Impact of Regulation on Trucking Carrier Prices and Capacity

by

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May 6, 2016

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Submitted to the Program in Supply Chain Management
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Requirements for the Degree of Master of Engineering in Logistics

ABSTRACT

This thesis analyzes the impact on prices and capacity of trucking industry due to the introduction of ELD mandate. This mandate requires truck drivers to record their working hours in a specified electronic device instead of a pen and paper method. This thesis utilizes the change in average truck driver working hours, cost of ELD equipment and distance from origin to destination of truck loads to determine the potential impact on trucking market. The models used provide an estimation of the impact on capacity and cost and the likelihood of impact on the economics of trucking industry.

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Chan How, Law

INTRODUCTION

Recent changes in the Federal Motor Carrier Safety Regulations on December 10, 2015 by Federal Motor Carrier Safety Administration (FMCSA) requires truck drivers to install electronic logging device (ELD) (Federal Motor Carrier Safety Administration (FMCSA), 2015). This device’s main function is to collect truck driver’s hours-of-service information, such as on duty, off duty, driving, resting and others. At the time of writing this paper, truck drivers are given the choice of recording their driving log through a pen and paper method or through electronic method. The ruling change mean truck drivers who are still using the pen and paper method will have to change to a new electronic method of recording their logs. The parties impacted includes truck driver, truck owners, and also shippers who procure trucking capacity.

A previous attempt by FMCSA to create similar regulation in 2011 was challenged and stopped by Owner-Operated Independent Drivers Association (OOIDA) through legal proceedings. The justification for the challenge to the ruling previously was that the ruling did not ensure that information stored within the device would not be used to harass truck drivers unnecessarily. This includes unnecessarily request for driving log data for more than 7 days before inspection which is not required by law.

At the time of writing, OOIDA is once again trying to sue FMCSA for trying to create a mandate that regulates the method of recording truck driver’s hours of service. OOIDA comments that the proposed mandate would not improve road safety and does not improve
reliability of driver’s log, while at the same time, create additional burden on truck carriers, especially the smaller ones.

This mandate involving ELD is an addition to FMCSA’s existing mandate on hours-of-service ruling. Truck drivers that carry loads across state are subjected to federal regulator’s restrictions on maximum number of hours to work, drive, and rest. The truck driver will keep their physical activity log with them on their vehicle when working and driving across the country. When truck drivers get pulled over by police for road side random inspection, the truck driver will have to provide this log for inspection as well. Truck drivers will be fined or face harsher penalties if found to be exceeding maximum driving hours or not keeping a good log of working hours.

This paper attempts to look at the impact of the trucking market caused by the ELD mandate, if it is implemented, and identify any trends. The area of focus will include any direct or indirect change to trucking demand, supply, cost and prices. Information on trend within the trucking industry could be used by brokerage or shippers to estimate their transportation cost post mandate.

Furthermore, this analysis could be used by shippers to understand changes to trucking capacity and work on the issues that causes any potential increase in price and decrease in capacity. Shippers can then use these identified issues to work with their suppliers and trucking carriers to work on factors limiting truck carriers from improving trucking operations and also to create a safe working environment.
LITERATURE REVIEW

This review aims to identify current literature addressing mandating truck drivers’ Electronic Logging Device (ELD)/ Electronic On-Board Recording Device (EOBR) usage and its impact on the economics of trucking in the US. This mandate is an addition to an existing law that limits the number of hours that truck drivers are permitted to work within a specific timeframe. This law, the hours-of-service (HOS) ruling, restricts the available driving hours for truck drivers. A brief summary of the current situation of ruling and stakeholder’s reaction will be presented here, followed by the rationale of ruling and its expected direct impact on truck driver’s productivity. There are also papers on the impact on trucking operations economics due to shorter driving hours from the hours-of-service (HOS) ruling. As the ELD mandate is new, much of the sources are anecdotal opinions from industry experts rather than researches based on data analysis.

Current State of the US Trucking Industry

Road safety in the US has been worsened by deregulation of driving hours’ restrictions in the trucking industry since 2003, according to Labaton (2006). Deregulation of driving hours’ restriction, which was executed in conjunction with deregulation of the trucking industry and allowed the industry to work on improving safety on its own. However, this deregulation did not seem to produce positive results as the death toll from truck crashes remain high. Labaton (2006) explained that in 1995, the Clinton administration intended to improve road safety drastically by appointing officials to investigate ineffective regulations that do not provide adequate oversight for controlling truck driver’s behavior. President George W. Bush then led an administration that focused on reducing federal regulations, including in the trucking industry, and this reverse the safety initiatives done in the previous administration.
Fast forward to 2015, the Federal Motor Carrier Safety Administration (FMCSA) put in place a ruling (Hours of Service Ruling, HOS) to regulate driving hours of truck drivers in hopes to reducing truck related crashes due to fatigue drivers. Table 1 below lists the main focus of the mandate related to restrictions in driving and resting hours.

![Deaths in accidents involving large trucks](image)

<table>
<thead>
<tr>
<th>Number of People</th>
<th>Rate per 100 Million Vehicle Miles</th>
</tr>
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<tbody>
<tr>
<td>5,000</td>
<td>4.0</td>
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<tr>
<td>4,000</td>
<td>3.5</td>
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<td>3.0</td>
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<td>2.5</td>
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<tr>
<td>1,000</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Source: (U.S. Federal Motor Carrier Safety Administration. Analysis Division., 2011)

<table>
<thead>
<tr>
<th>Hours-of-Service Ruling for Property-Carrying Drivers</th>
</tr>
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<tbody>
<tr>
<td>Drivers permitted to drive up to 11 hours with every 10 consecutive hours of rest</td>
</tr>
<tr>
<td>Drivers not permitted to drive more than 14 hours after 10-hour rest</td>
</tr>
<tr>
<td>Drivers required to take a break of 30 minutes or more for 8 hours of consecutive driving</td>
</tr>
<tr>
<td>Drivers not permitted to drive after 60/70 hours on duty in 7/8 consecutive days</td>
</tr>
</tbody>
</table>

Table 1

Source: FMCSA Regulation § 395.3

This HOS ruling in table 1 intends to remove tired drivers from driving on the road, and ensure truck drivers take adequate rest in 7/8 days’ time period before starting another cycle of driving. This means that truck drivers will only be allowed to take cargos/load that can be delivered within the 11 driving hours and 14 working hours per day unless the truck drivers take a 10-hour rest break. Truck drivers are also required to record how much time is spent driving,
how much time is spent on-duty but not driving, and how much time is spent off-duty. The current log keeping mandate of working hours allows for recording of required data through pen and paper method, which is more likely to have mistakes. Additionally, because the record-keeping is based on the honor system (left up to the drivers to self-report), it is possible for drivers to drive beyond the regulated hours and not record such violations. Within this paper, limit of hours will refer to either working hours or driving hours. Federally mandated limit for driving hours per day is 11 hours, while working hours per day is 14 hours. As truck drivers will have responsibilities that does not involve driving, such as, loading, unloading, and updating travel log, actual working hours will be more than just driving hours. Readers should not confuse between the two and definitely should not assume both are the same.

FMCSA introduced a mandate such that truck drivers are required to record their trucking hours through an electronic method, ELD, that is less prone to mistake entries as compared to the pen and paper method. Before the mandate, trucking operations were given the choice to adopt electronic logging voluntarily and this mandate requires the late adopters to make the shift by December 2017.

On another note, a report by the American Trucking Association (ATA) shows an increasing trend in truck driver shortage. The number of truck drivers is estimated to be at 48,000 personnel by 2015. Industry experts believe that the ELD mandate will aggravate truck driver shortage situation. This opposition towards ELD is seen much stronger in the independent and small fleet trucking operations, with what research believes is up to 88% against ELD. (Dills, 2014) Dills (2014) also believes these group would consider quitting truck driving as a career. Other research concludes that mandating ELD will make trucking a less meaningful job, in
which all the decisions and control is taken away from the truck driver, causing them to feel more like a machine executing orders instead. (Balay & Shattel, 2016)

**Rationale of Ruling**

The FMCSA performed an impact analysis as part of process for creating a regulation on mandating the use of ELD. For this mandate, FMCSA focuses mainly on the benefits to both the public and trucking companies generated from removing tired drivers from the road, and also the benefits from reduced paperwork required on the previous pen and paper method. The economic analysis within FMCSA’s analysis paper is mainly on the direct economic benefit related to the use of ELD in truck driver’s daily operations. Impact of ELD on truck driver is analyzed individually and not done at the macro level of trucking market demand and supply changes. The analysis from FMCSA also does not include the costs of training required to use ELD, especially on the older truck drivers who are currently already facing challenges in using technology devices, such as smart phones. Also, FMCSA’s analysis does not incorporate the costs due to reduced appeal of a career as truck drivers due to increased in surveillance and monitoring, as noticed by some other opinion pieces. (Balay & Shattel, 2016)

FMCSA conducted preliminary regulatory impact analysis and simulated potential savings from implementation of ELD in trucking operations. This savings is projected from potential benefits from health improvement and avoidance of losses due to fatigue related truck crashes. (U.S. Federal Motor Carrier Safety Administration. Analysis Division., 2011)

In order to estimate the effectiveness of EOBR/ELD in reducing driving hours’ violations, the regulatory impact analysis demonstrated a method by FMCSA to gather data, especially on driving hours’ limit. FMCSA compared driving habit statistics pre and post installation of ELD. The experiment is mainly conducted at Department of Transportation’s road
side inspection which randomly picked trucks on the road for inspection that involved checking on truck driver’s driving hours log. Previously, truck drivers who are caught, would face penalties that involves having safety rating of the trucking companies bumped down to an undesirable level. This lowering of safety rating by Department of Transportation will represent a harder time to find customers for these trucking companies with bad driving records. For the experiment, existing driving hours violators who are caught are given the option to adopt a voluntary ELD device that transmit driving hours’ data to FMCSA through settlement agreement, instead of facing the original penalty. FMCSA is confident that implementation of ELD would eliminate 22% of 11 hours driving hours’ violation. Overall, the report reveals that ELD would reduce 64% to 72% of all types of current HOS violations.

Furthermore, without a mandate in place to implement ELD, FMCSA estimated a market adoption rate of ELD to be around 20%. Based on this low adoption rate, FMCSA concludes that there are indeed additional benefits to mandating ELD adoption now, as compared to leaving it to voluntary adoption. If trucking industry is left to grow without a mandate, ELD is only expected to have 80% adoption rate by the 2040s.

![Figure 1: Percent of CMV Operations with Voluntary EOBR Use](image)
Impact on Trucking Economics

Contrary to popular beliefs, Peoples & Peteraf (1999) found that business failures in trucking industry, especially among the owner operated and smaller fleets, are not more than from the impact of usual up and down of the economy. HOS ruling does not cause an unfavorable market condition to owner operated operations as compared to larger trucking fleet.

In contrast, there is evidence from Berwick & Dooley (1997) that shows a reduction in available driving hours does increase the cost-per-mile of trucking operations on the owner operated trucking companies. However, the reduction does not necessarily represent a higher trucking company bankruptcy or a rise in trucking prices. Decrease in cost-per-mile however is most probably achieved from productivity improvements mentioned by the American Transportation Research Institute (2007), where driver productivity is improved from the reduction in need to spend time to track and record driving hours. In general, trucking operations that uses fleet management system do gain productivity improvement that will eventually lower overall cost of operations.

In Europe, a restriction on maximum driving hours' prompts trucking operations to consider team driving, in which drivers are paired up to take turns driving without stopping. The economics of this pairing start to make sense when there is restriction on maximum driving hours that enables 1 driver to drive while the other is resting on the sleeper berth within the truck. (Údarás Um Shábháilteacht Ar Bhóithre Road Safety Authority, 2015)

Also, Comerford (2015) proposed that shippers would favor using other modes, such as rail to move cargos/loads for a longer distance and reduce the use of trucks. This behavior could
promote trucking operations to focus on the increase in short haul loads demand, and the market would adjust accordingly.

Last but not least, there is a possibility of prize changes in trucking market which might attract new drivers to join the market. This is due to the shorter working hours of truck drivers, and shorter hauls which will make a job prospect as truck driver less challenging. Training to obtain a commercial driver’s license takes weeks to months, and thousands in training cost, which is not considered a huge hurdle. (Feld, 2015)
METHODOLOGY

This section describes our approaches to analyze the impact of ELD towards capacity and prices of the trucking industry. Firstly, we model changes to average truck driving hours and use it to estimate the change to overall truck driving hours. Secondly, we compared the price of buying ELD equipment and compared it to the overall cost of operating a truck. Thirdly, we compare the price-per-mile of transaction to the distance required to identify any relationship. Any identified impact could be used to estimate price changes in truck load for the near future. This calculation could be used for shippers interested in estimating trucking prices for the next few years or for trucking brokerage firms to estimate prices moving forward.

Potential Impact Analysis

Our research looks at opinions on behavior change in the trucking industry due to the ELD mandate and focuses on the changes that are believed to be caused by the mandate. Behavior changes that are relevant to this research are those that will impact truck driver’s operations and decision making. Reactions from truck drivers such as frustration and anger that might not directly change driving pattern or decision making of truck drivers will not be included in the analysis.

Since this research focuses on the impact of ELD towards capacity and prices in the trucking industry, the impact of other factors will not be included. Some notable factors that often influence pricing in the trucking industry include oil prices, macroeconomic growth, international trade, autonomous driving and other kinds of regulatory impact.

We identify how the mandate may affect the driving patterns change of trucking drivers. Even though existing federal regulation restricts truck driver’s working hours per day at 14 hours, however, there are violators who disregard this ruling and continue driving beyond the
limit. Any driving time by truck drivers beyond the federally mandated 11 hours are considered overdriving hours. These additional overdriving hours are currently part of the available driving available for purchase to shippers. Shippers often do not decide which hours of the driver’s shift should the shipper’s load be carried. Therefore, any changes to average driving hours of truck drivers due to ELD mandate will bring an impact to the prices of trucking industry as supply would be constrained.

Another direct costs that truck drivers experience immediately is the purchasing costs of ELD and installation costs onto their trucks. As cost of purchasing this equipment is required across of all the providers in this industry, we believe this is a factor to be investigated and estimated.

Also, with additional help from ELD in enforcement of maximum limit, we can identify any change in per mile pricing of loads that requires truck drivers to rest overnight. We can then further understand any additional costs in truck load pricing for borderline mileage that requires truck driver to stay overnight.

**Estimate Impact to Supply of Driving Hours**

Rather than relying on potentially biased interviews, there exists research on truck driver’s behavior and sleeping patterns and the possible improvement of road safety and truck crashes if their working hours are regulated properly. Hege, et al., (2015) identified sleeping patterns of truck drivers and the impact of regulation on truck driver's health and concentration on the road. Within Hege, at al.’s paper, there exists a distribution of truck driver’s working hours, used for sleeping pattern research. For our thesis, we could use the same distribution, but as a basis of existing driving behavior. Table 1 includes data of truck drivers whose average is
above the 14 hours limit set by federal regulators. Data from table 1 is useful for analysis on violator’s changes in behavior following the ELD mandate.

**Table 1: US Truck Driver’s Working Hours Distribution**

<table>
<thead>
<tr>
<th>Working Hours per day</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;6</td>
<td>0.4</td>
</tr>
<tr>
<td>7-8</td>
<td>0.7</td>
</tr>
<tr>
<td>8-9</td>
<td>2.3</td>
</tr>
<tr>
<td>9-10</td>
<td>9.7</td>
</tr>
<tr>
<td>10-11</td>
<td>16.3</td>
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<tr>
<td>11-12</td>
<td>17.1</td>
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<td>12-13</td>
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<td>13-14</td>
<td>23.2</td>
</tr>
<tr>
<td>&gt;14</td>
<td>15.1</td>
</tr>
</tbody>
</table>

Average hours driven: 11 hours 55 minutes


Continuing on, we model the change of driving patterns due to the ELD mandate to estimate the input on the supply of trucking market. Based on the research by U.S. Federal Motor Carrier Safety Administration, Analysis Division, (2011), FMCSA estimated violation of daily 14 hours limit would be brought down by 40% or more. This calculation is based on an experiment ran by US Department of Transportation through the road side inspection conducted on randomly selected truck drivers on the road. A group of truck drivers that were caught violating HOS rules were given the option to participate in the experiment to estimate effectiveness of ELD instead of being prosecuted. FMCSA then collect data on these volunteers to estimate the reduction in violating hours by truck drivers post installation of ELD. We used
this result to estimate the reduced HOS ruling violation and simulated the average driving hours with the reduced violations. Findings of this comparison is presented in the results section.

**Calculate Changes from Equipment Costs**

Any regulatory mandate that requires electronic devices will usually mean operational cost increase for trucking companies. For this ELD mandate, a purchase of equipment from vendors is required, and this equipment will have to adhere to the specifications released by FMCSA that ensures data integrity and for privacy concerns. This additional equipment cost will be treated as expenses in trucking operations regardless of the size of operation. We identify the cost impacts of the mandate through increased in equipment costs for both one time and recurring ones (if any).

The ELD devices which cost between USD $525 and USD $785, must be purchased from equipment providers. The devices are expected to last around 3 years before a replacement is required. Although we understand that large carriers might have more negotiation power and economies of scale to lower the costs of adopting ELD, we do not separate the analysis between large carriers and smaller ones, because looking at the already low costs of equipment compared to the rest of the costs within the truck.

Also, for this scenario, we simulate the cost of installing just a basic ELD without other productivity enhancing features such as those seen on the more complicated Fleet Management System which can track truck speed, location and other measurements. Although the higher price of a more sophisticated ELD with extra features might cost significantly more than our approximation, additional investment could be offset by additional productivity gain from better management of truck fleet from the devices. So, we see no incentive for small trucking fleets to purchase the more expensive version of equipment if trucking companies do no foresee any
benefits from purchasing the devices, and the cost increase approximation of ELD would apply to them.

To compare the increase in equipment cost to the changes in prices experienced by shippers, we scale the cost on a per mile basis. Within the trucking industry, cost-per-mile is a reasonable criterion for measuring cost impact even though most costs increase with higher mileage, the payout is also higher for longer distance travelled. This measurement is also a proxy of cost for time spent by truck drivers to work in hauling the load, as a longer distance will require a longer time of work.

We can amortize the cost of equipment to the miles driven and used it to assess equipment cost impact as a comparison of costs changes to the shippers. According to The American Trucking Association, long haul truck drivers complete an average of 100,000 to 110,000 miles per year. (American Trucking Association, 2015) Combining both average mileage and equipment cost information, we can provide a comparison of equipment cost changes due to the ELD mandate from the shipper’s perspective.

Once again, to understand the impact of equipment cost change due to ELD, we will compare it to the current costs. By having a current cost-per-mile operating costs, we can then compare the percentage change in costs from the mandate. American Transportation Institute (2015) releases estimate of this current cost-per-mile values separated by category for ease to comparison between the truck driver owner business model and for the trucking fleet model where driver’s salary is considered part of cost. This report estimate marginal costs per mile to be around $1.703 in year 2014. Detailed findings of this calculation is presented in the results section.

**Identify Impact of Borderline Cases**
Another area for investigation is prices of haul mileage where it could be between spending overnight, or complete within a single day’s work. If a truck driver’s destination is just half an hour to one hour away, while his daily limit of 11 hours driving is nearly maxed out, there is a huge incentive for truck drivers to just violate the ruling and drive a little more to complete the job. A truck driver will most probably believe he or she will not cause any harm by over driving a little to complete the job, and he or she can start from a fresh time cycle again the next day.

Using an estimate of 55 miles per hour driving speed, we can identify the trucking jobs that requires just slightly above mandated 11 driving hours. The method here is to identify if there is a premium on price per mile for loads that require additional overnight stay by truck drivers, compared to those that do not. As truck drivers have the option of accepting loads with distance required given, and can compare price with their costs before accepting a load, overnight stay requirements might be a consideration before receiving load. We understand that not all truck drivers will be receiving load before any of the full 11 hours has been utilized yet. However, that situation only allows other truck drivers, who still has the full 11 hours to drive, a more competitive price due to lower costs, from no overnight stay required, to be successful in bidding for the load.

We have data of completed trucking transaction and associated information from industry data. These data include prices to shippers, payment to trucking carriers, and miles required for haulage. Data of the trucking transaction are used to translate the mileage of load (within the transaction data) into estimated hours required. It is possible that a truck driver is more efficient in driving or consistently driving above the 55 miles per hour estimate used in this calculation,
however, we do not expect the average to differ too much, as there are drivers who drive slower to average out those who are driving faster.

Using the conversion mentioned above, we can look at price-per-mile information for loads that does not require additional overnight stay for truck drivers, and price-per-mile information for those that required additional stay. This is to investigate any preference change in truck driver’s behavior in accepting loads without additional stay. Any observed bump in price-per-mile can be use to develop better logistics network within shipper’s network. Detailed findings of this analysis is presented in the results section.
RESULTS

We simulated market dynamics and cost changes for the post-ELD-mandate period, and used the values to understand the potential impact on trucking market in the near future. The values used in these models are retrieved from different sources and combined to understand and analyze the trucking market dynamics. We then utilized the percentage change as an estimation of potential impact the mandate will have on various stakeholders in the market.

Reduced Violation and Changes in Supply

Previously in the methodology section, we explained our model to estimate the drop of driving hours for certain group of truck drivers. Using the 40% estimate of ELD effectiveness in reducing HOS violations, we simulated the behavior change to average working hours of current violators. In Table 1 we move 40% of drivers in the '>14 hours' region to 14 hours or fewer to represent the reduction in violations.

Table 1 shows that 15.1% of the truck driver working hours are above the federal limit of 14 hours, and we estimate that this will reduce by 40% and be added to the '13-14' hours region. Table 2 shows the distribution of average working hours simulated for post-ELD-mandate, and the reduction in violations of limits on working hours.

Table 2: US Truck Driver's Estimated Working Hours Distribution Post ELD Mandate By Simulation

<table>
<thead>
<tr>
<th>Working Hours per day</th>
<th>Distribution Before Simulation (%)</th>
<th>Distribution After Simulation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;6</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>7-8</td>
<td>0.7</td>
<td>0.7</td>
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</table>

Average hours driven: 11 hours 47 minutes

The portion of violators went down to just 9% of the truck driver working hours and the average working hours drops to 11 hours and 47 minutes. Compared to the original average of 11 hours 55 minutes, this reduction of 7.8 minutes represents a 1.1% drop in supply of truck driver working hours in the market.

**Cost Changes to Carriers from Equipment**

As mentioned in the methodology section, we used cost of equipment divided by cost of distance travelled to estimate the cost-per-mile increase. Using ATA’s estimate of average annual mileage by long haul truck drivers to be around 100,000 miles, we amortized one-time equipment costs by dividing it off mileage travelled through the life span of equipment. Since most ELD equipment is expected to last for 3 years, we estimated that purchasing a brand new ELD can be utilized for up to $3 \times 100,000 = 300,000$ miles.

Taking the higher bound of estimated equipment costs, $785, we then calculated the additional costs per mile is $0.0026. As costs and prices in the industry are tracked in per mile basis, we then used this value to compare it to the other costs and prices within the industry.

Next, we realized from ATRI’s research where marginal cost per mile of operating a truck is around $1.703 in 2014. This dollar amount is also calculated from the existing operating
costs of a truck and divided by distance travelled. This dollar amount, $1.703, includes driver’s salary as a component of costs, therefore the value is more relevant to trucking company’s operations with hired drivers. Comparing $0.0026 to $1.703, we noticed installing ELD represents an increase of approximately 0.153% in operating costs.

For owner-operated trucking operations, salary is not considered as part of operating costs. Based on ATRI’s numbers, marginal costs per mile in this scenario is $1.112 per mile. For owner operated situation, this increase in costs translate to an increase of 0.234% in marginal operating costs.

The results above assume that trucking operations will absorb the entire costs of equipment, which is highly likely since the cost has a small impact compared to the cost before purchase of ELD. However, our analysis here also simulates a situation where the full cost of equipment translated to the price of trucking charged to shipper. Comparing per mile cost increase of $0.0026 to an average price per mile of trucking at around $1.50. In this case, if we simulate that in the situation that all burden is borne by shippers, we expect an increase of shipping costs by 0.17%.

**Difference in Behavior of Pricing due to Characteristics of Load**

Continuing from the methodology section, we analyze the trucking load transaction, especially the transaction that requires driving exceeding federal ruling mandated 11 driving hours. We compared the cost-per-mile data with number of hours driven to identify change to cost-per-mile when number of hours required increases. Cost-per-mile is calculated from total price paid to trucking carriers for a load divided by number of miles required per load. Number of hours is based on number of miles of load divided by expected average speed of truck. For the
initial attempt, we plotted the aggregated price-per-mile data by time for travel to identify any potential deviation for loads requiring additional stay over or additional driver.

![Chart 1: Cost-Per-Mile vs. Average Driving Hours](image)

There are no sudden spikes of cost per mile at the range of driving hours that borderline exceeds maximum allowed driving hours per day. (exceeding 11 hours, exceeding 22 hours, ...)

We then proceed to change the assumption of truck driver’s driving speed, which is assumed at 55 miles per hour. A average driving speed of 55 miles per hour might be reasonable for shorter distance loads. However, if a trucker driver has a load for a much longer distance, there would be less requirements for truck driver to slow down and therefore continue driving a higher average speed. This change in assumed average driving speed would mean lower driving hours per mile, and would therefore move cost per mile chart in Chart 1. Chart 1 is based on industry data by industry experts, with information of price paid and distance of origin to destination.
There is a dip and then an increase in cost-per-mile at around borderline of 2 days as shown in graph 2. Therefore, we can identify that loads that takes 23 hours at average of 60 miles per hour will have higher cost-per-mile. This threshold of 1380 miles will be useful for shippers in understanding their cost drivers when planning for shipments.

Another approach we took was to understand types of truck drivers that would be more prone to adopt a difference in pricing for loads requiring overnight stay, and those without. One theory that was tested, was to separate the cost per mile for smaller trucking carriers with 3 or less trucks as compared to large carriers with more than 3 trucks. With that separation, we compared the cost per mile data versus average driving hours at 60 miles per hour for both groups.
We noticed in chart 3 that for small carriers, there is a dip and then increase in cost per mile at past the 11-hour mark, which is when truck drivers are required to rest overnight. With these results, we can see that price set by trucking carriers does behave to adapt to requirements of overnight stay, therefore, any regulation that pushes for more truck drivers to adhere to 11-hour maximum driving hours' limit will amplify the price differences at the borderline region.
DISCUSSIONS

We see results showing the impact of ELD mandate not contributing a significant change to the trucking market dynamics, however, there are more qualitative factors to consider. The challenge in coming up with a perfect model to predict a behavior change on truck driver is because not all humans behave rationally, and not all truck drivers plan to adhere to all regulations all the time.

Size of the US Trucking Market

US trucking market is huge with up to 4 million truck drivers and half a million trucking carriers. (Federal Motor Carrier Safety Administration (FMCSA), 2015) Even the largest trucking carriers in US only consists of a small portion of the market supply, and there is a long tail of small carriers and owner-operated truck drivers. This large number and variation of trucking carriers makes this research hard to predict and model truck driver’s behavior. As there are many players within the market, it is highly likely that there exist many types of action to be taken by different trucking carriers and drivers.

Looking at the models for analyzing truck drivers, and trucking carrier’s behaviors, it is presented such that majority of stakeholders will have similar reaction. However, in reality, not all stakeholders will have similar information, tools, and data to realize the rational action to be taken, or even the intention to take the rational decision. Even American Trucking Association (ATA) which is supposed to be representative of the entire industry, is often viewed as mainly advocating for the large trucking carriers. This is once again observed when ATA is showing support for the latest ELD regulation, but some owner operated truck drivers are showing resistance against the regulation, and are taking legal proceedings against FMCSA separately without support from FMCSA.
Monitoring of Driving Hours leads to Higher Speed

One factor that was not modeled in this analysis is the change in speed of trucks due to ELD mandate. In the model for identifying borderline truck load cases, we assume a standard average speed of truck assuming that ELD mandate would not cause changes to behavior of truck drivers in speed of vehicle. However, we should not forget that balancing between distance of load and driving time, will have an impact on driving speed of truck drivers.

Currently, the speed limit on interstate highways are in the range of 60 to 85 miles per hour differing by state or territory. ELD mandate does not include any regulations of logging truck’s speed limit into electronic device. With this, we noticed that truck drivers believe that truck speed and driving hours are not strictly monitored at all times. This is because there are no requirements to record driving speed during the haul, and at the same time the pen and paper method of recording driving hours does not appear as a constant monitor to truck drivers. Truck drivers can better balance between driving hours and driving speed to carry their load with an efficient and safe balance.

However, with this ELD mandate, truck drivers would be more worried about their recorded driving hours, and have a tougher time using driving hours as a balance. With electronic logging of truck driver’s working hours, truck driver no longer feels safe to sometimes exceed mandated hours as they will be recorded dispassionately by an electronic device. The change in situation will prompt truck drivers to believe that falling into speed traps are much smaller risk compared to violation of driving hours, and therefore, much more willing to speed up on interstate highway to still complete travelling for the load.

This potential change in behavior might mean that the ELD mandate might not be as effective in improving road safety, as we might have less fatigue truck drivers on the road, but
there can be more speeding truck drivers on the road. Some of these speeding truck drivers might be more tempted to constantly exceed the mandated speed limit to make up for limited allowed hours for driving.

Besides that, if the market reacts to ELD mandate by increasing the speed of vehicle, we might not actually see a decrease in supply of trucking capacity. This is because the change in driving speed would compensate for the decrease in driving hours available to carry the loads. Once again, we are unable to predict this potential change of behavior until implementation date of ELD mandate. Truck drivers would not likely be that willing to share their plans to violate the speed limit to compensate for shorter driving hours if that is their current plan to do so.

Current Adoption Rate of ELD or equivalent

According to data from Regulatory Analysis Impact, we noticed that currently there are around 30% of trucks that are presently equipped with ELD capability. Therefore, not all the trucking carriers will have to incur additional equipment costs when the ELD mandate is implemented. The cost impact for these 30% of trucks would be nothing if their current device is compliant to the specification determined by FMCSA.

Realizing that around 30% of trucks are equipped with ELD currently will bring a different dynamic to the US trucking market. Assuming a trucking carrier is trying to pass on the cost of installing ELD to the shippers by trying to quote a slightly higher price, trucking carriers which previously implemented ELD would have the opportunity to quote a price without the hike and be successful in winning the bid. On top of that, the 2 years’ transition period for implementing ELD is another variable that makes it hard for the industry to transfer the price of equipment to customer while still successful in bidding for the loads. Different carriers will
adopt ELD at different times and any collaboration to hike the prices together can also be seen as violating anti trust laws.

Another challenge of estimating costs of equipment for ELD would be from the more complicated electronic devices of fleet management system (FMS). FMS are usually electronic devices that are much more expensive than a plain ELD, but does have more function than just record truck driver’s working hours. Trucking carriers usually use FMS devices to collect data on their trucks to help understand the productivity of their fleet, and some has added features such as GPS information, truck speed recording and others. Therefore, if a truck driver decided to purchase FMS to be installed on his or her truck, the full equipment costs related to ELD mandate might not be the full purchase cost of equipment. FMS is a productivity improvement tool; productivity gain from utilizing FMS devices could offset the purchasing of equipment totally for certain trucking carriers. In the case where costs will be offset by productivity improvement, the equipment costs increase for truck drivers who purchase new FMS devices due to ELD mandate will incur zero or negative equipment costs.

Privacy Concerns and Legal Proceedings

Even though FMCSA’s intention of implementing this regulation is with the goal of improving road safety by removing fatigue truck drivers, this action is not welcomed by all parties. Trucking carriers and truck drivers, especially from the smaller fleet or owners-operated set-ups are opposed to the idea of this ELD mandate as they do not believe in the benefits it will bring and treat it as additional burden for truck drivers.

OOIDA had taken legal actions against FMCSA in trying to implement ELD mandate, and had succeeded in blocking it the first time round. This failed attempt in implementing ELD mandate the first time round was mainly due to the previous mandate’s failure to address privacy
concerns with ELD monitoring method. In short, the previous ELD mandate was found to not stop federal regulators from harassing truck drivers based on the data in ELD device that might be more than 7 days old. As per currently HOS regulation and inspection procedure, truck drivers are only obligated to provide HOS record from their log book of up to 7 days before from the time of inspection.

This uncertainty in the implementation of mandate causes drastic variation in the industry’s belief that the mandate will go through. Some trucking carriers who believe the announcement of mandate this time round being successful will adopt ELD much earlier to address any issues with implementation as early as possible before the mandate timeline of December 2017. Trucking carriers who are opposed to the idea and believe the new lawsuit against FMCSA will yield results might try to delay purchasing and implementing ELD into their trucks. Of course, truck drivers who are not outwardly showing support for OOIDA’s lawsuit might also try to delay implementing ELD in fear that the devices they purchase now might not be compatible with the final specification in any amendments towards ELD mandate that FMCSA will have to undertake due to OOIDA’s lawsuit. (Chao, 2016) We also have to take note that most large carriers who are supportive of this mandate, have implemented ELD within their trucking fleets.

This difference in support and willingness to install ELD will bring added complexity to our model of impact due to ELD mandate. Trucking carriers and drivers will purchase and install ELD in a different timeline, therefore it is also hard to coordinate the timing of increased equipment cost (if any) and to transfer the increase in cost to shippers. Trucking carriers will have a harder time increasing the price of trucking if other truck carriers do not increase the
price. Therefore, it is higher likely that truck drivers will have to absorb increase in equipment themselves than transferring it to shippers.

**Training Cost of Implementing ELD**

When considering the cost of implementing ELD, we assume that the cost of training is negligible. However, that is one aspect of implementation that trucking carriers would want to pay attention when planning for transition to the electronic devices. Electronic devices may be intuitive to the younger generation who are used to using smart phones, computer and other internet devices, but will be a challenge for the older generation. ELD such as the one in Image 1 might pose a challenge to pick up for those who are not used to complicated electronic devices.

![Image 1: ELD Device (Overdrive, 2015)](image-url)

A study by American Trucking Association (2015) estimated the average age of over the road truckload truck drivers at 49. If trucking carrier is planning to transition to electronic devices for operational record keeping, which includes electronic log of driving hours, some of the more senior truck drivers will have issues in learning to operate these devices.
This additional burden could be from the additional cost required to train the drivers to utilize new electronic systems. Also, truck drivers who are closer to the age of retirement might get frustrated with having to learn a new device, and be prompted to retire early. This expedited plan to retire by senior truck drivers could temporarily reduce supply of truck drivers in the market and potentially increase prices of trucking. These unknown additional cost of implementation are not incorporated when calculating cost of ELD in the model developed in Methodology.

**Trucking Supply Bottleneck – Trucks vs. Drivers**

There are 2 factors that make up a supply within the trucking market, truck and the truck driver. Whichever is lacking will be the limiting factor in supplying to the trucking market. As of the US trucking market today, truck drivers are the limiting factor, therefore the analysis on trucking market supply is focus on changes in truck drivers availability.

Truck manufacturing companies are constantly adapting production of trucks to replenish trucks to the market according to retirement of old trucks and potential ramp in demand due to trade pattern changes. Truck drive labor market however are less flexible, and is faced with labor shortage now, therefore the cost of operating higher. Impact of ELD on truck driver productivity will impact market prices more significantly than on truck utilization rate.

**Prices Impacted by Characteristics of Load**

As identified in results above, we noticed that especially more for smaller carriers, price per mile are higher especially at the region where loads just marginally exceeds the distance able to be covered in 1 full driving day of 11 hours. This is mainly because truck drivers will associate a higher cost if they are unable to complete a load and be forced to incur overnight stay expenses. During quoting of prices, for loads requiring more than 11 hours, truck drivers will
usually quote a higher price per mile as there is lower willingness by truck drivers to take up these types of load. Especially small truck carriers will have to complete delivering load on the morning of second day, unloading materials, and waste large amount of time to start looking for new loads to carry.

**Simulated Change to Supply of Driving Hours**

For the method used in methodology, we based our assumption that FMCSA’s calculation of the decrease in regulation is accurate. However, looking at the method conveyed by FMCSA, we can identify some potential pitfalls here. For example, if truck drivers know that their driving patterns will be recorded by FMCSA researchers for experiment, they might adapt their driving behaviors accordingly.

Besides the difficulty in estimating the driving behaviors after installing ELD, we also see difficulty in estimating the right violation behavior of the experimented truck drivers before experiment. Truck driver’s violation records are being used as a comparison to estimate the change in behavior. However, the original pen and paper method is not effective in estimating the actual truck drivers driving hours’ violation behavior. Using the pen and paper method, truck drivers are still prone to recording error in their log books therefore underestimating their violation rate.

Capturing violation rate is difficult as violators usually have various methods of avoiding detection. Truck drivers could avoid roadside inspection stations for up to 7 days such that regulators can no longer record their violation record. This is because truck drivers are not required to provide their log hours more than 7 days passed the day of inspection. This will disrupt the accuracy of estimation for drivers driving pattern change.
On another note, the simulation is done assuming that violators will reduce their violation
of driving hours. Simulation was done by only changing the driving ours of the identified
violators who will change their behaviors. The part that is difficult to simulate is the potential
reaction by the rest of the truck drivers. If truck drivers that previously does not drive beyond the
stipulated limit, will now drive longer to compensate for drivers who are adapting to reduce their
driving hours, then supply of driving hours will change again. The previously law abiding truck
drivers will drive more to compensate for the reduced driving hours by the violators and the drop
in truck driving hours as a market is reduced or removed.
SUMMARY

In this paper, we presented models to estimate the capacity and cost impact of introducing ELD mandate on the trucking industry. Three factors that were modeled here are trucking capacity, cost of operating trucks, and distance required for hauling a load. This paper does not try to dispute the claim from FMCSA that if ELD will or will not improve road safety. We used the simulated results to estimate the impact that shippers, trucking carriers, and truck drivers will experience. We find no evidence to show that implementing ELD will significantly change the capacity or prices of trucking industry.

From the trucking capacity perspective, we noticed only a drop of 1.1% in truck driver working hours. This drop is not expected to cause prices to increase as the small increase will not be able to cause shippers to worry about scarcity of supply and start bidding up prices. In certain markets, 1.1% might be too small and only be classified as a rounding error, and not bring any significant market shift to trucking industry.

Looking at the cost of operations, we compared the cost of purchasing ELD equipment with the current cost-per-mile. Additional equipment cost from ELD increases total cost of operating by 0.17% and would not cause a trucking carrier to go bankrupt due to it. Furthermore, ELD might improve productivity of truck drivers and this improvement would negate the 0.17% cost increase from purchasing the equipment.

We noticed that truck loads requiring overnight stay by truck drivers, due to mandated 11 driving hours’ limit, will have an additional price-per-mile than those below it. Introducing ELD mandate will increase the number of truck drivers who will abide by the rules and drive within 11 driving hours’ limit and potentially increase trucking prices for truck loads that requires overnight stay.

Some recommendations for further research would be for interested parties to get contacts to large trucking carriers and do a benchmark studies on the large trucking carrier’s operations. This further research can then use the operations cost data and process within large carriers who have already implemented ELD and compare it with those who have not to identify the differences.
Bibliography


