity and the examination of consistency of the model is satisfactory.

Managerial Implications

Before discussing the managerial implications of this study, it is necessary to reemphasize the importance of a balance or a coordination of all marketing efforts to achieve a desired goal. Marketing efforts can be compared with an orchestra. If a member of an orchestra misplays a note, the harmony in their play is distorted. Consequently, the overall performance of this team is far less than otherwise regardless of the excellent play done by the remaining members. The degree of impact by the uncoordinated efforts in marketing is less visible in the short-run, but in the long-run it is a matter of survival after the uncoordinated efforts have been accumulated. Thus this study suggests that the cornerstone of the following managerial implications is the coordination of marketing efforts from the top to bottom and from advertising through merchandise displaying.

This study suggests three fundamental steps to improve labor productivity.

1) Start to measure labor productivity.

2) Identify determinants of productivity.

3) Develop and implement a strategy based on the identified determinants.

As Vereen (1978, pp. 54-57) recommends, if a store does not utilize labor productivity as a measure of its performance, then by merely beginning to measure labor productivity it can improve productivity drastically with minimal cost and effort. This first step is a prerequisite condition for the next two steps, and, consequently, a store which is concerned with its performance must start immediately to measure labor productivity.

Since the second step, identifying productivity determinants, has been conducted in Chapter VI, the following discussion emphasizes the third step, the development and implementation of a strategy based on the six confirmed variables.

The first significant variable is scale of store. Since the decision on store size requires that a long-term commitment be made, it is necessary to take extra precaution before reaching any decision about this variable. The empirical finding shows that scale of store has a negative association with labor productivity. As scale of store increases by one percent, the labor productivity will drop by 1.043 percent. This result is based on the assumption that the other variables in the model are constant.

If a store cannot change several variables related to scale of store, then its labor productivity will drop with the expansion of its size. In other words, there is no assurance of higher labor productivity by increasing the scale of a store. In order to reduce the risk of lower labor productivity as store size increases, management must consider three other variables: management efficiency, in-store service and capital intensity. In short, the empirical results suggest that if a firm wants to have increased labor productivity as it increases store size, then it must also increase its management efficiency, increase its capital to labor ratios, and reduce in-store service (that is, to utilize more self-service merchandising methods).

The next managerial implication is drawn from wage rates. The empirical analysis supports the hypothesis that wage rates have a positive relationship with labor productivity. It also shows that the hardware retail industry utilizes its labor to maximize profits since the elasticity of this variable is near one. This finding reinforces the need in the hardware industry to recruit high quality labor and pay competitive wages to improve labor productivity. This is because the contribution to labor productivity by high quality employees is greater than their cost and in this particular instance wages are regarded as a barometer of experience, training and education of employees. The last comment on this variable is that a store manager must keep track of performance by comparing labor productivity with the average labor productivity of this industry. Furthermore, by measuring labor productivity of each employee, a store can determine who is worthy of his wages and who is not, and through this information it can replace low productivity employees with high productivity employees. The consequence of retaining only high productivity employees is that a store can operate with less employees and its labor productivity can be improved.

The next topic in managerial implications is related to self-service. The empirical result shows that both in-store service and out-store service have a negative relationship with labor productivity. Specifically, as a store increases its in-store service (measured by the number of employees divided by square feet) by one percent, labor productivity will drop by 0.126 percent when other variables are constant. Another service level also has a negative impact on labor productivity; as a store increases its out-store service (measured by the delivery expenditures divided by net sales) by one percent, its labor productivity will decrease by 1.047 percent. These two variables confirm that the retail hardware industry is on the way to self-service and this industry can further increase its labor productivity by continuing to adopt the concept of self-service.

Since it is not easy to change from a full-service store to a self-service store overnight, this study recommends that a full-service store consider eliminating out-store service and become a store which provides a relatively low level of in-store service with no out-store service. This slow change will minimize the resistance from its customers and help to increase its labor productivity by removing out-store service which is a key obstruction to improved labor productivity. In this process a store manager must convince its customers to accept reduced service in return for lower prices. After a careful analysis is made of the performance of this change, the store can expand to a self-service store.

The last managerial implication is concerned with marketing promotional variables, advertising and sales promotion. Advertising is found to have a negative relationship with labor productivity. As a store increases the ratio of advertising expenditures to inventory by one percent, its labor productivity declines by 0.064 percent. Three explanations are suggested in this paper for this negative association. First, in its measure, no consideration is given to the carry-over effect of advertising. Second, its measure assumes that the quantity of advertising, the amount of advertising expenditures, is equivalent to the quality of advertising. In reality, this assumption is often not justified. Third, although an intensive advertising campaign brings high sales and high inventory turnover, the result of high inventory turnover may be the loss of loyal customers due to stockout. The sequential effect may cause lower labor productivity by reducing value added.

These suggested explanations suggest the hardware industry may start to treat advertising as a capital investment rather than as a one time expenditure. Another implication lies in the importance of creative advertising. Creating advertising, based on well defined purpose, imagination and logical thinking, achieves the objective of advertising at lower cost than otherwise. Therefore, the hardware retail industry must emphasize creative advertising rather than the volume of advertising. Another implication of advertising lies in a stockout problem. One of the effects of an intensive advertising campaign may be the lack of coordinated efforts in a firm. Thus, before a store starts special advertising of products, it must schedule ahead to carry enough inventory to match its expected sales volume.

Another significant promotional variable is sales promotion. When sales promotion is measured by the ratio of discount sales to net sales, the analysis estimates that when a store increases sales promotion by one percent, its labor productivity will increase by 0.023 percent. The model indicates that in the short run sales promotion is a more effective vehicle to improve labor productivity than advertising. Thus the hardware retail industry can improve its labor productivity by using various sales promotion methods such as quantity discount, seasonal discount, cash discount and coupons. If these sales promotion methods are used at a proper time, they will be a good mode to obtain higher labor productivity as well as to manage inventory.

Suggestions for Future Research

Several suggestions for future research in productivity are made in this final section.

The productivity model in this study is based on decision making variables, business health and organizational structure. This study assumes that most but not all variance in labor productivity in the hardware retailing industry can be explained by this model. There is, therefore, room to improve the productivity model. One suggestion to improve the model is to include two types of determinants together, decision making variables and firms' uncontrollable variables. The reason for this suggestion lies in the fact that previous studies in productivity found that exogenous variables also have a predictive and explanatory power for productivity. Consequently, if a model considers decision making variables and some exogenous variables together, labor productivity can be better understood.

The empirical part of this study focuses on retailing in the hardware industry. A future study may expand its scope to wholesaling and to other industries to find whether any significant difference exists. For instance, a future study may conduct research to find the difference of productivity determinants across two industries, and two levels of marketing channels, wholesaling and retailing simultaneously. These studies may draw more general conclusions than most previous studies in productivity.

As mentioned earlier, the ultimate goal in productivity measurement and explanation must be total factor productivity rather than single factor productivity. Therefore, in the future, more empirical studies are needed using total factor productivity after its concept and measurements are crystallized.

In the study of productivity determinants, no general model exists. This is because no attempt has been made to compare several models on the basis of the same data. Without such a model, it is more difficult to improve productivity. Thus, another suggestion for future research is to compare several productivity models on the bases of the same data to find a general model for productivity.

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