

# **Evidence that truck driver remuneration is linked to safety outcomes: a review of the literature**

Lori, Mooren, Ann, Williamson PhD and Raphael, Grzebieta PhD

Transport and Road Safety (TARS) Research, University of New South Wales Australia

## **Abstract**

The evidence that remuneration and pay systems have an effect on truck driver safety is growing. A review of the scientific literature shows the connections between remuneration and safety risk factors and outcomes. A study conducted in one large American trucking company found that where drivers are paid mileage rates, a 10 cent increase in the rate paid per mile results in a 1.76% reduction in the risk of crashing. Not only do pay rates make a difference in safety outcomes, but also the way in which drivers are remunerated influences the likelihood of unsafe behaviours and crashes. A number of studies conducted between 1990 and 2014 in Australia, the United States (US) and Europe, focused on the safety effects of truck driver payment methods. There is also evidence that trucking industry economic pressures play a role in safety performance. This paper summarises the findings of the research on this topic.

## **Introduction**

There has been an abundance of research into safety risk factors that attempt to explain fatal truck crashes. For example, it is well established that driver fatigue (Crum & Morrow, 2002; Feyer & Williamson, 1995; Feyer, Williamson, Friswell, & Sadural, 2002; Hanowski, Hickman, Olsen, & Bocanegra, 2009) is a prevalent factors in these crashes. In a major US study into truck crash causation, a number of “critical reasons” for these crashes were identified (Department of Transportation U.S., 2006). Vehicle factors, especially concerning brakes and tyres were 10% of the critical reasons. Driver behavioural factors were the most prominent, especially driving whilst drug affected or fatigued and driving too fast for conditions. Knowing about prevalent crash risk factors enables authorities to focus regulatory interventions to the most important behaviours to control, as well as to guide and educate companies on things they should be doing to reduce crash risks. Much of the road safety regulation is focussed on controlling driver behaviour.

Some studies have gone a step further to determine some of the underlying conditions in which these risk factors manifest. Richards (2004) found that fatigue, peer pressure, wanting to fit the trucking ‘image’, socialisation, relaxation and addiction were powerful motivations for truck drivers to use drugs. Also, Kemp et al (2013) found that time pressures can lead to physical fatigue and emotional exhaustion, which in turn lead to negative attitudes about compliance with hours of service regulations.

Why do drivers feel excessively time-pressured? Perhaps there is something inherent in the characteristics of the trucking industry that perpetuate the manifestation of things like time-pressures. Michael Belzer (2000), citing that practices of paying drivers low piece meal pay rates for driving described the trucking industry as “sweatshops on wheels”. A literature review by Johansson et al (Johansson, Rask, & Stenberg, 2010) found that 27 out of the 31 studies examined indicated a link between piece meal pay methods and adverse health and safety outcomes.

A literature review focused on evidence of effective safety management characteristics (Mooren, Grzebieta, Williamson, Olivier, & Friswell, 2014) found that driver pay rates and company profitability have a bearing on safety outcomes. There are essentially two types of payment methods for drivers of heavy transport vehicles. Companies can choose to pay drivers by the hour or with a wage or salary that covers all work undertaken by drivers, including driving tasks as well

as time spent loading or unloading the truck and/or queuing or waiting to be loaded or unloaded. The alternative method is termed “productivity payment.” This is a compensation method that ties financial compensation to output, either by truckloads delivered, kilometres driven, or profits earned by a job. Under this type of payment method, the employer may or may not pay for time spent on non-driving activities such as loading, unloading or queuing/waiting. Sometimes either a flat fee is given to the driver for some or all of these tasks. Sometimes payment for time the driver spent waiting is conditional on how long the driver spends waiting, e.g. drivers get paid for time after the first hour. The two methods can be combined in other ways as well, such as drivers on hourly pay may receive bonuses as a share of the profits earned by a company.

This paper specifically reviews the growing literature on the connections between driver and company compensation and safety. The aim of this study was to identify whether truck driver pay and pay systems influence safety risk, whether driver remuneration, and whether trucking company profitability has a bearing on safety outcomes. In addition, the paper sought to identify features of the trucking industry that provide the conditions that influence poor safety performance.

## **Method**

The authors had conducted a prior literature review examining original research papers on safety management systems (2014). This review found a number of studies suggesting that an important safety management characteristic for heavy vehicle operators was the way in which drivers were remunerated for their work (Monaco & Williams, 2000; Williamson, 2007) and driver pay rates (Belzer, Rodriguez, & Sedo, 2002; Rodriguez, Targa, & Belzer, 2006). Related to these issues, a number of studies in this review found links between company financial performance, efficiency, unionisation and size (Britto, Corsi, & Grimm, 2010; Bruning, 1989; Corsi, Grimm, Cantor, & Sienicki, 2012; Fernandez-Muniz, Montes-Peon, & Vazquez-Ordas, 2009; Knipling & Bergoffen, 2011; Mayhew & Quinlan, 2006) also influenced safety outcomes. Initially, the references listed in the studies first examined were obtained as well as studies that cited these publications were obtained. A Google Scholar search on the terms, truck driver pay and safety risk, driver remuneration, trucking company profitability and safety found 16,500 references relating to these topics. Then the search was narrowed to include only articles that contained the phrase “driver pay”. This reduced the list to 71 references. A review of titles to exclude light vehicle studies, and those that did not directly link financial reward and safety outcomes was done. In addition, only studies using original data were included. This process resulted in 29 papers, representing 26 studies, being selected for inclusion in this review of the research evidence connecting pay with safety in the trucking industry.

## **Results**

There are four groups of literature that highlight the connections between safety and remuneration in the trucking industry. These cover: the effects of driver payment methods on risk behaviour; the effects of payment levels on safety outcomes; the effects of company financial performance and industrial relations on safety outcomes; and the effects of industry financial pressure on safety outcomes. Taking each of these topics in turn an analysis of the evidence of the connection between financial reward and safety is discussed.

### **Driver Payment Methods and Driving Behaviour**

Not only do pay rates make a difference in safety outcomes, but also the way in which drivers are remunerated influences the likelihood of unsafe behaviours and crashes. Studies conducted between 1990 and 2014 in Australia and in the United States (US), which focused on the safety effects of truck driver payment methods are summarised in Table 1.

***Table 1. Effects of Driver Payment Methods on Risk Behaviour and Safety Outcomes***

<b>Study focus</b>	<b>Author, year</b>	<b>Method/sample</b>	<b>Findings</b>
Effects of driver pay system on propensity to speed, self-impose tight schedules, take stimulant drugs	(Golob & Hensher, 1994)	Cross-sectional survey/ n = 402 Australian truck drivers	Drivers try to optimise money earned by self-imposed time pressure, leading to use of stimulants, leading to speeding (79% are paid based on productivity)
Effects of driver pay method on propensity to speed	(Hensher & Battellino, 1990)	Cross-sectional (pilot) survey/ n = 46 Australian truck drivers	Non-drug users drive 20 km/h slower than drug users Drivers paid on a percentage of truck earnings drive 15 km/h faster
Effects of productivity based payment on driver fatigue	(Williamson, Feyer, Friswell, & Saduri, 2001)	Cross-sectional survey/ n = 1,007 Australian long haul truck drivers	Drivers paid by amount of work done report fatigue more often than drivers paid by the amount of time they worked.
Effects of compensation on driver fatigue risk	(Arboleda, Morrow, Crum, Shelley, & Mack, 2003)	Cross-sectional survey of drivers, dispatchers and safety directors in 116 US trucking companies	Unregulated hours of work and unpaid non-driving work provides incentives for drivers to work longer hours and risk driver fatigue.
Effects of payment methods on drug use	(Williamson, 2007)	Re-analysis of 2 Australian surveys 7 years apart/ n=970 & n=1007	Drivers paid by productivity were 2-3 times more likely to use stimulant drugs.
Effects of payment methods on driver fatigue	(Thompson & Stevenson, 2014)	Cross-sectional survey/ n = 346 Australian truck drivers	Performance based pay encourages drivers to keep driving at the expense of sleep and rest, maintenance and safety checks.
Effects of payment methods on truck insurance claim rates	(Mooren, Williamson, et al., 2014)	Cross-sectional survey/ n=50 Australian heavy vehicle operating companies	<ul style="list-style-type: none"> <li>Higher claimers were 4 times more likely to pay employee drivers by truckload or trip</li> </ul>

Seven studies<sup>1</sup> in 2 countries from the 1990s to 2014 provide evidence that pay methods affect drivers':

- self-imposed time pressure;
- use of stimulant drugs;
- speeding;
- fatigue;
- truck maintenance and safety checks; and
- insurance claim rates.

<sup>1</sup> Cross sectional survey methods were used.

Productivity-based pay is found to produce incentives to self-impose time pressure, take stimulants, speed and work excessive hours. Productivity pay also predicts driver fatigue and encourages drivers to risk fatigue, poorly maintain trucks and skip safety checks. At a company level, those that pay on the basis of productivity have higher truck insurance claim rates compared with those that pay drivers for all hours worked.

In a survey of 573 US motor carrier drivers in 1997, Monaco and Williams (2000) found that hourly payment for drivers had a 10.2% lower crash risk compared with productivity pay, i.e. when drivers are paid by the mile or as percentage of revenue earned by the company. Moreover, where drivers are paid mileage rates, a 10 cent increase in the rate results in a 1.76% reduction in the risk of crashing.

### Effects of driver pay levels on safety outcomes

Eight papers reporting the results of six studies demonstrated links between pay levels and safety. Table 2 presents evidence of the effects of driver pay levels on safety outcomes.

*Table 2. Effects of Driver Pay Levels on Safety Outcomes*

Study focus	Author, year	Method/sample	Findings
Effects of driver pay on driver turnover and health	(Backman & Järvinen, 1983)	Cohort study/ n = 472 drivers in Finnish Transport Workers Union	Reasons for leaving job: 31% unsatisfactory salary 20% work too heavy 14% irregular hours 12% health affected
Effects of driver pay on propensity to speed	(Hensher & Battellino, 1990)	Cross-sectional (pilot) survey/ n = 46 Australian truck drivers	Non-drug users drive 20 km/h slower than drug users Drivers paid on a percentage of truck earnings drive 15 km/h faster
Effects of driver pay on propensity to speed, self-impose tight schedules, take stimulant drugs	(Hensher, Battellino, Gee, & Daniels, 1991)	Cross-sectional survey/ n = 820 Australian truck drivers	Freight rates for owner drivers influence speed Uncertainty of income encourages self-imposed schedules and drug use
Effects of driver pay on violations of work hours		Cross-sectional survey/n = 1,249 US truck drivers	Low pay and tight schedules predict violations of work hour limits
Effects of driver pay increases on crash involvement	(Belzer et al., 2002) (Rodríguez, Rocha, Khattak, & Belzer, 2003) (Rodriguez et al., 2006)	Cohort study/ n = 11,540 drivers employed by J.B. Hunt (US)	A 10% increase in pay reduced crash risk by 21% A 10% increase in paid days off reduced crash risk by 7%. For every additional cent per mile paid to a driver, the crash count decreases by 8%. A 1% increase in pay corresponds to a 1.33% reduction <sup>2</sup> in crash risk probability.
Effects of payment	(Williamson &	Cross-sectional	Incentive based payment and

<sup>2</sup> The safety benefit of increased pay levels does not reduce over time, but the effect reduces incrementally as rates of pay become higher.

Study focus	Author, year	Method/sample	Findings
methods on driver fatigue	Friswell, 2013)	survey/ n = 475 Australian truck drivers	unpaid waiting times predict driver fatigue.

Six studies<sup>3</sup> carried out in 3 countries from the 1980s to 2014 provide evidence that pay levels affect:

- driver turnover;
- speeding;
- self-imposed schedules;
- stimulant drug use;
- violations of work hour limits; and
- driver fatigue.

One large cohort study (Belzer et al, 2002) found increases in pay reduce crash risks. Moreover, one study (Williamson and Friswell, 2013) found that unpaid waiting time and incentive based pay predicts driver fatigue.

In the early 1980s Scandinavian researchers found strong links between driver pay and driver turnover (Backman & Järvinen, 1983). The most common reasons that drivers gave for changing their work were: unsatisfactory salary (31%), heaviness of the work (20%, irregularity of working hours (14%) and health (12%).

A survey of 820 Australian truck drivers, carried out in 1990, concluded that economic rewards were a major influence on drivers to speed on delivery journeys (Hensher et al., 1991). Work practices of truck drivers, including speeding, self-imposing tight schedules and taking stimulant drugs are encouraged by uncertainty or insufficient earnings. These findings were later again replicated in two additional cross-sectional surveys of Australian truck drivers, in 1991 (n = 970) and in 1998 (n = 1,007) confirming the influence of productivity payment systems on the use of stimulant drug use by drivers (Williamson, 2007). Golob and Hensher (1994), still concerned that a lack of appreciation of the relationship between trucking industry characteristics and on-road safety performance may lead to inappropriate and ineffective regulatory responses, examined the constellation of endemic pressures on drivers to speed on delivery journeys (n = 402 Australian truck drivers). They concluded that rates of financial rewards influences drivers' propensity to speed, self-impose schedules and take stay-awake pills. They also observed a complex relationship of decisions by drivers to optimise financial gains through a series of influences to impose difficult timeframes on themselves, which in turn encourages the use of stimulant drugs, which in turn leads to speeding. The majority of drivers (79%) were paid directly in relation to the earnings of the truck.

In parallel, major surveys of US truck drivers found links between driver pay and safety performance. Braver et al (1992) found that 73% of drivers report that they violate hours of service restrictions and that low pay rates and tight delivery schedules were a major impetus to this violation. Moreover, Belzer et al (2002) concluded that drivers who are paid a higher rate have significantly fewer crashes after estimating from the data that a 10% increase in driver pay from \$0.295 per mile to \$0.324 per mile reduced the probability of a crash by 21% from a 13.8% chance to a 10.86% chance.

Finally, the Williamson and Friswell (2013) survey found that nearly 90% of Australian truck drivers have to wait to load or unload their trucks, but just one quarter of them are paid to wait. Moreover nearly half of these drivers reported that work interferes with family responsibilities.

### **Industry pressures behind unsafe pay and payment systems**

<sup>3</sup> Cross sectional survey methods were used.

Characteristics of the trucking industry itself may in fact make it more dangerous to work in. While road transport of goods is vital to any economy, the industry conditions in the US and in Australia are plagued by fierce financial pressures.

Intense competition in any industry results in lower prices. While this may be seen by consumers as a good thing, when rates paid for the transport of goods by trucks fall below what a company or driver needs to survive, it becomes a safety issue.

In 1935, the US Congress passed an Act that established the authority of the Interstate Commerce Commission to determine safe rates for trucking. However, in 1977 this authority began to be dismantled. Then, Congress formally deregulated the industry by passing the Motor Carrier Act of 1980 (Belzer, 2000).

The Australian Government passed the Road Safety Remuneration Act in 2012. This Act gave powers to a new Tribunal established to determine safe rates for the Australian trucking industry<sup>4</sup>. This Tribunal can make remuneration orders, assist with collective bargaining agreements, resolve disputes and conduct research into pay, conditions and other matters related to trucking safety and remuneration. As this is a relatively new arrangement in Australia, it is too early to assess the effects of this regulation. However, Belzer and others have researched the effects of deregulation in the US.

Table 3 summarises the evidence of the effects of industry pressures on safety outcomes in the US and in Australia.

**Table 3 – Effects of Industry Financial Pressure on Safety Outcomes**

Study focus	Author, year	Method, sample	Findings
Effects of deregulation on working conditions and safety of truck drivers	(Belzer, 2000)	Analysis of implications on truck driver safety and working conditions after deregulation	Truck driver earnings dropped by 30% between 1977 and 1995. Median weekly hours worked by US truck drivers is 65 and climbs to 95 hours per week at the 90 <sup>th</sup> percentile
Effects of precarious employment on OHS	(Quinlan, Mayhew, & Bohle, 2001)	Review of studies/ n = 92 studies	76 out of 92 studies found precarious employment detrimental to OHS
Effects of commercial or industrial practices on safety	(Quinlan, 2001)	Inquiry/ n = ~50 written and ~60 oral submissions	Low freight rates encouraged pushing the safety margins, influenced by intense competitive pressures, poor business practices, non-compliance to regulations may deliver an economic advantage, performance based payment systems, low job security.
Effects of deregulation, de-unionisation, technology and human capital	(Belman & Monaco, 2001)	Time series population data analysis & cross-sectional survey/ n = 573 US truck drivers	Deregulation of driver wages coincided with a reduction in driver union membership and a fall in driver wages.
Effects of deregulation on workplace injuries	(Savage, 2004)	Time series injury data analysis US 1973-2001	A relationship could not be found between deregulation and truck driver injury rates.

<sup>4</sup> For more information about this go to: <http://www.rsrt.gov.au>

Study focus	Author, year	Method, sample	Findings
Effects of competitive industry economic pressures on contingent work arrangements and impacts on safety outcomes	(Mayhew & Quinlan, 2006)	Cross-sectional survey/ n = 300 long haul Australian truck drivers	Owner-drivers have worse OHS outcomes than employee drivers and contingent work arrangements increase with competitive pressures in the supply chain.
Effects of non-regulation of remuneration on truck driver safety	(Quinlan & Wright, 2008)	Inquiry/ n = 24 written and 48 oral submissions (consultations)	Regulation, in the context of the chain of responsibility, is needed to ensure that rates of pay and other elements of remuneration in the long haul transport industry may be determined to provide for safe rates, conditions and remuneration.

Australian studies in the early 2000s found that intense competition, poor business practices and non-compliance to regulations led to low freight rates and poor safety. A major inquiry into safety in the Australian trucking industry took submissions from a large number of industry experts and researchers that consistently advised that intense competition, industry tendering practices, low freight rates and pressure from clients was probably the most fundamental source of dangerous practices in the industry (Quinlan, 2001). Part of the Inquiry entailed a survey of drivers (n = 300). The results indicated that there is a percentage and range of physical and psychological health afflictions as well as low-level occupational violence that are disproportionately reported by truck drivers with more prevalence and severity, affecting owner-drivers. There was persuasive evidence in the Inquiry that many operators were not financially viable; and in fact the commercial environment for the industry was such that questioned the financial viability of the industry as a whole. Downward pressures on freight rates meant that the rates were so low as to pressure drivers and companies to *push the margins* (less truck maintenance, more trips, longer hours, speeding, etc.) In summary, it was found that commercial and industrial practices endemic in the Australian transport industry played “an important and significant role in fomenting hazardous practices.” Moreover, the existing mix of transport and occupational safety regulatory authorities and legislative frameworks were found to be less than effective in enforcing safety regulations in this industry. The Inquiry concluded that coordination and resourcing of regulatory activities in relation to safety in the long distance trucking industry are major issues that should be addressed as a matter of urgency.

While Belzer and others have argued that deregulation of the American trucking industry has had a detrimental effect on safety, others have argued that deregulation has improved the industry as it has resulted in contractual relationships between shippers and carriers that make responsibilities more transparent. On the other hand, Crum and Allen (1997) admit that smaller carriers are suffering worsening contractual disadvantages.

Moreover Quinlan, Mayhew and Bohle (2001) also examined the precarious nature of employment in the trucking industry and found that this was detrimental to drivers’ occupational health and safety. Furthermore, owner-drivers – who make up the majority of Australian trucking companies - were found to have worse OHS outcomes than employee drivers. And while non-employing Australian road freight operators make up 60% of the industry, they account for only 11% of the income earned in the industry (ACIL\_Tasman, 2003)

Also, US studies found that deregulation of working conditions and remuneration resulted in sharp drops in driver earnings and sharp rises in hours they worked per week and a reduction in union membership and associated fall in driver wages. Belman and Monaco (2001) observed that industrial deregulation in the US resulted in a reduction in driver union membership and a sharp decline in truck driver earnings between 1973 and 1995 (relative to other workers) falling by 21%

exacerbating the wage inequality and increased financial pressure on drivers. In addition, non-unionised drivers were found to earn 21% less than union members. Monaco and Williams later found that union employee drivers were 20% less likely to receive a moving violation than non-union drivers. However, an examination of rates of injury in the trucking industry following deregulation of employment conditions did not find a relationship between them, although the researchers have recognized that they could not discount other industry developments that may have mediated the effects of deregulation, such as improved trucks and seat belt usage by drivers (Savage, 2004).

### Company financial pressures and relationship to safety outcomes

An analysis at company level, there appear to be relationships between financial performance and safety, between safety management and financial performance and between unionisation and safety outcomes.

Table 4 summarises the literature on the effects of company level financial performance and unionisation of truck drivers and effects on safety outcomes.

**Table 4 – Effects of Company Financial Performance and Unionisation on Safety Outcomes**

Study focus	Author, year	Method/sample	Findings
Effects of job tenure and profitability	(Bruning, 1989)	Crash data analysis/ n = 468 US trucking firms	Job tenure and firm profitability is inversely related to crash rates.
Effects of safety management on financial and safety performance	(Fernandez-Muniz et al., 2009)	Cross-sectional survey/ n = 455 Spanish trucking firms	Safety management has a positive influence on safety outcomes, competitiveness and financial performance.
Effects of firm profitability on crashes and Government safety ratings for drivers and vehicles	(Britto et al., 2010)	Crash data analysis/ n = 657 US trucking companies	Poorer financial performance in the year prior is associated with more crash likelihood and worse driver and vehicle safety rating scores
Effects of firm size and contingent employment on OHS outcomes	(Mayhew & Quinlan, 2006)	Cross-sectional survey/ n = 300 Australian long haul drivers	Owner-drivers are most likely to experience ill health, stress, chronic injury and crashes compared with small and large company drivers
Effects of efficiency management practices on safety	(Knipling & Bergoffen, 2011)	Cross-sectional survey/ n = 132 US safety managers, 89 safety experts & 11 company interviews	Trip and route planning, use of maintenance management software, reducing empty trips, providing navigational and monitoring systems, reducing loading/unloading delays & using speed limiters have a positive influence on safety and financial performance.
Effects of unionisation	((Corsi et al.,	Crash data analysis/	Union membership



Study focus	Author, year	Method/sample	Findings
on safety outcomes	2012)	n = 157,292 US trucking firms	improves driver and vehicle safety performance and crash rates

Four studies in 2 countries from the 1980s to 2012 provide evidence that profitability is associated with:

- Lower driver turnover;
- Lower crash rates; and
- Better driver and vehicle safety ratings.

One study found that owner-drivers are more prone to ill health, stress injury and crashes and one study found that union membership improves driver and vehicle safety performance and crash rates.

Two studies found that proactive safety management improves safety as well as profitability (Fernandez-Muniz et al., 2009; Knipling & Bergoffen, 2011).

In later studies, Corsi et al (2002; 2012) found that unionised drivers work more safely as measured by the US Government's safety performance criteria and have fewer crashes than non-unionised drivers.

Collectively these studies concluded that poor financial performance predicts poor driver and vehicle ratings and increased crash risks. Conversely, good, proactive safety management influences profitability.

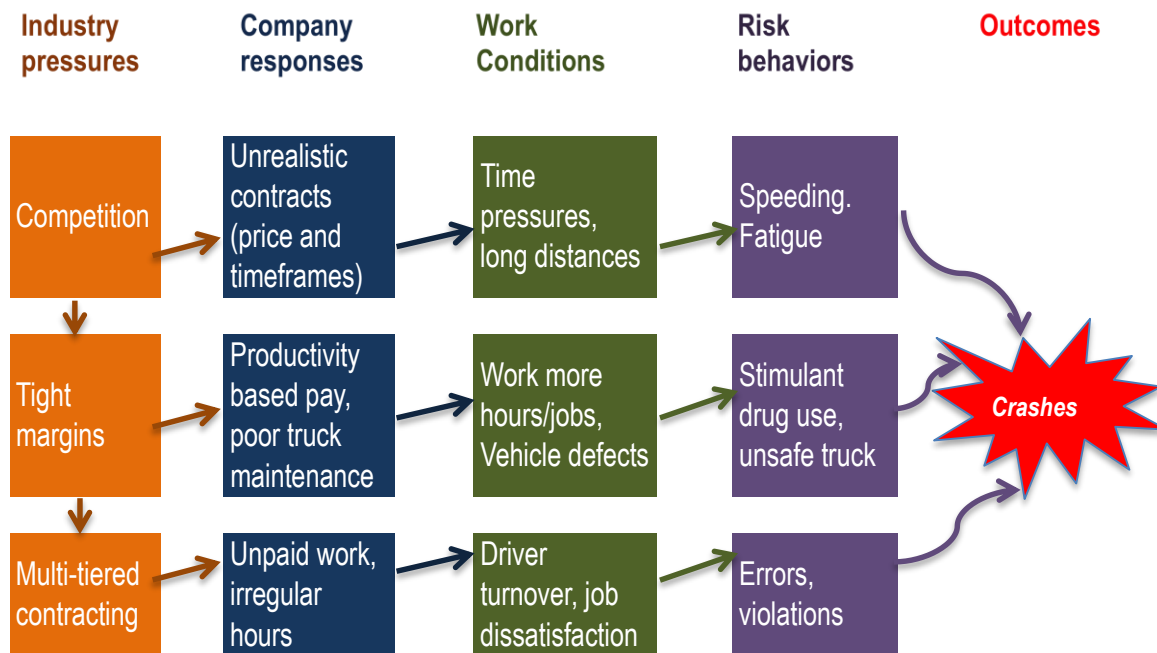
Moreover, unionization is positively related to driver and vehicle safety and lower crash rates. Also, owner-drivers are more at risk of OHS risk than small and large company drivers.

## Discussion

Increasingly the transport safety research is identifying the detrimental effects of systemic pressures, such as contingent work arrangements, low job security and low pay, on truck driver health and safety (Mayhew & Quinlan, 2006). With regard to the contingency-work effects on short haul drivers, Williamson et al (2009) found distinctions between sole contractors or owner drivers and casual or permanent employee drivers but did not find differences in OHS outcomes between these groups.

The disproportionate levels of sleep disorders and fatigue in truck drivers is well documented and explained by unusual and unhealthy sleep and rest patterns experienced by drivers due to schedules and general work environments that are too often not conducive to restorative sleep (Adams-Guppy & Guppy, 2003; McCartt, Rohrbaugh, Hammer, & Fuller, 2000; Moreno et al., 2004; Williamson et al., 2001). And while there is little evidence of disproportionate use of alcohol by drivers, the effects of even moderately fatigued driving in terms of decrements to performance has found to be equivalent to illegal and unsafe levels of intoxication (Williamson & Feyer, 2000). In addition, there are elevated morbidity patterns including obesity, diabetes, cardiovascular disease, cancers, musculoskeletal disorders, arthritis, chronic back pain, and depression – all related to environmental conditions that characterise the trucking industry (Apostolopoulos, Sönmez, Shattell, & Belzer, 2012).

In summary, the picture of trucking safety is not a very positive one. The industry, left unregulated, is characterised by inherent safety risks. Figure 1 depicts a model of the trucking industry pressures that link to risk and crash outcomes supported by the findings of this review.

**Figure 1. Chain of pressures leading to truck crashes (figure adapted from Williamson, 2014\*)**

### **Industry Pressures**

At a macroeconomic level the industry pressures include intense competition between trucking operators, tight profit margins and long chains of contracting and sub-contracting. Competition forces even greater downward pressure on margins that in turn lead to unsafe practices. For companies to achieve the operating flexibility to maintain profitability, they very often subcontract drivers to keep their wages commitment as low as possible. With intense competition, trucking companies and drivers are virtually forced to accept unrealistic contracts in terms of price and agreed delivery timeframes, which in turn impose time pressures and long journeys, often resulting in driving at higher speeds and driving while too tired.

### **Company Responses**

Company responses to low profit margins are often to pay drivers based on productivity. More than three quarters of drivers are paid by this method in Australia (Williamson & Friswell, 2013). Productivity pay encourages drivers to work more hours or take on more jobs, leading to the use of stimulant drugs to combat fatigue. In addition, low profitability encourages companies to keep trucks operating when the work is available even when this means skipping maintenance, resulting in defects and unsafe trucks on the road.

The trucking industry is characterised by multi-tiered contracting arrangements, making drivers vulnerable and being pressured to do unpaid work and to work long and irregular hours. This results in a lack of quality leisure and family time, job dissatisfaction and driver turnover.

### **Work Conditions**

All of the industry pressures, and company responses to these pressures described in Figure 1, provide an environment where drivers are under time pressures, drive long distances, work more hours, in vehicles that have mechanical defects. Consequently, there is high driver turnover and job dissatisfaction in the industry.

### **Risk Behaviours and Outcomes**

\* Keynote presentation at Occupational Safety in Transport Conference, Gold Coast, 2014.  
 Proceedings of the 2015 Australasian Road Safety Conference  
 14 - 16 October, Gold Coast, Australia

In the scenario described above errors and violations are likely to occur. Speeding, fatigue, use of stimulant drugs, vehicle defects, unsafe trucks are all major crash and injury risk factors.

### **Limitations**

This review was not intended to be a comprehensive systematic review of the literature. Rather it aimed to highlight an important safety management characteristic of trucking companies and the industry more generally. Also, while many of the Australian studies examined in this review were cross-sectional, the research methods were sound and findings were statistically robust. This topic warrants more research, especially longitudinal studies.

### **Conclusions**

Whether or not we can accurately describe the trucking industry as “sweatshops on wheels” truck drivers are a vulnerable workforce. Drivers are ‘price takers’ rather than ‘price setters’ because of:

- the length of the sub-contracting chain;
- prevalence of ‘undercutting’ to win work;
- high capital costs of entering the industry;
- tendering processes that have little or no regard for the safety of the transport task;
- limited negotiating ability of drivers;
- small number of large clients; and
- presence of a few large dominant transport companies with the ability to make efficiency and price gains through purchasing power.

There is clearly a relationship between driver payment methods and/or pay levels and risk behaviour and safety outcomes. Safety and efficiency in this industry are influenced by how, when and what is remunerated. Intense competition and low profit margins lead to poor safety conditions for drivers, manifesting in pressure to take driving risks – speeding, working long/irregular hours, driving tired, taking drugs, not doing preventative truck maintenance.

This paper provides a weight of evidence that remuneration and safety are linked in the trucking industry and that this is a fundamental issue that needs to be addressed through specific regulation and perhaps industry reform.

To break this industry-wide conundrum specific regulation is needed to address the pressures that create incentives for unsafe outcomes (fatigue, poor maintenance, speeding, drug-use etc). The pressures that need to be addressed include:

- competition that allows contracts with unsafe deadlines and prices;
- tight margins and freight rates;
- multi-tiered contracts allowing pressures on subcontractors; and
- productivity-based payments, only payment for driving work.

## References

- ACIL\_Tasman. (2003). *Freight rates and safety performance in the road freight industry*. Retrieved from
- Adams-Guppy, J., & Guppy, A. (2003). Truck driver fatigue risk assessment and management: a multinational survey. *Ergonomics*, 46(8), 763-779. doi:10.1080/0014013021000056980
- Apostolopoulos, Y., Sönmez, S., Shattell, M., & Belzer, M. (2012). Environmental determinants of obesity- associated morbidity risks for truckers. *International Journal of Workplace Health Management*, 5(2), 120-138. doi:doi:10.1108/17538351211239162
- Arboleda, A., Morrow, P., Crum, M., Shelley, L., & Mack, C. (2003). Management practices as antecedents of safety culture within the trucking industry: similarities and differences by hierarchical level. *Journal of Safety Research*, 34(2), 189-197. doi:[http://dx.doi.org/10.1016/S0022-4375\(02\)00071-3](http://dx.doi.org/10.1016/S0022-4375(02)00071-3)
- Backman, A., & Järvinen, E. (1983). Turnover of professional drivers. *Scandinavian Journal of Work, Environment & Health*, 9(1), 36-41. doi:10.2307/40964993
- Belman, D., & Monaco, K. (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), 502-524. Retrieved from <http://www.jstor.org/stable/2696106>
- Belzer, M. (2000). *Sweatshops on wheels: Winners and losers in trucking deregulation*: Oxford University Press.
- Belzer, M., Rodriguez, D., & Sedo, S. (2002). *Paying for Safety: An Economic Analysis of the Effect of Compensation on Truck Driver Safety*. Retrieved from
- Braver, E., Preusser, C., Preusser, D., Baum, H., Beilock, R., & Ulmer, R. (1992). Long hours and fatigue: A survey of tractor-trailer drivers. *Journal of Public Health Policy*, 13(3), 341-366. Retrieved from <http://www.jstor.org/stable/3342733>
- Britto, R., Corsi, T., & Grimm, C. (2010). The relationship between motor carrier financial performance and safety performance. *Transportation Journal*, 42-51.
- Bruning, E. (1989). The relationship between profitability and safety performance in trucking firms. *Transportation Journal*, 28(3), 40-49. Retrieved from <Go to ISI>://A1989U629400005
- Corsi, T., Barnard, R., & Gibney, J. (2002). *Motor carrier industry profile: Linkages between financial and safety performance among carriers in major industry segments* (FMCSA-RI-02-009). Retrieved from Washington, DC.: [http://ai.fmcsa.dot.gov/CarrierResearchResults/PDFs/FMCSA\\_RI\\_02\\_009.pdf](http://ai.fmcsa.dot.gov/CarrierResearchResults/PDFs/FMCSA_RI_02_009.pdf)
- Corsi, T., Grimm, C., Cantor, D., & Sienicki, D. (2012). Safety performance differences between unionized and non-union motor carriers. *Transportation Research Part E: Logistics and Transportation Review*, 48(4), 807-816. doi:<http://dx.doi.org/10.1016/j.tre.2012.01.003>
- Crum, M., & Allen, B. (1997). A longitudinal assessment of motor carrier-shipper relationship trends, 1990 vs. 1996. *Transportation Journal*, 37(1), 5-17. doi:10.2307/20713332
- Crum, M., & Morrow, P. (2002). The influence of carrier scheduling practices on truck driver fatigue. *Transportation Journal*, 42(1), 20-41.
- Department of Transportation U.S. (2006). *Report to congress on the large truck crash causation study*. Retrieved from Virginia:
- Fernandez-Muniz, B., Montes-Peon, J., & Vazquez-Ordas, C. (2009). Relation between occupational safety management and firm performance. *Safety Science*, 47(7), 980-991. doi:10.1016/j.ssci.2008.10.022
- Feyer, A., & Williamson, A. (1995). Work and rest in the long-distance road transport industry in Australia. *Work & Stress*, 9(2 & 3), 198-205. doi:10.1080/02678379508256554
- Feyer, A., Williamson, A., Friswell, R., & Sadural, S. (2002). *Driver fatigue: A survey of long distance transport companies in Australia* (CR209). Retrieved from Canberra:
- Golob, T., & Hensher, D. (1994). *Driver behavior of long distance truck drivers: The effects of schedule compliance on drug use and speeding citations*. Retrieved from Irvine: <http://www.its.uci.edu>
- Hanowski, R., Hickman, J., Olsen, R., & Bocanegra, J. (2009). Evaluating the 2003 revised hours-of-service regulations for truck drivers: The impact of time-on-task on critical incident risk. *Accident Analysis & Prevention*, 41, 268-275.
- Hensher, D., & Battellino, H. (1990). *Long-distance trucking: why do truckies speed?* Paper presented at the Australasian Transport Research Forum.
- Hensher, D., Battellino, H., Gee, J., & Daniels, R. (1991). *Long distance truck drivers on-road performance and economic reward* (CR99). Retrieved from Washington DC: <http://trid.trb.org/view.aspx?id=453651>
- Johansson, B., Rask, K., & Stenberg, M. (2010). Piece rates and their effects on health and safety - A literature review. *Applied Ergonomics*, 41, 607-614.
- Kemp, E., Kopp, S., & Kemp, E. (2013). Six days on the road: will I make it home safely tonight? Examining attitudes toward commercial transportation regulation and safety. *The International Journal of Logistics Management*, 24(2), 210-229. Retrieved from <http://www.emeraldinsight.com/0957-4093.htm>
- Knipling, R., & Bergoffen, G. (2011). *Potential benefits of motor carrier operational efficiencies*. Retrieved from Washington D.C.:
- Mayhew, C., & Quinlan, M. (2006). Economic pressure, multi-tiered subcontracting and occupational health and safety in Australian long-haul trucking. *Employee Relations*, 28(3), 212-229. doi:10.1108/01425450610661216

- McCartt, A., Rohrbaugh, J., Hammer, M., & Fuller, S. (2000). Factors associated with falling asleep at the wheel among long-distance truck drivers. *Accident Analysis & Prevention*, 32(4), 493-504.  
doi:[http://dx.doi.org/10.1016/S0001-4575\(99\)00067-6](http://dx.doi.org/10.1016/S0001-4575(99)00067-6)
- Monaco, K., & Williams, E. (2000). Assessing the determinants of safety in the trucking industry. *Journal of Transportation and Statistics*, 3(1), 69-80.
- Mooren, L., Grzebieta, R., Williamson, A., Olivier, J., & Friswell, R. (2014). Safety management for heavy vehicle transport: A review of the literature. *Safety Science*, 62(0), 79-89.  
doi:<http://dx.doi.org/10.1016/j.ssci.2013.08.001>
- Mooren, L., Williamson, A., Friswell, R., Olivier, J., Grzebieta, R., & Magableh, F. (2014). What are the differences in management characteristics of heavy vehicle operators with high insurance claims versus low insurance claims? *Safety Science*, 70(0), 327-338. doi:<http://dx.doi.org/10.1016/j.ssci.2014.07.007>
- Moreno, C., Carvalho, F., Lorenzi, C., Matuzaki, L., Prezotti, S., Bighetti, P., . . . Lorenzi-Filho, G. (2004). High risk for obstructive sleep apnea in truck drivers estimated by the berlin questionnaire: Prevalence and associated factors. *Chronobiology International*, 21(6), 871-879. doi:doi:10.1081/CBI-200036880
- Quinlan, M. (2001). *Report of Inquiry into safety in the long haul trucking industry*. Retrieved from Sydney:
- Quinlan, M., Mayhew, C., & Bohle, P. (2001). The global expansion of precarious employment, work disorganization, and consequences for occupational health: A review of recent research. *International Journal of Health Services*, 31(2), 335-414. doi:10.2190/607H-TTV0-QCN6-YLT4
- Quinlan, M., & Wright, L. (2008). *Safe payments: Addressing the underlying causes of unsafe practices in the road transport industry*. Retrieved from Melbourne:  
<http://www.ntc.gov.au/filemedia/Reports/SafePaymentsFinalReportNov08.pdf>
- Richards, N. (2004). *Fatigue and beyond: Patterns of, and motivations for illicit drug use among long haul truck drivers*. (Masters of Applied Science (Research) ), Queensland University of Technology, Brisbane. Retrieved from [http://eprints.qut.edu.au/16018/1/Naomi\\_Richards\\_Thesis.pdf](http://eprints.qut.edu.au/16018/1/Naomi_Richards_Thesis.pdf)
- Rodríguez, D., Rocha, M., Khattak, A., & Belzer, M. (2003). Effects of truck driver wages and working conditions on highway safety: Case study. *Transportation Research Record: Journal of the Transportation Research Board*, 1833(-1), 95-102. doi:10.3141/1833-13
- Rodríguez, D., Targa, F., & Belzer, M. (2006). Pay incentives and truck driver safety: a case study. *Industrial and Labor Relations Review*, 59(2), 205-225.
- Savage, I. (2004). 2. Trends in transportation employee injuries since economic deregulation. *Research in Transportation Economics*, 10(0), 11-33. doi:[http://dx.doi.org/10.1016/S0739-8859\(04\)10002-4](http://dx.doi.org/10.1016/S0739-8859(04)10002-4)
- Thompson, J., & Stevenson, M. (2014). Associations between heavy vehicle driver compensation methods, fatigue-related driving behavior, and sleepiness. *Traffic Injury Prevention*, 15, 10-14.  
doi:10.1080/15389588.2014.928702
- Williamson, A. (2007). Predictors of psychostimulant use by long-distance truck drivers. *American journal of epidemiology*, 166(11), 1320-1326. doi:10.1093/aje/kwm205
- Williamson, A., Bohle, P., Quinlan, M., & Kennedy, D. (2009). Short trips and long days: Safety and health in short-haul trucking. *Industrial & Labor Relations Review*, 62(3).
- Williamson, A., Feyer, A., Friswell, R., & Saduri, S. (2001). *Driver fatigue: a survey of professional heavy vehicle drivers in Australia*. Retrieved from Melbourne:
- Williamson, A., & Feyer, A.-M. (2000). Moderate sleep deprivation produces impairments in cognitive and motor performance equivalent to legally prescribed levels of alcohol intoxication. *Occupational and Environmental Medicine*, 57(10), 649-655. doi:10.1136/oem.57.10.649
- Williamson, A., & Friswell, R. (2013). The effect of external non-driving factors, payment type and waiting and queuing on fatigue in long distance trucking. *Accident Analysis & Prevention*, 58(0), 26-34.  
doi:<http://dx.doi.org/10.1016/j.aap.2013.04.017>