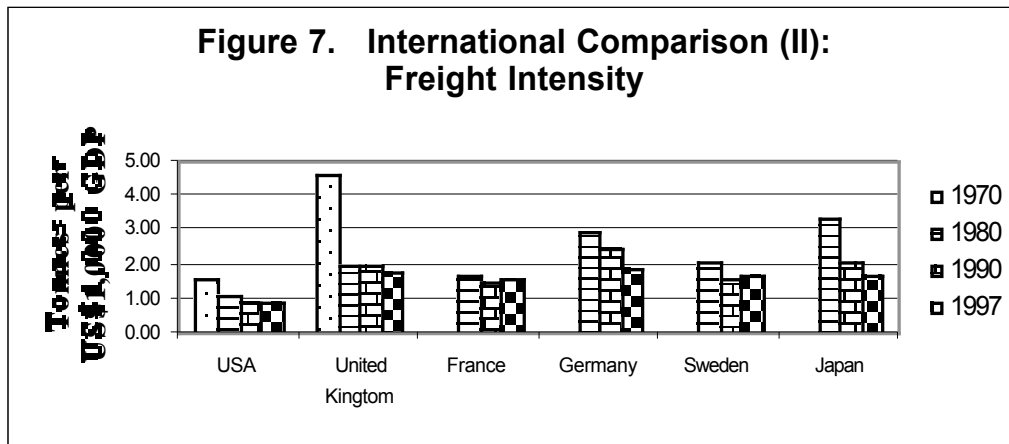
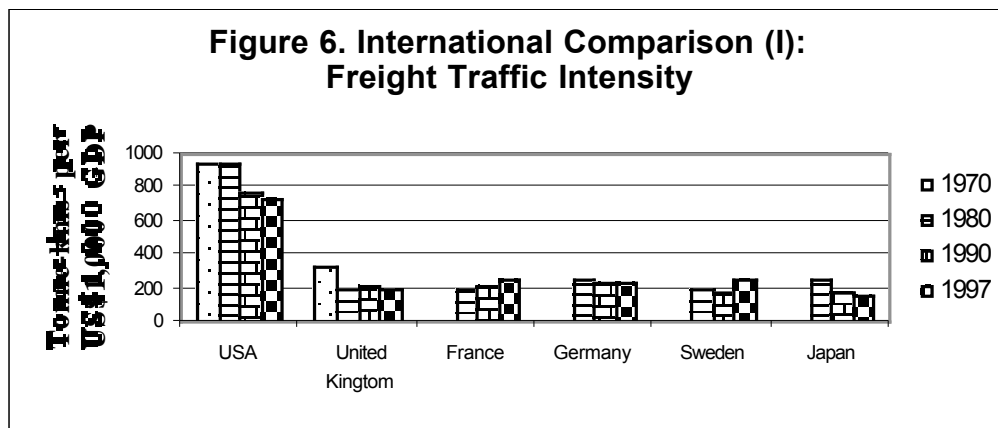


Figures 6 and 7 compare the recent American freight experience with those of some major industrialized economies. The ton-miles / GDP freight intensity indicator for the U.S. is declining over time (as in other countries). The U.S. index is much larger than in the European countries and Japan—a reflection of the highly integrated and spatially much larger American economy. The ton / GDP freight intensity indicator exhibits in all countries a common declining trend confirming the on-going shift of these highly industrialized economies towards services and a lower material intensity. The much lower levels of tons / \$GDP in the U.S. suggests its further evolution (compared to the other countries) in this path towards greater service intensity of the economy.

Figures 6. and 7. International Comparison of Freight Traffic Intensity I and II



The Context and Scope of Changes in the Freight Services Sector

There is a burgeoning literature emerging in the last decade on two aspects of the transformational changes in the freight industry. The first aspect deals with the major changes in the technologies, functions and spatial reach of the production and consumption activities in the U.S. and in the larger global economy, which define the *context* in which the freight services industry operates and evolves. The second element of this literature focuses on the qualitative changes in the *scope* of the expanded and new services developed by the freight industry in response to this emerging context. Taking advantage of new technologies of transportation and information, transport institutional and policy reforms, and transport infrastructure investments, a new world of freight transport, that is a vastly transformed landscape with many elements of discontinuity and novel and profound changes from the past, has emerged in the last decade and a half (e.g. OECD, 2000; Chatterjee, 2000, 2001; TRB, 1997; Lakshmanan and Anderson, 2000, Lakshmanan, Subramanian, Anderson, and Leautier, 2001). An inquiry into the role of transport infrastructure investments on these freight sector changes and thereby on overall economic productivity requires an understanding of the major elements of these *contextual and scope* aspects of the transformational changes noted above.

This section of the paper provides the relevant overview, first of the major changes in the broader economic context in which the transport sector operates, and secondly of how the freight sector responds to these contextual changes in the larger economy by developing new functions and services -- which in turn induce changes over time in the functioning of the larger economy.

The Changing Context of the Freight Services Sector

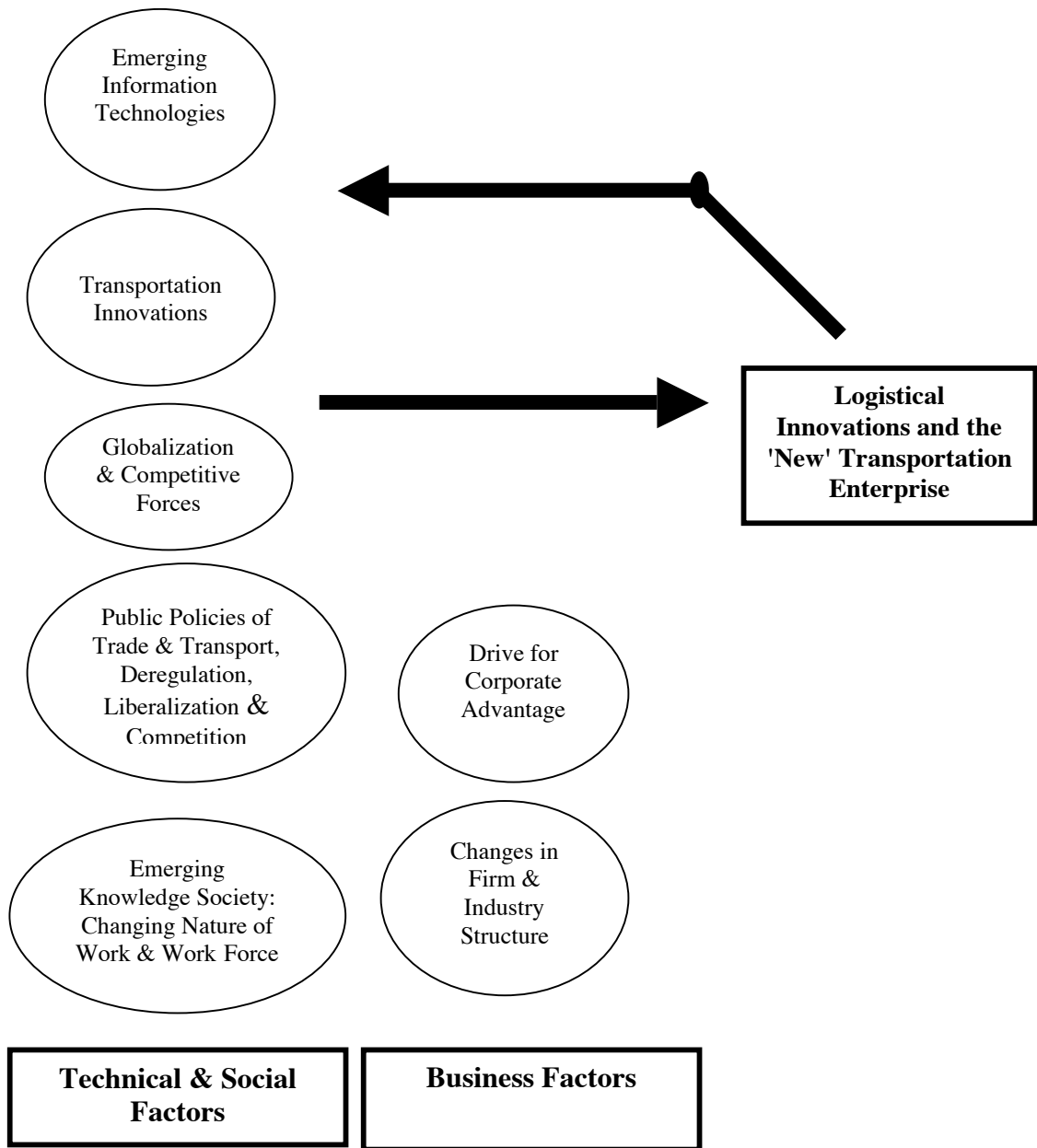
As noted above, a variety of technological, socio-economic, and business factors in the last two decades have combined to erect a globally integrated production system for an increasing number of economic sectors—in the process transforming the freight services sector itself in major ways (Figure 8). New developments in the *enabling and space-shrinking technologies* of transportation and communication are fundamentally transforming the space-time relationships in the U.S. and around the world. Innovations in the complementary technologies of transportation and information have led to sharp reductions in costs, and sharp increases in the service quality (speed, time-definite delivery, high frequency, etc.). This

combination of lower costs and better services makes possible the nation-wide and indeed world-wide search by production firms for cheaper and better materials, production components and product marketing. This in turn requires functional integration, management and coordination of nationally and indeed globally distributed set of diverse economic activities. The consequence is an increasing division of labor in the production processes as the component activities in many industries are further disaggregated and spatially reallocated.

Recent changes in the public policies in the U.S. related to trade and transport have also promoted interregional and global economic development processes. The advent of free trade regimes (GATT, WTO, NAFTA, etc.) and liberalization policies promoted by the U.S. has expanded U.S. firms' international trade and capital flows in NAFTA, Europe, Asia and all over the world. As production and consumption technologies change in this context, production value increasingly derives from knowledge. Materials, products, services, and transportation are becoming more knowledge-intensive in an increasingly competitive American and global economy (Chatterjee, 2001). To stay competitive in this environment, U.S. production and transportation firms cut costs by broadening the sourcing of raw materials and intermediate products in an increasingly interdependent regional and global markets. Such national and international sourcing of inputs by U.S. production and service firms which maintain lean inventories¹ can only be implemented if reliable and timely freight transport system is available. Further, the increasing trend towards intrafirm trade (deriving from a division of labor on a regional and global basis within American and other OECD multinational firms), which amounted to \$800 billion in the mid-90s, is possible only with a responsive freight transport system (World Bank, 2000; Lakshmanan, Subramanian, Anderson, and Leautier, 2001).

¹ Carrying and holding costs represented 25-30% of the value of inventories in US firms due to "product, depreciation and interest" (Chatterjee, 2000b). In 1998, more than 60% of production and sales were processed from direct orders rather than from stock (Gwilliam, 1998).

Figure 8. Factors of Underlying the Transformation of the Transport Enterprise



Source: Chatterjee, 2001

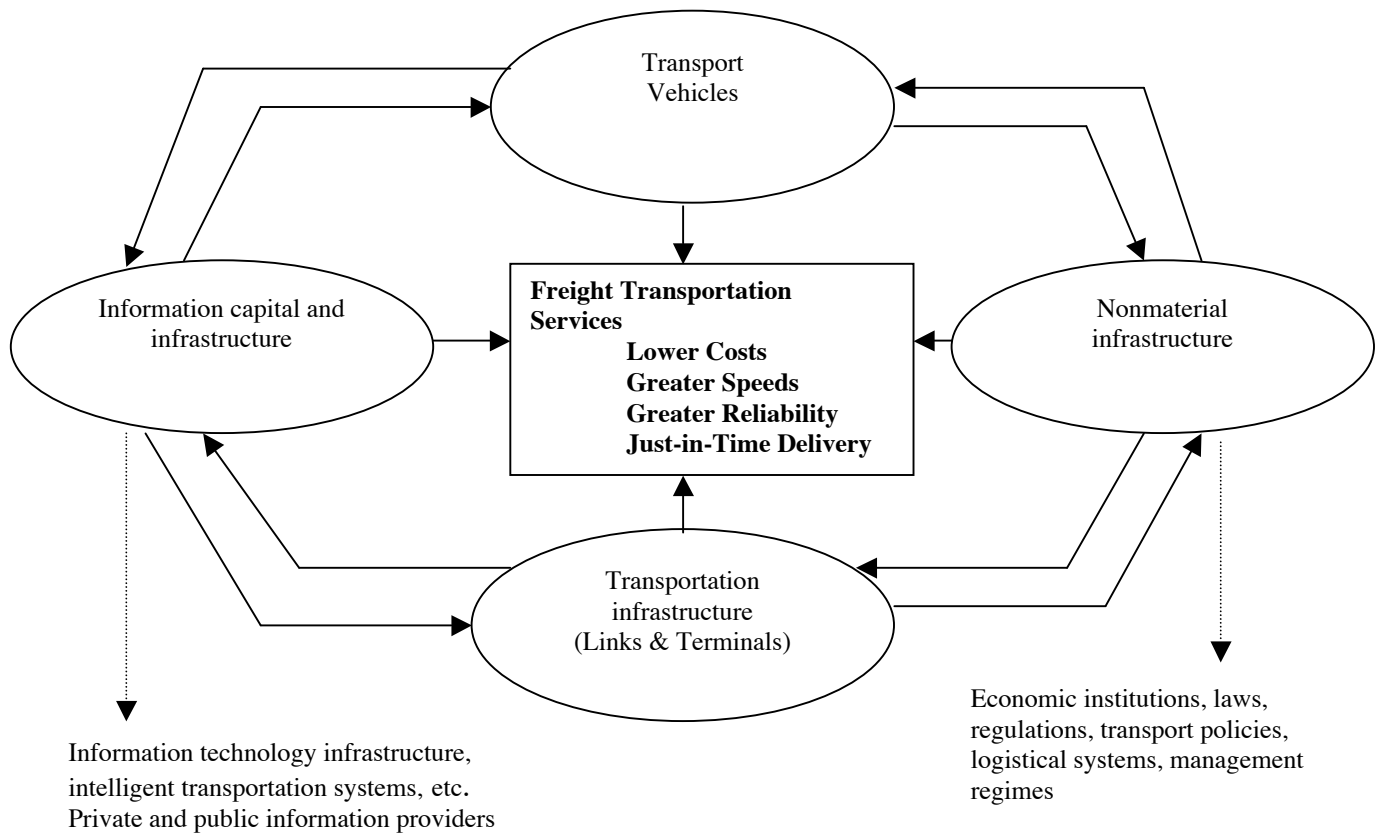
Adapted from OECD, 1996

The Emerging Freight Services Industry

The innovative and effective ways in which freight transport firms in the U.S. and elsewhere are responding to this challenge of supporting the highly integrated and rapidly evolving national and global production and consumption systems are best understood in a

systemic frame. The quantity, variety, and quality of freight transportation services at a point of time are jointly determined by the technologies embodied in the four system components -- vehicles, physical infrastructure, nonmaterial infrastructure, and information infrastructure -- and the interactions among them (Figure 9).

Figure 9. Components of a Freight Transportation System



The traditional discussion of freight services focuses on vehicles and physical infrastructure as the sources of the secular freight service improvements. While jet aircraft, containers, and the Interstate Highway System have contributed significantly to freight improvements, they represent only part of the story. What is only recently generally recognized about freight transportation progress is the role played by two other components -- the nonmaterial infrastructure of the freight transport system, and the complementary information

capital and infrastructure--of the transportation system (Lakshmanan, 1998; Lakshmanan and Anderson, 2001). Far less visible than its physical counterpart, nonmaterial infrastructure -- comprising economic institutions, regulations, policies, business logistical systems, the knowledgebase for transport governance, etc. -- facilitates the efficient coordinated use of vehicles and physical infrastructure.

The nonmaterial infrastructure has been changing recently in many ways. The role of the public sector in these changes is two-fold; first, *promoting overall growth* of the freight sector by changing the economic institutions and the economic incentives governing transport. Policies of transport deregulation and liberalization introduced in the last two decades in the U.S. have released competitive forces among transport firms and among transport modes. One consequence has been the dropping costs of freight transport, as evident from Figure 10. Another is the encouragement this new economic environment provides to freight firms to develop innovative businesses opportunities (e.g. Tradenet, third party logistics, etc.); second, *improving operational efficiencies* of the freight services sector by the public sector's promotion of intermodalism and of the spread of Intelligent Transportation Technologies (ITS). In response to this evolving economic, technical, and policy environment, business firms are developing innovative logistical practices helping the entire freight industry.

Figure 10a. Difference Between International Fares (U.S. - Foreign) and U.S. Domestic Fares Adjusted for Distance, Selected Years, 1978-1996.

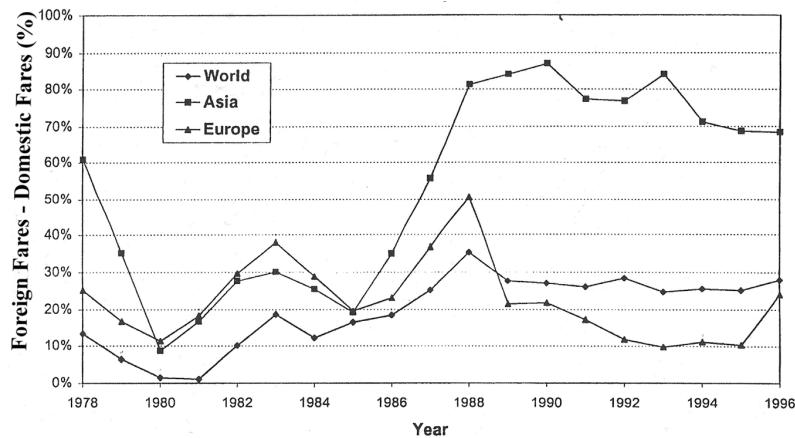


Figure 10b. Operating Costs of Less Than Truckload and Truckload Carriers, 1988-1995, in 1995 dollars per vehicle mile

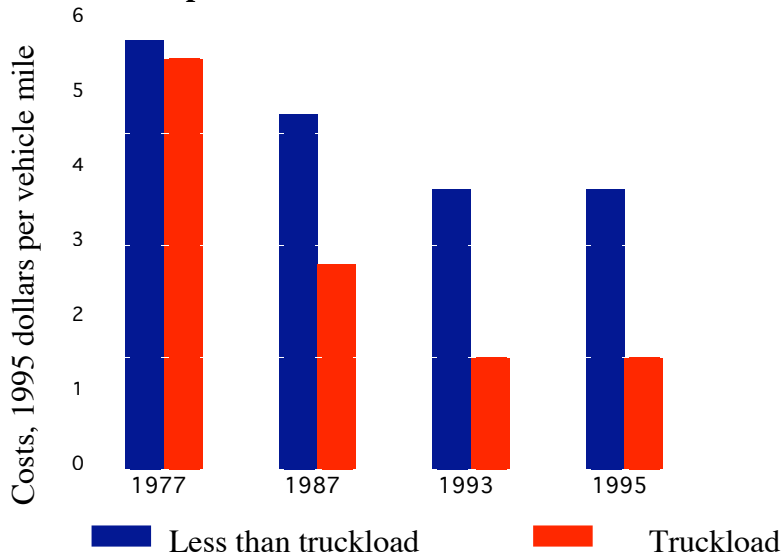
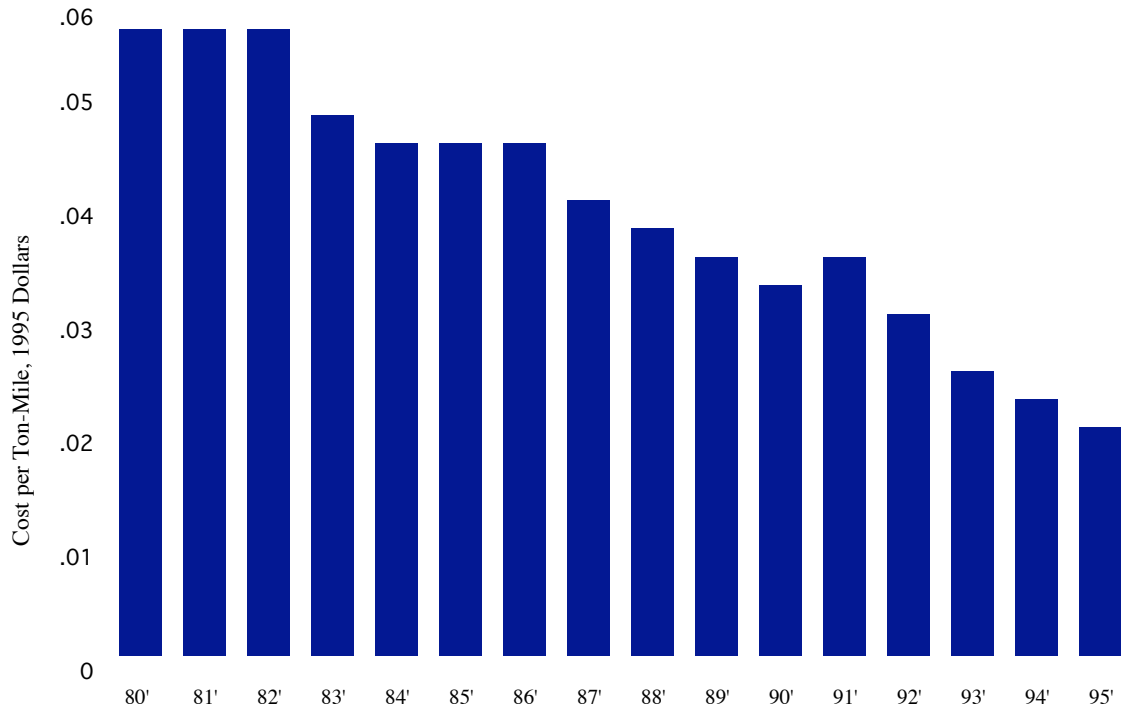


Figure 10c. Railroad Operating Costs per Revenue Ton-Mile, 1980-1995, in 1995 Dollars



Source: Morrison and Winston, 1999

Then, there is the role of the final component, namely the information technologies (IT) in increasing the capacity and functionality of transport operations, transport equipment, and

transport infrastructure. IT, comprising a broad range of devices, functions, and supporting tools used in sensing, generating, processing, transmitting, and communicating information, offer vital information to transport operators and travelers, enhancing their responsiveness and efficiency, and making possible other transport innovations.²

Customers of the freight services sector in the U.S. and the world economy demand currently a seamless transport service, with the most appropriate route/mode combination with no or low barriers for goods movement across regions and nations. This demand called for a reform of the pre-1990 freight industry structure. In the pre-1990 period, independent factories, supplemented by clusters of Original Equipment Manufacturer and subcontractors, constituted the industrial structure. The focus of freight transport firms was on shipments and material flow. The transport sector emphasized reduction of costs. The logistics function was organized as a separate department, with modest information support and with little or no links to production departments or decisions of the firm.

The post-1990 transport logistical structure is quite different. As global and virtual production firms appear, freight transport services firms innovate and offer to these production firms expanded and new services which can be best described as *the logistical channel* (OECD 1996; Chatterjee, 2001). As transport and information industries were being liberalized and deregulated, logistical innovations such as Just-in-Time (JIT), and quick-response services are reengineering business systems as well as production and commodity flow systems. Containers and cargoes are tracked around the U.S. (and indeed around the globe) and are continually 'visible' in transit to shippers and carriers. What is more, the slow and tedious paper trail that has traditionally accompanied goods to secure clearances (across borders as in NAFTA) from customs, revenue agencies, and financial intermediaries is being replaced by Electronic Data Interchange (EDI) and e-commerce (Lakshmanan, Subramanian, Anderson, and Leautier, 2001).

² Such *knowledge-providing and enabling functions* of IT in transport services have historical antecedents in the sextant and chronometer which enabled more precise global navigation in the 18th Century, in the telegraph which promoted transcontinental rail operations in the 19th Century, and the radio and radar which were so critical to navigation in the 20th Century (Lakshmanan 1998). The current efflorescence of new information technologies at the cusp of the 21st Century is massively transforming transportation industries and the scope of their services.

Customs agencies, finance ministries and treasury departments, and regulators are beginning to reinvent their practices governing the flow of goods in this new environment.

In the logistical channel developed in this evolving socioeconomic and technological context, freight transport firms not only provide traditional material flow faster, cheaper and more reliably than before; they also offer *new* types of transport and logistical services. These new services are in the form of reliability, timeliness, strategic outsourcing of a corporation's distribution functions, and flexibility in destination choices for customer firms. Such new services provide flexibility and new modes of operation for customer firms, thereby offering the manufacturing and service industry customers additional production value and strategic comparative advantages. Further transportation and distribution concerns are increasingly integrated into strategic decisions of firms, for instance, where to locate their production and warehouse facilities, where to source their intermediate goods, and how to manage their value chains such as using JIT systems, move into e-commerce, and so on. Freight transport firms are actively involved in lowering order cycling times and in implementing the consumer demand oriented "pull" systems of logistics (FHWA, 1998). These changes are incorporated in the supply and value management or integrated logistics processes. Through these processes, the new freight transport services firms help gain system-wide cost reduction *and value addition*.

For a transport public policy analyst, a major analytical issue of interest in this context is to ascertain the role played by public investments and policy in promoting these change processes in the freight services industry and thereby achieving the productivity increases both in the transport industry and in the larger economy -- a task we turn to next.

Linkages Between Transport Investments, Freight Services Sector, And Overall Economic Performance

Figure 11 outlines the complex and comprehensive linkages between transport public investments, freight services and economic performance. While the focus of this paper is on the effects of transport investments on overall economic performance, these economic linkages need to be framed in the context of other important drivers of the freight services system. In addition to transport infrastructure investments, two other driving forces of the freight industry are

consequently listed on the left of the chart: These are the (transport and information) technological factors and public policies of transport governance which, jointly with transport infrastructural investments, determine *the nature and scope* of freight services and thus potentially their influence on overall economic performance.

First, technological factors such as new transport and information technologies yield a variety of transport *service* and *process* innovations which are critical to the logistics process and its fruitful reorganization. Examples of service innovations offered by freight services firms include:

sourcing of intermediate goods, location of production and warehousing facilities, and other ways of managing the supply chains for customer production firms. Process innovation are exemplified by JIT systems, and the consumer-oriented "pull" systems of logistics.

These freight innovations proliferate, particularly in the supporting environment of new economic incentives and competition generated by the second driver of the freight industry, namely, the on-going reforms of Transport Public Policy initially in the U.S. and currently in many other countries. The two elements of the changing transport public policy pertain to a) overall economic governance (e.g. deregulation, privatization), and b) those governing transport physical flows (e.g. vehicle size/wt. rules, reinvented inspection processes, etc.). Both of these policy sets influence the freight services powerfully; first, deregulation and liberalization policies by changing economic incentives and releasing competitive forces, have enabled and motivated the service and process innovations and logistical improvements; second, the changes in transport physical flow rules—less restrictions on vehicle size/weight attributes and improved ports/ customs rules, etc. -- have influenced transport capacities on transport routes and terminals and logistical potential (Lakshmanan, Subramanian, Anderson, and Leautier, 2001). The variety of service innovations and process innovations in freight services, enabled by this combination of transport and information technologies and public policy reforms, promotes in turn a new set of freight service attributes and the subsequent restructuring of business logistics, as transport infrastructure attributes evolve.