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TRUCKING PRODUCTIVITY AS VIEWED FROM THE LOADING DOCK

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ABSTRACT

A decline of trucking prices, relative to other prices, has been observed in many markets during the past 15 years. Some observers have ascribed the price decline to economic deregulation by the ICC. Open entry under deregulation facilitated interstate hauling by non-union, truckload carriers. Deregulation was shortly followed by high unemployment in the early 1980s. Owner operators proliferated. They were typically on piece work, so many cents per loaded mile, with none of the fringes typical of union labor. The resulting low labor cost largely displaced pre-existing common carriers from truckload hauling. Teamster compensation packages with the surviving LTL carriers shrank. Driver pay subsequently bottomed out because of constraints on supply: demographic shifts and new government regulations of commercial drivers' licenses.

Technological change has improved efficiency of resource use in trucking. The 1983 and 1989 relaxations of size limits on the Interstate Highway system allowed bigger loads on some long haul trucks. Improvements to powerplants and reduced aerodynamic drag lowered fuel consumption of new vehicles. Advances in communications, computers, and software and increasing adoption of bar coding and satellite tracking have brought improvements to vehicle routing, vehicle and personnel scheduling, shipment and package handling and tracing, and paperwork processing. Increased mechanization such as palletization and stretch wrapping have reduced the time spent parked relative to that on the road. Improvements in TOFC technology and doublestack trains have attracted long haul traffic to rail, thereby increasing the number of loads handled per driver and tractor.

The several technologically induced productivity improvements have reduced the number of drivers and vehicles in use relative to the freight hauled. Such numbers are admittedly crude as measures of productivity but data permitting quantitative analysis of the industry

do not exist. Changes continue to take place in trucking technology and industry structure.

INTRODUCTION

Trucking productivity, the efficiency with which resources employed in the trucking industry produce transportation, has received much attention in recent years.¹ One reason is the debate over the fate of economic regulation by the Interstate Commerce Commission (ICC) and corresponding state agencies. Several authors have argued that ICC deregulation, started in the late 1970s, increased productivity and brought lower costs and prices, at great benefit to consumers.²

Most observers agree that costs and prices in trucking declined *post hoc* (post deregulation).³ Not much has been written describing the specific mechanisms whereby costs were reduced or productivity improved. The *propter* link has not been traced. Free market proponents simply ascribe all improvements to deregulation. The innuendo is that managers of regulated enterprises are less bent on profit maximization than are managers of unregulated enterprises. Anecdotal evidence of inefficiencies stemming from operating restrictions imposed by government regulations has also been cited.⁴

Published data permitting quantitative analysis of industry-wide productivity do not exist. The industry is heterogeneous, offering a wide variety of outputs. Authorized, interstate, for-hire carriers represent less than a third of the industry.⁵ Of 39,000 authorized carriers (in 1989) fewer than 2,100 enjoyed revenues of \$1 million or more.⁶ Only 931 reported operating data to the ICC.⁷ This sliver of the industry on which data are published has changed substantially since the 1970s. Most of the data are reported by the Less than Truckload or LTL segment of the industry. Since 1977, LTL carriers have lost much of the small shipment business to package express and air freight companies; contemporaneously, non-union truckload carriers have captured most of the large shipment business. As a result of mergers

and the disappearance (bankruptcy) of hundreds of firms, the surviving, large LTL carriers have expanded their geographic coverage.⁸ This evolution of product mix, industry structure, and market shares continues.

Measuring productivity in trucking has always been hampered by a difficulty in defining units of output. *Ton-miles* may be a satisfactory output measure for trucks carrying full loads direct from origin to destination. Its allure fades if the truck deviates from a direct route to make part load pick ups or drop offs along the way. It is worthless as a measure of performance for the largest trucking firm, United Parcel Service (UPS), which deals predominantly in small package shipments. It is similarly inadequate for measuring performance of the other LTL carriers. Neither *tons* nor *shipments* serves as a satisfactory measure, for analogous reasons. Published data constitute a marshy foundation for analysis. The problems were elaborated in two conferences on transportation data organized by the Transportation Research Forum in 1989.⁹

In the following, the problem of output measure is circumvented by focusing on opportunities for productivity improvement (Exhibit 1). The exposition is largely qualitative. The goals are to describe the possible, to illustrate how change could and did take place, and to suggest where we might look for future change. The description is supported by nationwide statistics of freight hauled per driver, per tractor, and per trailer, which yield a crude picture of productivity trends.

EXHIBIT 1

Opportunities for Cost Reduction in Trucking

- PAY DRIVERS LESS
- PAY LESS FOR MATERIALS/EQUIPMENT
- DRIVER LONGER HOURS; DRIVE FASTER
- USE A BIGGER VEHICLE
- IMPROVE FUEL MILEAGE
- GO DIRECT (MINIMIZE CIRCUITY)
- FILL THE VEHICLE WITH REVENUE FREIGHT
- KEEP MOVING
- REDUCE STAFF

PAYING LESS FOR INPUT FACTORS

Reduce Compensation to Labor

As pointed out by Lawrence and Sharp,¹⁰ price changes of input factors have nothing to do with productivity, the efficiency with which factors are deployed. There is little doubt that reducing labor cost was a principal goal of the Motor Carrier Act of 1980 (the MCA). Elected officials would not admit publicly to a vendetta against the Teamsters Union but some witnesses at the legislative hearings were less bashful.¹¹ Despite the work stoppages that occurred or were threatened every three years with the re-negotiation of the National Motor Freight Agreement, critics alleged that regulation permitted management to offer but passive resistance to Teamster demands and then pass along increased costs to their customers.¹² The media also carried lurid tales of ties between Teamster leaders and organized crime.

The Flood of Owner Operators

Whatever role anti-Teamster sentiment played in passage of the MCA, there is no dispute that one of its consequences has been the diminution of Teamster power.¹³ A flood of owner operators entered the business. The opening up of entry into trucking effectively knocked the union out of the for-hire truckload segment of the industry. Anyone who could show proof of insurance and pay a token filing fee could obtain ICC operating authority to engage in interstate trucking. The ICC was inundated with applications. Most were from proprietary (private) carriers seeking authority to solicit backhaul traffic for hire and from contract carriers seeking to expand their customer base. While some owner operators obtained their own authorities, most leased themselves out to established private or contract (in some cases common) carriers. Their sole compensation was typically so much per loaded mile. The 1982 recession, widely characterized as the worst since the Great Depression, reduced the demand for freight transportation. An oversupply of truckers soliciting traffic was exacerbated.

Truckload hauling rates plummeted. Owner operators enjoyed none of the fringe benefits that went with teamster membership:

sick leave, vacation time, holiday pay, pension, medical insurance, dental insurance, workmen's compensation, employer contribution to social security, compensation for empty miles and compensation for waiting time (waiting for access to the customer's loading dock or for assignment of a new load). The charm of this pay package looks different when sitting in a tenured chair driving word processor than when sitting in the cab driving an eighteen wheeler. Bankruptcies soared. No one has tallied the burden shifted to social service agencies.

Contrary Trends

As unemployment diminished in the mid-1980s, other events took place whose effects are still working their way through the industry. Federal legislation established uniform standards for a commercial driver's license and mandated that all drivers in interstate commerce have one, and only one. A written test had to be passed. Periodical physical examinations and drug testing were also mandated. The combination of shrinking unemployment, the new license and testing requirements, and demographic trends in the workforce have all conspired to shrink the pool of qualified truck drivers.¹⁴ Non-union drivers' remuneration bottomed out and started an upward climb whose end is not in sight. By 1991, for example, owner-operators hired out to established trucking companies were receiving pay for empty as well as loaded miles.¹⁵ Compensation packages for truckload carrier drivers became more generous. Despite high unemployment in 1993, one still saw recruitment notices on the rear doors of trailers rolling down the highways; the driver shortage persisted. If demand for drivers increases with economic expansion, we can anticipate more aggressive recruitment and negotiating efforts by the Teamsters.

The Squeeze on LTL Carriers

The downward pressure on labor costs spilled over from the truckload to the LTL carriers. As many observers have pointed out, the LTL business is characterized by substantial barriers to entry. An LTL carrier requires a network of terminals and non-driver employees engaged in freight handling, dispatching, and so forth. Many have complex software packages for pricing, administration, and operations. Under

deregulation there have been no successful new LTL entrants on the national scene.¹⁶ The number of LTL carriers has greatly diminished¹⁷ as has their market. They quickly lost most of the large shipment business to the new entrant, truckload carriers. The latter, using either owner-operators or non-union employees, could carry loads at lower cost by hauling direct from shipper's dock to consignee's dock without stopping at intermediate terminals or having to contribute to terminal overhead burden.¹⁸ The traffic diversion was initially of shipments that filled much of the trailer capacity but the erosion continues. Truckload carriers increasingly undercut LTL rates on shipments as small as 10,000 lbs., or even less. They do so either as backhaul loads or grouped with a manageably small number of either drop off or pick up shipments. LTL carriers are also under pressure at the other end of the shipment spectrum. UPS, Roadway Package Express, Courier services, and air freight forwarders and carriers like Federal Express and Airborne Express all vie for shipments in the 1-70 lbs range.¹⁹ By focusing on small packages, UPS, which is a Teamster carrier, has been able to mechanize both local and break bulk terminals so as to reduce platform handling costs below those of LTL carriers.

Finally, there are some successful, non-union carriers among the survivors in the LTL field.²⁰ Overnite and Watkins, on the national scene,²¹ are non-union as are some of the successful regional carriers such as the Con-way subsidiaries of Consolidated Freightways, Viking (a growing subsidiary of Roadway), and New England Motor Freight (in the northeast). One assumes that the non-union carriers offer compensation packages sufficiently close to union scale to keep the Teamsters at bay; their success suggests, further, a cooperative labor-management relationship. Some surviving, unionized carriers have likewise adopted motivating strategies such as profit sharing to improve productivity.

Send the Trailer by Rail

The ultimate in reducing labor expense is to dispense with the driver altogether. Long haul carriers are increasingly doing just that by sending the trailers by train.²² UPS has long been the largest TOFC shipper.²³ The national LTL carriers are following suit on their line haul

moves. Press reports indicate that large truckload carriers, in addition to using TOFC service, are investing in containers to take advantage of doublestack train service.

TOFC service has existed for decades. Two factors that contribute to its growing attractiveness are the driver shortage and technological advances by the railroads that have improved service quality. The railroads increased the speed and reliability of TOFC service during the 1980s by modernizing track, communications, data processing, loading and unloading, and rolling stock. In traffic lanes where it is an option, rail service promises to become increasingly popular. The trucker saves on running costs such as fuel in addition to labor. TOFC improves the productivity of both tractor and driver by allowing them to handle more trailers per day. Finally, drivers can live at home, a feature that makes employment more desirable.

Quantity Discounts on Materials and Equipment

Bargaining for low equipment and materials prices has more to do with industry structure than productivity. Deregulation opened the door to the growth of large trucking firms. Freedom of entry meant freedom to expand operating rights. Large firms use their market clout to drive down vendor prices of everything from fuel to tires. Volume purchases may bring lower costs per unit; the administrative and design effort per unit in filling an order for 1,000 trailers is lower than in filling an order for one. The growing concentration among for-hire carriers stems partly from this advantage of bigness.²⁴

DRIVE LONGER HOURS AND FASTER

As railroad lobbyists have rightly pointed out, construction of the Interstate Highways greatly improved the productivity of long haul trucks by reducing point to point travel time. With the system now largely complete, and often congested in urban areas, similar productivity gains in the near future are improbable. Limits on driving hours and speed are set by government and justified on the basis of safety. Some truckers seek to minimize the level of enforcement and the enforcement penalties. Driver log books (in which work and

rest hours are supposed to be recorded to document compliance with the law) have come to be called *comic books*. Some drivers resist both the imposition of on-board, automatic monitors and laws prohibiting radar detectors. In California, the legislature was long persuaded not to equip the highway patrol with radar. Lobbying efforts succeeded in raising the speed limit on rural Interstates from 55 mph to 65 mph in most states during the late 1980s. On the other hand, management policy at some large, sophisticated firms is to drive no faster than 55 mph and to respect statutory operating hours. Other than selecting powerplants capable of maintaining speed on upgrades in hilly or mountainous terrain, there is little opportunity for management discretion to improve productivity by driving faster. Sleeper cabs (discussed below) and driver relays are increasingly used to reduce travel time and, thereby, improve equipment productivity.

USE A BIGGER VEHICLE

Maximum vehicle size, both dimensions and weight, is also set by government. The federal standards governing trucks using Interstate highways were relaxed in 1983 and again in 1989. Most states, particularly in the West, followed suit on other highways. Innovative designers developed both light weight trailers that make best use of the allowable gross (or axle) weight and large volume (drop floor or tapered roof) trailers. The increases in weight or volume of load carried indisputably improved productivity for some carriers during the 1980s.²⁵ Industry lobbyists advocate further relaxation of length and weight limits.²⁶

BURN LESS FUEL

The oil crises of the 1970s sparked reductions in truck fuel consumption. Powerplants and power trains were improved and radial tires adopted. Tractor aerodynamics were modified so as to reduce drag at speed.²⁷ The most visible change was the addition of fairings on top of the cab but there were other improvements. Reductions in vehicle tare (empty) weight also reduced power required for acceleration (in stop and go traffic or hill climbing). The improvements influence performance of only the new vehicles, not the older ones still in service (although some of

these have been retrofitted with fairings). It is reasonable to suppose that the new vehicles are the more intensively used. A growing fraction of the fleet consumes less fuel than it would with pre-1980s technology.

The prospect for future fuel consumption and costs is uncertain to unpromising. Many expect the changes in permissible emissions under the Clean Air Act to raise fuel costs. The aerodynamic improvements that reduce the power required for over the road driving will remain. What powerplant engineers can come up with in terms of fuel consumption for modified diesel fuels or for competing fuels remains to be seen.

TRAVEL DIRECT AVOID CIRCUITY

Advances in computer software and communications technology have greatly improved our ability to route fleets and dispatch vehicles efficiently. The tumbling prices and increasing power of PCs during the 1980s converted these improvements from possibility to reality for an expanding number of firms. For example, a local LTL terminal manager is informed the night before how many drivers will be required to deliver the freight inbound from the break bulk terminal; a shipper with a large number of drop off shipments can query the computer to determine which carrier to assign to which destinations and in what order to load shipments into each carrier's trailer; large, truckload firms can use the computer to plan both marketing and scheduling so as to secure backhaul traffic, minimize deadheading,²⁸ and meet commitments such as delivery appointments and driver rest or home time; carriers, shippers, and consignees communicate by electronic data interchange (EDI) about shipment status; satellite communications, adopted by a few large firms, serve somewhat similar functions by facilitating vehicle tracking and saving the driver time (telephoning from a pay telephone, for example).²⁹ Firms using the new technologies report increased productivity of both vehicles and drivers.³⁰

FILL THE VEHICLE WITH REVENUE FREIGHT

The Backhaul Problem

Avoiding empty or part empty miles is the classical problem of transportation (pipelines excepted). Often it is the nature of the operation that creates the problem. What can a newspaper delivery van pick up at the end of its route to bring back to the depot? In other cases, economic geography imposes an imbalance of freight. Some cities or regions are *sources* of freight; they originate freight. Others are *sinks*; they receive freight but originate little. Sometimes, especially in agricultural regions, freight imbalance fluctuates over time. Backhaul loads materialize during the harvest season but may require refrigeration. Not enough freight is offered to fill *all* trucks departing a sink or returning to a source. Someone has to travel light or empty. Shifting backhaul freight from one carrier to another does nothing to improve industry productivity, to diminish the quantity of societal resources consumed.

We refer to freight imbalance as a *backhaul* problem in the context of regular route carriers who must reposition their vehicles at the origin. The same holds for a private carrier returning to a plant or distribution center. The problem in departing *sinks* is no different for irregular route carriers who can go wherever they wish. There is still a dearth of outbound freight. Empty miles in departing a sink are an inescapable drain on industry productivity.

Demand Fluctuations

With regular route operations there is a problem of demand fluctuations from day to day. The problem is especially acute for regional common carriers but it also afflicts private carriers. Many of these operators, on the line haul, function like intercity buses. The vehicle travels back and forth on a schedule. It is impossible to predict how many seats will be filled on a given run. The probability that the demand at either end will exactly match the number of seats is small. *Some* regular route trucks will routinely travel with less than full loads; the load factor will tend to be higher in one direction than the other. For carriers with tight delivery commitments, a surge in demand

is especially exasperating when there is just a little more freight than can be fitted into the trailer. Do you risk offending a customer by leaving freight on the dock, negotiate for permission to do so, or dispatch another vehicle with the overflow?³¹

Customer Service

Large shippers can dispatch full trailer loads direct to large receiving stations. Large and sophisticated firms manage to dispatch or receive consolidated shipments that fill trailers. At least they claim they do so. The bulk of firms are smaller and less sophisticated. They are customer driven and endeavor to ship whatever the customer has ordered. The purchasing agent or sales representative processing the order typically has no idea how much the product will weigh or how much space it will occupy. It is the exception rather than the rule when trucks serving these firms travel full (weight or bulk). Frequently, a number of shipments will be dispatched on one truck for drop off at different destinations. (The reverse occurs on part load pick ups.) The truck may be full when it leaves but it carries less and less until emptied at the final destination. The same holds for most LTL pick up and delivery trucks operating out of local terminals. In brief, for much of our commerce, trucks travel with less than full loads most of the time and there is little that management can do about it. Advances in communications and computer-based analysis like those cited above can reduce the problem but not eliminate it.

REDUCE STAFF

Work Rules

During the 1980s, two popular strategies for reducing staff, in transportation as in other industries, were: eliminate wasteful work rules and adopt new technology. The elimination of wasteful work rules followed the rise of non-union carriers and the diminution of Teamster power. Wasteful work practices were subject to criticism over 30 years ago.³² Linehaul drivers would only drive between terminals; they would not handle freight. Pick up and delivery drivers would not handle freight at the terminals. Some local agreements called for helpers on every pick up and delivery truck.

A variety of techniques were used to build up overtime. Such slack and waste were negotiated out of most Teamster agreements during the 1980s.³³

Piece Work Incentives

The low pay to owner operators and the growing ranks of non-union drivers (brought on by the general scarcity of jobs in the early part of the decade) probably helped persuade Teamsters to accept "give backs." But it is not only that owner operators were compensated less. They had to hustle to survive. They engaged in piece work. They sought revenue sufficient both to live and to cover equipment payments and other expenses. Thousands of bankruptcies during the early 1980s suggest that revenue frequently fell shy. The only way to generate revenue was to haul loads. The more loads hauled, the more revenue: no dawdling in cafes, no reluctance to help load or unload, no tardiness, etc. Incentives regarding compliance with speed limits and hours of work limits were perverse.

Spillover Consequences of Performance Based Incentives

Owner operators in truckload service functioned at higher productivity than did Teamsters under the agreements of the 1970s. The higher productivity and lower compensation of owner operators enabled them and companies employing them to capture most of the truckload business from the Teamsters and their employers. The latter have subsequently modified their agreements so as to improve productivity.

Technology

Driver productivity has also been improved by advances in material handling equipment, as discussed below under **Keep Moving**. For example, pallet jacks and powered liftgates or sidegates have helped make drivers' helpers superfluous.

Reductions in Overhead and Freight Handling Staff

Drivers are not the only staff of trucking firms. There are three other groups

who contribute but do not travel with the freight:

1. Maintenance personnel.
2. Marketing (sales and pricing).
3. Back office (billing, collections, miscellaneous paperwork).

In the LTL sector, there is a fourth group:

4. Terminal workers.

Maintenance

All machinery requires maintenance and periodic overhaul. Changes in this area have not been widely documented in the transportation literature. Adoption of radial tires has resulted in a smoother ride and lengthened life of many components. Generally, maintenance has gone high tech in terms of diagnostic equipment. Sophisticated fleet owners track vehicles and components by computer so as to rationalize preventive maintenance programs. Such programs reduce both waste and in-service failures. They are also capital intensive. One can speculate that the small operator working with local garage mechanics will be at an increasing disadvantage relative to large fleet operators.

Marketing

A popular image of owner operators was of a driver hauling loads and his wife at home raising the children, tending the stock, and taking orders over the telephone. Such operations still exist³⁴ but do not account for much of the freight that is moved. Most owner operators are associated with trucking companies whose dispatching staff finds loads, either by direct contact with customers or by engaging brokers or other intermediaries.³⁵ The large truckload companies and LTL carriers maintain staffs of sales people soliciting freight, more often than not seeking to divert it from other carriers. They also maintain pricing staffs who conjure up the rates, discounts, and rules that govern what customers are supposed to pay, and who try to restrain the sales staff from offering services at too low a price. These staffs have had to grow to keep track of the mushrooming complexity of freight pricing. Under regulation, all customers paid the same

price (set by the rate bureaus). Since the ICC abandoned the anti-discrimination strictures of common carriage, pricing managers have come to negotiate separate deals with each customer. Large carriers must engage specialists to design software to analyze and track costs, customers, prices, competition, investments, and maintenance; to control and optimize operations; to trace shipments; and to translate the results into forms that others in the company can use.

Impact on Overall Staffing?

Sales and pricing staffs are necessary to the functioning of for-hire freight transportation but contribute nothing directly to the movement of freight.³⁶ The functions are currently performed by employees, brokers, or other third parties. The author has seen no comparisons of the size and cost of today's marketing staffs with those of their antecedents under regulation. The corresponding overhead in those days included carrier sales staffs, rate bureau staffs, and the various attorneys and practitioners who jostled with one another over operating rights, commodity rates, and such.

Savings in Back Office Staff

The billing process in transportation has been vastly simplified by automation. In most of the industry, bills are no longer generated manually. Shipment information is simply entered at a computer terminal. The calculations are performed and the bill and associated paperwork generated automatically, often at a location miles away. Large carriers dealing with large customers now use EDI and dispense with much of the paperwork. The same computer will track payments and, when necessary, spew out past due bills and the other concomitants of commerce. The new technology has greatly reduced the number of people needed.

Freight Handling

Productivity of terminal or platform work by LTL carriers has benefited from a variety of technological advances. As mentioned above, sophisticated software has made possible the optimal sizing of the daily workforce. Bar-coding technology is coming into increasing use

to eliminate paperwork delays in transferring and tracking units of freight. Computer aided freight tracking minimizes the need for freight handling by facilitating shortcuts such as cross dock transfers. Finally, material handling advances discussed below have improved productivity in handling freight.

KEEP MOVING

Obstacles to Movement

A parked truck is not performing a useful transportation function. Candidate reasons for being parked include:

1. Waiting for access to a dock.
2. Driver on rest break.
3. Maintenance.
4. Nowhere for driver to go.
5. Driver at a pay telephone contacting dispatcher, home, customer, etc.
6. Loading or unloading, including any associated paperwork and weighing.

Access to Loading/Unloading Facilities

Waiting for access to a dock is a fact of life when trucking in and out of large, busy installations. The problem can be reduced by good management, good communications, and sophisticated scheduling but it still occurs. Food distribution warehouses and military installations are notorious for the queues of trucks that build up. Delays lasting hours can happen during peak periods.³⁷ Appointments are frequently made but are not a cure all. If the truck is coming a long distance, what is the probability of punctual arrival? An early arrival means waiting for the appointed time; a late arrival means waiting for an open slot in the schedule. Many plants based on JIT (just in time) logistics select nearby suppliers so as to ensure on-time delivery. Drop trailers, where the trucker leaves off one trailer and picks up another, is a solution increasingly used at installations where there is sufficient parking space. Since 1970, the ratio of trailers to tractors has increased 50%³⁸ (a trend that also reflects increasing use of TOFC).

Rest Breaks

Driver rest breaks are, at best, those necessary for the driver to remain a safe and alert worker. Hours of service laws or contract provisions serve that goal. At worst, they are devices used by hourly paid drivers to inflate overtime. The latter is a matter of employee motivation and supervision. The supervision is becoming easier with modern vehicle tracking technology. Driver teams using sleeper cabs circumvent the delay of rest breaks. The purpose is to shorten delivery time.³⁹ A consequence is that vehicle utilization is improved. Sleeper cab quality and use have increased in recent years.

Maintenance and Administrative Delays

Maintenance down time and en route breakdowns, have been treated above. The time trucks spend parked while drivers communicate is being reduced by modern telecommunications, as also discussed above. The same holds for dispatching delays, so long as loads are available. When there is over capacity in a particular area, some trucks must park or roll empty in search of another load. The large firms with sophisticated marketing and software suffer delays and empty driving the least by identifying profitable lanes where traffic balance exists.

Mechanized Freight Handling

It is in loading and unloading that some of the greatest advances in productivity have taken place in recent years. Shortening the time spent loading and unloading increases the time that both driver and vehicle can spend transporting freight. Improvements have occurred in many segments of trucking. Design of tanker trailers with quick attach nozzles and fast flow pipes and pumps have shortened both loading and delivery time.⁴⁰ In the timber industry, giant tractors with grapplers load logs and speed turnaround for logging trucks. Similarly large fork lifts load lumber trucks. Building supply company delivery trucks tow their own fork lifts to speed unloading. In TOFC, COFC, and doublestack yards, giant fork lifts or straddle cranes speed the loading and unloading processes. Other technological advances have shortened loading and unloading

time in package express and retail delivery services.

General Freight

In the handling of general freight, growth in use of material handling equipment has been significant. It has been largely customer driven rather than carrier driven. The goal of the customers was to reduce costs in storing materials and in moving them from one place to another in plants, distribution centers, warehouses, retail outlets, and so forth. Developments in mechanizing material handling date back many decades. Moving belts and chain bucket elevators were common in the 1930s. Palletized freight started to displace simple hand carts after World War II. The Industrial Truck Association, whose members include the major manufacturers of industrial trucks, like fork lifts, was founded in 1951.

Recent Growth.

By the late 1970s, mechanized material handling was already commonplace at large installations of modern firms. Despite this fact, annual sales of material handling equipment tripled between 1977 and 1988.⁴¹ Since much of the equipment can remain serviceable for years if properly maintained, there is a thriving aftermarket. The amount of equipment in service has grown rapidly in recent years. Use of it in trucking has likewise grown.

Impact

A skilled fork lift operator can load or unload a 48 ft. trailer of palletized freight in 30 minutes. A single worker hand loading or unloading the same freight might require five hours. The quicker turn around greatly increases the productivity of the loading bay and of the truck and driver. The proliferation of stretch wrapping and shrinking has speeded the process still further, in addition to improving shipment integrity and security.

Fork Lifts and Pallet Jacks

Annual sales of electric powered fork lift trucks increased approximately 150% between 1967 and 1990.⁴² Hand operated pallet jacks are another development but industrywide

sales statistics have not been collected. One estimate⁴³ is that sales reached 122,000 units in 1989 after a strong growth period starting in the mid 1980s. Pallet jacks are important for several reasons. They are widely used both by retail establishments and by truckers.⁴⁴ Drivers use the pallet jacks to move pallets around in the trailer. This is particularly useful in moving freight to and from the trailer door for handling by a fork lift on the ground at a site without a loading dock.⁴⁵

Resulting Productivity Improvements

One would expect the diminution in time spent parked at loading docks made possible by use of material handling equipment to have significantly increased the miles driven and freight carried per truck and per driver in recent years. Automation of shipping and receiving paperwork, the rapidity with which pallets can be counted (in contrast with individual packages),⁴⁶ and automation of truck weigh scales should also have reduced time spent parked and increased time spent moving. In motion truck weighing, in combination with automatic vehicle identification, may ultimately reduce delays at government operated, roadside weigh stations.

Disadvantages of Palletization

As the length of haul increases, the relative importance of quick loading and unloading fades. What comes to matter is that the trailer be filled to capacity.⁴⁷ Large firms may design retail and shipping containers so as to optimize space utilization by loaded pallets, but they can do so only for one set of trailer dimensions. Trailers of different vintages and purchased for different purposes offer a variety of internal dimensions. A good match is achieved only part of the time. For long hauls, hand stacking or, at least, hand top loading (loading packages between the trailer roof and the top of the pallet load) may be advantageous. A second disadvantage of palletization is that the loads can sometimes be loaded only one high rather than two. Single stacked palletized loads leave a lot of empty space above them in the trailer. The productivity gain from a fast turn around disappears if, as a result, there is too much air in the trailer. One cause of single stacking is that real life pallets offer

concentrated footprints. Not all packaging will withstand the imprint of a toploaded pallet without excessive deformation. Another reason is that pallets also cannot be toploaded above irregular pallet loads like uncrated machinery. A third disadvantage is that consignees sometimes reject the pallets under incoming loads. Whether it be a question of design or ownership, the driver may be obliged to transfer the load from the incoming pallets to those furnished by the consignee. The carrier loses the productivity gain expected from pallets. Controversy can be ensue over the time spent; carriers with sufficient market clout charge for the service. Finally, there is the issue of pallet returns. Pallets cost money. Shippers often insist that carriers return the empty pallets or replace them in kind. Since freight travels in one direction only, a truckload carrier rarely returns directly to the shipper from the consignee. How, then, are the pallets returned? Similarly, an LTL carrier is loathe to move pallets back through the en route terminals without charge. The logistics of pallet return are frequently inefficient and a source of controversy among shipper, carrier, and consignee.

SUPPORTING EVIDENCE

Anecdotal

Most of the truck fleet enjoyed access to productivity-increasing technology during the past 15 years. Transportation managers of many individual firms claim to have improved efficiency in resource use. Their fleets and drivers are better utilized. We suspect that those firms that enjoyed productivity improvement carry a majority of the country's freight but we are not sure. We know nothing about how productivity is faring in other segments of trucking.

Numbers?

One would hope to see the fruits of productivity improvement in national statistics. Exhibits 2 and 3 suggest that they are. What is shown are intercity tons and ton-miles, respectively, divided by registered full and semi trailers; tractor trucks; and drivers of heavy trucks. All points are indexed to 1985=1. (1985 is the first year for which the driver data were published. It is reasonable to suppose that

driver productivity paralleled that of tractors prior to 1985.) The curves must be interpreted with caution. *Intercity* freight data are being compared with *industry-wide* fleet data. The latter include a large fraction of local freight operations. Since technology cannot distinguish between local and intercity applications, the same productivity trends should appear in both. Also, much freight moves in trucks other than tractor-trailer rigs. There is no obvious reason to suspect that the results are misleading but they are imprecise.

Interpretation

Both exhibits show productivity improvements of 20% between 1985 and 1991, confirming expectations based on the technological changes described. Between 1977 and 1992, tractor utilization improved some 30% but trailer utilization increased very little. This contrast *may* be explained by increasing use of TOFC and trailer drops (for shipper load, consignee unload).

The year 1977 is widely considered to have been the last pre-deregulation year. Productivity declined during 1979-80, bottomed out during the early 1980s, and then began its upward trend. Other researchers who explored similar measures of productivity also observed deterioration after 1978;⁴⁸ they suggested that the freedom of entry under deregulation had led to resource waste as too many trucks chased too little freight. The post-1978 sag in productivity was probably exacerbated by the decline in demand for freight transportation during the 1982-1983 recession. If their postulation of overcapacity is valid, we cannot tell whether or not its effects persist, whether productivity improvements would have been even greater with fewer carriers in the market.

Other Data Problems

Exhibits 2 and 3 use aggregated, industry-wide data whose accuracy is open to some question. As discussed earlier in the paper, the units, Tons and Ton-Miles, are clumsy, inadequate measures of output. Other measures of productivity exist but are likewise poorly supported by published data.

There are other questions. What kind of freight is being hauled, where, and in what quantities? With what impact on measures of

Ratio of Intercity Ton-Miles to...

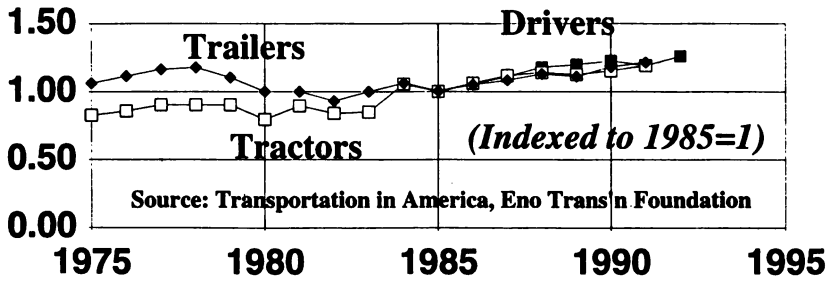


EXHIBIT 2

Ratio of Intercity Tons to...

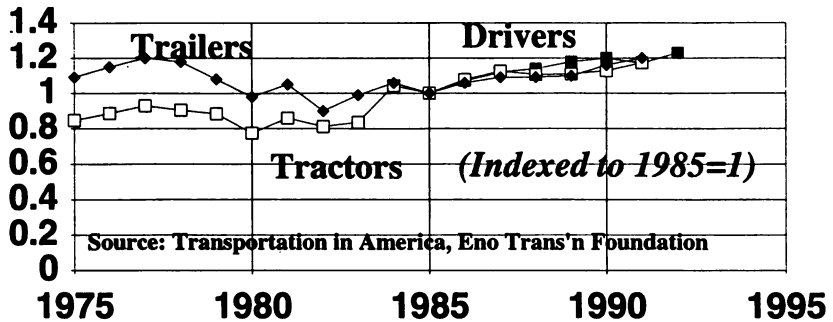


EXHIBIT 3

productivity? If, as some suggest, the average density of freight is diminishing over time, then a ton of yesteryear is different from a ton of today. For example, electronics gear, be it computers or boom boxes, is lighter, as packaged for transportation, than household appliances. Nails blister packed for retail sale are lower in density than nails by the barrel. What is the impact of JIT manufacturing and other, similar logistics practices? If nearby sources are tapped, then the distances traversed are shorter. If shipment sizes are smaller, how effective is consolidation in permitting the arrival or departure of full vehicles? The current fashion in logistics is to centralize distribution in a small number of locations. What are the consequences for productivity in transportation? What are the consequences of intermodal shifts or shifts from sophisticated carriers to unsophisticated ones?⁴⁹

CONCLUSION

During the past 15 years, trucking has undergone changes similar to those taking place in other industries. Technological advances in software, materials handling, and communication have increased productivity across a broad spectrum of the industry. Industry structure, market shares, and employee compensation have also changed. Whether firms were unionized or not, productivity improved in cases where workers were given better tools, were well motivated, or both. The changes continue. Whether or not open entry into for hire trucking dissipates productivity gains by stimulating overcapacity remains an unanswered question.

ENDNOTES

* TRANSLOG, Berkeley, California

1. Lawrence, M. B. and Sharp, R. G. "Freight Transportation Productivity In The 1980s: A Retrospective," *Journal of the Transportation Research Forum*, XXXII, No. 1, 1991, 158-169.
2. See Clifford Winston et al., *The Economic Effects of Surface Freight Deregulation*, The Brookings Institution, Washington, D.C.: 1990, and W. Bruce Allen, "Measuring the Impact of Intrastate Deregulation of Motor Carriage on the States," *Proceedings of the Transportation Research Forum*, Williamsburg, VA, October 1989, p. 82.
3. There is dissent regarding price trends in specific markets such as rural areas. Research on freight rates paid to hinterland points in Oregon by Folger Athearn, Jr. shows that interstate rates to small, rural communities have climbed substantially relative to both the producer price index and regulated, intrastate rates. Athearn, F., Jr. *Less-Than-Truckload Service in Oregon: What Went Wrong?* Examination Paper submitted for certification to the American Society of Transportation and Logistics, 1992.
4. These are recurrent themes in both pre and post deregulation literature cited in Endnotes (1) and (2) above. See also Ying, J. S., "The Inefficiency of Regulating a Competitive Industry: Productivity Gains in Trucking Following Reform," *The Review of Economics and Statistics*, LXXII, No. 2, 1990. Anecdotal evidence suggests that regulatory constraints were often circumvented. Since the techniques employed have not been publicized, their extent and significance are unknown. For example, common carriers routinely carried freight in one truck coast to coast, even without transcontinental operating rights. The ICC, of course, never set trucking rates on its own initiative; nor did it restrict the quality of service that carriers could offer.
5. As measured by revenues. Roth, R. D. *The Motor Carrier Industry in Transition*, Transportation Technical Services, 1990. Barely 23% of regulated truck revenues are accounted for by the LTL carriers and 22% by TL carriers of general freight. The remaining revenues accrue to Parcel, Specialized, and Miscellaneous TL carriers.

6. Rakowski, J. P., Southern, R. N., and Jarrell, J. L., "The Changing Structure of the U.S. Trucking Industry: Implications for Logistics Managers," *Journal of Business Logistics*, 14 No. 1, 1993, 113.
7. Lawrence and Sharp, *Op. Cit.* P. 161. Lawrence and Sharp point out that the LTL share of all expenditures on truck transportation in 1989 was only 11 per cent. Since LTL rates (and costs) are an order of magnitude higher than those of carriers hauling larger sized shipments, the fraction of actual freight moved by LTL carriers, measured by tons or ton-miles, is less than 11 per cent.
8. One consequence is that the average length of haul reported by individual carriers has increased. Prior to the widespread disappearance of local carriers under deregulation, most shipments traveling long distances were interlined (transferred from one carrier to another). Each carrier would report its segment of the haul separately. The same shipments are now picked up and delivered by the same carrier, who reports the entire origin to destination distance as one haul.
9. *Proceedings of the Special Conference on Freight Transportation Data: The Changing Federal Role Since Deregulation*, Transportation Research Circular No. 367, December 1990, Transportation Research Board; *Proceedings, Western Regional Transportation Data Forum, San Francisco, CA, June 1989, Transportation Research Forum, Arlington, VA: 1989.*
10. Lawrence and Sharp, *Op. Cit.*, p.159.
11. A few witnesses at Senate Hearings prior to the MCA mentioned the Teamsters directly. See *Hearings before the Committee on Commerce, Science, and Transportation, 96th Congress, on Economic Regulation of the Trucking Industry*, U.S. Government Printing Office, Washington, D.C.: 1979, p. 143 (testimony of Richard J. Zimmer) or p. 191 (testimony of Mike Parkhurst), for example. Elected officials were more circumspect but many agreed with Committee Chairman Cannon (p. 117) that "...one of the criticisms of regulation is that there is no incentive for trucking firms to keep down their costs because the ICC would automatically ... (pass along in higher rates any) ... increase in costs incurred ... " Since no objections were voiced to passing along higher costs of products like fuel, tires, and equipment that were purchased in relatively competitive markets, the criticisms presumably referred to labor and the Teamsters.
12. Moore, T. G., "The Beneficiaries of Trucking Regulation," *Journal of Law and Economics* 21, 1978, 331-339.
13. Hagedorn, A. and Karr, A. R., "Teamsters Remain a Mighty Force In Business and Politics Despite Many Apparent Setbacks," *Wall Street Journal*, June 12, 1991, A10.
14. LeMay, S. A. and Taylor, S., "The Truck Driver Shortage: An Overview and Some Recommendations," *Journal of Transportation Management*, I, No. 1, 1989.
15. *Transport Topics*, No. 2913, June 3, 1991, P. 6.
16. Glaskowsky, N. A., Jr., *Effects of Deregulation on Motor Carriers, Second Edition*, The Eno Foundation, Westport, CT. 1990, 5.
17. Kling, R. L., "Deregulation and Structural Change in the LTL Motor Freight Industry," *Transportation Journal*, Spring, 1990, 47. See also Rakowski, *Op. Cit.* 116-122 and Glaskowsky, *Op. Cit.* Chapter 7.
18. This loss of large shipment traffic often reduced productivity in handling the remaining smaller shipments. Prior to

- deregulation, large shipments that did not fully occupy the capacity of the trailer would routinely be routed through the terminals and filled with other LTL freight for the line haul. Trailer utilization was thereby improved, especially when loads were repetitive.
19. 70 lbs is the UPS maximum package weight. For RPS it is 100 lbs. For Federal Express, 150 lbs.
 20. Bohlander, G. W. and Farris, M. T., "Collective Bargaining in Trucking-The Effects of Deregulation," *The Logistics and Transportation Review*, 20 No. 3, 1984, 223-238.
 21. Rakowski, *Op. Cit.* P.123.
 22. McMullen, B. S., "Purchased Transportation and LTL Motor Carrier Costs: Possible Implications for Market Structure," *Journal of the Transportation Research Forum*, XXXI, No. 2, 1991, 433-436.
 23. McKenzie, D. R., North, M. C., and Smith, D. S. *Intermodal Transportation-The Whole Story*, Simmons-Boardman Books, Inc., Omaha, 1989, P. 274.
 24. Many writers, including some cited above, have explored the concentration among LTL carriers. Most understate the extent of concentration by focusing exclusively on the national market, which is clearly dominated by about half a dozen carriers (depending on one's definition of concentration). Those familiar with the industry know that similar concentration exists *regionally*, among the carriers that serve each region of the country. According to Roth, *Op. Cit.*, concentration exists in many of the specialized truckload segments: automobile carriers, household goods carriers, tank trucks, and reefers. He also shows that, in 1990, the top 10 carriers accounted for 20% of the truckload segment, a percentage that has doubtless grown since then. The latter are the advanced truckload firms first described by Lane, L. L., "Innovation in Trucking: Advanced Truckload Firms," *Transportation Research Record 1154*. Bulk purchase discounts are among their several competitive advantages.
 25. Larger trailers indisputably improved the productivity of those firms who could put them to good use. Lawrence and Sharp, *Op. Cit.*, P. 162, suggest that the impact on overall industry productivity is ambiguous; the new equipment may be poorly suited to the next owners in the aftermarket. The longest trailers, 53 feet or 57 feet, are ill suited to TOFC service because they do not mate well with rail equipment.
 26. Glisson, L. M., "The Changing Face of the Motor Carrier Industry," *Transportation Practitioners Journal*, 58, No. 4 1991, 348-349.
 27. Ozment, J., Cunningham, W. A., and Davis, G. M., "Motor Carrier Fuel Efficiency and Equipment Utilization: Effects of Deregulation," *Journal of the Transportation Research Forum*, XXX, No. 2, 1990.
 28. See Lane, *Op. Cit.*
 29. Bell, L. A., "Trading Partners Use Technology to Capture Delivery-Performance Data," *Traffic World*, Feb. 25, 1991, 38.
 30. Willis, D. K. *A Survey of the Use of Six Computing and Communications Technologies in Urban Trucking Operations*, The ATA Foundation, Inc., Alexandria, VA 1992.
 31. Many air freight carriers resolve this problem with what amount to space available rates for customers willing to wait a little longer. They may also engage small, charter aircraft for occasional overflows.

32. *National Transportation Policy, Report to the Senate Committee on Commerce by its Special Study Group on Transportation Policies in the United States (the Doyle Report), June 1961, 680.*
33. Bohlander and Farris, *Op. Cit.*, describe the beginning of the process.
34. They are especially important in rural areas where they may be the sole freight carrier.
35. McMullen, *Op. Cit.* 436-437.
36. A number of small, niche carriers have cornered stables of steady customers. They offer good service at competitive prices made possible, in part, by the fact that sales and pricing staffs are not needed.
37. It is the owner operator who often has to wait the longest. He has the least bargaining power. The dock supervisor is likely to give priority to his own company trucks or to trucks of large, established carriers that can enforce financial penalties when excessively delayed.
38. The ratio has increased from two to three. Smith, F. A. *Transportation in America*, 10th Edition, Eno Transportation Foundation, Inc. 1992, 63.
39. The use of sleeper cabs dates back at least to the early 1960s. Logistics changes emphasizing fast delivery substantially increased their popularity during the 1980s. Modern cab designs are far more comfortable and elegant than those of the 1960s.
40. Presentation by J. O. Powers of Chevron at a Transportation Research Forum Chapter meeting in Berkeley, CA, February, 1992. While hardware improvements and routing software helped, the real key to increasing productivity was a labor agreement that incorporated incentives based on performance. The task was replenishment of the retail stations with different grades of gasoline.
41. Data supplied by the Material Handling Institute Data Acquisition Service. Sales increased from \$17 billion in 1977 to \$52 billion in 1988.
42. According to figures compiled by the Industrial Truck Association. The increase is reasonably consistent except for recessionary dips, 1975-76 and 1981-83
43. Private communication with the author describing the view of one manufacturer's marketing staff.
44. The proliferation of pallet jacks has had what some consider to be a stultifying effect on productivity by frustrating the adoption of slipsheets. Slipsheets serve the same package consolidation function as pallets but are cheaper, lighter in weight, take up less space, and pose less of a disposal problem. Their use would allow more freight to be fitted into trailers (assuming appropriate package dimensions) and in storage areas. Retailers who have already invested in pallet jacks want no part of slipsheet shipments.
45. The pallet jack has the disadvantage that the tines are supported by little wheels rather than cantilevered as regular fork lift tines are. As a result, a pallet jack cannot be used with all pallet designs. It can only be maneuvered under a standard, grocery store "four-way" pallet from two sides, not four. Loads on grocery store pallets cannot be pinwheel loaded in a trailer. The number of pallets that can be carried is greatly reduced, as is the productivity advantage of using pallets.
46. Some shippers insist on a package count, even of loads their employees have palletized and wrapped. The driver must then disassemble each pallet load, count packages, and

reassemble the pallet load; otherwise, his employer is vulnerable to a loss claim if a short count results at the destination because packages are missing from the invisible interior of the pallet load.

47. The discussion here concerns freight that, as packaged, bulks out (fills the trailer volume) before it weights out (exceeds the allowable weight).
48. Ozment, Cunningham, and Davis, *Op. cit.*, 440.
49. Questions posed by Lawrence and Sharp, *Op. Cit.*, 162-165.