

# Supply Chain Security: Agency Theory and Port Drayage Drivers

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## Abstract

*Supply chain security presents numerous challenges to governments interested in defending against terrorist threats. While most approaches stress technological solutions, scholars and policy-makers tend to overlook economics, labour market issues, and industrial relations. Applying agency theory from behavioural economics, this article analyses threats to the US supply chain and opportunities for efficient solutions. Using data from a sophisticated web-based survey of owner-operator cost-of-operations, it shows that drayage<sup>1</sup> drivers are among the lowest paid truck drivers and workers in the US. We provide evidence that low pay is associated with both safety and security risk. Low-wage labour and subcontracting present challenges to US and foreign supply-chain security because the market attracts workers who have few other employment options. In this environment, principals and agents currently make inefficient and inequitable contracts because markets do not reflect the complete costs associated with low-probability/high-impact events like cargo theft and transport security.*

**JEL Codes:** J28, M52, N70

## Keywords

*Agency theory; compensation; industrial relations; labour markets; owner-operators; pay rates; principal-agent models; security; supply chain; terrorism.*

## Introduction

As with any chain, the strength of the freight security chain depends on the strength of each link. In a world highly dependent on international trade, the chain linking the producer to the consumer extends across thousands of miles, across many firms, and across many levels and forms of government. This article reviews studies that estimate the cost of this security — and lapses in security that have caused or have the potential to cause great personal and economic harm — and focuses on the human resource aspect of supply-chain security from

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an economic perspective. The US Department of Homeland Security (DHS) policy, as articulated in the Customs-Trade Partnership Against Terrorism (C-TPAT) program, relies on importers to know their supply chain partners and to manage risk intelligently. Although the program has a sound theoretical foundation, low-paid supply-chain workers in the United States and abroad may provide an exploitable opening.

This analysis differs from preceding work in that it attempts to get at economic factors that underlie the human resources essential both to transportation and to threats to transportation. Rather than focus on institutional or technological aspects of security, we look at supply chain security as a complex phenomenon of industrial organisation. Embedded in the economic relationship, the application of principal-agent theory and labor economics to the industrial relations and industrial organisation of supply chain operations provides a different perspective on global supply chain security. While security of facilities and borders provides certain personnel and technology challenges, security of an industrial process requires application of economic reasoning and the kind of process orientation appropriate to the industrial setting. The insights gained from this kind of analysis give policy makers and security experts a different set of tools to consider in their work.

### **Security and the Global Supply Chain: A Brief Summary**

A product manufactured in Wuhan, China may be composed of multiple components outsourced by that factory to other factories in China. After assembling the product it sells, the manufacturer may pack a container at an inland port facility on the Chang Jiang (Long River, or Yangtze), after which it likely will travel on a barge to Yangshan, Shanghai's deep-water port and one of the busiest ports in the world.<sup>2</sup> According to Lee Perkins, Lloyds' expert in Chinese logistics and CEO of China Intelligence Online, with only 17 per cent of all freight currently containerised at the manufacturer, the product more likely will travel via barge loaded in baskets for later containerisation, making the freight subject to tampering. Gaps in supply chain security hamper the safety and security of freight transport in China, and this risk increases the deeper in the hinterland it originates.<sup>3</sup> Twenty-four hours before departing, the steamship operator must notify US authorities in detail regarding the nature of the freight in each container to be loaded on the ship; the US will ask for inspections of containers it considers suspicious.

Maritime terminal cranes will load the container onto a ship along with thousands of other containers for the ocean voyage to the USA. Most containers from China probably face a safe and routine journey, at least for now, but the hazard posed by pirates (or terrorists) gaining access to the container on the high seas is increasing. Piracy especially has become a problem in regions such as the Malacca Straights near Indonesia and near the horn of Africa, near Somalia (BBC 2008a, 2008b, 2008c; Gettleman 2008a, 2008b; Nankivell 2004; Westcott 2008; Worth 2008). In addition, the ship may fly a 'flag of convenience' (FOC) representing a country with lax safety and/or manning regulations and low taxes, employing a crew from the poorest nations in the world (McPhee 1990: 65–71);

regardless of ownership, it probably will probably fly a flag from Panama, Liberia, the Bahamas, Greece, or Malta (Coyle et al. 2000; Donn 1989). Isolated on such ships, crews on a single ship may hail from many nations and speak different languages; many may have joined the crew under suspicious circumstances as well (Chapman 1992). The documented poor safety record of FOC shipping also may be associated with greater security hazards, but documentation on security is sparse (Chapman 1992; Crawford et al. 2002; Langewiesche 2003, 2004; Odell and Shelley 2003; Osieke 1979). Becker explicitly articulates this risk with respect to the transport and proliferation of weapons of mass destruction (Becker 2005).

The captain notifies US authorities when the ship is within 96 hours of a US port, providing them with detailed information on the identities of the ship's crew (Frittelli 2005). When the ship arrives in port, a US Customs and Border Protection (CBP) official meets the ship and identifies suspicious containers based on analysis of the data originally provided by the shipper, the consignee, the contents, and the list of individuals whom the shipping company has identified as being part of the supply chain in the foreign nation (in this case, China).<sup>4</sup> Information supplied to CBP was recently expanded to include more information such as where and by whom the container was stuffed and where it is stowed on the ship (Edmonson 2010). US Customs authorities will direct the inspection of suspicious containers, though only a small fraction of all containers receive a direct inspection. While an unknown number of people have been involved in the handling of each container in uncertain territory to this point, the information sharing is tight enough that US officials believe they have a pretty good idea what is in each container and whether it represents a security risk.

Our container now has arrived in a maritime terminal in the US. Cranes lift it off the ship and either place it on a rail car for transport to an inland terminal or stack it in the yard for later delivery via truck. Most ports will rely on drayage to move containers into their regional hinterlands, and this transfer is called the 'dray'. 'Drayage is the short-distance hauling of trailers or intermodal containers (loaded or unloaded) between a (i) rail head, seaport, or airport and (ii) terminal, distribution center, manufacturing plant, or warehouse' (Burks et al. 2010). With the advent of extremely large 'post-Panamax'<sup>5</sup> container ships carrying 10,000 or more twenty-foot-equivalent units (TEUs) of containers, intermodal yards and unloading facilities become extraordinarily swamped regularly, raising the level of confusion and the likelihood of temporary storage (Nankivell 2004).

## Principal-Agent Theory and Risk Management

While technical hazards, such as those posed by weather, natural disaster, or equipment failure, exist throughout the supply chain, such hazards are the 'background noise' for the security question. We cannot control weather and prevent earthquakes, although equipment standards and enforcement as well as weather forecasting and route planning can minimise risk. This paper focuses on the human risks associated with supply chain management.

Transportation activities require the actions of a diverse range of participating individuals, including loading and unloading personnel, truck drivers, railroad

employees, container lift and crane operators, and seafarers. By nature, the work is distributed throughout the globe, making direct observation of individual effort and responsibility difficult or impossible to monitor. Work processes like this lend themselves to agency explanations. Agency theory starts with the fact that a principal hires an agent to act on behalf of the principal to advance the principal's goals (Milgrom and Roberts 2002). The structuring of the agency agreement depends on the observability of agents, the cost of observing agents' actions, as well as the extent to which the interests of the agent and the interests of the principal align. Unfortunately, supply chains involve many principals including shippers, port operators, and US CBP. Therefore multiple principals must be examined to understand forces affecting risk in the supply chain. Nevertheless, agency theory and economic theory can be used to examine each of these principal-agent relationships.

When the agent is costly to observe and the principal's and the agent's interests conflict, the principal cannot achieve the desired result simply by hiring an agent at the market-clearing rate. Where principals and agents assess risk differently, the principal must take steps to realign these risks to make the principle-agent relationship efficient (Eisenhardt 1989). In such situations, the principal has several options, including paying to reward agents for observed, desired behaviour at a rate that provides a strong reason for agents to act in the principal's interest — 'efficiency wages' that cause agents to work especially diligently to retain above average compensation or making the agent responsible for effects of undesirable behaviour. The principal's decision depends on the effect of the agent's actions on the principal's profits, the precision and cost of assessing the agent's actions, the agent's risk tolerance, and the agent's responsiveness to incentives (Milgrom and Roberts 2002).

The situation becomes especially difficult where individual workers are engaged in producing a joint product, however. When the effort of each individual is independent of the effort of other individuals, workers at any level in the process may intentionally or unintentionally sabotage each other's efforts if doing so makes themselves look good. Essentially, they may act as individuals if their compensation depends on individual performance measures, even if individual performance undermines the performance of the organisation (Bloom 1999; Eisenhardt 1989; Lazear 1995). While work in the transportation enterprise may be individual, and suitable for individual measurement, the performance of the supply chain as a whole depends on the interactions among many cooperating participants who probably do not know each other. In sum, the supply chain creates a joint product and individual contributions to this enterprise cannot be assessed readily.

Risk also may change the performance of principal-agent contracts. In a low risk and individualistic environment, the principal-agent model predicts efficient contracting, even when compensation levels vary widely. In high-risk situations, however, widely dispersed compensation associated with market-driven pay may be associated with undesirable and inefficient outcomes (Bloom and Milkovich 1998; Eisenhardt 1988; Stroh et al. 1996). In a high-risk environment where agent behaviour is either unobservable or very expensive to observe, principals

often shift risk to the agent by using piece-rate systems. This strategy is especially prevalent in transportation where contracting permits the shifting of risk to independent contractors who fall outside normal employee regulatory regimes. Mileage pay systems used by the US trucking industry for long-haul shipments and flat-rate piecework pay systems used by drayage carriers shift the risk of agent (driver) behaviour from firms to drivers by making effective hourly compensation dependent on how fast the agent moves (Belzer 1995). The shifting of risk is not limited to agent effort alone, as equipment owners have routinely shifted the risk of intermodal trailer chassis failure to the motor carriers and drivers who use the equipment in the course of moving containers (Swan 2004).

Operational firms have used the principal-agent model conventionally to resolve these production efficiency dilemmas either by paying employees on a piecework basis or by contracting externally to shift production risk to small firms and owner-operators who will have provide efficient performance in their own self-interest. This model becomes questionable, however, when applied to transportation security. The hazard to society associated with a terrorist attack, for example, is not borne by the shippers, but instead is shifted to society in general because no firm could cover the expenses associated with a successful terrorist attack and because prevention of such attacks is broadly seen as the government's responsibility.

This shifting of legal risk introduces a moral hazard problem. Specifically, moral hazard exists when an agent either can cause or prevent undesirable events, but bears no cost for undesirable events and enjoys no profit from preventing such events, and thus will choose the action that saves them the most money. When moral hazards exist, agents will tend to take actions that increase their own wealth regardless of the effect on society. The savings and loan (S&L) crisis of the 1980s developed because S&L managers were rewarded for making risky loans (Milgrom and Roberts 2002), and the sub-prime mortgage melt-down of 2007 to 2010 similarly resulted from actions taken by mortgage brokers and numerous layers of intermediary sellers of synthetic financial instruments and hedges in unregulated financial markets; both markets illustrate moral hazard. In the case of freight transport security, moral hazard exists because while terrorist acts will have negative effects on the person or firm transporting the goods, no individual shipment can bear the uninsurable cost of risk remediation, so that neither the principals (with the exception of CBP) nor the agents have significant financial incentive to mitigate it.

Markets also can be truly efficient, however, only when prices reflect the true cost of the product or service. In cases where substantial costs are not included in market prices and pricing signals are invisible or uncertain at the time of purchase, purchasers will buy too much of the product, making economically inefficient choices. When security represents an important part of the cost of the service, as with freight transportation, shippers (and therefore consumers) should pay the full cost of importing goods, including the security that the service requires. Such an arrangement would produce security but make sure consumers bear the cost of the security associated with their consumption, sending the correct signals to the market and ensuring allocative efficiency.

## **Risks in the Supply Chain: Foreign and Domestic**

Risks begin at the first stage of the supply chain. Many foreign agents handle shipments. The producer (or a third party) packs and seals the shipment in a container. Importers trust the shipper, perhaps wrongly, to ship only what is on the bill-of-lading, and in the freight transportation business it is not uncommon for a shipper to inadvertently or purposely mis-state the contents (Belzer et al. 2000). From the point of shipment onward, the ability to gain access to the shipment creates risk. Highway carriers, rail carriers, or inland water carriers can have access to export shipments before they arrive at the port of origin. Often transportation workers handle such shipments with little or no direct supervision. While water carrier crews may find it difficult to make contact with potential co-conspirators at ports, crewmembers could plant a bomb and detonate it later. The fact that crewmembers are known does not guarantee that their background has been vetted completely.

Although the Department of Homeland Security (DHS) usually considers international shipments safe after they have arrived in the USA, this may not be a good assumption. People already in the country perpetrated the only terrorist attacks the US has experienced, including the attacks of 11 September 2001. One therefore cannot assume that shipments landed on US soil are out of danger or that foreign shipments constitute the only threat to critical infrastructure. It is just as likely, and perhaps more likely, that a terrorist could tamper with a shipment after it has arrived in the USA. Terrorists could use materials already present, insert explosive devices before shipments arrive at their targets, or poison goods distributed as food or food additives. A terrorist could also sabotage an outbound shipment, perhaps sinking a ship in the entrance to a harbour blocking shipments to and from the harbour for a significant period of time. For this reason, it is necessary to examine domestic risk as well as foreign risk and consider all situations where shipments and infrastructure are vulnerable to tampering.

After a container arrives in the USA, and after CBP officials have cleared it, the security problem becomes the responsibility of a patchwork of local organisations. Security in the storage yards at the ports depends on the competence of local port authorities, maritime terminals, railroad police, and local police agencies, and the communications among them. While efforts have been made to train these agencies' employees, transportation networks are notoriously hard to protect and attractive to thieves, and often local police agencies' budgets are already stretched responding to ordinary criminal threats.<sup>6</sup> Though DHS has spent billions of dollars on various projects, local officials complain that they have been left with unfunded mandates — security responsibilities particular to their location in the supply chain without an allocation from the federal government, which represents the nation's security interest, to cover the cost. Homeland security risks just add to their primary day-to-day security burden, which is pursuing freight theft.<sup>7</sup>

The same factors that matter outside the USA are at work in this country as well. Clearly, tampering is a risk anywhere freight sits unsupervised. All modes have situations involving containers that sit without supervision. Two-person

crews generally operate railroad trains. While the crew can safely operate a train, it cannot keep someone intent on doing harm from gaining access to the train when it is not moving, especially with both members of the crew located at the front of the train. Moreover, much of the US rail system is single track, and freight trains regularly dwell on rail sidings simply waiting for a train to pass from the opposing direction. Any time rail cars sit on a siding for any period, they become potential access points for terrorists. Finally, the public can access virtually the entire US rail network openly. A terrorist with the right materials could use rail cargo as a weapon of mass destruction even using a moving train. For this reason, CSX railroad rerouted hazardous material shipments moving through Washington DC from a track near the Capitol to another track passing through the Washington DC area (Natter 2007).

The same concerns apply to barge traffic in inland waterways and where extensive barge tows, comprised of multiple barges, operate around the clock in unguarded areas. Our freight, whether bulk or in small shipments and whether domestic or international in origin, remains inherently vulnerable to sabotage.

Trucking may be the most difficult mode to secure because it is so decentralised and so reliant on the quality of human resources. On the one hand, trucking provides the advantage of a one-to-one relationship between truck driver and container. On the other hand, trucks and drivers may be scattered about throughout the country, making shipments hard to supervise. Trucks operate individually and may be parked in unguarded locations and facilities in the course of operations. Most critically, in the typical single truck and driver freight movement, a driver cannot realistically supervise the truck and the load 24 hours a day. Once drivers park their trucks to eat, or after drivers complete their 14-hour shifts, they must go off duty for at least ten hours. While off duty, drivers cannot remain responsible for their freight. Even the safety- and security-conscious Institute of Makers of Explosives has found it necessary to ask for an exemption to the Federal Motor Carrier Safety Administration (FMCSA) truck driver hours of service (HOS) regulations to permit team drivers to leave their units unsupervised for up to 30 minutes, leaving their co-drivers sleeping and not supervising the load.<sup>8</sup> No practical solution currently exists that allows the driver to take that off-duty time in a supervised environment without developing an expensive network of secure freight storage yards throughout the USA. Criminals or terrorists can gain access to the load anywhere along its route.

In sum, freight transportation security varies by mode and by market segment within the mode. Risk mitigation may take the form of secured storage yards while in transit, direct observation of outgoing and incoming traffic in port for maritime shipments, a security force for otherwise unguarded rail and water right-of-ways, and dramatically increased port security. We can readily identify these security processes and approaches, but implementation of secure systems in each case likely will be expensive and relatively inefficient; it takes a great number of enforcement officers to maintain security in such a diverse environment.

## The Cost of Supply Chain Interruption

Terrorist acts in one place can have the broad effects over the entire supply chain as was seen at the border crossing between the US and Canada at Windsor/Detroit. After the events of 11 September 2001, security at the Ambassador Bridge was increased, resulting in 16 hour-long backups and shutting down assembly lines from Flint, Michigan to Hermosillo, Mexico (Shannon 2002). The direct cost of the interruption of air travel after 11 September 2001, was substantial. The ripple effects continue to this day, with air travel uncertain and the airline industry apparently faced with chronic overcapacity, destructively low prices and rising costs. Most of the major airlines either are bankrupt currently, recently have come out of bankruptcy, or are facing possible bankruptcy, and employees have lost a substantial fraction of their wages and benefits, including previously deferred earnings such as pensions that they have lost *post hoc*; for employees, a major downward restructuring continues (Associated Press 2006; Fedor 2006a, b; Gittell et al. 2004).

The nature of the supply chain makes it possible for attacks to be launched from both outside and inside the USA. Bombs and or contagion can be planted in shipments on foreign soil or while shipments are en route. Hazardous lading can be used as a bomb or contagion by outside action when it is on US soil. Terrorist acts need not kill people to be effective, but instead can destroy or render useless key pieces of supply chain infrastructure; since the terrorist's purpose is to disrupt by scaring people, even the threat of violent action can have the same effect and an attack anywhere in the system can disrupt the system everywhere. Examples might include contaminating a port, blocking a shipping channel, or destroying a bridge. In this sense, any person who comes in contact with shipments or key infrastructure has the potential to commit a terrorist act.

Further complicating the security problem, attacks need not succeed to be effective. The possibility of another air terrorist event thus represents a continuing threat and the cost of efforts to limit this risk is substantial. It may be hard to disentangle the extent to which terrorist threats or economic competition produced the financial crisis and economic weakness of the airline industry, but regardless of the reason, the additional security burden continues to weigh down the industry. Indeed, the arrest in August of 2006 of a large number of potential terrorists, allegedly planning to blow up several airliners in the middle of the Atlantic Ocean between London and the US simultaneously, and the tremendous ensuing disruption to air traffic to and from Britain and the consequent economic impact, represents another blow to the recovery of an industry already on the ropes due to decades of losses produced by intense competition encouraged by the deregulation of the 1970s. This same sort of risk has salience for the freight supply chain.

The consequences of a similar incident in the ports or in the inland domestic supply chain caused by a successful terrorist use of an intermodal container would be far greater than the costs we have borne so far. Analysts predict that the effects of a dirty bomb attack in the Port of Long Beach could include over sixty thousand deaths, relocation of 8–9 million people, complete destruction of both Southern California ports, and loss of one third of the oil refinery capacity



west of the Rocky Mountains (Meade and Molander 2006). Substantial indirect costs add to the direct costs of such an attack. Because of global free trade, we have become dependent on the international shipment of goods passing through maritime ports. A successful attack on the Port of Long Beach using a low-yield nuclear device, would mean that 'all ports would likely close indefinitely or operate at a substantially reduced level following the attack. This would severely disrupt the availability of basic goods and petroleum throughout the country' (Meade and Molander 2006). We can anticipate that any terrorist event would place enormous pressure on policy-makers to 'do something' about this risk, and that 'something' likely would add even greater inefficiencies to the freight transportation system than those substantial costs already created by the USA Patriot Act and new rules instituted by the CBP. The direct cost of another terrorist event, therefore, could reach one trillion dollars (Meade and Molander 2006), while the indirect cost of dramatically increasing security precautions on all land-based freight movements following such an event would be much greater (Flynn 2007).

Most solutions to date have been to increase surveillance and enforcement and to increase use of technology in this effort, and the economic burden is substantial. In addition, while the economic benefits flow to a narrow sector of the economy (the security and information technology sectors), the costs are borne by the public in the form of higher prices and distortions in allocative efficiency. Further, according to the Secretary of DHS, 'guarding against every terror risk would bankrupt the US' (Lipton 2006). Martonosi, Ortiz, and Willis imply that the cost of 100 per cent inspection of inbound containers would be approximately \$900 million annually (Martonosi et al. 2006). The cost of compliance with extremely high security standards would result in both increased cost to consumers and reduced economic activity (deadweight loss) and thus produce serious negative macroeconomic effects — all of which have much greater consequences since the global financial meltdown occurred in 2007–2010.

## How Government Uses Agent Incentives

As described above, shippers cannot attain absolute supply chain security for two reasons: the cost would make international commerce uneconomical and the cost of not providing such security currently is external to the market for international goods. Shippers individually therefore would gain little economic benefit from protecting the public and would shoulder substantial increased cost from such efforts. For this reason, the job of managing public supply chain risk in the USA falls mostly on the DHS and CBP, the primary agency within DHS responsible for import security. Because CBP does not actually control shipments and because shipments spend much of their time outside of ports (the only place shipments usually come in contact with CBP agents), CBP must rely on supply chain participants (shippers, port operators, and transportation workers) to act in a manner that secures supply chains. CBP, as the government's designated agency, uses several approaches to securing international supply chains, including collecting data on shipments before they are imported, inspecting some inbound shipments, and relying on supply chain workers to

be vigilant for security problems. To give effect to this policy, CBP can provide incentives for shippers to take actions in situations where the market does not provide such incentive. This is desirable because it forces shippers to bear costs of actions that otherwise might not be taken. This protects the public because it reduces the probability of a hazardous or damaging event and the chances that the public would be harmed by a terrorist attack. It also improves economic efficiency because the price paid for the service (the transport of goods) would rise to incorporate the cost of risk mitigation. With the price of the freight incorporating the cost of risk mitigation, consumer demand would match supply at a price that incorporates all the cost of freight movements. Because the cost of 100 per cent inspection is prohibitive, CBP uses the C-TPAT program to get importers to act implicitly as agents, making importers responsible for policing the supply chain and bearing the increased cost.

Agency theory provides a useful way to study the relationship between the government and private sector businesses; in this case, the government is the principal and the supply chain businesses are the agents. A central question in agency theory is how to provide an incentive for the agent to act in the principal's best interest. When the principal has information to verify agent behaviour, then the agent more likely will act in the interest of the principal. In such cases, paying the agent to act in the principal's interest provides incentive for the agent to do so. When principals cannot verify agents' actions efficiently, principals often pay for outcomes only and transfer the risk to the agent. While this provides incentive for the agent, the transfer of risk increases the cost to purchase the agent's services (Eisenhardt 1989).

CBP wants firms and workers in the supply chain to increase security. Unfortunately for CBP, importers (as agents) will shirk these duties if they can do so without detection and if economic incentives for shirking exist because these security duties are costly to the agent. Further complicating the problem, importers regularly hire agents of their own to perform many supply chain tasks. CBP must therefore not only monitor importers, but must provide incentive for importers to use reputable agents for their supply chain activities. In short, CBP must design incentives that influence the principal-agent relationship between shippers and transportation intermediaries.

CBP cannot observe importers' behaviour completely and the cost of making shirking observable is prohibitively high. Normally, a principal in this position would shift the risk of shirking to the agent (make importers responsible), but such an economic strategy might produce suboptimal results because the high impact / low probability risk associated with a terrorist event means that no agent could pay the cost of failure. Hence the public risk cannot be transferred to importers and observation of the entire supply chain is prohibitively expensive. Security must be controlled using observation of agents or an 'efficiency wage' to provide a strong incentive for desired performance.

C-TPAT provides a method for CBP to influence and monitor the use of agents by importers. As an agreement between CBP and importers, C-TPAT requires importers to secure their supply chains by selecting, auditing, and monitoring their supply chain workers. CBP in return agrees to give C-TPAT-certified

importers favoured treatment with regard to import inspections. Importers that fail to follow C-TPAT guidelines risk losing their C-TPAT member status and being subject to a greater number of more intrusive inspections. This leaves three questions. First, which agents will more likely cut corners on security? Second, what incentives can agents adopt to avoid hiring irresponsible agents? Third, do policy-makers need to resolve a moral hazard problem?

For the great majority of agents involved with freight transportation, neither importers nor government will know when agents hire or contract with risky direct service providers. Principals will find it extremely difficult to monitor many of these agents who operate without direct supervision. In these cases, incentives become critical.

Poorly compensated agents having little to lose present the greatest risk because they have little to lose from bad behaviour. Several domestic and foreign links in the supply chain have very low-paid operators when compared with relevant labor markets for these types of workers. In particular, drayage moves, long-haul trucking, and ocean transportation present situations where employees and subcontractors earn relatively little and thus have little to lose. Ocean labour may be less of a worry because sailors' behaviour can be observed more closely by keeping them aboard ship; in this case, human resource management depends more on direct supervision than on principal-agent contracts. Trucker behaviour, on the other hand, is much harder to observe and earnings are very low. Since 1977, when administrative deregulation began in earnest during the Carter Administration,<sup>9</sup> truck driver compensation has declined by approximately 30 per cent in real terms, between 7.5 per cent and 15 per cent of which is directly attributable to trucking deregulation separate from the decline associated with production workers generally in this period (Belzer 1995). In intermodal trucking in general and in port intermodal in particular, this decline has been so dramatic that motor carriers cannot afford to operate their own trucks in the ports, leading motor carriers to subcontract most of their port drayage work. The difference between hourly compensation for use of a motor carrier's truck (and driver) — as reflected in the daily rates that motor carriers can support — compared with the rates paid to owner-operator drivers who haul the international containers out of and into the port, probably approaches a 3:1 ratio.

## Port Drayage Compensation

While earnings comparability is difficult to measure given the wide variation in trucking operations, in 2004 a study by Global Insight showed that nationally, over-the-road employee truck drivers averaged \$37,700 (\$725 per week), plus benefits, and that in 2004 construction wages for construction labourers exceeded those of truck drivers (Global Insight Inc. 2005; Heaster 2007). The University of Michigan Trucking Industry Program (UMTIP) Truck Driver Survey showed similarly that the average over-the-road driver earned \$36,331 per year.<sup>10</sup> The Bureau of Labor Statistics (BLS) reports in their May 2005 Occupational Employment and Wage Estimates (OES) that average annual employee truck driver annual earnings in the Los Angeles-Long Beach-Santa Ana MSA are \$36,030 for heavy truck and tractor-trailer drivers.<sup>11</sup>

The UMTIP Truck Driver Survey also showed that over-the-road truck drivers work an average of between 63.2 and 64.5 hours per week and about 11.4 hours per day (around 3,200 hours per year), 25 per cent of which are mostly uncompensated waiting, loading, and unloading time (Belman and Monaco 2001; Belzer 2000; Belzer et al. 2002). Port drivers work an average of 11.2 hours per day, five days per week (2,912 hours annually), half of that time waiting to pick up or deliver a container (Monaco 2005); such waiting time is uncompensated.

The greatest cause of the low wages, however, stems from the fact that port drivers are overwhelmingly owner-operators. While the language itself has political implications because of the dispute over whether they are truly independent subcontractors or rather are owner-drivers who depend on carriers for operating authority and freight, a measurement problem arises because they commingle earnings to the truck and earnings to the driver, making it difficult to disentangle actual compensation from the data. Monaco's survey reports that port drivers reported net earnings average \$29,903 with median earnings of \$25,000 annually. Obviously, this is far less than the average for other truck drivers in the region and much less than earnings reported by Global Insight, UMTIP, or BLS. Calculating on a straight-time basis, these drivers earn \$12.37 per hour; paid according to the Fair Labor Standards Act (FLSA), which establishes a cross-industry labour market equivalency, port drivers effectively earn \$10.82 per hour. In addition, owner-operators take on substantial risk in the form of truck loan payments/opportunity cost, and the associated risk of breakdowns and accidents. Owner-operator earnings clearly do not reflect this risk, making them under-compensated agents in the principal-agent model.

Measurement problems involved in determining owner-operator earnings have frustrated analysis. Monaco's survey, for example, simply asked drivers waiting to enter maritime terminals what they earned in a year (Monaco and Grobar 2004). Since owner-operators do not simply earn a wage, the determination of net compensation takes a great deal of effort. The Trucking Industry Benchmarking Survey (TIBP) surveyed owner-operators in cooperation with the Owner Operator Independent Drivers Association (OOIDA) in 2003–2004. While the survey resided on the TIBP server, owner-operators could access the survey through a specially advertised link on the OOIDA web site. The survey provided owner-operators who participated with a spreadsheet of their financial and operating statistics as well as with a benchmark comparison with other similarly situated owner-operators (see Wayne State University 2011) to access the survey instrument and a 'test drive' of the survey and its benchmarking feature). While 1,536 drivers responded to this on-line survey, many were just looking, registering without putting useful information on line. A substantial additional fraction of these drivers entered insufficient or incorrect data on which to base a calculation of their cost of operations, and some employee drivers entered data on their wage earnings, but 338 owner-drivers entered substantially complete data on more than 100 variables sufficient to calculate net earnings and to separate out wages and net earnings from their other cost of operation. The survey was not random, since it was aimed at OOIDA members and readers of their magazine, *Land Line*, but the sophistication required to have maintained the level of

detailed information requested as well as the sophistication required to use the on-line data entry and retrieval system suggests the results probably are biased toward the highest functioning owner-operator truck drivers.

The mean owner-operator with one truck (a true owner-operator driver) reported annual revenue from trucking operations per truck of \$115,512 (median \$110,306) on a mean of 111,390 miles (median 110,000). The average driver earned \$21,266.70 (median \$17,988.50), combining net profit and personal wages. No port drivers responded to this national survey, unfortunately, so we cannot make a direct comparison between these data sets, but these results suggest that the compensation reported in the TIBP survey is substantially less than reported by Monaco and Grobar, and their data suggest that the median port driver earns approximately 70 per cent of the national and regional averages. These results, moreover, suggest that owner-drivers generally and port owner-drivers specifically earn between one-third and two-thirds less than similarly situated non-union long-haul employee drivers.

**Table 1: Owner-Operator Cost-of Operations (one driver, one truck)**

Summary of	Total miles	Revenue from trucking operations per truck	Net profit & wages from trucking operations
<b>Total cases</b>	421	421	421
<b>Count</b>	323	358	338
<b>Mean</b>	111,390	\$118,798	\$21,267
<b>Median</b>	110,000	\$113,694	\$17,989
<b>StdDev</b>	44,101	51,054.6	37,163
<b>PopStdv</b>	44,033	50,983.2	37,108
<b>Min</b>	7,087	\$185	-\$149,571
<b>Max</b>	305,000	\$350,000	\$301,400

Source: *Trucking Industry Benchmarking Program Owner-Operator Cost of Operations Survey (Belzer 2006)*.

Using Monaco and Grobar's conservative estimate of 2,912 annual working hours and the TIBP's meticulous accounting of owner-operators' cost of operation, these drivers may average \$7.30 per hour (median \$6.18 per hour) on a straight time basis; if the Fair Labor Standards Act (FLSA, which provides for a 40-hour work week and time-and-one-half for overtime) applied to these drivers (as it does for the referent non-driving labour market as well as to local cartage), hourly pay works out to an average of \$6.39 per hour (median \$5.41). Using annual hours worked, collected by the UMTIP Truck Driver Survey in 1997–98, owner-operators nationally appear to be earning an average of \$6.20 per hour (median \$5.24) without converting to the FLSA basis. These drivers are not subject to the FLSA both because the law exempts trucking employees working in interstate commerce and because the law also exempts the self-employed, but their net compensation and reward for risk-taking earns them less than the minimum wage. Finally, this earnings estimate includes net profit on operating

capital, so these earnings estimates include both wages and profit, which is not the case for employee drivers.

Why do they work so hard for so little? Ouellet argues that truck drivers choose to work either for extrinsic or intrinsic benefits: drivers with extrinsic preferences choose to make money while drivers with intrinsic preferences choose lower pay in trade for the status and prestige of driving the big rigs (Ouellet 1994). While Ouellet's research is similar because he studied non-union truckload drivers on the west coast, it is different because his study took place early in the era of deregulation, before unions had been almost completely driven out of the industry (and completely out of drayage). Since drayage is one of the lowest status types of truck driving, with the oldest and saddest equipment, the intrinsic value explanation can hardly be credible in this business. It likely is, however, as Monaco and Grobar suggest, an occupation and industry attractive to recent immigrants whose alternatives are limited.

### **Security and Low Wages**

Low compensation for truckers can affect security in two ways. First, lower wages attract lower quality employees. The higher the level of compensation, the more selective employers may be when hiring or retaining truck drivers or other agents. In addition, superior compensation packages attract people who have more and better occupational choices, because for them truck driving is not an occupation of last resort. Nearly 90 per cent of drivers in the Ports of Los Angeles and Long Beach survey were born outside the USA (Monaco and Grobar 2004), which is not typical of other employees in the region. Those whose opportunity cost is so low that they will accept loads for less than the cost of operation, and who will work for net compensation comparable to the minimum wage, are safety risks and will tend to be security risks as well. A similar situation existed with airport screeners before the Transportation Safety Administration (TSA), an arm of DHS, took over this function. A General Accounting Office (GAO) report demonstrated that airport screeners did poor job of screening in part because low-wages prevented the hiring and retention of qualified employees (2000). The turnover rate among these employees averaged 125 per cent and was over 400 per cent at one airport, with passenger screeners making less than fast food restaurant workers in many cases. The GAO noted that screeners in other countries were better paid and had better performance than US screeners (2000).

Research has shown that lower compensation leads to safety risk in trucking (Australia. Department of Education, Employment and Workplace Relations 2010; Belzer et al. 2002; Quinlan et al. 2008; Rodriguez et al. 2006); we argue that this is important for security because characteristics that make a driver safe should predict security performance as well (Belzer 2002). Smaller and newer carriers with low liquidity and lower return-on-assets (like port motor carriers) also pose greater risks to society (Rodriguez et al. 2004). Indeed, a study of safety by industry segment identified intermodal operations as among the least safe in the nation (Horrace et al. 2002).

Second, the effects of incentives also play a role for those already employed as truck drivers. If the port driver job is a better job than one otherwise avail-

able to them — if drivers earn an efficiency wage — they will perform to a higher standard than they might otherwise so that they may retain that job (Cappelli and Chauvin 1991; Holzer 1990; Weiss 1990). The good job they have provides them with an incentive to drive safely and to participate actively in mitigating security risks. Currently workers choose between being truck drivers in a sensitive environment such as the port, and being labourers; they receive little in trade for their effort and little to provide them incentives to put their jobs first. In contrast, given the opportunity to hold jobs that can advance them financially, drivers are likely to have a great deal of loyalty to the employment relationship as well as to the society that gave them the opportunity. After all, those with a full stake in the American Dream will tend not to undermine the system that produced it and vigilantly will protect that system from those who threaten it (Chinoy 1952, 1965). Conversely, the long hours and low wages in trucking labour markets tends to attract the kind of people who have few alternative employment opportunities, opening the door to those who might choose to do us harm. An efficiency wage also likely extends to higher benefits, which have been shown to reduce turnover, increase stability, and act as a bond on future performance (Lazear 1990, 1992).

While scholarly literature linking crime and security appears to be slim, this has not escaped the notice of public policy experts. The Interagency Commission on Crime and Security in U.S. Seaports noted in its report that security in US ports has been lacking, particularly with respect to crime, and that this shortcoming extends to security with respect to terrorist threats (Interagency Commission on Crime and Security in U.S. Seaports 2000). A Congressional Research Service report drew attention to the risk of ‘insider attack’ potentially posed by ‘disgruntled shipping workers’ (Parfomak and Frittelli 2007: 2), the source of whose dissatisfaction could easily be compensation-related. At the very least, the difficulty of hiring employees in low-wage occupations makes it more likely that firms will find it more difficult to screen out such disgruntled individuals. Indeed, the establishment of the TWIC program implies just this risk for individuals employed within port facilities.

Finally, the CRS notes that the biggest risk may well rest on containers and the drayage vehicles that transport them precisely because they are ubiquitous and so difficult to control:

[T]he containers on any given ship are packed at the factories or warehouses of many different companies that can be dispersed far and wide from the loading port, making it impossible for government authorities to ensure that only legitimate cargo has been packed. [T]he containers are typically trucked to the port of loading, during which the integrity of the shipments rests entirely on the trustworthiness or due diligence of the truck drivers. (Parfomak and Frittelli 2007: 19)

This report illustrates the point with a quote from an unnamed member of the Council on Foreign Relations who is a former Coast Guard Commandant, who lays out a scenario that ‘keeps him awake at night; in which al Qaeda sympathisers or plants successfully open a container in domestic transit and replace

sneakers with a dirty bomb (Parfomak and Frittelli 2007: 18).<sup>12</sup> In sum, CRS reports emphasise the need for 'scenario diversity', which must identify as many vulnerabilities as possible, and the implicit need for a principal-agent relationship with these drivers to ensure the security of these goods in transit.

### **Principal-Agent Contracts and Moral Hazard in Security**

Given that many links of the supply chain consist of individual workers operating without direct supervision, we need a way to improve security without attempting the impossible task of providing ironclad security for the entire chain (for a probability-based approach to security see Flynn 2004, 2007). The current DHS policy of using C-TPAT to provide incentive for importers to improve security in their entire supply chain attempts to do this. It is perhaps more desirable than using government security alone because although C-TPAT increases cost for shippers, those costs are reflected in the market cost of goods. For this program to be completely effective however, every link of the supply chain must be hardened against hostile use. Effective hardening of this link should include incentives for employers, as principals, to attract reliable workers and provide some disincentive for undesired behaviour. In some sense, DHS is shifting some of the risk for importing goods from the government to the importers. The importers in turn shift this risk to other firms and in many cases individual agents. In cases where these agents have nothing to lose, the whole nation and the public in general will end up responsible for the cost if one of these agents uses its access to the supply chain to attack the USA. In other words, the government passes transportation risk down to agents such as shippers, consignees, and a full range of freight transport service providers, including owner-driver and owner-operator truckers whose earnings lie near the bottom of the US earnings hierarchy. With the exception of the government, no single entity has adequate incentive to mitigate this risk. In this sense, the supply chain becomes saddled with a classic moral hazard or tragedy of the commons (Hardin 1968), in which individual supply chain participants and their customers, acting in good faith within the market structure, cannot insure against the risk of failure and consequently may not do enough to prevent it. Perhaps realising that certain areas of the supply chain could not be effectively hardened using C-TPAT, DHS instituted the TWIC program.

The Transportation Worker Identification Card (TWIC) program requires transportation workers with access to 'sensitive areas' to use a biometric ID card to gain access to such areas. To get the TWIC, transportation workers must pass a background check that excludes suspected terrorists, illegal aliens, and certain felons (Edmonson 2007a). While hailed as a good idea by many, the program has had problems, including the development of the biometric ID card (Disard III 2007), the anticipated cost of the ID card, and the possible effects on the workforce (Edmonson 2007b). Congress requires the TWIC program to be self-sustaining, so workers will pay the fee for getting a card (Edmonson 2007b). This cost, and the requirement that disqualifies illegal aliens, have raised fears that the new rules will cause some ports to suffer labour shortages. However, if raising the qualifications of transportation workers (specifically underpaid ones) results in a labour shortage, then wages should rise in response to this shortage,



as long as the labour market is functional. In this way, market forces that reflect a 'reasonable' security constraint would increase the cost of transportation and of importing goods by raising truck driver compensation; in this way, the cost of security passes to consumers, which it should in an efficient market.

## Conclusion

An efficient and effective solution to security problems requires both that the nation seek low-cost solutions and that users of the transportation system pay the costs of security measures. The current trend to require each participant to ensure the security of its own processes and of its agents clearly is less expensive as long as we do not consider the cost of a major security failure; it therefore may not be economically efficient because it works only if the dependability of agents can be monitored physically or insured financially up to the full replacement cost of economic losses. Clearly, government has a systemic oversight role and public policy can rely heavily on private industry to decrease security risk. However, this market-based method will not work for those links in the supply chain where physical monitoring is ineffective and where market forces prevent any sort of incentive for good behaviour, such as an efficiency wage. Efforts to keep wages down, in fact, would defeat the purpose by defeating the supply and demand functions in the labour market.

While many costs pass directly to system users, many other costs do not. The DHS budget does not pass freight security costs directly to users of the freight system. This sort of externality will lead to inefficient economic decisions with regard to transportation and the location of production facilities, because the users do not bear the entire cost of transportation. While some elements of the US government's security plan have a sound basis in economic theory, others do not. Low-paid, private contractors and the control of strategic infrastructure by private and foreign entities represent two glaring areas for improvement.

## Notes

1. A term not widely outside the shipping and logistics industry, drayage refers to the intermodal transport of goods, usually over a short distance, in a single trip that is part of a longer movement. See Burks et al. for market definitions.
2. While trucks may haul shipments directly and more quickly to Shanghai, the cost is much greater so shippers choose this option less frequently.
3. Personal communication, 25 April 2007.
4. The Bureau of Customs and Border Protection is an agency within DHS with the primary mission of protecting the borders (<http://www.cbp.gov/xp/cgov/about/mission/guardians.xml>).
5. 'Panamax' is the maximum size of ship that can pass through the Panama Canal. 'Post-Panamax' ships are too large to pass through the Panama Canal, although they may be able to pass through after the Panama Canal is expanded. However, about 37 per cent of the world's container-ship fleet will continue to be Past-Panamax. As of 2011, the world's largest container ship is the 12,000 TEU Emma Maersk, and Maersk announced early in 2011 that

- it had purchased ten 18,000 TEU container ships and has an option for ten more, limiting the expanded canal's impact.
6. One of the most successful of these is Cargo Criminal Apprehension Team, or CargoCATs, a program of the Los Angeles County Sheriff's Office, which recovered \$205.5 million in stolen property and made 1,239 arrests between 1990 through 2004 (Journal of Commerce 2005: 10).
  7. CargoCATs was disbanded in 2002 in order to save \$60 million at the county level. After an enormous outcry, the team was re-funded in December 2002 (Landline 2002:1). Insufficient funding along with new unfunded DHS mandates, however, has made it difficult to support such organisations in all ports and intermodal terminals.
  8. US Department Of Transportation Federal Motor Carrier Safety Administration (2006) Notice. Hours of Service of Drivers: Institute of Makers of Explosives (IME); Application for Exemption, Federal Register: April 10, 2006 (Volume 71, Number 68), pp. 18141–18142. From the Federal Register Online via GPO Access (wais.access.gpo.gov), Docket ID fr10ap06-105.
  9. Congress wrote trucking economic deregulation into law in 1980.
  10. Source: Author's analysis of UMTIP data.
  11. U.S. Bureau of Labor Statistics (2007). Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates, May, available: [http://stats.bls.gov/oes/current/oes\\_31100.htm#b53-0000](http://stats.bls.gov/oes/current/oes_31100.htm#b53-0000) [accessed 15 March 2007].
  12. We have reason to believe that this unnamed source is Stephen Flynn.

## References

- Associated Press (2006) 'Mesaba unions approve new contracts', *New York Times*, 28 November, Dow Jones Factiva, Document APRS000020061127e2br002sd [accessed 13 March 2011].
- Australia. Department of Education, Employment and Workplace Relations (2010) *Safe Rates, Safe Roads*, Directions Paper, Commonwealth of Australia, Canberra.
- BBC (2008a) British Broadcasting Corporation 'Somalia's pirates face battles at sea', *BBC News*, 29 September, available: <http://news.bbc.co.uk/2/hi/7358764.stm> [accessed 13 March 2011].
- BBC (2008b) British Broadcasting Corporation 'Somali pirates "seize cargo ship"', *BBC News*, 16 November, available: <http://news.bbc.co.uk/2/hi/7731920.stm> [accessed 13 March 2011].
- BBC (2008c) British Broadcasting Corporation 'Pirates capture Saudi oil tanker', *BBC News*, 18 November, available: <http://news.bbc.co.uk/2/hi/7733482.stm> [accessed 13 March 2011].
- Becker, M. A. (2005) 'The shifting public order of the oceans: Freedom of navigation and the interdiction of ships at sea', *Harvard International Law Journal* 46(1), pp.131–230.
- Belman, D. L. and Monaco, K. A. (2001) 'The effects of deregulation, de-unionisation, technology, and human capital on the work and work lives of truck drivers', *Industrial and Labor Relations Review*, 54(2A), pp. 502–524.

- Belzer, M. H. (1995) 'Collective bargaining after deregulation: Do the Teamsters still count?' *Industrial and Labor Relations Review* 48(4), pp. 636–655.
- Belzer, M. H. (2000) *Sweatshops on Wheels: Winners and Losers in Trucking Deregulation*, Oxford University Press, Oxford, UK and New York, NY.
- Belzer, M. H. (2002) 'Truck driver security issues: The new world of secure surface transportation,' *Perspectives on Work*, 6(1), pp. 13–15.
- Belzer, M. H. (2006) OOIDA 2003–2004 cost of operations survey: Report of results, Detroit, Wayne State University. Detroit MI, 5 April 2006. p. 50.
- Belzer, M. H., Burks, S. V., Dowell, M. S. and Swan, P. F. (2000) Less-than-truckload trucking industry case study and benchmarking report. University of Michigan Trucking Industry Program, unpublished.
- Belzer, M. H., Rodriguez, D. A. and Sedo, S. A. (2002) *Paying for Safety: An Economic Analysis of the Effect of Compensation on Truck Driver Safety*, United States Department of Transportation, Federal Motor Carrier Safety Administration, Washington, DC.
- Bloom, M. (1999) 'The performance effects of pay dispersion on individuals and organizations,' *Academy of Management Journal*, 42(1), pp. 25–40.
- Bloom, M. and Milkovich, G. T. (1998) 'Relationships among risk, incentive pay, and organizational performance,' *Academy of Management Journal*, 41(3), pp. 283–297.
- Burks, S. V., Belzer, M. H., Kwan Q., Pratt, S. G. and Shackelford, S. (2010) *Trucking 101: An Industry Primer*, Transportation Research Board Committee on Trucking Industry Research (AT060), TRB Transportation Research Circular, Transportation Research Board. Washington. Available: <http://onlinepubs.trb.org/onlinepubs/circulars/ec146.pdf> [accessed 1 April 2011].
- Cappelli, P. and Chauvin, K. (1991) 'An interplant test of the efficiency wage hypothesis,' *The Quarterly Journal of Economics*, 106(3), pp. 769–787.
- Chapman, P. K. (1992) *Trouble on Board: The Plight of International Seafarers*, ILR Press, Ithaca, NY.
- Chinoy, E. (1952) 'The tradition of opportunity and the aspirations of automobile workers,' *American Journal of Sociology*, 57(5), pp. 453–459.
- Chinoy, E. (1965) *Automobile Workers and the American Dream*, with an introduction by David Reisman, First Edition, Beacon Press, Boston.
- Coyle, J. J., Bardi, E. J. and Novack, R. A. (2000) *Transportation*, Fourth Edition, South-Western College Publishing, Cincinnati.
- Crawford, L., Dombey, D., Houlder, V. and Shelley, T. (2002) 'The prestige has awakened concerns that maritime safety standards are inadequate, but improvements are coming slowly,' *Financial Times*, 21 November.
- Dizard III, Wilson P. (2007) 'TSA, industry dispute TWIC flaw claims,' in *Government Computer News*, Washington, DC, available: <http://gcn.com/articles/2007/01/25/sources-twic-flaws-could-endanger-program.aspx> [accessed 15 April 2011].
- Donn, C. B. (1989) 'Concession bargaining in the ocean-going maritime industry,' *Industrial and Labor Relations Review*, 42(2), pp. 189–200.

- Edmonson, R. G. (2007a) 'TWIC card rules published', *Journal of Commerce*, 3 January, available: <http://www.joc.com/maritime/twic-card-rules-published-0> [accessed 14 March 2011].
- Edmonson, R. G. (2007b) 'Two-step: Industry says rule-making on transport worker IDs is a move in the right direction', *Journal of Commerce*, 15 January, p. 22.
- Edmonson, R. G. (2010) 'Customs adding up 10+2; Penalties won't start for months, but the agency isn't waiting to notify violators', *Journal of Commerce*, 8 February, available: <http://www.joc.com/102isf/customs-adding-102> [accessed 14 March 2011].
- Eisenhardt, K. M. (1988) 'Agency- and institutional-theory explanations: The case of retail sales compensation', *Academy of Management Journal*, 31(3), pp. 488–511.
- Eisenhardt, K. M. (1989) 'Agency theory: An assessment and review', *Academy of Management Review*, 14, pp. 57–74.
- Fedor, L. (2006a) 'Pilots union reaches deal with Mesaba: Talks with attendants and mechanics continue, as the carrier struggles through bankruptcy', *Star Tribune*, Minneapolis, 28 October, available: <http://www.startribune.com/business/11215266.html> [accessed 13 March 2011].
- Fedor, L. (2006b) 'Mesaba reaches deal with attendants: Talks continue with the mechanics union as the regional carrier strives to secure deals with three big unions', *Star Tribune*, Minneapolis, 30 October. available: [http://goliath.ecnext.com/coms2/gi\\_0199-9286202/Mesaba-reaches-deal-with-attendants.html](http://goliath.ecnext.com/coms2/gi_0199-9286202/Mesaba-reaches-deal-with-attendants.html) [accessed 13 March 2011].
- Flynn, S. E. (2004) *American the Vulnerable: How our Government is Failing to Protect us from Terrorism*, Perennial [2005] Edition, HarperCollins, New York, in cooperation with the Council on Foreign Relations.
- Flynn, S. E. (2007) *The Edge of Disaster: Rebuilding a Resilient Nation*, Random House, in cooperation with the Council on Foreign Relations, New York.
- Frittelli, J. F. (2005) *Port and Maritime Security: Background and Issues for Congress*, CRS Report for Congress, Congressional Research Service, Washington, DC.
- Gettleman, J. (2008a) 'Somalia pirates capture tanks and global notice', *New York Times*, 27 September, available: Factiva Document NYTF000020080927e49r00053 [accessed 13 March 2011].
- Gettleman, J. (2008b) 'Somalia's pirates flourish in a lawless nation', *New York Times*, 30 October, available: <http://www.nytimes.com/2008/10/31/world/africa/31pirates.html> [accessed 13 March 2011].
- Gittell, J. H., von Nordenflycht, A. and Kochan, T. A. (2004) 'Mutual gains or zero sum? Labor relations and firm performance in the airline industry', *Industrial and Labor Relations Review*, 57(2), pp. 163–180.
- Global Insight Inc. (2005) *The U.S. Truck Driver Shortage: Analysis and Forecasts*, American Trucking Association, May.
- Hardin, Garrett (1968) 'The Tragedy of the commons: The population problem has no technical solution; it requires a fundamental extension in morality', *Science*, 162, pp. 1243–1248.

- Heaster, R. (2007) 'Driving drivers away in droves: Stagnant pay, lonely lifestyle prompt many to leave for construction jobs', *Kansas City Star*, 20 February, available: <http://www.kansascity.com/mld/kansascity/business/local/16735717.htm?template=contentModules/printstory.jsp> [accessed 13 March 2011].
- Holzer, H. J. (1990) 'Wages, employer costs, and employee performance in the firm', *Industrial and Labor Relations Review*, 43(3), pp. 147S–164S.
- Horrace, W. C., Keane T. P. and Braaten, K. N. (2002) *Motor Carrier Industry Profile Study: Statistical Inference of Safety Performance Measures*, U.S. FMCSA report, 23 October, Department of Transportation, Washington, DC.
- Interagency Commission on Crime and Security in U.S. Seaports (2000) *Report on Crime and Security in U.S. Seaports*, Washington, DC.
- Journal of Commerce (2005) 'This week', *Journal of Commerce*, 23 May, [accessed 31 March 2011]
- Landline (2002) 'Cargo CATs again prowling ports', *Landline Magazine*, 4 December. available: [http://www.landlinemag.com/todays\\_news/Daily/2002/Dec02/120202/120402-04.html](http://www.landlinemag.com/todays_news/Daily/2002/Dec02/120202/120402-04.html) [accessed 13 March 2011].
- Langewiesche, W. (2003) 'Anarchy at sea: Ordeal of the *Kristal* and the *Alondra Rainbow*', *Atlantic Monthly*, 292(2), pp. 50–80.
- Langewiesche, W. (2004) *The Outlaw Sea: A World of Freedom, Chaos, and Crime*, North Point Press, New York.
- Lazear, E. P. (1990) 'Pensions and deferred benefits as strategic compensation', *Industrial Relations*, 29(2), pp. 263–280.
- Lazear, E. P. (1992) 'Compensation, productivity, and the new economics of personnel', in David Lewin, Olivia S. Mitchell and Peter D. Sherer (eds) *Research Frontiers in Industrial Relations and Human Resources*, Industrial Relations Research Association, Madison, WI, pp. 341–380.
- Lazear, E. P. (1995) *Personnel Economics*, MIT Press, Cambridge, MA.
- Lipton, E. (2006) 'U.S. can't protect all targets, Chertoff says', *New York Times*, 13 September, available: <http://www.nytimes.com/2006/09/13/washington/13chertoff.html> [accessed 13 March 2011].
- Martonosi, S. E., Ortiz, D. S. and Willis, H. H. (2006) 'Evaluating the viability of 100 per cent container inspection at America's ports', in Harry W. Richardson, Peter Gordon and James E. Moore (eds), *Economic Impacts of Terrorist Attacks*, Edward Elgar Publishers, Cheltenham, UK, pp. 218–241.
- Meade, C. and Molander, R. C. (2006) *Considering the Effects of a Catastrophic Terrorist Attack*, The Rand Center for Terrorism Risk Management Policy, Santa Monica, CA.
- McPhee, J. (1990) *Looking for a Ship*, Farrar Straus Giroux, New York.
- Milgrom, P. and Roberts, J. (2002) *Economics, Organization, and Management*, Prentice Hall, Upper Saddle River, NJ.
- Monaco, K. (2005) 'Wages and working conditions of truck drivers at the port of Long Beach', in Proceedings of the 2005 Annual Meeting of the Transportation Research Board, National Academies, Washington, DC.

- Monaco, K. and Grobar, L. M. (2004) A Study of drayage at the ports of Los Angeles and Long Beach, AR04-01, METTRANS, University of Southern California, California State University, Los Angeles, CA.
- Nankivell, K. L. (2004) 'Troubled waters,' *Foreign Policy*, 1 November, pp. 30–31.
- Natter, A. (2007) 'DOT to reroute hazmats (United States. Department of Transportation),' in *Traffic World*, 31 July, available: <http://www.accessmylibrary.com/article-1G1-167015103/dot-reroute-hazmats-united.html>, [accessed 13 March 2011].
- Odell, M. and Shelley, T. (2003) 'Security lapse revealed over crews of army supply ships,' *Financial Times*, 5 February, available: Factiva Document Document ffft000020030205dz25000a4 [accessed 13 March 2011].
- Osieke, E. (1979) 'Flags of convenience vessels: Recent developments,' *American Journal of International Law*, 73(4), pp. 604–627.
- Ouellet, L. J. (1994) *Pedal to the Metal: The Work Lives of Truckers*, Temple University Press, Philadelphia.
- Parfomak, P. W. and Frittelli, J. F. (2007) *Maritime Security: Potential Terrorist Attacks and Protection Priorities*, CRS Report for Congress, Congressional Research Service, Washington.
- Quinlan, M., Wright, L. and National Transport Commission (2008) *Safe Payments: Addressing the Underlying Causes of Unsafe Practices in the Road Transport Industry*, National Transport Commission, Melbourne.
- Rodriguez, D. A., Rocha, M. and Belzer, M. H. (2004) 'The effects of trucking firm financial performance on driver safety' in James H. Peoples and Wayne K. Talley (eds) *Transportation Labor Issues and Regulatory Reform*, Elsevier Science Publishers Rotterdam, The Netherlands, pp. 35–55.
- Rodriguez, D. A., Targa, F. and Belzer, M. H. (2006) 'Pay incentives and truck driver safety: A case study,' *Industrial and Labor Relations Review*, 59(2), pp. 205–225.
- Shannon, E. (2002) 'The inspector: Manning the bridge,' *Time Magazine*, 9 September, available: <http://www.time.com/time/magazine/article/0,9171,1003225,00.html> [accessed 13 March 2011].
- Stroh, L. K., Brett, J. M., Baumann, J. P. and Reilly, A. H. (1996) 'Agency theory and variable pay compensation strategies,' *Academy of Management Journal*, 39(3), pp. 751–767.
- Swan, P. F. (2004) A study of the economic impacts and the need for proposed changes to intermodal container chassis inspection rules, The International Brotherhood of Teamsters, The American Trucking Associations, The International Longshoremen's Association, The International Longshore and Warehouse Union.
- United States. Bureau of Labor Statistics (2007) Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates, May, available: [http://stats.bls.gov/oes/current/oes\\_31100.htm#b53-0000](http://stats.bls.gov/oes/current/oes_31100.htm#b53-0000) [accessed 15 March 2007].
- United States. Customs and Border Protection (2010) Mission statement and core values, available: <http://www.cbp.gov/xp/cgov/about/mission/guardians.xml> [accessed 14 March 2011].

- United States. Department Of Transportation Federal Motor Carrier Safety Administration (2006) Notice, from Federal Register: April 10, 2006 (Volume 71, Number 68), pp. 18141–18142, available: <https://www.fmcsa.dot.gov/rules-regulations/administration/rulemakings/notices/E6-5140-HOS-Makers-of-Explosives-Exemption-4-10-06.htm?printer=true> [accessed 14 March 2011].
- United States. General Accounting Office (2000) *Aviation Security: Long-Standing Problems Impair Airport Screeners' Performance*, Report to Congressional Requesters, GAO/RCED-00-75, United States General Accounting Office, Washington, DC.
- Wayne State University (2011) Trucking Industry Benchmarking Program, available: <http://www.ilir.umich.edu/TIBP> [accessed 13 March 2011].
- Weiss, A. (1990) *Efficiency Wages*, Princeton University Press, Princeton, NJ.
- Westcott, K. (2008) 'Somalia's pirates face battles at sea', *BBC News*, 29 September, available: <http://news.bbc.co.uk/2/hi/7358764.stm> [accessed 13 March 2011].
- Worth, R. F. (2008) 'Pirates seize Saudi tanker off Kenya', *New York Times*, 18 November, available: <http://www.nytimes.com/2008/11/18/world/africa/18iht-18pirates.17912822.html> [accessed 13 March 2011].

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