The Economic Impact Of Internet Usage In The Trucking Industry

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The information highway is changing the business practices of the trucking industry and, in turn, is reshaping how the trucking industry affects the rest of the economy. The internet-enabled new business practices of the trucking industry contribute directly to economic growth. In addition, the trucking industry contributes indirectly to the growth in the general economy as other sectors, such as manufacturing and wholesale and retail trade, depend on the value added by trucking services. We define e-commerce to include business processes that permit transactions and trade to take place on the web, as well as processes that use the internet as a repository, an enabler, and a conduit of information[1]. Trucking firms are using the internet's strategic building blocks of distributed access to valuable information, quick communication, and boundary-defying connectivity to exploit current resources and capabilities and to explore new e-commerce business opportunities.

This paper proceeds as follows. Section A discusses the background of the trucking industry, concluding that the industry is highly competitive and volatile. Section B discusses the impact of trucking on the U.S. economy, concluding that the contribution of the trucking industry to the national economy is significant and larger than estimated in traditional accounts. Section C discusses the use of the internet in trucking, using data and examples from multiple sources. We conclude that information availability stemming from the internet is creating demands to exploit existing skills in order to serve existing customers better, as well as opportunities for exploration of new transportation markets and services. The section also discusses emerging changes in industry structure that stem from acquisition activity. Many of these changes in industry structure stem from firms' attempts to gain access to new resources and to coordinate the use of heterogeneous capabilities. Section D begins with a quantitative assessment of the financial impact of the internet on the operations of trucking firms, concluding that, at present, the internet is having greater impact on growth than on cost reduction. The net impact of the revenue and cost trends may lead to larger trucking businesses with profitability that is similar to current levels. Section E discusses how changes in the industry may affect the economy and identifies several policy issues. We estimate that changes in the trucking industry will have modest but notable direct impact on economic activity due to trucking industry revenue growth. The trucking industry is also likely to have a substantial indirect impact on the economy, quite

possibly to a degree greater than the direct impact, due to the value added contributions of trucking to other sectors. Internet-usage in the industry raises policy issues concerning mergers policy, labor policy, and technology policy. Section F concludes the paper.

A. Trucking Industry Background

Freight transportation, particularly by truck, is central to the health of the U.S. economy. The transportation sector moved over 12 billion tons of freight in the United States during 1998, with 7.7 billion tons being transported by the trucking industry in primary and secondary shipments. These shipments generated over $486 billion in revenue for the domestic trucking industry, including the truckload, less than truckload, and private segments of the industry. In 1997, the most recent year for which aggregate modal data are available, trucks provided for nearly 60% in shipment volume and nearly 82% in shipment revenue in the transportation sector, making the trucking industry the dominant mode for freight movement.[2] Trucking is a major employer in the U.S., with 9.7 million people employed in trucking or trucking-related jobs in 1998.[3]

The trucking industry has gone through a long cycle of regulation and deregulation, leading to high industry volatility. Following the Motor Carrier Act of 1935, for-hire companies that wanted to haul freight across state lines had to obtain authority from the Interstate Commerce Commission. Most carriers set prices for their services through a collective rate-making process made legal by federal antitrust exemption. The federal Motor Carrier Act of 1980, although it did not eliminate state-based regulation of trucking companies, initiated substantial changes for inter-state transport by allowing easier entry, providing greater pricing flexibility, eliminating restrictions on how many customers a contract carrier could serve, and reducing restrictions on private fleets. Following 1980, increased industry capacity quickly resulted from the rapid expansion by entrants and incumbents. During the late 1990s, over 3,000 carriers a year were gaining new or additional operating authority.

Competition has held down the rates that trucking firms charge shippers, and typical operating ratios now average in the mid to high ninety percent range (the "operating ratio", which is the percent of operating revenues required to pay operating expenses, is a key efficiency measure in the industry). In the three years prior to 1980, the trucking industry operating ratio averaged approximately 94.9% for ICC-regulated carriers. In 1991 the average was 96.8% and in

1997 the average operating ratio was just over 95%, that is, under five cents per revenue dollar. About 48,000 carriers went out of business from 1980 to 1999, following deregulation, including 74 of the top 100 firms from 1984[4].

The trucking industry is both highly segmented and extremely fragmented. Within the trucking industry, freight movement, using shipment size as the distinguishing factor, is distributed among truckload (TL), less than truckload (LTL), and private fleet segments. A reasonable approximation of the number of U.S. trucking firms, combining information from several sources, is that there were more than 500,000 inter-state motor-carriers in the U.S. in 2000; this number includes about 30,000 for-hire carriers, while the remainder were private fleets. Of the 30,000 for-hire carriers, about 21,000 (69%) were TL specialists, about 8,000 (28%) handled both LTL and TL shipments, and 1,000 (3%) were LTL specialists. Most firms are quite small. Over 70% of the inter-state carriers operated six or fewer trucks, while 80% had 20 or fewer trucks. Nearly two-thirds of the 30,000 for-hire carriers had annual revenues of less than $1 million.[5]

Truckload (TL) carriers specialize in hauling large shipments for long distances. Most TL shipments are over 10,000 pounds, with the average TL shipment weighing about 27,000 pounds. The national truckload market is further segmented into national dry van, regional dry van, refrigerated/temperature controlled, flatbed, tank truck, and specialized operators. In the TL segment, an owner-operator[6] or a driver employed by a TL firm will pick up a load from a shipper and carry the load directly to the consignee, without transferring the freight from one trailer to another. Thus, TL carriers do not need a network of terminals. The TL segment of the industry consists of highly competitive operations, which typically are non-union facilities that use owner-operators to minimize fixed costs and focus on achieving high vehicle productivity. The TL segment moves 45% of primary shipment volume, while accounting for only 37% of shipment revenue. TL firms concentrate on high-density corridors and balanced freight flows, in order to ensure high vehicle use and low costs.

Less than truckload (LTL) carriers haul shipments that tend to weigh between 150 and 10,000 pounds. The average LTL shipment weighs slightly over 1,000 pounds. Key economies of scale and density for an LTL carrier come from consolidating many shipments that are going to the same area. Such consolidation requires a network of freight terminals. Therefore, LTL

carriers are characterized by networks of consolidation centers and satellite terminals. The average length of haul for national LTL firms is about 650 miles and the average for regional LTL firms is about 250 miles. Thus, a pickup-and-delivery truck typically will transport an LTL shipment from the shipper's dock to the trucking firm's local terminal, where dock workers will unload and recombine the shipment with other shipments that are going to similar destinations, most often a destination terminal in another city. The process of moving groups of shipments from one city terminal to a terminal at another destination is known as line-haul operations, which may be accomplished by large trucks or by another transportation mode (e.g., rail or ship), depending on price and service considerations. Once the shipment arrives at its destination terminal, the load is processed, moved to a pickup-and-delivery truck, and then hauled to the consignee. LTL shipments accounted for 3% of U.S. shipment volume and 16% of revenue in 1997.[7]

Table 1a provides a view of the financial structure of trucking firms, using the most recent Form M data available from the Bureau of Transportation Statistics. [8] Although the number of firms included in the table is small due to the limited availability of current data, we believe that the information provides insight into the current state of the industry[9]. In 1999, the operating ratio for the LTL firms was 93.9%. TL firms had a mean operating ratio of 94.7%. Firms that reported operating in both TL and LTL had the highest operating ratios among the segments (95.5%). The higher operating ratio could indicate, as we discuss later in this paper, that while trucking firms are responding to customer demands for integrated trucking services, additional coordination costs needed to create the integration are lowering the firms' profitability. When the firms from all the segments are combined, the operating ratio is 94.5%, indicating that on average a trucking firm makes an operating profit of just over 5 cents to every operating revenue dollar. As of the second quarter of 2000, many of the public TL firms indicated significant increases in revenue but declines in net income, while LTL firms showed increases in revenue and small increases in net income[10]. The key conclusion is that operating ratios are tight throughout the industry, particularly among firms that are offering integrated services.

Despite competition and over-capacity in the for-hire segments, private fleets operated by manufacturers or distributors still account for about half of U.S. volume (52% in 1997) and revenue (47% in 1997) of general freight shipments. Private fleets typically focus on medium to

short hauls, while out-sourcing the lengthier hauls to the for-hire market. The private trucking market share grew following deregulation, but has been declining recently. Reasons for the decline include the availability of low price alternatives, inefficiencies that arise when private carriers have difficulties obtaining back-hauls, and the complexity of the logistics process required for increased imports and exports.

In summary, several features of the trucking industry are notable. The industry is critically important to the economy, is highly competitive, faces high demands for efficiency, has frequent entry and exit, and consists of many small carriers with a few larger firms. This is the industry setting in which the opportunities and challenges of e-commerce arise.

B. The Impact of Trucking on the U.S. Economy

The trucking industry is an integral part of the U.S. economy. Our earlier figures noted that trucking services make up well more than half of the volume and revenue of transportation volume in the U.S. For goods produced in the U.S., trucking services begin with the transport of raw materials to manufacturer and continue through shipments to distributors, retailers, and, in increasing numbers of cases, to end-consumers. For imported goods, trucks transport freight from the docks to break bulk terminals and from there to manufacturers, distributors, and retailers. Moreover, as Figure 1 shows, trucks serve as key conduits within inter-modal transportation systems of train, air, ship, and pipeline, making the trucking presence ubiquitous in all parts of the transportation sector.

Although identifying the importance of the trucking industry is straightforward, measuring the impact of trucking on the U.S. economy is more difficult, because trucking services are so intertwined with all sectors of the economy. In this section, we summarize estimates of the measurable share of the economy that trucking services represent. These estimates will provide the basis of our later estimates of the impact of internet-based trucking services on the economy. In that later section, we will also attempt to approximate how trucking industry use of the internet may affect the economy through the less-measurable, but critically important, intertwining of trucking services with disparate economic activities.

Several sets of figures help measure the contribution of trucking services to the economy. We summarize the trucking industry share of GDP, intermediate inputs, total industry output,

and total commodity output (Table 1b). We examine direct and indirect demand for trucking services in different industries (Tables 2 and 3). We also discuss cross-border transport (Table 4).

We start by considering the share of trucking in the GDP (Panel A of Table 1b). According to figures that the U.S. Department of Transportation released on July 10, 2000, all modes of commercial transportation services contributed 4.8% of GDP ($378 billion) to the national economy in 1996, which is the most recent year for which reliable figures are available. Comparable figures for 1992 were 5.0% of GDP ($313 billion). These figures, which are based on the Transportation Satellite Accounts (TSA), include both the end-user expenditure on transportation services and the intermediate expenditure on transportation services that arise during production stages in other sectors. In a change from prior practice, the Department of Transportation figures include in-house provision of private commercial transportation services as well as for-hire segments of the transportation sector. [11] In the trucking industry, as our earlier figures show, private fleet trucking services are important elements of the transportation sector, so that including in-house commercial transport is critical if we are to recognize the contribution of the industry to the economy. [12]

As Panel A of Table 1b shows, trucking represents a substantial majority of the transportation sector value-added, accounting for about 3.1% of the U.S. GDP in 1996 ($243 billion; about 65% of transportation services[13]). For-hire trucking and warehousing accounted for 1.3% of GDP ($101 billion), while in-house trucking added 1.8% of GDP ($142 billion) in 1996. The 1992 trucking industry shares were similar (about 3.3% of GDP), when for-hire trucking and warehousing accounted for 1.3% of GDP ($83 billion) and in-house trucking added 1.9% of GDP ($120 billion).

Another way of measuring the impact of trucking is to consider its share of intermediate inputs in the economy and, in turn, its share of total industry output. Intermediate inputs are the goods and services that contribute to value-added processes within industries. Total industry output is the sum of each industry's intermediate inputs to other industries, in addition to an industry's contribution to GDP. In 1996, as Table 1b shows, trucking services accounted for 2.7% of total industry inputs (Panel B) and 2.9% of total industry output (Panel C) in the country. In parallel, Panel D of Table 1b shows that trucking services account for a similar proportion of total commodity output across all industries (2.9%).[14] Thus, on multiple measures,

including both end product output and intermediate production, trucking services account for a notable proportion of economic activity in the country.

It is also useful to consider how trucking services contribute to different sectors of the economy, in addition to the industry's aggregate contributions to economic activity. Table 2 reports the direct demand for trucking services by different industries. On average (weighted by industry output), trucking services contribute about 2.2% of the intermediate inputs to other industries. The agriculture, forestry and fisheries (1.4 c per $ cost), construction (1.5 c), and manufacturing (1.6 c) industries are among the largest direct users of for-hire trucking. The agriculture, forestry and fisheries (5.2 c), construction (5.6 c), and wholesale and retail trade (3.8 c) industries have the largest direct requirement for private trucking services. The central conclusion in Table 2 is that trucking services are important parts of the inputs that other industries require in order to produce their own goods.

As well as direct requirements, it is helpful to consider how changes in end-product demand for other commodities will affect the demand for trucking services. This approach helps show how trucking services will change as the economy changes. Table 3 shows how much additional services from intermediate industries will be required for each dollar increase in final demand for a commodity. Averaging across all industries (weighted by industry commodity output), a dollar increase in demand for commodities other than trucking leads to an increase of 4.6 cents for trucking services (about 2.0 cents for for-hire motor freight; 2.6 cents for own-service trucking). Overall, Table 3 shows that trucking services are key parts of other commodities.

Several elements of Table 3 stand out. Commodities for which for-hire trucking plays an integral role include communications and utilities (3.9 cents per dollar), manufacturing (3.7 c), and agriculture, forestry, and fisheries (3.5 c). When considering private fleet services, agriculture, forestry and fisheries (8.0 c), construction (7.1 c), and wholesale and retail trade (4.5 c) commodities have the largest draw in terms of the service output that every dollar of final demand requires. Notably, changes in demand for other transportation modes (rail, water, pipeline, air) also create the need for additional trucking services, including both for-hire motor freight and own-account transport (incremental demand ranges from 1.0 c for pipeline demand for own-account trucking to 2.1 c for railroad demand for motor freight). In turn, changes in motor freight demand leads to needs for additional services from other transportation modes,

especially pipelines (5.2 c) and air transport (1.3 c). Again, trucking services are important inputs throughout the economy.

In addition, the role of trucking in cross-border transport has become critical, as international trade has grown. Table 4 shows the value of U.S. land exports and imports for Canada and Mexico in 1994 and 1997. In 1997, trucking had a dominant share of transportation for exports (74% to Canada, 85% to Mexico) and imports (63% from Canada, 77% from Mexico). Rail accounted for most of the balance.

In summary, the trucking industry plays a vital role throughout the U.S. economy, with substantial contributions from both for-hire trucking and in-house trucking services. In 1996, the trucking industry directly accounted for 3.1% of GDP. In addition, the industry plays a critical support role for other transportation modes and for other sectors of the economy such as the resource, manufacturing, construction, and wholesale and retail trade industries. Across other industries, a $1 increase in demand for a commodity leads to about 4.6 cents in new demand of for-hire and in-house trucking services. Trucking also plays a vital role in international trade, especially in the movement of freight to and from Mexico and Canada.

C. Internet Usage in Trucking

The title of the July 31st, 2000 edition of Transport Topics states, "For Trucking, 1999 was the Year of the Internet". Three independent sources confirm that the internet is widely used in the industry. First, the ATA Foundation and the National Private Truck Council conducted a survey of 1998 internet usage. The ATA survey found that 51% of TL carriers and 61% of LTL carriers were using internet technology in 1998 compared to 11% (TL) and 14% (LTL) in 1996. Second, more recent information on internet use in trucking comes from a mail survey the University of Michigan Trucking Industry Program (UMTIP) is conducting concerning the use and impact of information technology in the trucking industry. The information from the UMTIP survey applies to late 1999 and early 2000; we base our discussion here on 177 respondents[15]. Table 5 summarizes the results, showing that 75% of the respondents use the internet (79% of the TL respondents, 72% of the LTL respondents, 75% of the firms that participate in more than one segment, and 75% of the private firms). Third, in August 2000, we searched the web for public internet sites at 132 for-hire trucking firms for which we had 1999 Form M data. Of these firms, 80% had public web sites in August 2000 (75% of 97 TL firms; 95% of 24 LTL firms;

82% of 11 firms that operated in multiple segments). Thus, the two sources of recent information provide similar estimates of current web-usage rates by trucking firms (75% in our survey from early 2000, 80% in our search of the web in August 2000).

The key reason that the internet is affecting the industry stems from the availability of more detailed information to customers and competitors about goods and services, prices, and timing. Firms are changing the way they gather, process, and disseminate information. The changes in information result in both potential for greater efficiency in traditional transportation activities and in the creation of demand for new types of transportation activities. The immediate consequences of increased dissemination of information include greater price pressure and greater incentives for efficiency. In addition to greater efficiency of traditional services, though, increased information is also leading to more fine-grained market segmentation, as well as to demands for new goods and services by trucking companies. In section C.1 we present vignettes of how firms in the trucking industry are using the internet to exploit existing opportunities and to explore new opportunities. In section C.2 we present data on the internet's most popular features based on our survey. We argue that firms are transforming the way they do business as the internet becomes increasingly ubiquitous in the trucking environment.

C.1 Vignettes Of How Firms In The Trucking Industry Are Using The Internet

With the demands for greater speed, reliability, efficiency and service innovation, the internet is causing substantial pressure on the capabilities of trucking companies. Firms are able to respond to some demands through incremental expansion of their existing expertise. [16] We illustrate such incremental changes with the example of ABF Freight. Many changes, though, require major changes in business routines and resources[17]. Arnold Industries is an example of a firm that is exploring new opportunities by both building on its existing repertoire of skills and acquiring new skills. In some cases, the new skills will destroy firms' existing competencies[18]. Transplace.com and freightquote.com are examples of how the new competitive environment threatens the existence of traditional freight brokers. As customers of trucking services demand one-stop trucking, firms in the industry are responding by restructuring, consolidation, mergers, and acquisitions. These examples show that the trucking industry structure is changing as firms respond to the new economy.

ABF Freight System

ABF Freight System is an example of a firm that gradually exploited the web to improve existing capabilities. Table 6 lists the evolution of internet applications that the company offers. Almost 5 years ago ABF offered downloadable personal computer rating software, along with routing and zip code directories, and general marketing information. Since then ABF has added a rating guide, shipment tracing, the ability to create bills of lading online, and the ability to request pickups online. ABF also offers customer-specific pricing quotations over the internet. In 1998, the company introduced an ABF Toolkit to help customers navigate through the site. Customers were also able to retrieve shipping documents, as well as review loss and damage claims online. In 1999, ABF introduced Transparent Direct Links, which enables shippers to incorporate data from ABF's internet site directly into their own site. In January, ABF introduced the Shipment Planner, which is a patented program that displays shipment reports on a calendar, and the Dynamic Rerouting module, which is a program that allows customers to re-route in-transit shipments. ABF has made the internet a focal point of their growth strategy. The company has expanded and exploited existing capabilities to improve both its interactions with customers and its internal processes[19].

Arnold Industries

Arnold Industries illustrates a trucking company that is exploring the new competitive environment and redefining the boundaries of the services it offers in the internet-enabled economy. Arnold Industries has long been a profitable LTL company. Over the past decade, the company has expanded into the regional TL segment by acquiring TL firms. The company is now combining its trucking and warehouse operations to offer one-stop order fulfillment services for e-tailers and mail-order catalog companies. These services include order processing, inventory management, and small package shipping. In this process, the company has transformed its business to improve its ability to fill orders quickly and precisely. The firm has turned its warehouses into logistics hubs where more than 600 people are involved in the order fulfillment process. The process involves receiving goods from manufacturers or suppliers, processing, packaging, and delivering to customers. Arnold Logistics also provides value-added services by comparing freight rates and handling customer returns. Further, Arnold Logistics takes online orders on behalf of its shippers and also provides live-chat and e-mail support for

customers. The traditional LTL and TL segments of Arnold Industries have benefited from the new business activities, because shipments to the firm's logistics warehouses use TL and LTL services. In addition, and at least as importantly, the company has gained substantial expansion into new transportation services that emphasize information management rather than physical handling of goods. Thus, Arnold Industries has transformed the company's definition of the transportation business to extend far beyond movement of freight. The firm has leveraged its knowledge and expertise to become "an information transfer point" in the new economy[20].

Transplace.com

Cooperation in the trucking industry reached new heights when six of the largest publicly held TL carriers formed a new alliance called Transplace.com to explore new web based business opportunities. The venture will combine the firms' logistics services. In addition, Transplace.com will negotiate discounts for fuel, equipment, maintenance and parts, insurance, credit, and other services for its equity partners and other carriers that choose to join the purchasing cooperative. The founding firms hope to leverage their bricks and mortar experience, their physical assets, their industry-specific information technology expertise, their brand equity, and their customer relations in the electronic market-space.

In the trucking industry, productivity gains, given legal restrictions on size and weight, come mainly from two sources: (1) fewer empty miles and/or higher cubic space utilization[21] and (2) less idle time, e.g., less waiting time at the dock. The trucking industry is fragmented and geographically dispersed, as we noted in the prior section, and load-matching and other logistics services that coordinate disparate fleets and drivers are critically important. Load-matching services provide information that matches available shipments with trucks that have available cargo space, in order to increase trailer utilization and decrease waiting times. Load matching information is valuable to small firms and owner-operators, as well as to large firms that are interested in increasing productivity by reducing empty back-hauls.

Load matching traditionally has been the business of freight brokers (freight forwarders), which act as transportation intermediaries to manage the coordination of information and freight. New types of electronic brokers such as Transplace.com and freightquote.com, which we discuss below, are threatening the future of traditional information brokers, both from within the industry and through entry to the industry. Some trucking industry incumbents are exploring new

boundaries while exploiting their existing capabilities and physical assets to extend into the information brokerage segment of the industry.

Transplace.com is an example of how industry incumbents are combining asset rationalization and the management of information to gain efficiencies. The objective of Transplace.com is to create a high volume freight network that will increase equipment utilization for fleets and reduce waiting time for drivers. Transplace.com serves as an information aggregator in the fragmented truckload sector, with its tens of thousands of competitors, by helping both shippers and carriers to match loads and rationalize capacity.

Freightquote.com

While Transplace.com leverages its traditional transportation asset base in the e-business environment, a new genre of information brokers is emerging on the internet. Freightquote.com is an example of an industry entrant that is using the internet to integrate information and offer load-matching services. Table 7 lists some of the other load matching exchanges spawned by the internet. These exchanges arise owing to the geographic dispersion of the industry and the small size of most carriers. The new exchanges challenge traditional freight brokers in managing the coordination of information and freight. At the annual convention of the Transportation Intermediaries Association in March 2000, the dominant topic of discussion was the threat posed by the internet and new load matching software. Freight brokers note that the internet is challenging them in two ways. First, in shipper-driven brokerage substitution, the internet enables many shippers to post loads and solicit competitive bids directly from carriers, which use the internet to identify backhauls. This process combines load matching with competitive pricing. In the process, the shipper receives the advantage of a low bid and the shipper increases productivity by reducing empty miles. In this scenario, however, the traditional freight broker has no role. Instead, shippers function as their own brokers, dealing directly with freight companies.

Second, the internet allows new intermediaries to aggregate loads and obtain volume discounts. Freightquote.com is an internet-based info-mediary that specializes in the trucking industry. Freightquote.com targets smaller shippers that do not have enough volume to negotiate discounts on their shipments. On its internet site, shippers can identify prices and order deliveries. Membership is free for shippers, although membership information provides

freightquote.com with valuable shipper and carrier data. Shippers pay a fee each time they use the service to ship a load of goods. Freightquote.com handles arrangements for pick-up, paperwork, and billing online. This scenario provides a critical role for freight brokers in the changing industry, unlike the emergence of shipper-driven brokerage substitution, but requires brokers with new information technology skills and management abilities.

Integrated Services: Mergers and Acquisitions

In the e-commerce environment, customers tend to demand transportation as an integrated service, with no regard to segments or length of haul. Faced with stringent demands for shipment time and quality, shippers would like to deal with one company for most or all of their inbound and outbound shipping needs. The new customer mandate requires routines that the firms cannot create from their existing repertoires of routines[22]. As a result, acquisition activity is becoming increasingly common in the industry, as a complement to internal development, with acquisitions arising from the need to gain access to new resources and coordinate the use of heterogeneous resources[23]. Thus, through combinations of internal development and acquisitions, firms are attempting to exploit their existing skills while also exploring new business opportunities[24].

Many incumbents in the trucking industry are restructuring to offer integrated transportation solutions by including logistics and other transportation options in their corporate portfolio of asset-based transportation management services.[25] These firms are now offering suites of "one call, one carrier" services including TL, LTL, logistics, package express, and inter-modal services. Several trucking firms have developed portfolios of asset-based transportation management services through mergers and acquisitions. Examples include CNF Transportation, Caliber Systems/Federal Express, USFreightways, and CRST International. The operating units of CNF Transportation include a package express firm (Emery Worldwide), an LTL firm (Con-Way Transportation Services), and a logistics provider (Menlo Logistics). Similarly, the operating portfolio of Caliber Systems includes a package express firm (RPS), an LTL firm (Viking Freight), and a logistics provider (Caliber Logistics). Caliber, in turn, was acquired in late 1997 by Federal Express, as FedEx sought to become a more broadly integrated carrier. Recently, USFreightways acquired Transport Corp. of America making it one of the nation's largest truckload carriers. USFreightways has expanded its primary business of providing regional LTL by acquiring a domestic and international freight forwarder, a logistics firm, and a

regional truckload carrier. Similarly, CRST International has recently restructured itself into a single transportation services company by combining its six units into one operating unit. In the past, each unit served customers separately in their niche markets. Through the restructuring, CRST International combines CRST for TL, Malone Freight lines and the Three 1 truck line for flat bed services, CRST Logistics for logistics services, and an express LTL service. According to company President John Smith, "It didn't take a genius to figure out it was better approaching this as one team of professionals totally focused on the customer and making transportation as easy as possible for our customers."[26]

Competitively, these companies have to contend with the challenges posed in each of the segments in which the firms participate. Many of the firms began restructuring and consolidating when logistics software became widely available and increasing cross-border shipments necessitated shippers to require multiple services from their trucking vendors[27]. As more firms present themselves as providing integrated transportation management services, the formidable task that lies ahead of them is to achieve the close coordination that is required to capture the benefits of being a single entity. Acquisitions stem from need for access to capabilities and coordination of activities[28]. Firms can sometimes use alliances of these purposes, such as the Transplace.com example above. In many cases, however, it is likely that the needs for coordination will involve sufficiently complicated interactions among the firms that alliances will provide only partial solutions[29]. Instead, we believe that there will be increased reliance on business acquisitions in order to undertake the substantial changes that internet-based business will require.

Summary

The examples above illustrate the manner in which the internet is challenging the strategies and capabilities of trucking firms. Firms are responding with by exploiting existing skills and exploring new opportunities. The internet is also encouraging industry reconfiguration via alliances and acquisitions, in order to gain coordination of integrated services. The activities are causing significant changes in industry structure and competition.

C.2. Survey Data On Internet Usage In The Trucking Industry

In order to investigate the most recent internet technology adoption practices in the trucking industry, we are conducting the survey of trucking firms that we noted in the prior section. Our

goal is to identify how the firms are using internet technology, and to gain an understanding of how early internet usage is affecting firm performance and profitability. We present some of our findings here and in the following section of the paper.

The 177 respondents to the survey represent a cross section of the trucking industry. Segments represented include TL (40%), LTL (71%), logistics services (20%), package express (9%), and private fleet (30%) operators. About 55% of the firms participate in two or more of these segments of the industry. There is also a useful size distribution of respondents, with about 65% of the firms operating 100 or fewer power units and 35% operating more than 100 units.

As we noted in Section C, 75% of the respondents report at least minimal internet activity by early 2000. At the same time, however, the impact is at very early stages of both investment and customer activity. The firms on average devoted only about 12% of their investment in new technology on internet-related projects. Internet sales activity is even lower, also, as on average the firms with internet activity procured only about 5% of their shipments by the internet in 1999. Thus, although internet applications are diffusing widely among trucking firms, e-commerce still accounts for only small parts of the firms' business activities.

Table 8 lists the most frequently used applications of the internet. As we noted earlier, most firms use the internet to exploit many aspects of their existing capabilities and improve customer relationships and internal processes. In addition, many firms go beyond skill exploitation and look for new ways to identify new markets and customers using the internet as a springboard. Accordingly, we classify the features in one of three categories -- "Exploration", "Exploitation of existing skills: Customer-related", and "Exploitation of existing skills: Process-related" -- to understand how firms are using the internet. The most common exploration features are attracting new customers (72%), followed by service customization (27%). The most commonly used skill exploitation features that firms use to improve the customer experience are (1) marketing services (75%), followed by (2) online shipment orders from existing customers (37%), (3), online pricing and rating software (31%), and (4) freight pick up request (29%). The most commonly used skill exploitation features for internal process improvement are office communications (61%), followed by recruiting drivers (39%) and recruiting personnel other than drivers (37%). The central conclusion from Table 8 is that firms are using internet applications both to enhance many types of existing skills and to explore new opportunities.

In summary, many trucking firms are using the internet widely, although at relatively early stages of business development. Many companies are using the features enabled by the internet to improve their ability to serve existing markets and customers, by enhancing existing customer services and improving efficiency in internal processes. Firms are also using the reach and connectivity of the internet to explore new frontiers.

D. The impact of the internet on the trucking industry

The internet has had a significant impact on the trucking industry[30]. In this section we present data on the association between internet uses, change of business activities, and firm performance. The data suggest that the internet is having greater impact on business activities that enable growth than on cost reduction.

Impact on business functions

There are many ways by which trucking firms can use the internet. The internet helps firms explore new opportunities by aggressive sales and marketing. By providing immediate access to customers about routine information and documents, the internet allows marketing personnel time to offer exceptional service to existing customers and to explore venues for new markets and growth. Trucking firms as the physical conduits of e-commerce have access to customer specific data. Trucking firms are combining new data management capabilities, network management capabilities, and existing warehouses and mobile assets to offer integrated transportation services within the supply chain. The internet also allows firms to exploit existing skills by improving the quantity and quality of information available to customers in real time and in a customized manner.

The internet has also become instrumental in process improvement. The incremental cost of transacting on the internet is as much as fifteen times less expensive than paper transactions and trucking firms are aggressively moving to the net, in some cases replacing existing systems and in many cases creating new electronic interfaces. For instance, traditional electronic data interchange (EDI) services such as load tendering, status reporting, and invoicing cost thousands and tens of thousands of dollars to set up and run, while also requiring substantial ongoing effort to maintain inter-firm system compatibility. These costs and difficulties inhibited adoption of EDI systems by small carriers and, in turn, the limited adoption hurts the capability of small carriers to work with large shippers that mandated EDI transactions. Now, some shippers are

using systems that allow EDI transactions over an Extranet, which is a secured internet location that reduces set up costs. Still in its nascent phase, web-based EDI systems require manual entry and have not yet been widely adopted. However, the potential low cost and standardized accessibility of EDI over the internet may level the playing field for carriers that had been excluded from many freight opportunities earlier. Smaller firms are also able to obtain loads and conduct more business due to the freight matching transparency of the internet. Therefore, the internet allows the firm to explore new opportunities, as well as exploit existing skills to improve processes and customer services.

Tables 9 and 10 present findings from the UMTIP survey. The findings show the use of the internet for different business functions and describe how the internet has helped firms change their business activities.

Table 9 reports the use of the internet for several business functions. We find that the internet has had the most use for company image enhancement (mean 2.8, on a 1 to 5 scale, where 1 indicates no use). The wide reach of the internet has facilitated the broadcast of information in an environment where all the constituents are geographically dispersed. The connectivity enabled by the internet also has facilitated the exchange of information with shippers and consignees (2.7), and third parties (2.5). Thus, the internet has contributed to multiple business functions needed for offering new services, dealing with existing customers, and operating internal processes.

Table 10 presents the reported impact of the internet on helping firms change their business activities since 1996. Firms were asked about the extent to which changes in different business activities were due to their internet activities. Possible responses were that none of the change is attributable to the internet, some of the change is attributable to the internet, most of the change is attributable to the internet, and not applicable. Once again we organize the features in terms of exploration, customer skills, and process skills. As the table indicates, in the exploration category, we found that 72% of the respondents said that some or most of the change in acquisition of new customers is due to the internet. In improving services to existing customers, trucking firms respond that the internet has helped them improve relationships with their shippers (67%) and consignees (63%), as well as provide quicker service (57%). In improving processes, many firms said that the internet helped facilitate internal process improvements

(72%), improve relationships with third-parties (64%), and enhance the management of change (64%). The key conclusion here is that the internet has helped facilitate recent improvement on many dimensions, although the internet is far from the sole source of improvements. [31]

Impact on trucking firm performance

We now consider the initial impact of internet activities on trucking firm performance, using data from two sources. Tables 11 and 12 present this information.

Table 11 presents data from the UMTIP survey. The table shows the correlation between indicators of firm performance and the number of internet features the firms report using. We use the number of features as a measure of the extent to which a firm uses the internet. We find that greater internet use correlates positively with growth on many dimensions, including assets, market share, revenue, miles operated, number of shipments, and tons of freight. Greater use of internet features also correlates positively with reported increases in profits. The correlations suggest that internet usage associates closely with growth and the level of profits of trucking firms. Notably, though, internet usage does not correlate closely with costs, whether labor cost or total cost. The results suggest that internet investments, at least so far, are helping firms grow, but are not reducing service costs. At the same time, though, the growth appears to recover the expense of the internet investment, so that relative costs do not increase, even if they do not decline.

Table 12 reports data from our complementary analysis of Form-M reports and firms' public web sites. As we noted earlier, in Section C, we undertook a web search for firms for which we were able to obtain Form M financial data.[32] We identified whether each firm offered a public web site and what skill exploitation and exploration features were present on the site. The table presents the correlation between the number of features available on the sites and financial measures based on data available in the Form M reports for 1999 and 1996, including operating revenue and operating income. The table presents the data pooled from 113 firms, for which we were able to obtain data on multiple measures. [33]

Several correlations in Table 12 are notable. First, there is a strong correlation between firm revenue in 1999 and web activity in all three categories of skill utilization, suggesting that larger firms are undertaking more extensive web-based services. Second, there is a substantial correlation between 1999 profitability and web utilization. The causality of this relationship

likely stems both from the contribution of web activities to profitability and from the ability of more profitable firms to invest in web activity. Third, there is a modest positive relationship between web utilization and revenue growth from 1996 to 1999, with the strongest growth relationship arising from use of the web for exploration opportunities. Fourth, there is little relationship between web utilization and growth in profitability between 1996 and 1999. Indeed, the strongest of the weak relationships lies with lower profitability (i.e., higher expenses) and greater utilization of customer-related web features. The strongest implication of this analysis is that web utilization contributes more to firm growth than it does to efficiency. This conclusion is consistent with the performance results (Table 11) that we found in our survey of trucking firms.

Implications

Several implications arise from this quantitative investigation, coupled with the descriptive information from earlier sections. At this point of internet service development, e-commerce is supporting growth more than improving efficiency. e-commerce is facilitating growth of individual trucking firms and the industry as a whole, by allowing the firms to offer more services to their existing customers and to offer services to new customers. For instance, several firms offer on-line package tracking applications to inform customers of package status, which has been very useful in keeping and attracting customers. So far, though, the evidence suggests that the internet has had little overall impact on trucking firm costs, as operating margins have not improved at firms that use the internet extensively.

The contrast between the initial effects on growth and efficiency raises the issue of future growth and expense trends. Clearly, internet usage will continue to support ongoing growth of trucking services. A key question, though, is whether we should expect greater efficiency benefits to emerge in the future. Certainly, there are potential efficiency gains from minimizing waiting times, maximizing trailer utilization, avoiding traffic congestion and bad weather, substituting EDI for paper-based transactions, managing inter-modal relationships, and improving other business processes. Although the data suggest that such benefits have not yet emerged in any large scale, it may simply be too early for the benefits to have reached critical mass. It seems likely that some such efficiencies will begin to emerge.

It is quite possible, though, that many costs of providing trucking services will not decline substantially in the future. While there certainly will be some efficiency benefits, there also will

be ongoing investment costs in internet technology and, indeed, somewhat higher unit costs for the fine-grained and integrated services that the internet supports. In addition, there may well be higher employment costs given the need of increased skills in the workforce. Web-based EDI, meanwhile, may tend to supplement traditional systems rather than replace them. So far, the evidence from the survey and the Form-M data suggests that the benefits and costs appear to be in balance, resulting in maintaining traditional operating efficiencies. While the trends could change in the future, it appears likely that much of the growth in demand for trucking services will be in the realm of services that would be too costly or impossible to provide at present. As a result, the benefits of the internet may arise primarily in creating more shipments and, especially, new types of services, rather than in making traditional services more efficient. In parallel, the internet may allow smaller firms to use more sophisticated routing, dispatching, and other processes than they now undertake, again resulting in greater service but not in lower cost than present operations. This conclusion is consistent with firms' experience with information technology investment during the past half-century, in which IT often enables change more than it makes current activities more efficient.[34] In the banking industry, for instance, electronic services such as ATMs and on-line banking provide benefits to customers, but also represent higher costs for the banks. Thus, the benefits of IT often arise through allowing people to do things that they could not do otherwise, rather than being more efficient in their traditional activities.

One possible venue for increased efficiency might occur with the rise of specialist trucking firms that provide "traditional" trucking services using internet technology to gain operating efficiencies. For instance, we might see web-based specialist TL firms that minimize waiting times and maximize trailer utilization. Such specialist firms might well be more efficient than current providers of similar services. However, such specialization conflicts with the trend for the major carriers to become asset-based transportation management service providers, as we discussed earlier, in response to their customers' demands for integrated services. These integrated services will often be more costly, rather than less expensive than existing services. Thus, the efficiencies are unlikely to show up in aggregate firm data, because the integrated firms provide a mix of more-efficient traditional services and more-costly new services.

Rather than greater trucking firm efficiency, then, internet usage may be more likely to fuel greater end-user productivity. Major benefits of end-user productivity will arise as business customers of trucking gain better information on where their shipments are, can plan better, can manage their inventories better, and gain other operating advantages. That is, the trucking industry is producing a better product and many or most of the benefits will show up in the increased efficiency and effectiveness of their business customers, more than in lower costs of trucking services. For instance, initial analyses suggest that business-to-business internet usage may provide end-users with cost savings of 15% to 20% on their freight transport costs.[35] Such benefits will lead to improved productivity for some shippers and consignees, so that the productivity improvements of web-enabled trucking services will spill over into the general economy.

Even in the case of end-user productivity, though, it is not clear that most business customers will enjoy lower costs for current practices as the result of improved trucking services. Instead, many of the gains to business customers may well show up in providing more-refined services to their own end-customers, say, for instance, in providing customized production and delivery of various products, rather than in cheaper provision of existing services. Thus, many of the economy-wide productivity benefits will show up not as lower costs for traditional services, but as the ability to provide new services, such as faster production, more agile "mass customized" production, quicker and more frequent deliveries, and effective delivery systems for new internet-based business-to-business and business-to-consumer sales.[36] In turn, these new services will tend to fuel economic growth through the spillover demands that they create.

In addition, it is possible that some of the efficiency benefits of internet-facilitated trucking services may arise from business and retail customers ordering existing goods directly from producers and bypassing intermediaries. However, pure disintermediation is unlikely to be common, because customers will often lack the necessary skill and scale to manage such purchases. Instead, we are more likely to see the rise of new intermediaries that manage the order-production-delivery-service interface, either as operating units within producers or as distinct firms. Major e-tailers, for instance, are building warehouses to supplement their "inventoryless" business models, using the availability of web-based just-in-time delivery services from trucking firms to facilitate their inventory activities. Another example is emerging

with internet-based auto orders and deliveries, where changes in existing dealer networks are beginning to occur as the use of the internet to order vehicles increases. Rather than eliminate the concept of auto dealers, though, this evolution is much more likely to lead to the development of new and/or transformed dealers that can stock example vehicles, facilitate option choices, help arrange financing, organize delivery, and provide after-sales services. The availability of web-based trucking services clearly will play a vital role in such activities. However, the overall cost of dealer service is unlikely to decline much or at all. Instead, consumers will benefit by getting better service than they do at present. Thus, gains that stem from utilizing internet-facilitated trucking services will tend to show up as service improvement for customers.

In summary, there is evidence that, so far, firms that use the internet more have more potential for growth, within traditional cost structures. Firms are using many features of the internet for exploiting their current skills, including both internal processes and relationships with customers, and exploring new opportunities. Clearly, it is still too early to measure the full productivity impact of internet-facilitated improvements. Initial estimates, though, suggest that the internet is having greater impact on growth than on cost reduction. The net impact of the revenue and cost trends may lead to larger trucking businesses and/or a larger trucking sector, with profitability that is similar to current levels.

E. The impact of the internet driven trucking industry on the U.S. economy.

This section attempts to estimate how internet usage by trucking firms might affect the U.S. economy. Although, by necessity, this assessment is highly speculative, several realistic scenarios suggest that there will be substantial impact. We consider, first, how changes within the industry may contribute to the GDP through 2002 and, second, how the changes within the industry might facilitate or inhibit growth throughout the larger economy.

GDP contribution of changes within the trucking industry

First, consider scenarios of GDP and trucking industry growth, which Panel A of Table 13 summarizes. The scenarios require assumptions for GDP growth, trucking share of GDP in 1999, and trucking services growth. The most recent estimate of GDP for 1999 was $9.3 trillion, while the most recent estimate of GDP growth (second quarter of 2000) was 5.2%[37]. An optimistic forecast for GDP growth might project a growth rate of 5% over the next three years. A modest forecast might project a 3% rate, while a pessimistic forecast might project a 1% rate.

Table 1b reported that the trucking industry's contribution to GDP, including both for-hire firms and private fleets, was about 3.3% in 1992 and 3.1% in 1996. We will assume that the share in 1999 was 3.2%, which is a conservative assumption given the economic growth and growing demand for trucking services during the past three years.

In order to project post-1999 growth in trucking services, we start with the figures in Table 1b. The table shows that trucking value added grew by about 5% a year between 1992 and 1996, about the same as GDP growth during the period. The 5% trucking growth figure provides a baseline forecast, arising as it does from a period of only preliminary internet usage in the industry.

Our studies, which we discussed in the previous sections of this report, suggest that growing current internet usage in the industry is likely to lead to increased trucking growth, at rates in excess of GDP growth. Our analysis of internet use by trucking firms suggests that, initially at least, web-based trucking services have led to revenue increases with relatively little change in relative costs, that is, to increased shipments with operating margins that are similar to traditional levels. Thus, the impact of the internet on the trucking industry arises primarily through increased revenue, rather than through greater efficiency. We note that the firm-level revenue effects include both exploration opportunities by attracting new customers and skill exploitation opportunities by providing more services to existing customers. While some of these additional revenues simply will shift shipments within the industry, from trucking companies that lag in providing internet services to more innovative firms, additional revenues will come from increased overall usage of trucking services. Examples of such increased usage include existing end-users adopting more frequent shipments for just-in-time production and distribution, and new end-users using commercial shipping for retail deliveries of web-based distribution and retail sales. An optimistic forecast might suggest 10% growth in trucking services in a 5% GDP growth economy. A more modest forecast might suggest maintaining a 5% growth rate for trucking in a 3% GDP growth economy. A pessimistic forecast might suggest 3% trucking growth with 1% GDP growth.

Panel A of Table 13 summarizes the output of these assumptions concerning GDP and trucking growth. Under the optimistic forecasts (scenario 1), the trucking share of GDP grows from 3.2% in 1999 to 3.7% in 2002. Under the modest and pessimistic forecasts (scenarios 2 and

3), the trucking share of GDP grows to 3.4% in 2002. These estimates suggest an incremental contribution to GDP that ranges from $19 billion to $52 billion per year by 2002. These contributions from internet-driven changes within the trucking industry are moderate but real contributions to economic growth, providing from an additional 0.2% to 0.5% of GDP.

Contributions from trucking-industry internet usage that affects the larger economy

We now turn to considering how changes in trucking might affect the larger economy through its inter-connected relationship with other industries. Again, we note that these estimates are highly speculative, but stem from reasonable estimates of the role of trucking services within the economy.

The key starting point here is that trucking services are intertwined with many sectors of the economy, as our discussion in Part B of the paper showed. Moreover, the availability of more sophisticated web-based trucking services, offering fine-grained, faster, integrated services is critical to continued growth of many sectors of the economy. That is, other industries require new types of trucking services to continue their own expansion. In the manufacturing and construction sectors, for instance, the availability of reliable just-in-time delivery services are essential to modern production systems. The ongoing redefinition of wholesale and retail trade that is occurring with the growth of business-to-business and business-to-consumer internet commerce, moreover, depends critically on growing sophistication of transportation services, particularly on trucking services. These changes will require refinements in existing package express, LTL, and TL services. In addition, as we discussed earlier, internet trade will require greater integration among the different types of trucking services, as well as the provision of complementary activities such as logistics, warehousing, and customer service. Quite simply, effective adoption of internet technology by trucking companies will be required for other sectors of the economy to even approach the potential of their own internet-based growth. Thus, adoption of web-based technology by trucking companies almost certainly will have an impact well beyond the contribution to GDP that arises from internal changes in the trucking industry. In addition to the internal contributions, trucking industry internet-usage will have multiplier effects on growth throughout the economy.

Attempting to quantify the multiplier effects is highly tentative. Nonetheless, consider several possible scenarios.

We start with scenario 1 in Panel B of Table 13. On the positive side, suppose that highly effective adoption of internet technology by trucking firms might facilitate as much as 0.25% to 0.5% of additional GNP growth, that is, an additional 5% to 10% beyond the current baseline projection of 5% per year (scenarios 1a and 1b in Panel B of the table). If so, by 2002, effective internet usage by trucking firms would contribute as much as an additional $155 billion to the economy (1.4% of GDP) through its multiplier effect on the industries that require trucking industry services.

Conversely, suppose that flawed adoption of internet technology by trucking firms inhibits potential growth in other sectors, by as much as 0.25% to 0.5% below the current high growth baseline projection (scenarios 1d and 1e in Panel B of Table 13). In such scenarios, ineffective trucking industry internet usage would depress the economy by as much as $150 billion (1.4% of GDP) by 2002.

Scenario 2 in Panel B of Table 13 tests the sensitivity of the analyses to the baseline GDP growth rate. The modest growth scenario results in similar figures for trucking industry impact.

There are two key points here. First, the multiplier effect of the trucking industry outweighs its direct contributions to the U.S. economy. Where our scenarios of direct contributions range from about $20 billion to $50 billion, the multiplier contributions reach as high as $150 billion. Second, the industry can either raise or depress the overall economy as a result of how successfully trucking firms develop and adopt web-based services. Thus, adoption of internet services has implications that range far beyond the profitability and survival of individual trucking companies.

Fortunately, our study provides evidence that trucking firms are already beginning to use the internet very effectively. Nonetheless, continued improvements in internet adoption are necessary if the U.S. economy is to reach its positive potential. In greatest part, these continued improvements depend on continuation of the managerial initiatives within individual trucking companies and private fleets. In addition, though, several implications for public policy arise here.

Policy implications

We will consider policy implications concerning three issues. The effectiveness of trucking industry internet-usage will increase with sensitive attention to policies concerning mergers, labor, and internet technical support.

U.S. antitrust policy and enforcement has long viewed mergers between firms in the same industry with suspicion. Traditionally, the primary concern was that mergers would lead to greater market power and consequent ability to raise prices. More recently, antitrust policy has added concerns about inhibiting innovation to its suspicion of mergers. We believe that such suspicions would be misplaced in the trucking industry.

As we discussed earlier, many mergers are taking place within the industry. Rather than leading to increased prices or reduced innovation, however, these mergers are necessary for firms to offer business innovations needed in the broader economy. Most critically, the mergers help firms create integrated transportation services that include TL, LTL, package express, logistics support, and other complements. The role of web-based services is critically important here, as integration of previously disparate trucking businesses facilitates firms' ability to develop and adopt sophisticated internet features. Without the mergers, independent firms would need to attempt to coordinate both the provision of integrated trucking services and the development of internet features for those integrated services. Quite simply, such arms length coordination would be suboptimal or impossible in many cases, because of the complicated evolution that the development paths must follow. The key implication here is that antitrust merger policy must develop the sophistication to recognize most trucking industry mergers as opportunities to improve and innovate, rather than to inhibit competition and reduce technical advance.

A second policy concern is the availability of labor. Drivers and other personnel in the trucking industry have to operate in an environment that requires training and skill in new electronic technologies. The booming economy has seen unemployment at among the lowest levels in decades. Trucking firms will need to address the pressing need for skilled labor in order to play their substantial role in the new economy. Increased emphasis on information technology skills in educational institutions clearly would benefit the industry.

Several regulatory initiatives that influence the availability of labor need thoughtful attention. A topic of great debate at present is the "hours of service" regulations that the trucking industry must follow. There is much opposition within the industry to the newly proposed rules since these rules could increase the difficulty of managing operations in an industry that already has very little room for error. The tension between the time a driver can safely drive and the need for a firm to do more with less is exacerbated in the new competitive environment. As more physical goods are demanded in the electronically efficient environment, trucking firms are scrambling to move the freight in the most efficient way possible. Greater efficiency might somewhat ease the labor shortage, for instance, if a smaller percentage of time is spent by drivers waiting at docks. Operational options to increase efficiencies that the industry and regulatory authorities are considering include increasing the number of axles and allowing longer trailers. The implications of these moves on the safety of drivers and the public, together with the impact on the highway infrastructure need to be considered carefully.

The third public policy implication concerns technical support of internet technology development. Our study found that most internet usage by trucking companies derives from internal development.[38] We believe that the privately led internal development will continue to lead to growing sophistication and effectiveness of internet systems. At the same time, there will continue to be opportunities for public support of technical development in this industry.

F. Conclusion

The impact of the internet on the economy is notable. As the economy continues to grow and business practices change and adapt to the new "e"conomy, the trucking industry will have to respond with making dramatic changes to accommodate their demanding customers. Indeed, the industry is facing its greatest challenge since deregulation two decades ago.

Trucking firms are moving aggressively to respond to the challenge posed to them by the internet enabled global economy. Many firms in the industry have adapted by making major changes in business practices, involving both exploitation of existing skills and exploration of opportunities that require new capabilities. Trucking firms are participating in the new economy by expanding existing resources, adopting new technologies to enable internet-based communication with their customers, and by improving processes to improve service and efficiency. The freer flow of information, the connectivity, and the opportunity to aggregate

dispersed information have spawned new web-enabled businesses and these new entrants are challenging many traditional assumptions and business practices. At the same time, trucking industry incumbents are using alliances and acquisitions to redefine themselves as asset-based transportation management companies. The actions of the trucking firms will affect far more than the performance of the trucking services industry alone. In addition, the response of trucking firms to internet-based opportunities and challenges will have major influences on the economy as a whole.

The prediction that tomorrow will be much like today is based on forecasting in an environment of incremental change. Many of the predictions about the impact of the internet are based on present trends. However, the internet has created enormous turbulence and is the harbinger of discontinuous change in the economy. We attempt to estimate the impact of the internet on the trucking industry and consequently on the economy using recent trend data. Given the dramatic and integral role of the internet in the redefined economy, the past and the present may be pale imitations of what the future holds. No matter what the new rules of competition are, however, the future of e-commerce depends on how physical goods are transported within the constraints of time, cost, and quality. As a result, the response of trucking firms will play a significant role in determining the extent to which the full potential of e-commerce will be fulfilled in the economy.

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Endnotes

1 Sampler, 1998; Rayport and Sviokla, 1995

2 Standard & Poor's, 1999; American Trucking Trends 2000

3 American Trucking Trends 2000

4 Newport Communications, 1999; Bureau of Transportation Statistics, 1998

5 Sources that we used for the information in this section include American Trucking Association (2000), American Trucking Association (1999), Newport Communications (1999), and Standard & Poor's (1999). Estimates of numbers of U.S. trucking firms vary substantially, because of the size and fragmentation of the industry. There were 501,744 interstate motor carriers on file with the Office of the Motor Carriers as of March 2000.

6 An owner-operator is a sole proprietorship or other small company whose primary purpose is to operate one or more trucks for-hire.

7 In the past few years, largely as a result of the emergence of the internet economy that we talk about in this paper, package express (PX) companies such as UPS have become a highly visible part of the LTL segment (indeed, many of the larger package express firms have merged with "traditional" LTL companies). There are several key differences between PX and the rest of LTL, including (1) the equipment needed to move goods; PX has more items to deliver but the goods are lighter and PX pick-up-and-delivery vehicle (PUD) drivers do not need to operate fork lifts; and (2) the volume of material to pick up and deliver; PX usually has 10 to 15 pick ups or deliveries an hour while LTL has about 2 to 5 per hour. PX and the rest of LTL share key similarities, though, in aggregating shipments from multiple sources and then disaggregating them to multiple consignees.

8 We thank BTS staff members for their timely and enthusiastic assistance in our data gathering efforts.

9 According to ATAs American Trucking Trends, the operating ratio for trucking firms based on reports to U.S.DOT of 1500 firms with $3 million or more in annual revenue, was 96.4% in 1990, 95.8% in 1992, 95.0% in 1994, 96.9% in 1996, and 94.5% in 1998.

10 Transport topics, August 7, 2000

11 The magnitude of transportation services has long been underrepresented in the U.S. economic data. Until recently, national measures of transportation services only counted the value of for-hire transportation, ignoring the contribution of in-house private transportation. The Transportation Satellite Accounts (TSA), developed jointly by the Bureau of Transportation Statistics (BTS) of the Department of Transportation and the Bureau of Economic Analysis of the Department of Commerce, provide more comprehensive estimates. Including in-house transportation adds $142 billion to the 1996 estimates compared to estimates derived from traditional accounts that emphasized for-hire services. The TSA is statistically and conceptually consistent with the national accounts used to calculate gross domestic product (GDP). These accounts are based on the 5-year Economic Census; 1992 and 1996 are the most recent years for which complete data are available.

12 For the purposes of this paper, we use the terms “in-house””, “own-account”, and “private” transportation interchangeably. We attribute all the value added by own-account transportation to in-house trucking (this attribution means that we include in-house bus, which contributes less than 1% of the value added of own-account transportation, within in-house trucking).

13 Transtats April 1998

14 Across the full economy, industry inputs and commodity output are the same. At the industry level, however, industry inputs and commodity output may vary.

15 We conducted the survey during early 2000, with the sponsorship of the University of Michigan Trucking Industry Program (UMTIP). UMTIP receives generous support from the Sloan Foundation and from trucking industry corporations.

16 Richardson, 1972; Langlois and Robertson, 1995

17 Karim and Mitchell, 2000

18 Tushman and Anderson, 1986

19 Transport Topics, July 31, 2000 Page 16

20 Transport Topics. Jan 24, 2000 Pages 10-12.

21 Space utilization is particularly important for LTL shipments, particularly for LTL companies providing national service, but also applies to TL carriers. The benefits from reducing empty miles arise in both segments.

22 Nelson and Winter, 1982

23 Capron, Mitchell, and Oxley, 1999

24 March, 1991

25 Nagarajan, Canessa, Mitchell, and White, 2000

26 Traffic World 252 (5) Page 23.

27 Nagarajan, Bander, and White, 1999

28 Nagarajan and Mitchell, 1998

29 Capron, Mitchell, Oxley, 1999

30 Haltiwanger and Jarmin, 1999; Moulton, 1999

31 Very few firms reported that "most" of a change stemmed from internet activities. The mean for such extensive impact was about 1% of the cases, with the maximum being 6% of the cases. Therefore, for most firms, internet-facilitated change is part of larger change efforts.

32 The Form M – web analysis is largely independent of the survey, as only 8% of the firms in the Form M analysis were respondents to the survey.

33 The reported analysis pools the TL and LTL firms, because there were no material differences in the segment-specific correlation.

34 See, for instance, Wilson. D., 1995; Powell. T. C. and Dent-Micallef. A., 1997.

35 Brookes and Wahhaj, 2000.

36 The same study that found that freight costs decline for users of business-to-business web sites also concluded that "the long term impact of B2B will be higher volumes not lower prices" (Brookes and Wahhaj, 2000).

37 BEA 00-22 National Income and Product Accounts, August 7, 2000.

38 Nagarajan, Canessa, Mitchell, and White, 2000