# ENERGY TRANSPORTATION, AND LOCATION OF ECONOMIC ACTIVITY

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The overall purpose of my talk today is to increase the awareness of the relationship between energy, transportation, and location of economic activity. My discussion has four principal sectors to it. First, I will examine the role and function of transport in the United States with attention to the aggregate energy consumed. In the second section, I will examine the differing production functions associated with the alternative transportation modes of different product movements. My third section delves specifically into the interaction of energy constraints, transportation, and location of economic activity. I will give the institutional characteristics of transportation at least passing reference. The final section will be an estimate of what and how policy issues on transportation and energy will manifest themselves.

**Transportation Facts**

The importance of size of transportation to the United States economy can be examined in various ways. Approximately 20 per cent of our total annual expenditures for goods and services are made for transportation of one kind or another.

Almost 15 per cent of our total federal taxes come from transportation sources. In 1975 this amounted to over $43 billion, which was obtained as follows: corporate income taxes, 10 per cent; excise taxes, 21 per cent; and individual income and employment taxes, 68 per cent.

About 15 per cent of the time, capital outlays in the economy were for transportation equipment and facilities of one kind or another. This was broken down by for-hire carriers, 41 per cent; transport equipment manufacturers, 21 per cent; and petroleum and rubber for transport, 38 per cent.

Transport is a strong source of employment as well. Eleven per cent of our total civilian employment is in transport or transport-related industries. These 9.8 million employees were hired by transportation services 23 per cent of the time, transport equipment manufacturers 19 per cent of the time, and government, suppliers, and miscellaneous 59 per cent.

Finally, transport is a heavy user of other industries' products, consuming 75 per cent of rubber, 24 per cent of steel, 21 per cent of aluminum, 67 per cent of lead, 36 per cent of zinc, 27 per cent of cement, and even 12 per cent of the copper. Most of these are obviously unrenewable resources.

**Energy and Transportation Facts**

Transportation accounts for 24 per cent of the total energy consumed in the United States. But, of the total domestic demand for petroleum, the importance of transportation increased to 54 per cent in 1975. Of this petroleum, highway users consumed 85 per cent, waterway 4 per cent, rail 3 per cent, and air 8 per cent. It is obvious that recent and anticipated increases in energy prices or scarcity will result in direct increases in transportation costs or shortage of transportation capacity.

**Transportation Function**

The importance of transportation and, therefore, the stress caused if transportation isn't available can be further emphasized in a more analytical fashion by examining the function it performs in our economy.

(1) On a social and political level, transportation brings ideas, cultures, and nations together. The world is "getting smaller every day." Transportation does tend to break down provincialism and broaden the outlook of individuals with a resulting increase in tolerance and understanding. The advent of low cost and efficient transportation with high quality of service has made new products, places, and experiences available to the wealthy and non-wealthy. Transportation in the United States has served to wipe out political boundaries between states and might minimize the importance of national borders in the future.

(2) On an economic level, transportation serves to make up for natural mistakes. People or economic activities do not always choose to locate where the resource base exists or consumption is not where production takes place. Transportation creates place utility and, when properly used, time utility. The more complex life becomes, the more indispensable are the activities that make up our transportation system.

(3) Transportation is the umbiblical cord upon which comparative advantage relationships are attached. The advent of technological innovations in transportation has changed many a matrix of comparative advantage or disadvantage. The variation in natural resource endowment by region or nation is transferred into

economic importance only by an adequate transportation system.

Resource allocation remains dependent on location of productive activity in the most economical manner. Although extractive industries are fixed in location, there is a choice in locating plans relating to those industries. For manufacturing or distributive enterprises with considerable freedom to locate, transportation is a basic factor. While many factors influence plant location, location theory tells us that four main items exert influence, namely: whereabout of the market, location of raw materials, transfer costs, and finally the location of competing firms.

**Impact of Transportation Changes**

The basic elements of location theory also offer a framework for examination of interregional competition of agricultural production. Changes have already occurred relative to interregional competition and transportation, changes that have been dynamic and forceful in the restructuring of the geographical dispersion of the food and fiber industry. Moreover, these changes occurred during a period of "cheap" energy, prior to the recent instability which is leading towards a more realistic energy supply appraisal.

The meat packing industry has tended to follow livestock production because of the decreases in transport costs due to significant weight reduction in processing.

The significant broiler production increase in the southern states since the 1950's results from the decrease in farm price of broilers and the relatively cheaper feed prices in southern states. The lower price of feed grains was affected by the "Big John Hopper" rail rates of the Southern Railway. Additionally, backhaul truck movements have allowed the market area of these southern broilers to reach even into the Pacific Northwest.

These shifts reaffirm that location of processing firms, regional production, and changes in value of production are affected directly by transportation rates.

The relative portion of both total and variable costs born by the energy components in each mode have been investigated. Energy components as a percentage of total costs was 15 per cent, 8 per cent and 13 per cent, respectively, for barge, rail, and truck. As a percentage of variable costs (relevant for rate making) energy increases to 22 per cent, 13 per cent, and 15 per cent, respectively, for barge, rail, and truck. Although truck and rail percentages are similar, the tonmile cost is quite different. Doubling the energy costs, as occurred in 1973-1974, increased costs of operation .068

cents per tonmile for barge, .056 cents per tonmile for rail and .17 cents per tonmile for truck movements. The difference in variable costs between truck and rail increases from .72 to 1.062 cents per tonmile. As an example, the costs of moving a ton of Washington apples 2,000 miles to market by rail increased $1.12. The cost increase was a corresponding $3.40 per ton for truck movement. Such changes are the price directing mechanism by which energy will affect the location of economic activity.

**Modal Energy Consumption**

Much -traffic, especially agricultural movements, has shifted from rail to truck carriage, thus further increasing the dependence of rural areas on energy. It is now time to evaluate what form of impact can be expected from this interaction of energy, transport, and location of economic activity.

A review of the energy intensiveness of alternative modes will help explain why significant shifts of traffic between modes are not only desirable but expected. The relative energy consumption per tonmile moved for different modes of transportation is as follows: pipeline (400-500 BTU/tonmile), barge (500-600 BTU/tonmile), rail (600-650 BTU/tonmile), truck (2,500-3,500 BTU/tonmile), and air (42,000-63,000 BTU/tonmile). These coefficients indicate the approximate four-fold increase in energy use when a commodity is moved via truck rather than rail or barge and an 80 fold increase when moved by air.

The work on energy intensiveness is still inconclusive. The literature on computation of modal energy consumption varies along a macro-micro spectrum. At the macro level are those studies that take annual fuel consumption along with transportation production statistics to compute annual intensiveness coefficients. At the micro level are a series of engineering studies of motive power and friction which compute energy consumption.

The impact of differing energy consumption coefficients between modes is felt as energy costs are incorporated into transportation cost functions. Not only will transportation rates increase, but they will increase in different proportions for each mode, thus causing modal cost shifts with accompanying differences in quality of service available to shippers.

**People and Space**

Personal mobility in rural areas is extremely dependent on private motor vehicles and will be seriously affected by price changes or reductions in the supply of motor fuels. In urban areas we can

expect people to switch to less fuel intensive modes, reduce the traveling distance, or consolidate trips. Rural households do not have these alternatives to the degree that urbanites do. The rural household may well have to consume less of other goods if it cannot alter its expenditure pattern, thus incurring a larger loss of purchasing power and welfare. A saving factor, on an individual family budget, is the difference in relative energy efficiencies of rural and urban automobiles. Urban gas consumption is 11.5 MPG, compared to rural consumption of 15.5 MPG, but the higher mileage driven by rural people will still cause energy to have a stronger impact on them.

As energy supplies tighten in the future, the characteristics of urban versus rural households must be considered if the costs are to be allocated among the urban and rural population so as to minimize excessive dislocations.

**Interregional Competition and Location**

Past eras of "cheap" energy can be credited with allowing the existing location patterns and regional comparative advantages to be established. The relevance of distance from the production area to the market, compared to competitive production areas, was negated by low energy price combined with a broad, efficient transportation system. Energy costs increases will affect comparative advantage by changing both the production costs and transportation costs.

Commodity and regions will have varying abilities to withstand higher energy-induced transportation costs. Perishability of product forces the choice of mode to be dependent on quality of transportation service, so it is expected these products will remain dependent on the energy intensive truck. Conversely, products that can move by various modes of transport have an advantage. If a commodity has a high value relative to weight or is processed enroute it can more easily withstand a transport rate increase.

Regions also experience differing degrees of impact. Elements affecting interregional competition include distance to export or domestic market, availability of an "all mode" transportation system, backhaul possibilities, and seasonally balanced movements.

As energy costs cause production to change in regions, the regional product mix may vary, thus causing a demand for different service characteristics of modes, further causing a restructuring of the production-transportation system.

**Institutional Framework**

Much of the economic restructuring in the economy, as a result of energy and transportation relationships, will be modified by the institutions running the economy.

Waterways user fees have strong support from many interests in our economy. One defense against this fee by the barge and waterway interests has been the energy savings of barge over rail and truck movements. A study recently completed at Washington State University reveals that waterway tolls could be energy saving rather than energy wasteful.

In the same study, rail rate decreases brought about significant savings in both energy and shipper transportation charges. This implies that if the policy goal is to conserve energy and simultaneously reduce shipping costs, rail rate decreases are an effective and easily accessible policy tool due to the very regulated nature of rail rates. If the regulatory environment allows or forces more "cost of service" pricing versus "value of service" the same impacts may be felt nationwide.

Another study examined the impacts on energy transportation consumption when Lower Granite Dam was developed. This dam, which allows slack water navigation into Lewiston, Idaho, on the Columbia-Snake river system, had the effect of decreasing energy consumed in transporting Pacific Northwest wheat. This savings occurred because railroads reacted competitively to the new movements by reducing rates and gaining a proportionately larger share of the traffic.

Other examples of institutional complexities in the area of energy are the 55 mph speed limit which immediately increased truck labor costs by 20 per cent, or the question of safety on our highways versus energy efficient truck-trains.

Finally, institutions, constraints, or directions become further muddled as to impact because the United States has chosen to have a curious mix of public and private enterprise. Transportation is a prime example of delayed reaction by the public institution (ICC) to identified changes in the private enterprise. As rationale for regulatory action has receded, decrease in regulatory rules has not followed. Such changes will be necessary if the market signals of energy scarcity are to be heard.

**Future — What We Know**

Energy costs are increasing and can be expected to increase even further. Transportation is a major consumer of energy and

has been a focal point for much of the attempts at conservation. Modes vary significantly in energy efficiency, and such differences will have noticeable impacts. In people movement, we will see a continued movement towards mass transit. It may not be directly into train or bus movement but certainly a significant increase in "batch" movements or an increase in vehicle occupancy density. For products, it appears those commodity movements that can change modes will. Those that are wedded to a particular mode, whether because of quality of service needs or lack of competitive alternatives, will have to bite the energy bullet and fight for interregional markets.

That much regional location and development was encouraged and aided by past transportation and energy policies. This aid will be under tight examination and analysis in future policy decisions.

**Future — What We Think**

The reactions to energy changes are not going to be pronounced in the near future. Past increases in energy costs (gasoline prices) have thus far caused little decrease in consumption. Shifts in public opinion and personal lifestyles may be necessary before quantum conservation comes about.

Energy may be the catalyst that generates changes some economists have been seeking for years. Some of these are: (a) imposition of user charges on inland waterways, (b) incremental cost pricing in regulated rates, (c) a diversion of Highway Trust Fund monies to mass transit, (d) relaxation of restrictions on motor-carrier backhauls, and (e) revision of weight and size restrictions at the state level.

**What Public Policy Educators Can Expect**

The impacts of energy costs on transportation and location of economic activity are not going to be easily identifiable Since transportation is only a derived demand, any impacts seen in the marketplace will be via the commodity or passenger being moved. This can make it difficult to develop a specific education program. An area of needed information will be for those regions and commodities feeling the stress of energy relocations, whether at the firm or industry level.

Finally, the overall role of public policy educators may be one of simply increasing the awareness of energy considerations as institutional and regulatory reforms are being considered in the public arena.

# PART III

## *World Food — U.S. Policy Choices*