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# Safe rates and unpaid labour: Non-driving pay and truck driver work hours

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**Abstract**
In the trucking industry, truck drivers' duties include not only driving trucks but also non-driving labor. However, non-driving work is not necessarily paid. This article analyses how the payment for non-driving duties (non-driving pay) affects truck drivers' work hours. Using the National Institute for Occupational Safety and Health Long-Haul Truck Driver survey, the study finds that remunerating drivers for non-driving duties decreases drivers' work hours. Drivers who are paid for their non-driving labor may reach their target earnings in fewer work hours, leading them to refrain from working extremely long hours and more willingly comply with working time regulations. The policy implication is that paying for non-driving labor can prevent drivers from working excessively long hours, mitigating fatigue, and consequent accidents. Thus, pay for non-driving labor may enhance their safety and health.

**JEL Codes**: J33, J28, J31

**Keywords**
Truck drivers, piecework, remuneration, safety, working time, unpaid labor time, wage rates, target earnings, fatigue, compensation

## Introduction

The purpose of this article is to explore the effect of non-driving pay on truck driver work hours. One of the compensation practices peculiar to the trucking industry in the United

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States (US) and some other countries is payment based on miles driven. Almost all US long-haul truck drivers are paid by the mile, and more than half earn nothing for non-driving work (Belman et al., 2004; Chen et al., 2015). According to Friswell and Williamson (2013), nearly 66% of Australian long-haul truck drivers similarly are paid based on miles driven. Across Europe, truck driver compensation is subject to a wide diversity of national interpretations, as is the definition of work applicable to driver time, but most driver pay is stated in monthly salary terms even as drivers are paid by the kilometer, which may take the form of a bonus that may be excluded from ordinary earnings subject to social security deductions. The determination is complex and only in France is non-driving labor considered part of the base for which drivers must be compensated. The result is a fourfold difference in basic earnings and a 10-fold difference in earnings subject to social security taxes between high-wage and low-wage countries in the European Union (Comité National Routier, 2016). The truck driver's job is to carry freight for cargo owners—shippers and consignees—who pay to move it. Because contracts between cargo owners specify the product, quantity, and distance, in the majority of cases in the US, trucking firms pay only for driving duties based on the miles driven or a percentage of revenue charged to transport the freight.

However, in all countries, driving is only one of the duties to which trucking firms assign drivers. In fact, truck drivers' duties include non-driving work, including loading and unloading; waiting to load or unload (what French regulations call "availability"); performing ancillary tasks like regulatory and business requirements such as record-keeping; and performing or waiting for both maintenance and repair. According to a survey by the University of Michigan Trucking Industry Program (UMTIP), the sample average of truck drivers' work hours per day is 11.4 hours; on average truckers drive 8.4 hours per day, and the sample average of hours of non-driving duties per day is 3.1 (Belman et al., 2004). This suggests that roughly speaking, 27% of the average truck driver's work hours are devoted to non-driving duties, which usually are unpaid. Failure to pay all working time has become widespread in many industries. For example, Macdonald et al. show that unpaid labor remains a significant problem for disability support workers in Australia (Macdonald et al., 2018). Airline pilot fatigue due to unpaid off-duty commuting time has contributed to pilot and passenger safety risk, pilot health risk, and the potential for major disasters in this highly competitive industry in which liability has shifted from the contracting carriers to subcontractors (National Research Council, 2011; US Department of Transportation, National Transportation Safety Board, 2010).

Truck drivers often are not paid for non-driving duties. Moreover, when drivers are paid for non-driving duties, they are not necessarily paid for all non-driving duties to which companies assign them. According to Belman et al. (2004), in the US, 44.7% of truck drivers are paid for loading and unloading and 21.2% of truck drivers are paid for dropping and hooking. This fact implies that most truck drivers have a substantial amount of time during which they are working for free. From the truck drivers' perspective, such unpaid non-driving duties waste the opportunity cost of their time. Being paid for miles driven, the time expended on unpaid non-driving work could otherwise have been spent putting on the miles, which earns them money.

How do truck drivers behave if they face such a waste of their time? Drivers may work longer hours to compensate for the loss of income (an assertion implied by Belzer and Sedo, 2018). Conversely, if drivers are paid for non-driving labor, they may work

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less. Is this story true? In this article, we examine how the remuneration for non-driving duty affects truck drivers' work hours. The effect of overall income and wages on work hours is also examined to benchmark previous studies.

There are few previous papers that study the effect of truck drivers' compensation, in general, on their work hours. Belzer and Sedo (2018) published the only paper that analyses the effect of truck drivers' compensation rates on working hours. Their paper estimates the truck drivers' labor supply curve with respect to mileage rates; as the mileage rate increases, drivers work fewer hours, trading labor for leisure. This article focuses more on how non-driving pay, which is a unique compensation practice in the trucking industry, affects drivers' work hours.

We show that pay for non-driving work can decrease truck drivers' work hours. In other words, truck drivers paid for non-driving responsibilities work fewer hours than those not paid for this work. These results are important because long work hours may be related to drivers' crashes and health problems. As earlier work shows, higher wages can decrease their work hours. Drivers who work fewer hours have less fatigue, including a lower likelihood of having crashes. Working fewer hours leads to superior health outcomes in general (Dembe et al., 2004; Panel on Research Methodologies and Statistical Approaches to Understanding Driver Fatigue Factors in Motor Carrier Safety and Driver Health, 2016). If pay for non-driving duties decreases drivers' work hours, it may provide a rationale for requiring pay for non-driving labor in order to improve public health and safety outcomes.

## Literature and contribution of this article

The trucking industry has unique compensation practices, which many industries do not have. In other industries, workers' pay is based on work hours, and only to a limited extent on piecework. Schildkraut (2003) shows that less than 5% of business establishments adopt piece rates or incentive pay as a compensation scheme in the general population. In contrast, long-haul truck drivers' pay primarily is based on miles driven or on a percentage of motor carrier revenue. Long-haul truck drivers paid based on an hourly basis are a small minority (mainly United Parcel Service, a Teamster-represented company). Non-driving duties, such as loading and unloading, are paid or unpaid depending on employer pay packages and carrier operations.

Such a unique compensation system is an interesting subject of economic analysis. In particular, how truck drivers change their work hours based on compensation structure appears to be thought-provoking. Oddly enough, there are few studies which tackle this issue. Belzer and Sedo (2018) seem to have produced the only study that analyzes the effect of compensation on drivers' work hours. Using a two-stage least-squares model, they estimate truck drivers' labor supply curve with respect to mileage rates. They find that the truck drivers' labor supply curve is backward-bending. This suggests that drivers have a target level of income, which they struggle to achieve. Until drivers achieve their target level of income, they continue to work, leading half of all long-distance truck drivers to exceed general legal limits. Once drivers achieve their targets, they significantly reduce their work hours. This further implies that drivers work shorter hours when the mileage rate is higher than the backward-bending point, at which drivers start to purchase leisure by sacrificing income.

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Similar to Belzer and Sedo (2018), some studies analyze the effect of taxi drivers' pay on work hours. Camerer et al. (1997) demonstrate that taxi drivers' labor supply curve also slopes negatively with respect to wages. That is, taxi drivers also have a target level of income, which they also struggle to achieve. Once they achieve the target, they decrease their work hours significantly. Thus, taxi drivers' labor supply curves slope backward once drivers achieve income that is high enough to purchase leisure with work hours—trading labor for leisure, as economic theory predicts. Crawford and Meng (2011) support this conclusion, finding that taxi drivers' daily work hours are negatively related to daily cummulative income. This provides further support for the hypothesis that more highly paid drivers work shorter hours. Likewise using data on taxi drivers in San Francisco and New York, Martin (2017) also finds that the probability that drivers stop working for a day increases with daily shift income. Nonetheless, applying the implications of these studies to truck drivers may require caution because work practices differ between these two occupations. Compared with taxi drivers, truck drivers often need to be away from home for weeks, dispatched from one delivery to another as required by their employer and freight transport demand.

The phenomenon that more highly paid workers work less can also be seen among workers in general. Indeed, Drakopoulos and Theodossiou (1997) use data on general workers in six regions in Britain and reveal that workers who earn more than their expected income significantly reduce work hours.

None of these studies, including Belzer and Sedo (2018), focuses on the effect of non-driving pay on work hours, which is a compensation practice peculiar to the trucking industry. Certainly, Belzer and Sedo (2018) show that the length of unpaid time increases truck drivers' work hours, but they do not use non-driving pay as an independent variable. Thus, it is not clear if the result is due to the absence of non-driving pay. In other words, an increase in work hours may be a simple arithmetic truism that drivers work longer because they are assigned longer unpaid work time. Therefore, it should still be subject to a statistical study on whether the absence of non-driving pay induces drivers to work more.

Investigating the effect of non-driving pay on work hours is important because it is related to truck drivers' safety and health. According to Belman et al. (2004), truck drivers work approximately 64 hours a week on average. Similarly, Chen et al. (2015) report that the average long-haul truck driver works 60 hours per week. These numbers show that truck drivers overwork, which can cause fatigue and create safety and health problems (Panel on Research Methodologies and Statistical Approaches to Understanding Driver Fatigue Factors in Motor Carrier Safety and Driver Health, 2016). In particular, studies indicate that long and irregular shifts threaten workers' safety and health (Brachet et al., 2012; Dembe et al., 2004, 2005, 2006; Jovanis et al., 2012; Kaneko and Jovanis, 1992; Lin et al., 1993). If non-driving pay is related to truck drivers' work hours, it may also be linked to their safety and health. Motivated by this concern, this article studies how non-driving pay affects drivers' work hours.

## Theory

In this section, we provide a theoretical framework with which to analyze how non-driving pay affects truck drivers' work hours. Some empirical studies imply that

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commercial motor vehicle (CMV) drivers, such as truck drivers and taxi drivers, may have a certain target level of income which they try to achieve (Belzer and Sedo, 2018; Camerer et al., 1997; Crawford and Meng, 2011). These studies also imply that drivers' work hours decline once their income reaches the target level. Given this hypothesis, pay for non-driving labor time can reduce long-haul truck drivers' work hours since it makes it easier for drivers to achieve a target level of income without having to extend their work week unnecessarily. Because truck drivers' pay mostly is based on piece rates, unpaid non-driving work hours create an opportunity cost of time for drivers. This may lead truck drivers to work longer to achieve a target level of income. Non-driving pay decreases the opportunity cost of non-driving duties by making it possible to achieve the target level of income in fewer hours of work.

A mathematical interpretation of the target income hypothesis can be given by the utility function which has the point of regime change: the level of income at which marginal utility of income decreases acutely if income exceeds it. For example, an S-shaped function may describe this feature of the utility function precisely. In this function, the slope of the tangent line increases until the level of income reaches the critical point. Once income exceeds the critical point, the slope of the tangent line starts to decrease. The critical inflection point represents the target level of income. Under this utility function, drivers work until they achieve the target level of income since the marginal utility of income increases until income reaches the target level. Drakopoulos and Theodossiou (1997) propose a utility function which has a kinked point at which marginal utility turns out to decrease in a discontinuous way. An S-shaped utility function is an extension of Drakopoulos and Theodossiou's utility function in the sense that marginal utility decreases at some point, but it does not need to happen discontinuously. Figure 1 shows the graphical expression of an S-shaped utility function.

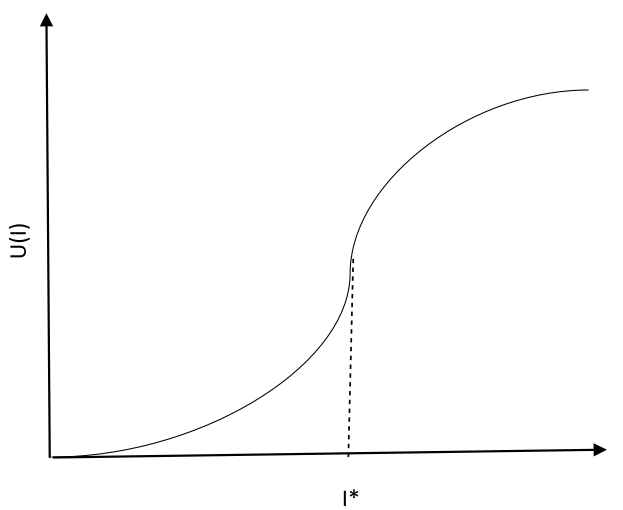


**Figure 1.** S-shaped utility function for target earnings.
I: income; I*: target level of income; U(I): utility of income.

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The target income hypothesis, as well as neoclassical labor supply, also assumes that drivers have the liberty of choosing work hours and leisure. As Belzer and Sedo (2018) point out, truck drivers possess such liberty only to a limited extent. That is, once long-distance truck drivers leave home and begin a tour of duty, they may need to make one delivery after another if trucking firms assign multiple sequential loads. As a result, they may need to be away from home for weeks or months. Therefore, it is plausible to say that drivers exercise the liberty of choosing work hours with significant practical limitations. For example, they may possibly be given a choice to haul another load or to go home when other drivers who drive in the adjacent area currently can do the same delivery instead. At least, at the margin, they may have the liberty to decline an additional load when they are approaching their legal work-hour limit.

## Data

We use the National Survey of Long-Haul Truck Driver Health and Injury (the National Institute for Occupational Safety and Health (NIOSH) survey data), which was conducted by NIOSH in the Centers for Disease Control and Prevention (CDC) in 2010. The NIOSH survey aims at collecting the data on long-haul truck drivers' occupational safety and health. The survey focuses on long-haul drivers. Short-haul and local truck drivers are not included in this survey.

The NIOSH survey defines long-haul truck drivers thus: "Long-haul truck drivers are drivers of heavy and tractor-trailers (trucks having a capacity of at least 26,000 pounds Gross Vehicle Weight (GVW)). Their freight delivery routes require them to sleep away from home" (NIOSH, 2015). NIOSH provides an additional specification in Chen et al. (2015). Chen et al. state that the long-haul truck drivers in the NIOSH survey drove a truck with three or more axles as their main job for at least 12 months and took at least one mandatory 10-hour rest period away from home during each delivery. Drivers who have driven less than 12 months in their careers are, therefore, not covered by the NIOSH survey.

The NIOSH survey contains both employee drivers and owner operators. We exclude owner operators from our sample since their income seems to be incomparable with that of employee drivers. Owner operators normally pay the cost of operation on their own whereas employee drivers do not. The cost of operation includes but is not limited to capital cost, fuel and maintenance cost, insurance, tolls, electronic devices (e.g. satellite receivers, transmitters, and transponders), truck license, and permits (Belzer, 2006; Hooper and Murray, 2017). Such difference in compensation may lead to different behaviors between employee and owner-operator drivers, as well as different earnings calculations.

Eliminating the subjects with missing data, we obtained a final sample size of $N = 715$.

### *Descriptive statistics*

The descriptive statistics of the variables in the model are shown in Tables 1 and 2. Table 1 shows the summary statistics for the continuous variables: work hours, income, job experience, and age. The median and mean weekly work hours are approximately 63.

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**Table 1.** Descriptive statistics of continuous variables.

| Variable | Mean | Median | Standard deviation |
|---|---|---|---|
| Weekly work hours | 63.03 | 62.00 | 24.21 |
| Annual income | 51,622.14 | 50,000.00 | 20,798.29 |
| Annual miles driven | 114,546.70 | 120,000.00 | 42,250.34 |
| Mileage rate | 0.68 | 0.43 | 1.50 |
| Age | 46.48 | 47.00 | 10.32 |
| Weekly non-driving duty hours/ weekly work hours | 21.79 | 17.64 | 17.54 |

Mileage rate is the ratio of (Annual Income/Annual Miles Driven). Type distinguishes drivers who drive enclosed vans from those who drive other trucks.

**Table 2.** Descriptive statistics of categorical variables.

| Variable | Percentage |
|---|---|
| Non-driving pay | 48.53 |
| Team drivers | 13.57 |
| Union | 2.52 |
| LTL | 20.28 |
| Enclosed van | 50.35 |
| White | 70.63 |
| Education | 78.74 |
| Male | 93.15 |
| Married | 51.89 |

LTL: Less-than-truckload.
Non-driving pay distinguishes drivers who are paid for non-driving duties at least in part from those who are not paid for non-driving duties at all. If non-driving pay is paid, drivers are not necessarily paid for all non-driving duties. As long as they are paid for a piece of non-driving duties, the variable equals one. Enclosed van distinguishes drivers who drive enclosed vans from those who drive other trucks. Education distinguishes drivers who have a high school diploma from those who do not have one.

This is consistent with the UMTIP survey data, which report that employee drivers' mean and median weekly work hours are 65.7 hours and 62.0 hours respectively (Belman et al., 2004). The data imply that truck drivers work for long hours relative to average American workers, who work slightly fewer than 40 hours (US Bureau of Labour Statistics, 2015). Moreover, the median work hours imply that many drivers may violate the spirit of the hours-of-service (HOS) regulation, if not the letter. The HOS regulations state that drivers are not allowed to drive after 60 hours on duty in 7 consecutive days and can work no more hours than that. Nevertheless, drivers still can legally work more than 60 hours a week by taking 34 consecutive hours off-duty after they reach this limit, after which they can reset cumulative work hours to zero. This allows them to work as many as 84 hours per week legally (Saltzman and Belzer, 2007). They also can evade weekly HOS limits by logging their non-driving labor off duty, further extending their effective

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work hours, and they can do so while using electronic logging devices. Nonetheless, the purpose of the HOS regulation is to control drivers' fatigue and prevent truck crashes. Working more than 60 hours a week, including non-driving duties, can be against the purpose of the HOS regulation to control drivers' fatigue.

The NIOSH survey shows that mean and median annual income are approximately US$51,622 and US$50,000 respectively, apparently higher than other jobs which do not require extensive education. For example, US production workers' mean and median income is approximately US$33,000 and US$29,000, respectively. The mean and median annual miles driven are 114,546 miles and 120,000 miles, respectively, and such mileage figures support the contention that truck drivers are working the long hours reported in the survey.

Using the NIOSH data, we calculate mileage rates by dividing annual income by annual miles driven. The mean and median mileage rates thus calculated are US$0.68 and US$0.48, respectively. Strictly speaking, mileage rate calculated in this way is not the same as what drivers are paid per mile driven. Because the NIOSH survey data do not contain mileage rates set by trucking firms, we use the ratio of annual earnings to annual miles driven as a rough approximation. The UMTIP dataset also measures the ratio of annual earnings to annual miles driven. According to UMTIP in 1997, the mean and median ratios of annual earnings to miles driven are US$0.50 and US$0.42 respectively, for non-union employee drivers and US$0.60 and US$0.62 respectively for union employee drivers.[1] Unlike the NIOSH survey, UMTIP also collected the mileage rates which are set by trucking firms in addition to the ratio of annual earnings to annual miles driven. The mean and median estimated mileage rate is US$0.38 for non-union employee drivers. For non-union drivers, the mean and median are US$0.65 and US$0.50 respectively.[2]

In the NIOSH data, the mean and median percentages of non-driving duties hours out of total work hours are approximately 22% and 18%. In the UMTIP survey, roughly speaking, the mean and median percentages of non-driving duty hours are 27% and 18%, which are quite close to the percentages in the NIOSH survey data.[3]

Table 2 shows the summary statistics of indicator variables. The percentages on the table are those of drivers for whom each indicator variable equals one. Approximately half of the drivers are paid for at least some non-driving work. For instance, drivers may be remunerated for loading or unloading duties whereas they are not remunerated for waiting for dispatchers' direction; commonly, long-haul truck drivers are paid by the stop (piecework) for non-driving labor (if they are paid at all), rather than by the hour, thus making their effective hourly compensation rate contingent on other unpaid time. Indeed, UMTIP found that 44.7% of truck drivers are remunerated for loading and unloading, and 21.2% of truck drivers are remunerated for dropping and hooking (Belman et al., 2004).[4] This fact suggests that there is a large difference in the percentage of drivers who are paid for each non-driving task, depending on the types of tasks and employers. The NIOSH survey data do not contain information on which non-driving duties are paid: loading and unloading, waiting to load or unload, and performing ancillary task like regulatory and business requirements such as record-keeping and both maintenance and repair. In addition, the NIOSH survey data do not contain information on the amount of non-driving pay that drivers receive if they are paid for non-driving duties. Therefore, the

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indicator variable of non-driving pay equals one as long as drivers are remunerated for at least some non-driving duties.

Team driving is a work practice of driving trucks with another driver. While one driver is operating a truck, the other driver is sleeping. Team driving is employed so that drivers can carry freight for longer distances without stopping. Roughly 13% of all employee drivers work in teams.

Union drivers account for approximately 2% of the sample. In Hirsch and Macpherson (2018) based on the Current Population Survey (CPS), union membership among truck drivers was 12% in 2010, when the NIOSH survey was conducted. The difference may be explained by the fact that Hirsch and Macpherson's statistics includes short-haul and local truck drivers and driver/sales workers whereas the NIOSH survey includes only long-haul truck drivers. Indeed, the UMITP survey shows that 11% of long-haul truck drivers were union members in 1997 while Hirsch and Macpherson show that 21% of truck drivers are union members. This seems to provide indirect support for the view that the difference in union drivers' percentage representation in the survey is due to the definition of truck drivers used by NIOSH. However, we do not have any evidence on this issue. We also note that Hege et al. (2017) find that 3.5% of long-haul truck drivers have union membership though their sample is relatively small (N = 260).

Long-haul trucking is segmented into less-than-truckload (LTL) and truckload (TL) sectors. The LTL sector carries relatively light freight (typically 150–10,000 pounds per shipment). The LTL sector also carries multiple clients' freight on one truck. The TL sector carries relatively heavy freight (typically over 10,000 pounds per shipment). The TL sector also carries a single owner's freight on one truck (Burks et al., 2010). LTL drivers account for roughly 20% of employee drivers.

High School is an indicator variable which equals one if drivers have high school diploma and equals zero otherwise. In the original survey, drivers' education is categorized more in detail: 8th grader or less, 9th –12th grade (no diploma), GED or equivalent, high school graduate (diploma), some college (no degree), associate degree (vocational/technical), associate degree (academic), bachelor's degree or higher. A relatively large number of drivers graduate from high school, but fewer drivers have bachelor or associate degrees. Hence, we converted the variable into a binary variable which distinguishes drivers with a high school diploma from those without one.

## Statistical model

We formulate the model in the following way:

$$\begin{aligned}\ln(WH) = {} & \alpha + \beta_1 \times non\text{-}driving + \beta_2 \times \ln(mileage\,rate) + \beta_3 \times LTL \\ & + \beta_4 \times Team + \beta_5 \times Union + \beta_6 \times Enclosed\,Van + \beta_7 \times white + \beta_8 \times High\,School \\ & + \beta_9 \times age + \beta_{10} \times age^2 + \epsilon\end{aligned}$$

The dependent variable, ln(*WH*), is the natural logarithm of weekly work hours. The independent variables are defined as follows:

Non-driving represents an indicator variable which equals one if drivers are paid for non-driving duties at least in part. This is the coefficient of primary interest.

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We use other variables defined in *Results and discussion* section. The rationale for incorporating each variable in the model is the following:

ln(*mileage rate*) represents the natural logarithm of mileage rates, which is calculated by dividing annual income by annual miles driven. As the previous section mentions, this is a rough estimate of mileage rate. In contrast with Belzer and Sedo (2018), we do not use a quadratic specification for mileage rate since the coefficient for the quadratic term is statistically insignificant.

*Union*: This variable is included to control for the bargaining power of the labor union, though the percentage of union members in the survey is quite small. The t-test also does not indicate a statistically significant difference in mileage rate between union and non-union drivers. However, Belzer and Sedo's (2018) mileage rate equation shows that union drivers receive higher pay than non-union drivers. This implies that union drivers may work under more generous conditions though some of these conditions cannot be observed.

*Team*: The effect of team driving on work hours is not clear theoretically. Team driving may decrease work hours because drivers may be able to sleep longer. However, team driving can be used to operate trucks longer, particularly at night time, which may increase work hours. The previous literature does not analyze the effect of team driving on work hours. Though the effect is not clear, we control for it in the regression model.

*LTL*: Drivers in the LTL sector may be relatively better paid than those in the TL sector. There are a couple of reasons for this. First, though both sectors are competitive, the competition is less intensive in the LTL sector than in the TL sector due to higher entry barriers (Burks et al., 2010). With less competition and higher freight rates per ton-mile in this sector, LTL drivers may work under better conditions. Though mileage rates in the LTL and TL sectors are not significantly different, other unobservable difference in working conditions may exist between the two sectors. Second, the LTL sector carries relatively expensive freight (Burks et al., 2010), which may induce LTL trucking firms to offer drivers more generous work conditions to hire drivers with higher human capital.

We also employ other controls: *Enclosed Van, High School, White*, and *age*.

Finally, we use an OLS to estimate the regression. Theoretically, mileage rate and work hours can be determined simultaneously. Thus, these two variables can be endogenous, which normally justifies the use of a two-stage least square model (2SLS). That is, we should make the fitted values of mileage rates by using instruments and employ the fitted mileage rates, as done by Belzer and Sedo. However, the F-statistics of the first stage regression is lower than 2 with the instruments available in the data. In addition, the R-squared for the first stage regression is smaller than 0.10. This suggests that the 2SLS may suffer from statistical bias due to weak instruments. Therefore, we employ an OLS instead of 2SLS in this study.

## Results and discussion

Table 3 shows the result for the OLS estimation of the regression. The coefficient for non-driving pay is negative and statistically significant at the 1% level. The coefficient for LTL is significant at the 5% level. The other coefficients excluding the intercept are insignificant.

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**Table 3.** The results for the work hours equations.

| Dependent variable = ln(weekly work hours) | | | |
|---|---|---|---|
| Variables | Model (1) | Model (2) | Model (3) |
| Intercept | 4.08*** | 4.10*** | 4.51*** |
| | (0.030) | (0.036) | (0.29) |
| Non-driving pay | −0.093*** | −0.089*** | −0.089*** |
| | (0.034) | (0.034) | (0.034) |
| ln(Mileage rate) | −0.029 | −0.023 | −0.022 |
| | (0.026) | (.026) | (0.026) |
| LTL | | −0.10** | −0.10** |
| | | (0.042) | (0.042) |
| Team | | −0.0084 | −0.034 |
| | | (0.050) | (0.052) |
| Union | | −0.11 | −0.11 |
| | | (0.10) | (0.10) |
| Enclosed van | | 0.0037 | −0.0036 |
| | | (0.034) | (0.034) |
| White | | | −0.042 |
| | | | (0.037) |
| Education | | | −0.078 |
| | | | (0.041) |
| Male | | | −0.0040 |
| | | | (0.069) |
| Married | | | 0.0063 |
| | | | (0.034) |
| Age | | | −0.010 |
| | | | (0.012) |
| Age^2 | | | 0.000081 |
| | | | (0.00013) |
| N | 715 | 715 | 715 |
| F-statistic | 4.34** | 2.67** | 2.10* |
| R-squared | 0.012 | 0.022 | 0.034 |
| Adjusted R-squared | 0.0093 | 0.013 | 0.018 |

LTL: Less-than-truckload.
All $p$ values are for two-tailed tests. Non-driving pay distinguishes drivers who are paid for non-driving duties at least in part from those who are not paid for non-driving duties at all. If non-driving pay is paid, drivers are not necessarily paid for all non-driving duties. As long as they are paid for some non-driving duties, the variable equals one. ln(Mileage Rate) is the natural log of the ratio of (Annual Income/Annual Miles Driven). Enclosed Van distinguishes drivers who drive enclosed vans from those who drives other trucks. Education distinguishes drivers who have a high school diploma from those who do not have one. Male distinguishes male drivers from female drivers.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

The results show that pay for non-driving work reduces truck drivers' work hours significantly, supporting the target income hypothesis. Since non-driving pay enables

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drivers to achieve their target level of income more quickly, drivers who are paid for non-driving responsibilities work fewer hours. In the absence of non-driving pay, drivers try to compensate for the loss of their income by working longer hours. This finding is consistent with Belzer and Sedo (2018), who find that unpaid time increases drivers' work hours. The US Department of Transportation, Office of Inspector General (2018) also reports that longer detention time significantly increases the risk of truck crashes. This may be due to increased work hours and fatigue, which are caused by unpaid non-driving work time—particularly when such non-driving labor exceeds 2 hours at a time.

Unlike Belzer and Sedo (2018), this study does not find that the mileage rate has a significant effect on work hours. However, the quality of the NIOSH data on mileage rate is poor, which likely explains the insignificance of that measure. As discussed above, in this article, mileage rate is a rough approximation that is computed from annual income and annual miles driven. The mileage rate thus computed includes the remuneration (or lack of it) for non-driving work; drivers who are paid for non-driving time probably earn a higher overall pay rate because they probably work fewer hours for the same pay. Belzer and Sedo, in contrast, could use the mileage rate, which is paid specifically for driving work, because the data they use provide a specific rate. This difference in the quality of the data may disturb our result.

Though it is not a primary interest of this study, the result also shows that LTL drivers seem to work fewer hours, controlling for other factors. This may be due to the fact that the LTL sector may be less exposed to competition than the TL sector but it also may be due to operational characteristics of LTL. While most LTL carriers operate across specific intercity routes between regular and predicable loading and unloading points, many TL carriers operate on irregular routes and provide much less predictability to the driver. An indirect support for this hypothesis is that in the LTL sector, fewer drivers report that they have been assigned unrealistic time delivery schedules by their employers or clients. In the NIOSH data survey, 22.46% of TL drivers answer that they have never been assigned unrealistic delivery schedules while 31.72% of LTL drivers answer that they have never been assigned unrealistic delivery schedules.

The low quality of the noisy NIOSH data on work hours creates significant limitations. In addition to the fact that the dataset commingles driving labor with non-driving labor, weekly work hours in the NIOSH survey data are those in 7 days counted from the date of the survey, while income is reported on an annual basis. Finally, in whichever sector drivers may work, their work is based on work shifts. Truck drivers' work hours can vary depending on their tasks. Once they leave their original domicile, they may need to do one delivery after another, depending on employer requirements. Therefore, the work hours reported in the NISOH survey may not be representative.

## Policy implications

This study suggests that remunerating drivers for non-driving duties can prevent drivers from working excessive hours, which may reduce drivers' safety and health risks. As Saltzman and Belzer (2002) point out, safety and health problems should be recognized as negative externalities created by drivers' excessively long hours. This analysis shows that more than half of all long-haul truck drivers work 63 hours a week or more, and

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drivers working more than 63 hours per week likely violate the HOS regulations. This implies that more than half of long-haul drivers are in a condition perilous to the public as well as to themselves. In particular, as Williams and Monaco (2001) point out, truck drivers who violate the HOS regulation are more likely to have crashes. As Jensen and Dahl (2009) suggest, the HOS regulations contribute to improving safety. If so, providing a rationale and a mechanism to reduce drivers' excessively long hours seems to be an urgent policy agenda.

Literature documenting the link between competition in the freight transport sector, intensified by neoliberal deregulatory policies governing the trucking industry (Belzer, 2000), and safety among trucking companies and heavy goods vehicle driver safety and health, has expanded significantly. The report of findings from an Australian study showed that competitive pressures contributed significantly to truck crashes (Quinlan, 2001) and a subsequent report found explicit links between remuneration and safety in Australia (Quinlan and Wright, 2008). In a later study, Thompson and Stevenson found a significant safety effect associated with pay methods and piecework pay. Specifically they found that compensation methods predicted kilometers driven per day, hours driven per day, total hours worked per day, and mean driving time between breaks, and that piece rates were associated with greater fatigue (Thompson and Stevenson, 2014). Testimony by the Australian Federal Transport Minister acknowledged that unpaid labor time causes truck drivers to work excessively long hours and contributes to fatigue and low income (cited in Rawling and Kaine, 2012: 245–246). Finally, Rawling and Kaine (2012) show how the New South Wales Industrial Relations Act of 1996, as well as the Road Safety Remuneration Act of 2012 and the Road Safety Remuneration Tribunal (RSRT) that began operating in January 2013, could create conditions for public policy to contribute systematically to highway safety improvement. Unfortunately, the RSRT was dismantled by the National/Liberal Coalition government 15 months after beginning operation despite having cut fatal crashes by one-third in just 15 months, which is a dramatic result not achieved anywhere in the highway safety world. See the National/Liberal Coalition critique of the RSRT (PricewaterhouseCoopers, 2016: 29–33) and an independent third-party critique of this report (Belzer, 2016) for some elements of the debate over the value of the RSRT and specifically whether the benefits of the RSRT exceeded the cost.

Similar findings have been reported in the US. A study performed for the US Federal Motor Carrier Safety Administration found strong links between compensation and safety within motor carriers, among motor carriers, and among truck drivers (Belzer et al., 2002). Subsequent research substantiated the finding that higher paid individual drivers at one very large truckload carrier were significantly safer (Rodriguez et al., 2006). Unpaid labor time reduces the overall average rate of pay significantly. Drivers for whom 27% of all work time is unpaid non-driving labor work excessively long hours to make up for unpaid labor time. Obviously, paying drivers for all their working time would raise their effective pay rates while reducing their incentive to work exceedingly long hours to achieve their target earnings. Using a national survey of truck drivers in the US, Belzer and Sedo (2018) determined that drivers with higher pay rates actually traded leisure for labor and reduced their hours of work after they reached target earnings, in turn making them safer. Finally, a study using an intensive data set on large truck crashes

showed that work pressure strongly predicted that truck drivers under competitive workplace stress were significantly likely to be involved in large truck crashes for which crash reconstruction investigators found that they had committed an error that precipitated the crash (Belzer, 2018). In sum, this and other research continue to hammer home the fact that truck drivers are like any other workers, motivated to earn enough money to pay their bills. With unionization and collective bargaining seemingly an unreachable dream, at least in the US, the policy prescription of minimum pay rates and pay systems—like pay for all time during which the driver is engaged by his or her employer and unable to return home—seems to be a pressing issue.

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## Notes

1. Using 2010 as the base year, we adjusted for inflation the mean and median ratios of annual earnings to miles driven. According to UMTIP in 1997, non-union employee drivers' mean and median ratio of annual earnings to annual miles driven is US$0.37 and US$0.31 respectively, and those of union employee drivers are US$0.44 and US$0.38 respectively (Belman et al., 2004). However, the US city average of Consumer Price Index for All Urban Consumers (CPI-U) is 160.5 in 1997 and 218.056 in 2010 (US Bureau of Labour Statistics (2017), Table 24). Historical Consumer Price Index for All Urban Consumers (CPI-U): US City Average, All Items-Continued. Available at: https://www.bls.gov/cpi/tables/historical-cpi-u-201709.pdf. Obtaining the inflation rate from 1997 to 2010 (218.056/1650.5) and multiplying the numbers by the inflation rate yields the values above.
2. Likewise, we adjusted the mean and median mileage rates for inflation using 2010 as the base year. In the UMTIP survey data, both mean and median mileage rates set by firms are roughly US$0.28 for non-union employee drivers in 1997; the mean and median mileage rates for union employee drivers are US$0.48 and US$0.37 respectively, in 1997 (Belman et al., 2004). Multiplying these numbers by the inflation rate (218.056/1650.5) yields the values above.
3. This rough estimates are computed from Belman et al (2004), who show that the mean and median total work hours in 24 hours are 11.4 hours and 11 hours respectively, and the mean and median non-driving duty hours are 3.1 hours and 2 hours respectively.)
4. These numbers are not additive since they are counted as separate pieces of work. That is, some drivers are paid for all of these duties, but others are paid for only one of them or neither.

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