INDUSTRY ANALYSIS IN TRANSPORTATION

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Introduction

This research has been supported by the United States Department of Transportation, Transportation Systems Center, Cambridge, Massachusetts (U.S. DOT/TSC). The specific research objectives which were chosen are:

I.   To conduct a survey of industry analysis techniques and methodologies, and provide a selective bibliography of books, articles and reports on the subject;

II. To provide a simplified supply-side taxonomy of the transporation industry;

III. To identify the most critical methodology(ies) as they may be applied to one or more of the key industries;

IV. To suggest future research in innovation and productivity in transportation;

V.   To identify and prioritize key industries that TSC should consider in future industry analysis activities; and

VI. To suggest a feasibility approach to a research plan for carrying out the suggested industry analysis studies, and for analyzing the interconnections between Federal policies and corporate strategies and structures.

It must be stressed that the purpose of this paper is limited to suggestions and a selective bibliography. Several members of the U.S. DOT/TSC assisted us in this study, by providing useful references to prior work, expecially in the area of transportation. While we are very grateful to them for facilitating our task we must hold them harmless as far as the results are concerned.

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I.   Survey of Industry Analysis Techniques

An extensive but not exhaustive literature scanning covering the most relevant subjects in transportation economics, methodology for industry analysis applicable to transportation, productivity and innovation, was performed.   Below, we will present exerpts from some representative samples of the material covered in the following four areas as they apply to transportation: A)   microeconomics;   B)   industrial economics and/or econometrics;   c)   field research;   and D)   productivity and innovation.   The above classifications were chosen for convenience of presentation and not because they result in a mutually exclusive taxonomy.   It will become obvious during the review of some of the chosen references, that the work of some authors spans over several classifications.

A.   Microeconomics Applied to Transportation

Some authors have attempted to transfer concepts from microeconomic theory to transportation industry analysis.

Zannetos (1965; 1966),in addition to applying economic theory to the ocean transportation industry, introduces the notion of interperiod demand substitutions due to price-elastic expections.

In the general area of applying classicial microeconomic theory to transportation one can also include the work of Mohring (1970).   The latter views the transportation industry as a public utility and presents an interesting model for optimal toll charges.

Kneafsey (1975) attempts to combine classical microeconomic theory and transportation models, including demand characteristics, forecasting methods and regulatory aspects.   The focus of the book centers on the airline, truck, rail and urban transit transportation industries without dealing with a very crucial research topic in transportation, the automobile industry.

B. <u>Industrial Economics and Econometrics Applied to Transportation</u>

Industrial economics is a huge discipline covering almost all the important aspects of applied microeconomics. Because of the limited scope of our review we will only examine those facets of research in industrial economics that have the most promising potential for the transportation industries.

For convenience of presentation, we have arbitrarily divided our material into four subclasses: (1) industrial economics research applied to transportation; (2) econometric models from the transportation area; (3) research done in industrial economics and econometrics whose focus is more general than transportation, but because of the conceptual frameworks and methodology used, has the potential to be applied in transportation industry analysis; and finally, (4) classical works in industrial economics. The first two sub-classes are covered in the following pages, whereas the latter two are covered in Appendices 1 and 2. In all cases, however, our listing is selective—illustrative rather than being exhaustive.

1. <u>Industrial Economics Applied in Transportation</u>

a) Zannetos (1966) provides an in-depth analysis of the oil tanker market structure and conduct, looking at both the supply and demand for transportation services, as well as the demand for oil tankers. He also provides a methodology for analyzing the dynamics of capital investment decisions and of the various facets of tanker operations. In another effort (1965b) he analyzes the relationship between short-term and long-term rates and the impact on rates of market conditions, economies of scale and risk.

b)   White (1971), in his very interesting dissertation, looks

at twenty-five years of the automobile industry. He assesses

the technology, the minimum efficient size of the firm and

the degree of scale economies. His exposition of entry

barriers, integration,and diversification is,however,rather

insufficient. In terms of conduct, he deals with the product

differentiation and pricing leadership aspects of the automobile

industry. The performance of the industry is considered

oligopolistic with a stagnant technology.White's work,although

interesting, does not provide any insights into the critical

situation of the industry as it unfolded in the early seventies,

as a result of oil-price increases, and the keen competition

from imports. One may foresee that the future of the U.S.

automobile industry may come to rest on technology.

c)   Kneafsey (1974) studies the market structure of airline, truck,

rail,and urban transit industries and also presents several

dimensions of performance and regulatory aspects of the rail

industry.

In terms of regulation, the U.S. Department of Transportation has
produced some interesting pieces of analysis :

a)   John, Coonley, Ricci and Rubinger (1978) present a detailed

history of legislative and administrative measures that led

to the fuel economy standards until 1985. A comparison

between safety, emissions,and fuel economy controls shows that

they were the results of crises, R. Nader's campaign, the environ-

mental movement, and of the oil embargo, rather than the

consequence of a contemplated strategy. The economic effects

of regulation are debatable in their opinion and need to be
reexamined. Finally, legislation has provided guidelines
to improve automobile fuel economy until 1985 because by then
it is estimated that all known and well proven Western Europe
and Japanese technological innovationswill have been employed.
The problem that arises now is how to stimulate technological
innovation and necessary subsequent capital formation that
will allow for increased fuel economy standards after 1985.

b. The U.S. DOT (1979) summarizes the regulatory history that led
to the promulgation of the mandatory fuel standards for auto-
mobiles and light trucks. It was anticipated that this
regulation would result in a reduction in oil imports and provide
a positive impact on the trade deficit and on inflation. The
existing technology was deemed sufficient to achieve the
regulated standards until 1985. From then on new technologies
would have to be developed if higher standards are to be
implemented. The capital requirements would be excessive with
the result of increasing the risk of high losses because of bad
designs and inferior products. This may have an adverse effect
on competition in an already highly concentrated market. The
Secretary of Transportation, however, has the discretionary
power to ease off some of the requirements in the case that
exogenous economic factors (e.g., recession) endanger the
existence of small manufacturers. Employment and GNP are,
therefore, not likely to be affected negatively. The program
can be improved by giving allowances to low volume automobile
manufacturers and giving incentives for domestic production of
foreign automobiles.

c)   The U.S. DOT (1980) provides a picture of the urban road

transit, past and present. Four different scenaria of

demand growth are used. An assessment of production capacity,

manufacturing characteristics,and financial considerations of

the domestic urban road transit vehicles and the associated

subsystem industries are derived. The aforementioned four

scenaria are examined in terms of funding requirements both

in capital equipment and operating and maintenance costs.

Finally, the report provides a technology assessment of the

urban road transit products for the next ten years. The report

concludes with a list of suggested federal actions.

2.   Econometrics Applied to Transportation[1]

Econometrics has been one of the most popular methods to be

applied to the transportation industry.

a)   Toder (1978) uses econometric equations to find the effect of

tariffs on foreign-car demand and on public welfare. Similarly

he studies the effect of imports on domestic-car prices. He

then derives the cost function and the minimum efficient size

of operations. Finally, he does an international comparison

of costs, or productivity and the effect of output decline on

U.S. labor employment. Toder's efforts and contributions are

commendable, but his definitions are not very tight and his

data can benefit from some refinement.

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[1]Our views regarding the uses and misuses of econometrics are presented in
Part III of this paper under Description of Critical Methodologies.

b) Moving along the same lines, R. H. Spady and A. F. Friedlaender

(1978) examined the cost functions of the trucking industry.

Transportation is an industry where qualitative differences

seriously affect the costs associated with the final output.

For example, ton-miles are affected by routes and submarket

specialization. Their results are interesting and in their

conclusions they advise deregulation, because, they claim,

economies of scale do not exist and service does affect costs

and profits. It is interesting to note that despite the

impressive name of their methodology, (Hedonic Cost Functions)

their approach boils down to an econometric model which included

non-market as well as economic variables.

Many other authors mentioned in this report have used econometric

methods as part of their methodology but did not rely exclusively on such.

For this reason they will not be mentioned under this section.

C. Field Research Applied to Transportation

Field research is an area where some worthwhile efforts and funds

have been applied, but mostly on the demand side. In our opinion there

is a need for field research in the supply side of the transportation

industry and the D.O.T. should seriously consider filling this gap,

either by means of grants or internal research.   Such research is also

needed for assessment of productivity.

a) Keeler, Merewitz, and Fisher (1975) compare the costs of using

autos versus bus and rail, in the San Francisco Bay Area. The

authors go into considerable detail to describe the transportation

demand and density during peak and off-peak hours. They then

assess   the full costs, including investment and operating

costs, for all three modes. Their conclusion is that bus

is the cheapest mode for the demand and structure of

San Francisco. Their numbers need considerable updating,

but their approach is exhaustive.

b) Related to field research but not exactly of the type

described above, is a very worthwhile study performed by

D.O.T. The U.S. Department of Transportation (1977) has

studied the institutional factors in transportation systems,

comparing the relative effect that taxes and regulations,

federal policies and programs, automotive industry structure

and practice, and other institutional factors may have on the

introduction of electric vehicles and hybrid vehicles. The

study provides a good selection of data in terms of costs,

safety standards, weights, fees, taxes, speed, accident averages,

demand for transportation, ownership of automobiles, mileage,

parking requirements, electric utility costs, government R&D,

and rate of return on stockholders' alternative investments.

Their findings show that 33 of the 60 factors examined bias

against electric vehicles.

D   Productivity and Innovation Applied to Transportation

Finally we come to the all important question of productivity and

innovation. Amazingly, very little research exists in this area especially

as concerns the automobile industry. One of the reasons may be the

orientation of researchers who appear to be interested mostly in demand

analysis, oil consumption/energy efficiency, and pollution propensity

of existing equipment.

Research in the area of productivity and innovation focuses on
the reasons behind the well-known decline in productivity. The
researchers in this area adopted either a macro point of view focusing
on the whole economy or a micro-approach focusing on the productivity
of a particular firm or industry.

Within the macro-approach, two main methods have been used:
(a) the growth accounting and (b) the production-function method.
Growth accounting assumes that there is a competitive market and a
well-behaved aggregate production function, and that for most factors
the contribution of inputs (the marginal product of a factor) is measured
by its market return. Most of the studies used this technique to
estimate the effect of a specific factor on productivity growth. A
review of some   important studies using growth accounting is given
in Appendix 3.

1.   Productivity Research in Transportation

a)   Using transportation industries as a research focus, Scheppach and
      Woehlcke (1976) attempt to define rational and unbiased productivity
      measures. They measure output in terms of operating revenues, labor
      input in terms of compensation and hour data, and capital input in
      terms of constant dollars (taxes included as costs). Railroads, motor
      carrier and air carrier industries are examined and "rational"
      productivity measures are developed for each carrier class. The level
      addressed by this study is rather elementary, which is characteristic
      of the existing research, and points out the need for further
      substantive investigation into issues of productivity in surface
      transport.

b)   Focusing on the automobile industry, Coonley (1980), poses the

problem of the lack of consistent and meaningful definition of

productivity and lack of productivity measures. A historical

review reveals that for the United States the growth rate of

productivity has been declining while that of the rest of

industrialized countries of Western Europe and Japan has been

growing. Although the growth rate of productivity for the automobile

industry is above average for the U.S. manufacturing sector, it

is apparent that the industry is threatened by the Japanese. It

is expected that technological innovation will enhance the performance

of the U.S. automobile industry, but only if i) new technology is

introduced more rapidly in the United States than in the respective

countries of competitors; ii) the market share of U.S. manufacturers

does not drop below some 'critical point' consistent with minimum

efficient-size requirements; and iii) capital is available for the

heavy expenditures required.

c)   For the railroad industry, Kerr, Korhouser, Alan et al. (1980) ,

present a collection of papers from a conference. Topics covered

include work rules and productivity, truck rehabilitation, equipment

utilization, general productivity, cooperation within the industry,

and competition. The authors suggest that for improvements in

productivity the industry must obtain greater cooperation from

labor regarding work rules, economical maintenance, better utilization

of plant and equipment, and progressive marketing.

d)   Wyckoff [1974], looking at his subject from a management point

of view, found that organizational "formality" influences the

performance of the terminal operations of the motor-carrier

industry.   The organizational formality can be represented by,

(i)   Financial resources allocation methods; (ii)   the use of

profit centers; (iii)   organizational structures; (iv) reward

systems and (v)   centralization of decision making.

e)   In contrast to Wyckoff's approach, Davis and Dillard

[1977], use an econometric model to find that the limitations of

weight, length, and height of motor-carriers reduce the productivity

of the industry.

f)   For the airlines industry, Morrel and Taneja [1979] found that the

U.S. airline companies out-performed European airline companies in

productivity.

After examining various papers in the field of productivity, one realizes

that the productivity problem in transportation is very complicated.   It does

not only depend on the firms' behavior, given a transportation mode, but also

on the transportation equipment supply industries (auto, airplane) and on the

particular investment policies adopted by the U.S.Department of Transportation.

For example, the more efficient is the care of the interstate highway system

the greater the productivity of the trucking industry.   In order to understand

the intermodal relationships and the market conduct of each particular

transportation mode, a complete industry analysis is necessary.   As we mentioned

before, the sources of the productivity decline are different among industries.

In trucking the problem may be government regulation; in railroads, the

problem may be unions or the slow adoption of management techniques; in auto,

the problem may be attributed to lack of technological innovation or

inefficient management systems. Therefore, if one were to construct and
apply a more-or-less common methodology to each specific industry for
analysis, one could obtain more insights regarding productivity problems.
We must stress, however, that one cannot use one equation or one simple tool
to solve productivity problems for every industry. In Part III of this
report, we suggest a methodology which may be adapted to study the
productivity problem of transportation industries.

It is rather difficult to examine the productivity problem without
discussing innovation. Innovations can be mainly classified into two
categories: product and process. Process innovations are usually embodied
into production equipment or manufacturing processes and organizations. The
more widespread is the use of this equipment and methods of organizing work,
the higher the firm's productivity. It is logical to hypothesize, therefore,
that innovation is the key to the enhancement of productivity. In spite of
this, no empirical research has been carried out to analyze the relationship
between innovation and productivity, and as a result we only present papers
concerning innovation.

2.   Innovation Research in Transportation

Basically, we can identify three types of approaches in studying
innovation . One approach is to study innovation across industries, and try
to test general hypotheses regarding the impact on innovation of firm size
and market structure. The second approach focuses on the innovation adoption
in a particular industry, and a third focuses on the adopters of a particular
innovation. A review of some research studies on innovation in industries
other than transportation is given in Appendix 4. Under this section we will
limit ourselves to research focusing on transportation.

a) Harlow [1977] presents five detailed case studies which examine

    the decision process involved in the adoption of innovation after

    the companies studied were nationalized. The firms are:

    (i) The European branch of British Airways; (ii) the National

    Coal Board; (iii) the Central Electricity Generating Board,

    (iv) the British Gas Corporation, and (v) 'the telecommunication

    service of the British Post Office. The author starts by presenting

    a historical review of each company, paying particular emphasis on

    major innovations in the respective industries. For example, in

    airlines, the author studies the decision to employ new-style air-

    craft and,in the electricity generating industry, bigger power

    stations.

        Having identified the important industrial innovations, Harlow

    then examines their effects by comparing the cost structure of each

    firm before and after the adoption of the respective innovation.

        In order to realize continuous growth one needs continuous and

    successful investments in innovations. The companies studied by

    Harlow made incorrect investment decisions and as a result their

    productivity growth slowed ،   Because of this observation, the

    author focused on the decisions concerning the adoption of innovation.

b) A more comprehensive research of innovation in the automobile industry

    has been carried out by Abernathy [1978]. He examined the innovation

    stimuli and concluded that: (i) process innovation follows product

    innovation; (ii) major innovations come from industries outside the

    automobile industry; (iii) competitive strategy determines the field

    of innovations; (iv) R&D efforts respond to government regulation;

    (v) innovations are interdependent ; (vi) innovations

    are the cause of increases in demand, rather than demand inducing

innovations; and (vii) recent R&D efforts were in response to manifested consumer tastes. The implications of the last two observations are that the source of final demand (the consumers) impact demand indirectly through research and development efforts, which in turn affect innovation.

c) As far as the technology and policy nexus is concerned, Abernathy and Chakravathy [1979], suggest that the government interventions can be classified into three categories: (i) direct technology push actions; (ii) product characteristics interventions; and (iii) market modification actions. The latter two categories can be grouped under "indirect technology pull" actions. The authors then positioned ten innovations on a two dimensional space, indicating the intensity of technology pull actions. They suggest that technology push actions by themselves do not ensure the success of innovations.

After proposing a general framework of assessing the effectiveness of government policy with respect to technology, they evaluate the government policies that relate to fuel economy and pollution control. They argue that due to the Motor Vehicle Air Pollution Control Act, the government increases the intensity of intervention of the "indirect technology pull" type. Thus, the decisions behind technological change with regard to pollution control are "satisficing". However, in the area of fuel economy, there is little progress. Because of the distortions in competitive circumstances caused by regulated oil prices, industry regulation did not create the demand for fuel economy nor increase the technology-push of innovations. Besides, the lack of government support for research projects on fuel economy makes it difficult, if not impossible, to introduce the radical technological changes needed within the next 10 years.

Abernathy and Chakravathy suggest that government policy should:
(i) focus on far-reaching technological advances; (ii) initiate a "market-linked" program to create demand-pull technological advance; (iii) let the firms in the auto industry participate in the R&D projects sponsored by the government, because such a participation can enhance innovation diffusion; and (iv) formulate a long-term program for the auto industry, which includes consistent long-term objectives and administration.

II.   Transportation Taxonomy -- Supply Side

There are many dimensions across which a taxonomy of the transportation industry can be carried out. Before doing so however, we would like to try to justify the existence of transportation itself.

Transportation exists because it adds utility to goods and services and therefore makes them more desirable to the user as well as more marketable. The utility that transportation adds is of a spatial nature, allowing for the expansion of markets either directly, as in the case of goods and services which are transported to locations away from the place of their original physical locus, making them accessible to the potential users, or indirectly,as people are transported to places where these goods and services are located. The latter case where utility is indirectly added, is of great importance in modern, technological societies where people move from their homes to work places, to schools, or to other countries for business or recreation.

Because the broader markets permit greater specialization and economies of scale, transportation and its cost become critical elements in the whole area of comparative advantages and the penetration of markets protected by geographical monopolies.

One may derive the supply side of transportation by looking at the physical ways through which the present demand is satisfied. Illustration II-1 is such an attempt derived from Kneafsy's transportation demand taxonomy. We prefer to look at transportation in terms of the enabling capabilities spatial utility provides either directly or indirectly. Given that the demand for transportation is mostly derived, an examination of the reasons for its being will enable us to free ourselves from the constraining bounds of "what is" to alternative approaches of

TOTAL TRANSPORTATION DEMAND *	TOTAL TRANSPORTATION SUPPLY (MEANS)

Domestic

Highway
- Auto
- Truck
- Bus

Auto   (D+I) **

Truck   (D+I)

Bus

Local Transit - Electrical Vehicle

Electrical Locotives - Passenger Vehicles (D+I)

Rail
- Passenger
- Freight

Diesel Locomotives - Passenger Vehicles - Freight Vehicles - (D+I)

Air
- General Aviation
- Air Carrier

Commerical Jets - Private Jets - Propeller Planes - Helicopters (D+I)

Water
- Passenger
- Freight

Barges - Commercial Ships (D)

Pipeline - Sludge

Pipelines (D)

International

Air
- Certified
- Supplemental

Commercial Jets - Military Planes (D+I)

Water
- Passenger
- Freight

Commercial Ships - Naval Ships (D+I)

* The demand side is from Kneafsey (1974)

**"D" stands for Domestic

"I" stands for International

"how things ought to be" to satisfy in the most effective manner the end
objectives which are served by the transported goods and services.

It is obvious that this very broad definition of transportation
gives us flexibility and stimulates our thoughts about substitutions.
We saw that there is a duality between goods moving to people or vice
versa. In both cases we are stimulated to think of substitutions
between economic factors that might make transportation most cost
effective, e.g., fuel efficient cars and mass transportation. In the
latter case especially, of people having to move to places where goods
and services are located, we might envision even more revolutionary changes;
in many cases those goods are intangible like information, school lectures,
contractual agreements, etc., which are more prone to be substituted
by telecommunication systems than conventional transportation means.
We must note that in addition to efficiency, such substitutions
contribute to effectiveness and market expansion.

Although we will constrain ourselves in this taxonomy to conventional
transportation means, we could always add the possibility of telecommunications
whenever we encounter the need of a person to be moved, or service to be
shipped. This "need" concept brings us to the first important tax-
onomical element of transportation: demand for transportation is a
derived demand often twice or three times removed. That is to say,
consumers need goods and services to satisfy some "end", and transportation
is derived on the basis of the demand for these goods and services.

In this taxonomy we start with an analysis of total transportation
demand. Our taxonomy is functional, specific, and physical. We first
break down the various functions of transportation demand specifically and

and then we describe the physical means that satisfy each branch of total demand. The consideration of physical means allows us to describe the interface between demand and supply of means of transportation. Hence each means is supplied by a manufacturer of transportation means. This clearly disinguishes between suppliers of means of transportation; for example, manufacturers of automobiles for automobiles ` , of trucks for trucks , shipbuilders for ocean-going vessels, airframe manufacturers for airplanes, and suppliers of services of transportation such as the consumers for private automobiles, shipping companies for trucks or cargo vessels, airlines for aviation, and so on.

In our taxonomy of present transportation demand and of the present means for satisfying such demand, we distinguish between domestic (U.S.) and international demand. The functions that domestic transportation covers are: highway, local transit, rail, air, water and pipelines. The functions that international transportation covers are: air and water.

The physical means that are used by each function domestically are: automobiles, buses and trucks on highways, to satisfy the demand for moving people and goods; electrical locomotives and passenger vehicles for local transit, satisfying the demand for moving people; passenger and freight trains and diesel locomotives for rail, to satisfy demand for moving people and goods respectively; propeller and jet airplanes, both private and commercial, and helicopters for moving people and goods; barges, commercial ships, hydrofoils for water, satisfying the demand for moving people and goods along rivers and coasts of the U.S., and pipelines satisfying the demand for moving goods in liquid form (or sludge).

The physical means that are used by each function internationally in addition to the ones used domestically are the following: military

propeller and jet airplanes and helicopters for air, satisfying the demand

for moving people and goods and also providing national security to the

U.S. (public good), and naval surface vessels, hydrofoils and submarines

for water, satisfying the demand for moving people and goods and providing

national security.

The next step now is to classify the suppliers of physical means of

transportation. A class of manufacturers provides automobiles, trucks,

and buses. Another class of manufacturers provides locomotives, electrical

and diesel, and passenger and freight rail vehicles. Airframe manufacturers

are usually classified as small ones (private planes), medium ones

(private jets), and large ones (commercial and military airplanes). Finally

shipbuilders provide barges, commercial vessels, naval vessels, and

submarines.

III.   Description of Critical Methodologies

The most critical methodologies that may be applied in industry analysis consist of using econometric and systems analysis concepts in order to resolve the complexity of the problems posed.   We believe that each industry presents its own peculiarities, but we are confident that a general methodology for industry analysis can be developed and adapted to particular situations as needed.

Econometric methods have been criticized as being tantamount to "driving a car forward by looking into the rear view mirror".   We accept this view to some extent, but we also think that the use of econometrics for interpretation of past performance and learning from history is appropriate.   Hence one could use microeconomic and industrial economics analyses expanding these as necessary to include variables whose values are not the direct outcome of market mechanisms. We also realize that innovations produce discontinuities and that static econometric analyses are not very suitable for predictive purposes and do not, as such, provide us with causal diagnosis.   On the positive side, econometric techniques provide us with an opportunity to capture the intelligence embodied in econometric history and learn from the experience of past economic inter-relationships.   Hence we suggest that the use of concepts from systems analysis for developing a strategic model be flexible enough for incorporating it in future growth paths of the industry and government policy constraints. Econometric techniques will be used for determining the values of inputs to this model wherever appropriate.

Before we present the most promising methodologies that may be applied to key transportation industries, we would like to stress again that no general methodology exists now for a general cross-industry analysis.   Research must be directed toward remedying this deficiency.

The classical industrial economics approach up until now has primarily focused on the following topics:

1. Market structure: This implies an examination of the historical evolution of an industry as it relates to the concentration of buyers and sellers. Various entry barriers are usually studied as well as economies of scale, vertical integration, product differentiation, and diversification. A very important element of some transportation industries, such as automobile and ocean transportation, is that they compete in an international environment which is affected to various degrees by the above elements of market structure.

2. Market conduct: By conduct we mean the behavior of the participants in an industry on issues such as collusion, pricing policies, introduction of or barring innovation, and treatment of suppliers and customers.

3. Industry performance: As regards industry performance, industrial economists are usually and mainly interested in two issues: (a) Production and allocative efficiency of the firms within an industry; and (b) Full employment and equity issues within an economy or society.

The econometric methods normally applied to study these aspects are profitability studies and construction of cost functions. Most of these studies were carried out for the railroad and trucking industries, but deal more with the specification of elaborate statistical models than with the underlying rationality of the relationships and data used.

As for tools traditionally used by industrial economists, one may employ some of the following in the analysis of transportation industries:

A. Quantitative Methods

1. Anticipation Surveys: These surveys of various groups of shippers, carriers, and users of different classes of commodities and freight are quite useful for short range forecasts. The surveys are usually quite brief and are geared to the respondent's immediate decision-making needs. In the case of general consumer surveys, however, the questionnaires are occasionally quite lengthy, and pose the usual difficulties of interpretation and distinction between perception and reality.

2. Diffusion Indices: A diffusion index is a composite of various business and economic indicators. Its purpose is to capture the general flow or trend of all the leading, coinciding, and lagging indicators normally used to reflect general business conditions. To the extent that the demand for travel and the demand for commodities are derived from more aggregate demands, this method should be useful in some areas of transportation planning.

3. Leading Indicators: A leading indicator is a particular index that has been developed by the National Bureau of Economic Research to reflect changes in the aggregate economic conditions by preceding or "leading" the indicator change. It is particularly useful in forecasting turning points in the rate of growth in various categories of economic and monetary data.

4. Economic-Base Studies: To some extent, economic-base studies are the heart of classical regional location theory. These studies reflect the changing economic and industrial base in local areas and regions. They are extremely useful in capturing the industrial mix of a local community and in generating employment information on its industries.

5. Time Series and Projection Methods:

    a.   Box-Jenkins Method: This method assigns probability weights to a series of historical data with the assistance of a quantitative model. It is more cumbersome than using moving averages, but its accuracy in forecasting short-term movements is much higher.

    b.   X-11 Method: Originally developed at the U. S. Bureau of the Census, this method decomposes time series into the classic distributions of trend, cyclical, seasonal, and irregular components.

    c.   Trend Projections: This in some ways is the simplest forecasting method in usage. The analyst or planner needs only to take an existing series or equation and extrapolation can be done in many ways. For example, one may develop a range or band of extrapolations, or apply a known statistical distribution to generate the extrapolation.

    d.   Motionary Triangles: These are among the most complex of the statistical methods. Essentially, these are techniques for plotting or charting short-range movements in a particular indicator.

B. Qualitative Methods

1. Delphi Method: This method is a fairly well-defined procedure for using cumulative questionnaries to solicit expert opinions from a group of carefully selected panelists. First a check list of variables which are thought to influence the problem are identified. Next, a group of experts rank these variables and form a composite index of reference based on the weighted variables.

2.   Market Research Methods: This method uses personal and on-site interviews with shippers, carriers, agencies, and users of commodity transportation. The principal intention is to forecast the longer range developments or shifts in the flows of commodities or in the contributions of what are considered as the critical industries.

3.   Panel Consensus: This is simply an organized approach to appraising the consensus of a panel of individuals on a specific set of issues. The approach is quite useful to generate fairly quick and accurate short-range predictions.

4.   Factor Analysis: This is the most complex method, from the mathematical point of view, among the set of qualitative approaches. It incorporates the preferences of individuals and experts by ranking their views, either with cardinal or ordinal measures. The end product is a set of important factors or attributes that are regarded as explaining a particular event.

IV.   Future Innovation and Productivity Research in Transportation

Turning to innovation, we wish to distinguish between managerial,

technical, and institutional innovation. Managerial innovation refer to

the methods of organization of the work setting and of the relationships

between the various factors of production. As such it includes strategy

formulation, strategic planning, the implementation of plans, the design

of organization structures and the design of control systems. The rather

elusive concept of managerial innovation can be studied and analyzed using

painstaking series of interviews, company history data, published financial

information, and trade journal articles.

A very useful tool that one could use to answer some of the questions

inherent in industry analysis is stochastic processes.

In recent years there has been an ever increasing interest in the study

of systems which change in time in a random manner. Mathematical models of

such systems are called stochastic processes. A stochastic process can be

defined generally as any collection of random variables $X(t)$, $t \in T$, defined

on a common probability space. T is a subset of time period $(-\infty, \infty)$. If

the values of the random variables $X(t)$ are taken from the fixed set L, then

L is called the state space of the process.

Most of the stochastic processes possess the property that the present

state of the system contains all the information of its history, and the

present state enables one to predict the future states. Mathematically, this

means that the conditional probabilities of the future events are only

affected by the present state, and that events recur in predictive patterns.

Although stochastic processes have been widely used in the fields of production management and finance, little has been applied to analyze an industry. In this section, we will attempt to point out several directions the application of stochastic processes to industry analysis may take ,especially in the area of innovation, birth and death process of the firm, market concentration and spin-off phenomena.

A.   Innovation and Industry Evolution

There is no doubt in economic theory that innovations will increase productivity, lower the cost of products and services, and stimulate the demand of the industry. However, how much exactly is the impact of innovation and how it occurs are still a mystery.

We may observe that new industries are born, grow, mature, and finally decline. Most of the new industries in the past were created by radical product innovations. At the early stages of the life of an industry, the cost is normally high and demand is small. After that, through product innovation, learning ,and process innovation, costs are reduced. In a "competitive" market, the lower the cost the lower the price, and the greater the distances products may be shipped profitably. As a result, demand grows, markets expand,and the industry grows. As the industry reaches the limit of the learning effects, prices cannot be used as a dimension of strategy to expand the market. With a decreasing impact of innovations, therefore, the industry becomes stagnant. As new products from other industries replace the function served by the products of the original industry, as for example, the automobile replaced the train, and the color television replaced the black and white television, the old industry declines. Therefore, the creation, growth, maturity and decline of an industry can be partially explained in terms of innovations impinging on the industry.

Since innovations are recurrent events, one can assume that these, as well as their impact, may be modeled as stochastic processes. Employing, therefore, the principles and mathematical properties of stochastic processes, one can explain part of an industry's growth and decline.

For example, with experimentation we may find that we can view innovation as a renewal process which has the regeneration property. Renewal processes are Markov processes that study the recurrence or return to a certain state which which help us predict probabilistically where the next innovation may be obtained. This, and a determination of the impact of innovations on productivity and costs, may help us predict the growth or the decline of an industry.

One may also employ birth and death processes to study the industry life cycle, and the demand facing the firms within it.

The birth and death processes can be employed to model market concentration. The greater the entry barriers and the higher the monopoly power, the lower the "birth" rate and the higher the "death" rate of new firms. If, after a period of time, the industry reaches an "absorbing state", market concentration is stabilized. This may explain why many industries have had stable market concentration ratios for twenty years.

Another interesting topic is the "spin-off" phenomenon which was observed in some high-technology industries. "Spin-offs" are new firms which come out from existing organizations, and stay within the same or similar industry as that of the parent. Spin offs reduce market concentration, increase competition and facilitate innovation diffusion. The spin-off phenomenon can be approached by a "branching chain".

About fifteen years ago, Zannetos (1965a) suggested that the major
motivating factor behind divisionalization was the elimination of complexity
and uncertainty inherent in plans and operations. He then introduced the
notion of investment inflexibilities - partial fixities or semi-permanences -
in the context of organization theory. He further proposed to subject the
organization to covariance analysis in order to obtain signals for
effective reorganizations (relative centralization or decentralization).

The above conceptualization and method of analysis can be readily
applied to industries. This method may provide an answer to the analysis of
oligopolistic industries where formal economic theory has not as yet
developed effective tools for analysis. The elements of the covariance matrix
of the automobile industry, for example, may consist of measurements for the
four major firms plus probably suppliers and dealers, across a number of
dimensions. The DOT has already collected a great number of data that wait
to be used in formal models.

Econometric methods can be used to the extent that past data may be
statistically analyzed and used to derive the elements of the covariance
matrix. As far as future states are concerned, a systems-analysis approach
will be very helpful in estimating the elements of the covariance matrix over
time.

A very interesting by-product of the above approach is that sensitivity
analysis can be done, using past data as a basis and various future predicitions
and trends of government incentives and plans as scenaria.

B. <u>Methodology for Studying Innovation and Productivity</u>

1. <u>Refine Productivity Measurements</u>

The standard approach to measuring productivity is to use the average product of labor as measured by the Bureau of Labor Statistics (BLS). It is calculated by dividing output, or GNP, by the total man-hours (or employment multiplied by the average hours of work). Its appeal is that it can be calculated by using published government data without making any statistical adjustments.

There are several flaws in the above method of measuring productivity:

a) Average productivity is misleading if the composition of the changing labor force is rapidly changing (Perloff and Wachter, 1980). Marginal productivity may be more useful in this respect.

b) Average product of labor is an imperfect proxy for the marginal product of labor which equals the real wage. Policy makers are and ought to be concerned with real wage.

c) The average product of labor is too sensitive to cyclical fluctuations. Productivity tends to decline during recessions and increase during expansions (Perloff and Wachter, 1980).

d) Traditional productivity measures cannot account for the shift between direct costs and indirect costs which are caused by the adoption of managerial innovations.

Because of the above reasons we are not satisfied with the current measurements of productivity. One can attempt, therefore, to develop new productivity measures which hopefully can distinguish better between labor capital and managerial productivity as they pertain to the industries of interest.

Before the adoption of new measures the analysts should examine the
implications and robustness of alternative productivity measurements,
perform demographic compositional adjustment, and control for cyclical
fluctuations.

One measure of productivity that holds promise is value added per
dollar of salaries and wages. This, plus a time series analysis of the
components of value added may provide one with the necessary signals
to identify the particular stage of a firm or an industry.

2. Perform Historical Analysis

As we mentioned earlier one can perform an exhaustive historical
review of the introduction of innovations and the consequences of such.
This exercise will also lead to a comprehensive cost structure analysis.
Innovation affects productivity mostly through capital investment. The
capital expenditures, in turn, create cost fixities, which in some cases
may hamper the increase of productivity, and also may discourage further
innovation. One should test those hypotheses and examine the impact of
innovation on four dimensions of the cost fixities as described below.

3. Study of Cost Fixities

It appears very promising to carry out research on the definition of
critical cost fixities, the identification of their role, and the more specific
consequences of such. More specifically, one should:

   a) Identify the "quantity" effect of a cost fixity: The hypothesis
      is that the greater the cost fixity and the longer its physical
      life, the lower the probability that a firm will adopt future
      innovations, and the lower the diffusion rate of innovation will
      be. We hence have slower growth which in a "vicious circle"
      pattern brings slower adoption of innovation.

b) Determine, given existing technology, how long it takes to
    marginally adopt an available new technology. This implies
    that in industries with extensive barriers to entry, new
    technology may be adopted only for replacement of capacity
    and expansion.

c) Relate the cost fixities of the primary industry to those of
    the ancillary industries.

d) Assess, given technology, how long it will take a firm to
    change from one type of activity to another, and how this
    time is related to that required by the ancillary industries
    to retool.

We also propose that the breakdown of indirect vs. direct costs be
analyzed because we hypothesize that lower direct costs are the result of
successful management innovation which increases productivity. One can also
apply statistical covariance analysis, as we mentioned before, to control
for this effect and to obtain a surrogate measure for the externalities.

C. Policy Implications for D.O.T.

a) The interfirm and interindustry analysis of cost fixities can lead the
     DOT to more sound investment decisions in innovation producing activities.

b) The need for the DOT to pioneer in the development of a strategic information
     system revolving around the implications of the cost fixities and the
     externalities identified. We envision that no firm within the industry
     will have the incentive to develop and maintain a data base and a
     strategic information system for smoother inter-industry movement of
     human resources or retraining. This may be something for the DOT to provide
     for the transportation manufacturing industries.

c) The identification and measurement of the social costs involved
as a result of labor force or industrial relocation to
avoid unemployment will also be a by-product of our research. A
prognostic strategic information system may mitigate these costs.

d) Finally and most importantly the DOT can obtain from such research
a methodology that will derive the "critical investment in
innovation" for an industry. In other words, this methodology may
identify the amount of capital expenditure after which the returns
to scale to innovation become smaller than a threshold level.
Identification of industries most likely to absorb the labor slack
created by a mature or declining industry, with a minimum amount of
retraining is also likely to result from the application of
variance analysis.

V.   Key Industries for Future Analysis

In the last few years we have beome painfully aware that our predominance in the industrialized world has eroded extensively. The image of the United States as the most productive nation in the world has been tarnished. Even in the area of business organization and management we are slowly losing our comparative advantage.

The symptoms of the above mentioned erosion are many. Our share of the international trade is diminishing continuously. On top of that the foreign penetration of U. S. markets continues unabated causing serious balance of payment problems for the United States.

In years past, other industrial countries were envious of our overall technology and productivity. They tried to copy our technology and our approach to management, especially those for firms in the high technology and production methods of others.

Other symptoms of the economic problems of our industrial sector are the high unemployment rate and the rate of inflation. These do not only pose economic costs to the nation but also burdensome social costs, the dimensions of which range from welfare costs to dislocation of industrial workers, family break-ups, social unrest, and possibly crime and societal polarization.

Going to the transportation sector we find that a economic problems are even more pronounced. If we look at the supply side of the industry we find that labor productivity declined, according to BLS, from an average rate of 2.92% in the 1965 to 1973 period to 0.9% for the years

1973 to 1978.[2] For the last 1-1/2 years some feel that the labor

productivity in the transportation sector has been negative.

Taking the automobile industry as a first illustration, we have seen

dramatic shifts in the international market structure. The U. S. supremacy

has diminished, and if the trend continues, by 1985 one out of two cars sold

in the United States will be foreign made. The burden of such an eventuality

on the U.S. economy will be enormous. Not only the balance of payments

and the value of the dollar will suffer because of the amount of imported

versus exported cars, but also many industries which now depend on the auto

industry will be adversly affected. Unemployment will rise, in addition to

the case of auto workers, in areas such as steel, aluminum, glass, plastics,

rubber, and semi-conductor-based electronics.[3]

Another segment of the transportation-supply industry in the United

States, which went into decline and some will claim complete extinction,

is that of shipbuilding. With the economies of scale realized by large-size

vessels, markets opened up for American products all over the world. Ocean

transportation was one of the few services where, in spite of inflation, the

nominal cost went down in the 1945-1975 period. The increase in oil prices

brought an end to the decline, but still freight rates for large crude carriers

are nominally not far from what these were in the late fifties, in spite of

the inflationary surge we experienced worldwide.

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[2] Scheppach and Woehlcke also present some productivity figures relevant to the transportation industry.

[3] This is another industry which has been predominantly controlled by United States firms up until recently. Erosion of the U.S. technological and technical preeminence is becoming more and more obvious, forcing us to consider the probability that a thorough study and analysis of the automobile industry may foretell the fate of the semi-conductor electronics industry.

Today, over 55% of all shipbuilding activity for ocean going vessels takes place in Japan, while in the late forties over 65% of all new tonnage was built in the United States. The contribution of this sector of economic activity to the United States economy and trade surplus was extensive. Unfortunately , now it has become a drain, and the only way some limited activity cause sustained is through protectionism and military contracts. A thorough analysis of the birth, growth, and decline of this industry will be of interest in understanding these phenomena and in collecting in the overall methodology of industry analysis.

The transportation manufacturing industries suffered from another shock, of course, when the OPEC cartel flexed it muscle and caused oil prices to rise to meteoric levels. From a posted price of $2.85 per barrel for the marker crude in February of 1973, we have seen the FOB prices rise by more than thirteen-fold in a matter of eight years, increasing the cost of energy input to our manufacturing processes and setting in motion an inflation multiplier, whose economic impact is still undulating. What is more, these oil price increases resulted in an overflow of revenues to the oil producing countries approximate 35 times greater in 1980 than in 1973, enabling some of them to distort, with their expenditures, the orientation of industrial economies and also manipulate their currency at will.

For the United States and especially the transportation manufacturing industries the impact of the oil price increases has been more pronounced than in the case of other industrialized nations. Spoiled by the abundance of low-cost energy in years past we geared our manufacturing technology to energy-intensive approaches, and our personal habits and living to transportation intensive modes. On top of all this we find ourselves in a condition of importing approximately 43% of our oil requirements, most of it over long (oil-consuming) routes.

Although the oil-price increases may have precipitated the crisis in the automobile industry, it is fair to say that we have been surprised in the past too often by the difficulty faced by our industries. The plight of shipbuilding, railroads and steel to mention a few, occurred prior to the "energy crisis". If we are not careful, similar adversities may befall other industries where we now have dominance, such as aircraft manufacturing, computers , and semi-conductor electronics.

The DOT should take the leadership in efforts that provide answers to the above questions, having as an empirical focus the automobile, ocean transportation, air-frame manufacturing, and possibly the semi-conductor electronics industries. To do that we should:

1. Study the history of innovations and major changes in productivity within the aforementioned industries, on an international scale, and analyze, as well as interpret, the causes of the present state of the respective U. S. industries.

2. Develop alternative measures of productivity and of diffusion of innovation.

3. Develop a general methodology for industry analysis, focusing on the internal structure of the industry and on its conduct/performance across critical strategic dimensions (to include, but not be limited to investment decisions, productivity, externalities and resources fixities).

4. Develop a model or alternative models, explaining the past performance and predicting the future of the chosen industries. The model(s) should also identify and provide quantitative estimates by type of externalities, linking the industry in question with other industries and providing criteria for the choice of strategic signals for monitoring performance over time.

5. Develop criteria which will help the relevant industry and the DOT choose strategic policy directions and make strategic investment decisions in the transportation infrastructure.

6. Look at innovative alternatives that would possibly completely revolutionize the conventional transportation industries. It is useful to think again in terms of the developed taxonomy. Transportation services are demanded because people need goods and services that are not accessible in the immediate region, as defined by their physical abilities. In modern societies people usually use personal transportation in order to move from their homes to work places, or to shopping centers or to recreation areas. It is very interesting to observe that at least two of the above three needs behind demand for personal transportation can be satisfied by unconventional as well as conventional means.

Finally, we think it is necessary to suggest to the DOT to extend its list of priorities for industry analysis to some other industries that are seemingly doing well today, but are also fraught with signs of possible future distress.

1) Air-frame manufacturing. This industry has traditionally experienced a cyclical pattern of business with equally high peaks and slumps. One of the reasons behind this variability is that the air-frame manufacturers, especially the larger ones, are very much dependent on government defense expenditures, since almost 50% of their business comes from military airplanes, missiles, satellites, etc. Beyond this well-known risk, however, a new threat has been recently developing. European air-frame manufacturers are proving consistently that they cannot only build high technology airplanes (Mirage, Concorde), but also they can build efficient and competitive commercial airplanes (Airbus).

2) Dramatic changes in automobile models, shipbuilding practices, and airplane design will definitely require huge investments, for retooling. However, machine tools are not a free good and hence a stiff price may have to be paid if we suddenly were to decide to equip our plants with new machinery. In addition to the wastage of resources, we may not be able to afford the time delays which follow retooling which has not been orderly planned ahead of time. A sudden surge might very well cause an inflation in machine tool prices and contribute to national inflation while the original purpose of retooling is to increase productivity in order to battle inflation.

3) The industries of primary material inputs are also areas where attention should be paid. Steel, aluminum, alloys, rare and specialty metals, and plastics are some of the industries that need analysis. The plight of the steel industry has been with us for a long time, but the industries will also be endangered in the future as the markets expand and the world market becomes a more relevant concept than the U. S. market.

4) We can now come to some "iconoclastic" ideas about subsitution of communication for transportation. In order to do that our computer industry will have to expand and provide us with the millions of inexpensive mini- and microcomputers and computer terminals that will be needed.

In these diverse industry analysis suggestions we have a common framework in mind. The analysis should look beyond the usual industrial economics paradigm of market structure, conduct, and performance. The analysis should get into the question of lead times, critical fixities, average vs. marginal costs consideration, externalities, productivity, and available as well as probable substitutes for the functions performed by critical industries.

Finally the question of the importance and utility of a centralized strategic information system sponsored and accessible by the government and all the members of each industry needs to be resolved. Such a system would provide signals of impending dangers to healthy industries. It would also improve Pareto efficiency and social welfare because it would greatly facilitate the dissemination of information, and accelerate the application of innovation. Because of the extensive positive externalities involved, no firm can afford to undertake such a task, but it could be exactly the type of service that a government agency can perform rather than provide direct subsidies. Obviously this topic should be extensively researched subsequent to a thorough analysis of the relevant industries.

VI.   Research Plan

In this section we will propose an approach to a research plan for (a) carrying out industry analyses and (b) analyzing the interconnections between Federal policies and corporate strategies as well as structures.

The traditional industrial economics approach to industry analysis focuses on three topics; market structure, market conduct, and market performance. As for process, industrial economists first develop their hypotheses, then collect data, and finally subject the latter to analysis.

It is necessary that we repeat at this point that since there is no uniform methodology for industry analysis, we will present only some useful approaches to such analyses.

A.   Data Collection

The first step in performing industry analyses is to set objectives to focus the research. "Anything about the industry" is too broad a task to be an effective guide for research.

Following the general framework of classical industrial economics we classify the objectives of industry analysis into three categories, those referring to market structure, market conduct, and market performance, respectively.

Similarly, data to be would if analysis can follow the same classification pattern.

1.   Market Structure Data

a)   Historical data. Including historical data of output, evalution of important innovations, trends in demand, trends in costs and prices, growth rates of the industry, major structure changes, mergers, acquisitions, divestituters, diversification, patterns of growth (season or cyclical), determinants of industry growth and capital investment.

b) Data on product lines : The number of product lines, the birth-growth-maturity of product lines, the nature of products, the patterns of evolution of each, product complexity, substitute products, complementary products.

c) Data on technology of production and distribution:

(i) Cost structure: the proportion of indirect costs,and direct costs, fixed costs vs. variable costs,the pattern of capital investments and the causes of such, major cost fixities and interdependencies introduced by those investment at any moment the time and over time (internally, as well as externally for customers and vendors.).

(ii) Economies of scale: calculated from the production function, from experts' opinion, or from the survivorship method.

(iii) Labor: labor supply, degree of unionization, constraints introduced into the cost structure, production process, investment in new technology.

(iv) Organization structure of production and distribution processes.

d) Data on demand: demand function, price elasticity of demand, cross-elasticity of demand (static as well as dynamic), possibility for interperiod substitutions, and asymmetries.

e) Data on political and legal environments: government regulation, local constraints, relevant constituencies.

2. Market Conduct Data

a) Marketing and selling: including market segmentation, promotion, advertisement, distribution channels, key competitive weapons.

    b)   Collusive behavior: possibility of reaching agreement, possibility of maintaining argument, overt collusive behavior as in price fixing, territorial division, bid rotation, limits on advertising and R&D, and tacit collusive behavior.

    c)   Pricing behavior

3.   <u>Market Performance Data</u>

    a)   Innovation:

        (i)   Types of innovation: product innovation vs. process innovation, radical innovation vs. incremental innovation.

        (ii)   Sources of innovations .

        (iii) Rate of innovation diffusion .

        (iv)   Impact of innovation on: economies of scale, cost structure, competitive strategy, and productivity.

    b)   Profitability of firms, causes of profitability.

    c)   Productivity of firms: calculated from value added, wage, work hours.

    d)   Impact of Government policies and regulations.

Once a determination is made of the objectives of the analysis and the appropriate classes of data are identified, data must be collected from various published sources and interviews. Published sources usually provide some information about market structure and market performance. Personal interviews usually provide qualitative data concerning market conduct, history of the industry, and key innovations.

The published sources include:

a)   Annual reports, 10-K forms , and prospectuses of public corporations.

b)   Industry studies: our bibliography provides a review of some automobile studies. Some consulting firms and financial institutions conduct industry analyses.

c)   Trade associations

d)   Company directories and statistical service publications, like Thomas Register of American Manufacturers, Standard and Poor's Registers of Corporations, Moody's, Value Line , and other similar publications.

e)   Major government sources: The Internal Revenue Service provides extensive annual financial information in the IRS Corporation Source Book of Statistics of Income. Another source of government statistics, is the Bureau of the Census. It provides concentration data, outputs in Census of Manufacturers, Census of Retail Trade. Also publications by congressional committees, government agencies.

f)   Other sources:

- Antitrust Records

- State Agencies

- Local tax records

- Reports of financial analysts

- The work of other professionals

Published data will definitely not satisfy fully the requirements of industry analysis and, as a result, field interviews must be conducted to provide supplementary data. Porter's view of potential sources of field data is shown on the following page.

Sources of Field Data for Industry Analysis

```
                    ┌──────────────────────┐
                    │  Industry Observers  │
                    └──────────────────────┘
                                │
Standard setting organizations  │        State government
    (e.g., underwriters laboratory)
                                 │        Federal government
Unions
                                 │        International organizations
Press, particularly editors of  │            (e.g., OECD, United Nations)
    trade press and local press  │
    where competitors facilities │        Watchdog groups
    or headquarters are located  │            (e.g., Consumer's Union,
                                 │            Ralph Nader)
Local organizations ( e.g.       │
    Chamber of Commerce) where   │        Financial community
    facilities or headquarters   │            (securities analysts)
    are located                  │
                                 │        Agencies involved in regulation
                                 │        industry promotion, financing,
                                 │        and so on
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┌───────────┐      ┌──────────┐      ┌──────────────┐      ┌───────────┐
│ Suppliers │ ──▶  │ Industry │ ◀──  │ Distributors │ ◀──  │ Customers │
└───────────┘      └──────────┘      └──────────────┘      └───────────┘
```

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┌─────────────────────────────────────┐        ┌───────────────────────┐
│ Interview Sources about Competitors  │        │ Service Organizations │
│      Inside the Company              │        └───────────────────────┘
└─────────────────────────────────────┘
```

Market research staff   Trade associations

Sales force   Investment banks

Service organizations   Consultants

Former employees of competitors,   Auditors
    observers, or service organizations

Engineering staff   Commercial banks

Purchasing department--in contact   Advertising agencies
    with suppliers who call on
    competitors

R&D department--generally follows technical
    developments and scientific conferences
    and publications

B. <u>Data Analysis</u>

The definition of what data we need for industry analysis is an exacting task and derives from the general methodology the researcher chooses to apply. We have already addressed the necessity for research in order to: (a) trace historically major innovations in order to identify their causes,(b) identify the process of application of innovation to increase productivity within an industry, (c) define more meaningful measures of productivity, (d) tie in capital investment with productivity and innovation, (e) trace the consequences of capital fixities on the primary, vendor,and customer industries, (f) develop on the basis of (a) through (e), a causal diagnostic model combining econometrics and systems analysis to capture both the normative as well as the behavioral aspects as identified by the research, of business decision making, and finally,(g) develop surrogate measures of externalities to aid in D.O.T. policy regarding investments in transportation-industry infrastructure. Now we would like to discuss briefly another important topic:that of methodologies for data analysis.

As in the case of the general methodology, one may resort to econometric and statistical methods for data analysis. Wherever   modeling enters into the picture the general rules governing systems also apply. The subsystem in effect is a system itself.

If one wishes to test the hypothesis that the structure of an industry influences its strategic behavior, then methods for unambiguous classifications of "structure" and strategic behavior, must be developed. This,in turn,may entail further classification across various dimensions of strategic behavior, positioning industries and firms within each industry in an n-dimensional coordinate system.

Cluster analysis appears to be a very promising method for handling data of the type described above, with two-way ANOVA employed to test the significance of differences among groups. If, on the other hand, numerical values cannot be obtained, non-parametric multi-dimensional scaling methods may be used to cluster firms into similar groups.

Other techniques, which were mentioned in Part III, such as stochastic processes (birth and death), discriminant, and canonical analysis are also useful in analyzing data. It is very important, however, that data classifications and structuring be aimed at causal analysis, in order to identify enabling relationships between industry structure and industry conduct.

C.   Interconnections Between Federal Policies and Corporate Strategies and Structures

As in the case of overall industry analysis one cannot find a theoretical framework which can provide insights into the linkages between government policies and industrial strategy and structure. Research in this area will have to start at a taxonomy level before it can proceed to the causal diagnostic stage.

Abernathy and Chakravarthy (1979) suggested a taxonomical framework for understanding the impact of government policies regarding technology. Their focus is concentrated on two dimensions: government actions which affect technology push and those that affect technology pull. While this is a useful effort in taxonomy, research on the many other dimensions of government policy and regulation must be encouraged.

To launch   meaningful research in the area of government policy and
its impact on industry strategies and structures, and recognizing the
present state of this field now, one could (1) develop functional (most
likely probabilistic) relationships between policy decisions and firm
strategies, and (2) extend the analysis to encompass macro-implications
by using the notions of externalities and cost fixities which we have
previously described.

VIII.   Conclusion

We have attempted in this paper to look into the literature on industry analysis and determine whether there is a need for expending research efforts in this area.   Our conclusion is an unequivocal,"yes!" We find that there is a need for research in developing a methodology for industry analysis, a need for new definitions of productivity measurements, identification of the conditions affecting the birth and determining the impact of innovation, and the definition and measurement of the economic inter-relationships between the capital investments of an industry and those of its vendor and customer industries.   Finally, we believe that research is necessary in the area of government policy and regulation and its impact on the strategy of the firm. Approaches must be developed, and we suggested ways to start such efforts in order to assess the value of alternative investments by DOT, in its efforts to build a healthy infrastructure for support of transportation industries.

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APPENDIX 1

Industrial Economics Literature Survey

In the general area of industrial economics, we can discern the following works that contain techniques and results applicable to transportation industry analysis. We start with papers examining the dimensions and measures of market structure:

a) Dansby and Willig (1979) present a theory of indices which measure potential improvement in the welfare performance of an industry. These indices indicate the magnitude of gross social gains achievable from appropriate governmental intervention. The measures developed refer only to the functional domain they have examined and can be calculated from data pertaining to the current industry structure.

b) Mueller and Hamm (1974), examined U. S. Bureau of Census data for manufacturers and derived unweighted and weighted (with respect to value added) concentration ratios. They conclude that stagnant industries are difficult to enter, and that absolute size, concentration and product differentiation are major entry barriers.

c) Pryor (1972) states that four-firm four-SIC-digit concentration ratios among large industrial nations are roughly the same, and that concentration in these nations is less than what one finds in smaller nations. The data also show that the rank order concentration ratios by specific industries are roughly the same in all nations. Also average enterprise size (both from manufacturing as a whole and for individual industries) and total market size appear to be highly correlated.

d) Caves and Porter (1978) extend the concept of entry barrier to include groups of firms as well as industries. Clusters of firms with similarities among some dimensions comprise groups within industries that differ in their production, marketing, and pricing strategies. The mobility from one group to another becomes more and more difficult with time, due to barriers similar to entry barriers for industries. Groups can consist of one or more firms, e.g., in the automobile industry we might discern three groups, G.M., Ford-Chrysler and A.M.C.

e) Willig (1979) revisits the analyses of multiproduct perfect
    competition and natural monopoly using a generalized motion of
    average cost and several technological characteristics pertinent
    to joint production (synergy) in order to assess the impact of
    concentration on market structure.

f) Williamson (1971) explains the anomaly of vertically integrating
    under the conventional assumption that the costs of operating
    perfectly competitive markets are zero. Integration gives the firm
    greater intraorganizational control. However, the major reason
    behind vertical integration is market failure in the following
    instances:

    i.   static monopoly: it pays off integrating backwards than
         being at the mercy of the monopolist holding an important
         resource;

    ii. contractual incompleteness: when the product in question
         is technically complex and periodic redesign and/or volume
         changes are made in response to changing environmental conditions,
         and vendor technology, it may pay off to integrate to secure
         supply;

    iii. risk mitigation: moral hazard, externalities, entry barriers;

    iv. institutional adaptions: avoiding sales taxes on intermediate
         products.

    v.   information processing effects: centralization of information
         flow;

g) Carlton (1979) develops a model to elucidate the incentives and
    consequences of (backward) vertical integration. The basic
    assumption is that prices do not adjust instantaneously to keep
    supply and demand in balance, and firms never feel that they can
    produce or sell instantaneously. Production decisions must be made
    exante, and hence a risk of unused or insufficient production
    capacity exists. Vertical intergration takes place when the
    expected profit from such a move is positive. It has been proven
    that under perfect competition in both vendor and supplier markets,
    vertical integration results in a decrease of social welfare.

Market conduct is the second dimension of industrial economics. Strategic behavior and entry conditions are the topics of the following papers:

a) Bhaghwati (1970) presents a review of the basic theories of oligopolistic behavior, of kinked demand curve, and of the limit-pricing and entry-prevention models of Andrews, Harrod and Sylos-Bain-Modigliani.

b) Salop (1979) examines symmetry between "innocent" entry barriers (e.g., economies of scale) and "strategic" entry barriers(e.g., advertisement). Even under perfect information and costless communication assumptions there are deterrence instruments (e.g., capitalization practices) that constitute strategic pre-entry barriers. Post-entry barriers may also exist in the sense of limit-pricing conduct.

c) Spence (1977) argues that entry is deterred in an industry when existing firms have enough unutilized capacity to make new entry unprofitable. Given output levels, this results in higher costs and prices. Capacity and other forms of investment are effective entry deterrents, partly because they are irreversible and represent preemptive commitments to the industry.

d) Joskow (1975) presents a review of formal profit maximization and behavioral models of the firm, summarizes empirical research and deviations from models. He also presents a behavioral approach to limit-pricing and entry-deterrence behavior.

e) Osborne (1970) constructs a theoretical model explaining the quota rule employed by OPEC in order to deter cheating. The problem of detection of cheating is also discussed and answered in a "second best" manner.

f) Spence (1979) presents a study of strategic interaction among firms, with focus upon the investment decisions. Investment and growth are constrained by physical and financial factors. Firms that enter early and/or can grow rapidly can make preemptive investments and the implications for the long-run structure of the market.

g) Porter (1979) presents a theory of, and empirical research on, the determinants of profits. The basic concept rests on the structure within industries as well as on traits of market structure in each industry. Built on the concepts of strategic groups and mobility barriers, this theory provides an explanation both for stable differences in competitive strategies among firms within an industry and for persistent intraindustry profit differences among firms.

h) Peltzman (1977) argues that most professionals have chosen to interpret the profitability-concentration relationship as evidence for collusion. A minority has emphasized the concentration-efficiency nexus. This paper presents evidence with an eclectic view, but one in which efficiency effects predominate. An important implication of this finding is that more research is needed on the welfare effects of efficiency. The problem of separating the symptomatic from the causal elements in the statistical relationship between concentration and efficiency is also discussed.

i) Spence's (1976) purpose is to discuss some of what has recently been learned about the welfare aspects of production differentiation and monopolistic competition in a market system. The forces that generate welfare problems are analyzed and welfare losses are measured.

j) Salop (1979) constructs a model of spatial competition in which a second commodity is explicitly treated (as opposed to classical Chamberlinian analysis). In this two-industry economy, a zero-profit equilibrium with symmetrically located firms may exhibit strange properties. First, demand curves are kinked, although firms make Nash-Cournot conjectures. In the short run, prices are rigid in the face of small cost charges. In the long run, the model postulates that increases in costs lower equilibrium prices. Increases in market size raise prices. The welfare properties are also perverse at a kinked equilibrium.

k) Schmalensee (1976) has been concerned with the question of whether it is fruitful to apply the Cournot behavioral assumption to the formal analysis of promotional competition. The model presented passed the usual formal tests by yielding stable equilibria for reasonable parameter values.

1) Menge (1962) analyzed the automobile industry and found it to be a tightly differentiated oligopoly characterized by a price leadership which determines overall industry prices and volume. As a result of the decline of price competition, shares, in what appears to be a zero sum game, were for a long time based on periodic style changes. This behavior can be possibly offset by emphasizing different parameters such as economy and function.

m) Comanor and Wilson (1979) present a thorough review of the effects that advertising can have on competition. These include theoretical issues, empirical evidence, capital investment considerations, economies of scale, and implications for public policy.

n) Stuart ed. (1965) examines the effects of advertising, quality appraisal and design of cars on the market share of a particular brand of car. The researchers develop measurements for advertising, quality and the level of design, then they run regressions against the change of market share, with quality, design, and advertising as independent variables. They found that these three variables cannot explain the variance of market share change, (the correlation coefficient is 0.11 only).

0) Fisher and Temin (1973) test J. Schumpeter's hypothesis that there are increasing returns to R&D, both with respect to size of R&D expenditures and to firm size, meaning that combinations of small firms into big ones would increase R&D output. The present paper shows that the tests that have been attempted in the literature, looking at the relation between scale and R&D, are inappropriate.

p) Romeo (1975) using data obtained from a sample of 152 firms in 10 industries, tests a number of propositions concerning the diffusion of numerically controlled machine tools. He found that there is a relationship between market structure and the rate of technical change, with innovation spreading more rapidly in less concentrated industries.

q) Grabowski and Mueller (1978) attempt to prove that high R&D expenditures can be used as entry barriers. It is a competitive weapon that can possibly lead to high profits.

A new approach to analyze industries uses the cybernetic method. In this aspect, one piece of work is presented.

a) Niculescu-Mizil (1979) analyzes the chemical industry of Rumania by employing notions from cybernetic theory. The chemical industry is composed of subsystems which interact with each other. The critiera for identifying these systems are the following:

   i) The function of each economic unit: R&D, production, marketing, financial and accounting, personnel.

   ii) The hierarchical levels of organization: Ministry, industrial centers, and enterprise. These three levels are connected with each other by information flows.

   iii) The hierarchical levels of management may be considered subsystems of the chemical industry system.

The regulatory aspect of public policy have attracted wide research interest:

a) An excellent example of this work is the work of Baumol and Klevorick (1970). It is a theoretical paper but with impressive practical applications. The authors, using mathematical analysis, critically review the work of Averch and Johnson, who found that rate-of-return (ROR) regulation leads to inefficiencies (over-capitalization and suboptimal use of labor). It is argued that ROR regulation is the only way to avoid monopoly profits from public utilities but that it contributes to X-inefficiencies to management. It appears that the latter result may be more relevant to the case of the transportation industries but nothing more can be said until one performs a thorough analysis to prove or disprove the hypothesis.

In the general area of shipbuilding literature one can discern the following works:

a) Kavanagh (1977) presents a historical analysis of the shipbuilding industry showing that the impressive expansion of this industry in the past as well as after World War II was mostly a result of legislative measures. It proves, to some extent, that the wild cyclical fluctuations of activity in this industry domestically were the result of fluctuating government spending.* Heavy capital expenditures associated with modernization and innovation as well as the cyclical pattern of business led conglomerates to acquire most of the shipbuilders. Another prominent feature of these conglomerates is their specialization in weapons procurement and/or energy exploration and production which allowed them to expand construction of Naval vessels and also transfer their experience of dealing with the Federal government to the traditionally government dominated shipbuilding industry.

b) Marcus (1978) gives an analysis of strategic decisions made by shipyards acquired by conglomerates. Data from various sources and particularly from Kavanagh's report are compiled. Tentative conclusions about probable strategies are drawn stressing the benefits of exchanging technology and capital for the costs of lost flexibility.

c) Veliotis (1978) gives a historical review of trends in the shipbuilding industry. Advantages to shipyards which have been acquired by conglomerates accrue from capital availability, organizational decision support from the conglomerate, change of management philosophy, and exchange of technology and R&D.

d) The National Research Council (1979) reports that direct subsidies are extensively used by U. S. Government in order to support the shipbuilding industry. This approach, however, is only a short-

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* In the case of the international shipbuilding cycles, Zannetos (1966, 1972) has shown that price-elastic expectations create cyclical price behavior and orders placed without the necessity of cyclical demand. This phenomenon of cyclicality was also observed by Tingergen (1959) and Koopmans (1939).

term measure. Indirect subsidies, as tax-investment credits, should be used, therefore, to spawn innovation in the shipbuilding industry and technology transfer from other industrial sectors. Development of a new managerial approach towards innovations, labor, and regulatory problems is of primary importance. The role of information exchange and dissemination has not as yet been adequately developed and exploited, with the result that new technologies tend to remain unexploited for a long time. For example, the LNG technology which was developed by NASA, was subsequently used by French shipyards long before the U.S. shipyards became aware of its existence.

APPENDIX 2

SURVEY OF INDUSTRY STUDIES

Some of the studies already done, which focused on total
industries are of importance to our endeavor, especially as
guidelines   for sound fundamental construction of approach and
for further research. Among the most prominent are the
following:

a) Adelman (1959) conducted a study in price-cost behavior and
    public policy in the food-retail industry and specifically
    analyzed the practices and facts that led to the dismemberment
    of A&P. Much of this study is historical in form, but it is
    not merely a business history. It is a study of cost-price
    policy in corporations and of judicial processes in an
    antitrust case.
    The study is divided in three parts. Part I is concerned
    with economic research. The impact of the forces of demand and cost

    and of changes in these variables, on top management is analy-
    zed. It is a study of "why" certain decisions were made, insofar
    as we can udnerstand them, not a study of "how they do it", or
    a substitution of "realism" for understanding.

    Part II covers more social ground. It examines the buying method
    of A&P , and the relation of suppliers to a large buyer. A very
    important question raised, which may also be of importance in the
    case of transportation manufacturing industries, is that of price
    discrimination by suppliers. Imperfect competition, but more im-
    portantly a serious misunderstanding of the "price discrimination"
    concept as interpreted by formal economics and as interpreted in
    the Patman-Robinson Act, provide startling conclusions. The inter-
    action of analytically erroneous provisions of the Antitrust Acts
    and of lawyers and public interest groups eager to expose corporate
    "wrongdoers" may be very relevant to the transportation manufactur-
    ing industries.

    Part III, probes   the A&P prosecution briefs and court opinions.
    It is shown that the predatory campaign indictment can be rejected
    from the point of view of both management rationality and account-

ing data analysis. The possibility that the prosecution's final
goal was the infusion of the Robinson-Patman Act into the Sherman
Act is also examined in Adelman's study. Finally, Adelman con-
cludes the aftermath of this case for public policy is that economic
principles should be the handmaiden of policy, especially in the area
of antitrust structure and behavior legislation.

b) Bain (1943) in the first part of his monumental study dealt with the
economics of the petroleum industry in the Pacific Coast area of
the United States. The goal of the entire study is to describe, to
interpret, and to evaluate from the standpoint of public welfare,
the economic behavior observed in the several interrelated markets
for petroleum and petroleum products within this region. Bain's
study is important for two reasons:

   i. because it analyzes part of the domestic oil industry
      which is a very important factor for the transportation
      manufacturing industries, and

   ii. because the study is a perfect example of
       the Market Structure (Part I) - Market Conduct
       (Part II) - Market Performance (Part III) paradigm
       of Industrial Economics.

Part I, as we mentioned, is devoted to an analysis of the structure
of the industry. It is thus concerned with a description of the
principal characteristics of the market environment which seem to
be relevant to the explanation of the economic behavior which
emerges from it.

Part II deals with the measurement and evaluation of price re-
sults throughout the industry, the history of competition and
collusion, and the connection between price results, competition
and market structure. The main analytical and expository con-
tent of the study thus falls in this part. It considers the
problems surveyed in Part I, and establishes the findings upon
which Part III, concerning public policy, principally draws.

Part III deals with issues of public policy toward pricing and
competition in that industry. This part is essentially a positive
approach toward present and future regulatory problems within the
indicated sphere.

c) Brock (1973)*after a historical review of the evolution of the
    computer, competently analyzes the economics of the computer in-
    dustry and concludes that the barriers to entry - economies of
    scale, marketing and capital requirements - are very formidable
    for those firms attempting to enter the integrated systems part of
    the industry. In contrast, the barriers for entry into the
    peripheral segment of the industry are "quite moderate" and
    "extremely small" for firms attempting to penetrate the mini-
    computer market.

As one might expect, the central focus of the book soon becomes
I.B.M. The author analyzes the "price and product" strategies
and actions of I.B.M. and derives consequences for I.B.M's com-
petitors and for the industry. As far as "progressiveness" is
concerned, his arguments lead him to conclude that"...the computer
industry would have a higher rate of technical progress with a
different structure. In particular, both the practice of leasing
computers and the practice of marketing complete systems reduce
the incentive for rapid innovation."

The author also points out that I.B.M.'s technical contributions
are few, ·   that no single firm has been a consistent
leader in a technical progress, that innovations in the computer
industry are copied quickly, that innovation often depends upon
events outside the computer industry,and that "The rate of advance
has been kept extremely high by the many opportunities for advance
and the competitiveness of the industry." All this appears to be
somewhat inconsistent with conclusions that technical progress
could be greater with a different structure.

Another set of criteria that the author uses for assessing the
performance of the computer industry includes efficiency, income
distribution,and distribution of power in the economy.

*This is abstracted from a review of the book by Zannetos which appeared in
 the Sloan Management Review, Spring 1976, p. 97 - 99.

The author believes that I.B.M. has excessive power. He is concerned not so much because of the relative loss in economic efficiency but because of the hold I.B.M. has over the economy. He rejects regulation as "unduly inhibiting the freedom of the industry to improve performance" and proposes "effective restructuring" as the only alternative. His solution is to break I.B.M. functionally into four independent companies to handle maintenance, peripheral equipment manufacturing, marketing and manufacturing CPUs. And this because he wishes to remove barriers to entry caused by integration, the necessity of marketing systems and the leasing of systems by the manufacturers. At the same time that the author is advocating this solution for I.B.M., he appears to be permitting other computer manufacturers to remain integrated and in the systems market. One wonders whether this arrangement will not force the four "new" companies to get together for survival or allow the marketing company to become a monopsonist and possibly become as powerful as the predecessor organization.

While it is true that market imperfections allow some firms to derive some "monopoly rent " to affect the redistribution of income, to cause some inequities and to possess economic and political power with potentially abusive consequences, no one can guarantee that technical efficiency and innovation can occur without them. Indeed, it is the strife for economies of scale and innovation for product differentiation which mostly creates market imperfections. Given a certain state of technology, it would be more equitable to have many firms producing the industry output, if we can accommodate them without losing efficiency. But the question is, would we have reached that state of efficiency under perfect competitive conditions and would there be any incentive to move away from wherever we happen to be? While it is important to look at the relative size of the pieces of "an economic pie" we must also look at the size of the pie itself, because in many cases inequitable distribution of a large pie may be better (not always in a Paretian sense) than an equitable division of a smaller pie. More specifically would the computer be such an important part of our life without an I.B.M.?

The author reveals some inherent bias toward the restructure of
I.B.M.,which cannot be fully supported by his analysis. Overall,
however, the book represents a good intellectual work and is
highly recommended for students and professionals in the fields
of economic history and industrial economics. Its style, approach,
and comprehensiveness, while appealing to the professionals will,
I am afraid, discourage the average manager.

d) Hodges and Cookenbook (1953) examine the oil-drilling-contractor
industry, and find that this industry has no entry barriers, such
as patents and high initial costs. Furthermore, this industry is
found to have constant long-term costs and mobility as regards
factors of production (the rig can be moved easily from one place
to another). Based on th se characteristics of the production
technology, this industry corresponds closely to a purely com-
petitive market structure; large number of firms (not only
nationally, but in each drilling area) prices set by competitive

bidding with many alternative sources of supply, and no appre-
ciable profits (if anything, losses). Besides, due to the keen
competition, the driller has to adopt new equipment which embodies
technological innovations, and thereby increases the productivity
of the industry.

In terms of the various criteria of performance, technological
innovation, technology diffusion, profits and productivity, the
drilling contractor industry has shown satisfactory results. The
authors agree that this has resulted from the competitive struc-
ture of the industry. Therefore they suggest that public policy
should be so designed as to establish pure, or almost pure, com-
petition in the economy.

e) MacAvoy (1962) analyzed a complex and controversial subject: that
of natural gas price regulation. The subject is not irrelevant
to the analysis of transportation manufacturing industries, because
the domestic energy situation affects considerably imports and con-
sequently construction of oil tankers and liquefied natural gas
carriers.

Most discussions that preceded the regulatory policy formation
referred to the necessity of preventing monopoly pricing in gas
fields, a familiar sounding theme in today's Congressional hear-
ings. The purpose of MacAvoy's study is to state the characteris-
tics of monopoly price formation, as well as of competitive and
monopsony price formation, in order to see which corresponds more
closely to actual price formation in the natural gas industry in
the 1950's.

This study provides new material pertinent to policy formulation.
The general conclusions of this economic analysis are that field
markets in the 1950's were centers of highly competitive pricing,
or were characterized generally by movement away from monopsony
toward competition. The results show that monopoly pricing was
not a substantive reason for regulation, a lesson that one must
bear in mind when dealing with policy aimed at the transportation
manufacturing industries.

f) Markham's study (1952) isbased on the author's Ph.D thesis submitted
to Harvard University in 1948. The major objective of his study
is to justify the relationship between market structure and
market conduct (price behavior) in the domestic rayon industry.

According to Markham, several factors result in the oligopolistic
structure of the rayon industry. First, economies of scale in
the rayon industry are very extensive for plants with annual
capacity of 6 millions pounds and over. The smaller rayon pro-
ducers show more frequent losses and considerably lower rates
of return. Second, the rayon plants need abundant supply of
flowing water. One million gallons of water per day are required
for a plant with annual capacity of two million pounds. The site
of a rayon plant must be practically level with a minimum area of
about fifty acres and located one thousand feet above sea level.
There are not many sites to satisfy the above requirements.
Third, by 1930, although most basic patent rights had expired,
the decline of rates of return as well as the rapid expansion
of existing firms have been the principal deterrents to entry after
1930. As a result, the number of the firms had varied from one to
twenty, but the four largest firms accounted for 75 per cent of
all installed capacity.

After the historical and market structure analysis, the author
turns to the price behavior of the rayon industry. Interestingly
enough, there is almost conclusive proof of list-price leadership
by the largest producer, American Viscose. It has been the first
to announce all but a few list-price changes. This is because: (1)
most of the domestic firms started as subsidiaries of established
European companies; hence, they are loosely connected together
through the European cartels; (2) the same European firms had
established subsidiaries in Great Britain, where American Viscose
was recognized as the price leader. The acceptance of a price
leader in the U. S. may be considered as a logical consequence
of their previous experience in Great Britain ; (3) rayon producers
had maintained loose contacts. The Rayon Institute was established
by rayon producers in 1927 for joint advertising purposes; a yarn
producers' trade association was also formed and all producers
had central offices in and around the Empire State Building in
New York City.

However, in periods of severe depression, rayon producers try to
maintain output levels and do not hesitate to cut prices.

As for the price level, Markham found that the list-price is a
function of the cost of the natural fiber yarn and the prices of
three foreign-produced rayon rather than be based on a cost plus
profit margin calculation.

The author also points out that the success of the rayon industry
is attributed to the secular decline of the rayon price, made
possible by unusually high rates of technological change. This
seems to support Schumpeter's hypothesis that monopolistic firms
are more capable as well as more likely to introduce technical changes.

As far as the methodology is concerned, the author derives
economies of scale based on cost data of various firms, analyzes
price behavior by looking at time-series, and presents data justi-
fying the relationship between market structure (oligopoly) and
market behavior (price).

g) Peck's book (1961) follows the typical industrial organization analysis procedures, starting with historical reviews and technology description, and examining the factors which cause the market structure of an industry and the market behavior of the firms within it. Finally, he discusses the public policy implications of his findings.

The production stages in the aluminum production (ingot production), fabrication, and final product manufacturing. Each stage involves a distinct technology and different economies of scale. The technologies of the first three stages are unique to the aluminum industry, involving substantial economies of scale which create high entry barriers. In contrast, the technologies in fabrication are similar to those of other metals with economies of scale varying with the products involved. As a result the aluminum industry consists of three big primary producers: Alcoa, Reynolds, and Kaiser, and many independent fabricators, distributors and producers of secondary (scrap) aluminum. The three big producers are vertically integrated and account for the total ingot output, three quarters of the fabricated output, and fifteen per cent of the end-product markets.

The aluminum industry competes with other kinds of metal materials, such as steel and scrap aluminum. The long-run demand for aluminum, because of potential substitution, appears to be relatively price elastic. Thus, the market power of the big three ingot producers is limited.

The cost of reducing aluminum ingots is quite substantial, and the switch by aluminum buyers from aluminum to other metals requires capital expenditures. The inherent risk faced by both aluminum producers and buyers leads to certain actions by both sides aimed at reducing uncertainty. These actions include price stability, long-term contracts, price leadership and vertical integration.

The existence of price stability increases the consumption of aluminum by reducing the uncertainties in purchase decisions. Price leadership reduces the oligopolistic uncertainty of competitors' behavior which may force the oligopolists to reduce output. In the aluminum industry, departures from the price leadership of Alcoa were infrequent.

The role of price leadership in the aluminum industry is assigned
to the firm with the preference for the lowest market price.
Because the long-run demand function is elastic, relatively
stable and low prices increases the rate of growth in demand
and thereby maximizes the long-run profit.

Therefore, the price leadership is in the "right" direction in the
sense that the firm which sets the lowest price, the highest rate
of investment, and the greatest marketing effort, becomes the
leader.

Finally, the low tariffs imposed on aluminum result in threats
from Canadian aluminum producers, and create some competitive
pressures toward lower prices, expansion, and product improvement.

After carefully examining various policy alternatives toward the
aluminum industry, the author ratifies the present market structure
not because it is workably competitive, but because the costs of

deconcentration and vertical disintegration are greater than the
benefits to be derived.

h) Steele (1957) attempts to find the point at which the cost of domes-
tic crude oil production and the refining of petroleum products be-
comes equal to the cost of production of synthetic shale oil and
shale oil products from domestic shale oil. He starts by es-
timating the cost of discovering crude oil reserves, based on
various econometric models. One of the principal findings is that
the cost of proving new crude oil reserves has been increasing
appreciably, and the "marginal productivity" of exploratory wells
has been falling dramatically. The "unit cost" of crude oil may
be obtained by adding the cost of discovering oil reserves and
the unit production cost of crude. The unit cost increases as the
costs of discovering oil increase and this helps determine the po-
tential demand of synthetic liquid fuels from oil shale.

Steele then conducts detailed engineering estimates of the costs
of producing crude oil and of refining synthetic liquid fuels from
oil shale. His estimates include the costs of mining, restoring,
refining,and pipeline transportation.

The prospects for marketing shale oil products, concentrated on
the Pacific Coast market, are derived from taking linear trends of
the oil prices. Finally, combining the demand for oil products
with the costs of crude oil products and shale oil products, Steele
concluded that,with a capacity of 50,000 to 250,000 barrels per day
of shale oil, the shale oil industry may well be expected to serve
the Pacific Coast market between 1962 and 1973.

i)   Zannetos (1966) conducted a study in the area of oil tanker trans-
portation economics. This study does not examine directly the
transportation manufacturing industries, but indirectly analyzes
and resolves surprisingly the puzzling question of shipbuilding
industry cycles and fluctuations, as far as oil tankers are con-
cerned.

Zannetos did that by addressing the question of the institutional
structure and the economic factors affecting the supply and demand
of oil tankers. In order to do so, the author marshalled the
powerful concepts of expectations and interperiod substitutions
that affect the behavior of buyers and sellers. It is shown that,
unlike their static equivalents, dynamic supply and demand schedules
may assume various shapes with positive and negative slopes that
give rise to very interesting and unique phenomena.

The major factors that affect the supply of oil tankers are the
spot rates, the paradoxical pattern of ownership,and the diverse
behavior of independent owners and oil companies. Orders placed
for new tankers follow directly from this framework which along
with the cost of shipbuilding,determine the number of tankers
actually built and the cyclical pattern of tanker building activity.

The characteristics of oil tanker markets are the balance between
oil production and refining temporally and geographically, the
mobility of the firms (ships), the ease of entry and the absence
of artificial controls.

Some of these characteristics affecting the supply and/or demand

APPENDIX   3

PRODUCTIVITY LITERATURE SURVEY

a)   One of the most well known studies to apply this method
     is that of Denison. Denison (1979) employs a growth accounting
     method to identify the sources of the decline in the growth
     rate of productivity. He identifies more than twenty sources
     of the decline, but found no dominant factor among the
     twenty explaining the decline. Using the same method, but
     different data sources, Kendrick (1980) identified the following
     causes in the decline of productivity growth:

     i.   Advances in knowledge, R&D stock, informal innovations.
           (Kendrick thought that the rate of diffusion of
           "advances of knowledge" can explain a quarter of the
           decline, while Denison concluded that the effect of this
           factor was very small. This discrepancy appears to be
           caused by the use of different data).
     ii.   Resource allocation: decreasing capital to labor ratio.
     iii. Volume change: Economics of scale, capacity utilization.
     iv.   Government regulation.

b)   Using the same method but different point of view, Thurow (1979)
     also discusses the effects of structural changes on productivity
     He discusses the structural change, agriculture dramatic
     movement to full employment, and of the growth in output. He
     argues that these factors are the major sources of the decline
     in productivity.

c)   As far as public policy is concerned, Nordhaus (1980) states
     that policy issues to improve productivity include:

     i.   Anti-inflation measures;
     ii.   Demand-management policy to: (a) stimulate demand,
           (b) obviate a stop-go policy, (c) effect an appropriate
           division of labor between monetary and fiscal policy;
     iii. Encouragement of capital investment by appropriate division
           of labor between monetary and fiscal policy;

  iv. Emphasis on energy in R&D;

  v. Relief from government regulations.

d) In the area of "production functions", Berndt (1980) examines
the impact of high energy prices on the productivity of the
U.S. manufacturing industries. He concludes that the impact
is pretty small, because the energy cost is a small portion
of the total production cost. He does not raise the probable
multiplier effect of energy prices on other costs through
sympathetic pressure.

e) Kopcke (1980) also employed production function methods and
found that one-half of the decline in labor productivity is
due to the slower growth of the stock of plant and equipment.

f) Cradall (1980) employing econometric methods suggests that
the amount of total capital expenditures cannot explain the decline
in the growth rate of productivity and only "productive capital
expenditure" can. Productive capital expenditure is defined as
total capital expenditures minus the capital expenditures that
government regulation necessitates. His econometric model finds
that pollution-control costs increase unit costs and output prices,and
thereby reduce demand for the industry product, and maybe reduce
the productivity growth. He also suggests that theorists under-
estimated the opportunity cost of the non-productive capital ex-
penditure. In his view the dominant factor causing the decline of
productivity growth is "productive" capital expenditures.

g) From the methodology point of view, Perlass and Walter (1980), re-
viewed various methods of productivity measurement and concluded
that the solution of productivity slowdown depends on which pro-
ductivity measure is used as a target by policy makers.

As we have observed, different answers may be obtained regarding
productivity because there are no definitions of productivity,
productivity measurements, and data sources which are universally
accepted. Besides, for different industries, different produc-
tivity measurements may be applicable, as well as different causes
for the decline. In this sense, the macro-approach has limitations.

As a result, some of the researchers turn their attention to micro-approaches to analyze productivity problems. For example, Thurow (1980) after using a macro-approach with limited success, examines the effects of structural change on productivity in 1979, by focusing on the productivity decline for each industry. He finds that different industries have different reasons that cause the decline, and that there is no one solution which can solve the productivity problem for every industry.

h)   Stoker (1979) examines the decline of productivity in the construction industry. He suggests that the slowdown can be attributed to slower growth in capital stock per hour worked, and to the age of the capital stock.

i)   Eliot, Gold, and Soeson (1970), start with a discussion of the definition of productivity, provide a critique of the traditional productivity measurements, and then develop a new measurement of productivity in terms of accounting data.

The latter half of the book presents the application of the new productivity measurement to three manufacturing plants in three different industries. The researchers utilized longitudinal accounting data to calculate the productivity for each organization; then, identified the sources of productivity growth and slowdown. The three plants examined have different production processes, and different accounting procedures. Consequently, one must apply different adjustments to the accounting data in order to get a value of productivity. One of the three plants was involved with a simple chemical process, the second with a complex steel process, and the third was an integrated steel mill.

The main contribution of this book is that it shows how to use accounting data of plants to calculate their productivity and to identify the sources of productivity growth. and decline.

APPENDIX 4

INNOVATION STUDIES

a) Kamien and Schwartz (1975) comprehensively reviewed a great number of papers concerning the linkage between market structure and innovation, and found that no conclusive theory can be applied.

b) Myers and Sweezy (1977) have conducted an industry-wide study. They used interview techniques to identify the obstacles to innovation and the causes of innovation failure. The obstacles studied are law and regulation, low market demand, lack of capital, and technological barriers. Technology was found to be less of an obstacle to innovation than the other factors. The policy issues identified included the establishment of a productivity bank, consistent government regulations, and the increase of capital supply.

c) Mansfield (1977) and his students have been engaged in studying the innovation process and the process of adopting innovation. His latest work is the study of the adoption of innovation in the chemical industry, and it includes innovation and market structure, an econometric model of development costs, the development of a technological diffusion model, and the social and private rates of return from industrial innovations.

d) Levinson (1979) examined the interaction effects of technological change among three industries. He analyzed the coefficients of steel and aluminum in the production function for can manufacturing, and measured the impact of technical change on these coefficients. He then derived a dynamic model to explain how technological change affects the coefficients in the input-output model.