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Incentivizing Truck Retrofitting in Port Drayage: A Study of Drivers at the Ports of Los Angeles and Long Beach

Final Report

Metrans Project 06-02

February 2008

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DISCLAIMER

ABSTRACT

Using data from detailed surveys of truck drivers, we analyze the wages and working conditions of drivers involved in port drayage. We also focus on drivers' willingness to pay for retrofitting and their preferences regarding different truck replacement programs. We find that drivers are willing to pay a portion of truck retrofitting costs. Drivers with higher annual incomes are willing to pay more for retrofitting. We also find that though a grant-based truck replacement program was ranked highest among drivers, drivers were somewhat polarized on this program; many drivers also ranked this program as their least favorite. A subsidized interest rate program had the most cumulative first and second rankings.

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DISCLOSURE

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1. INTRODUCTION

The San Pedro Bay (SPB) ports are the major gateway to the U.S. for Asian imports. They serve a key role in the national economy; the flow of goods into the country through this region leads to lower transportation costs and allows for increased trade. It is widely recognized that while the benefits generated by the SPB ports accrue to both the region and the nation, the external costs (eg. pollution and congestion costs) directly impact only the region.

There have been legislative attempts to internalize these externalities; most recently through a container fee proposal by California State Senator Alan Lowenthal, which was vetoed by Governor Schwarzenegger. The proposed container fee was an attempt to charge for the use of the SPB ports and use the revenue to mitigate the pollution generated by international trade. The SPB ports, though competitors in attempting to attract tenants (terminal operators) have cooperated in issuing their joint "Clean Air Action Plan" (CAAP) which proposes a number of measures to reduce pollution from port traffic (including ships, rail, and trucks).

This paper attempts to assess the feasibility of different truck mitigation proposals by examining the operating margins of port truck drivers. This extends on a prior study of port drivers (Monaco, 2004) and, like the prior study, relies on in-depth surveys of drivers to analyze the economics of the providers of port drayage services (the truck drivers). This new study examines driver expenses in detail, asks drivers about their willingness to finance truck retrofitting, and asks about their attitudes towards different truck replacement scenarios. To provide background to this analysis, we first discuss the issues of pollution, review the CAAP (as it pertains to port trucking), and discuss the literature on willingness to pay. We then analyze the earnings and expenses of port truck drivers and conclude with an analysis of the feasibility of different measures designed to reduce pollution from port truck drivers.

2. POLLUTION

Air pollution has become a growing concern for many living in Southern California. Los Angeles ranks as one of cities in the nation with the poorest air quality (EPA, 2006). A variety of sources such as auto emissions from trucks and cars, industry activities such as refining, among other things are attributed to poor air quality. Diesel emissions from port activities are of major concern due to the expected increase in port traffic as international trade continues to grow. Over the next fifteen years, the Los Angeles and Long Beach Ports are expected to see one hundred percent growth in the volume of containerized cargo passing through (Clean Air Action Plan Overview, 2006).

As a result, there is a plan in place to reduce overall emissions from the ports. The Port of Los Angeles/Long Beach's Clean Air Action Plan calls for incentive programs aimed to reduce emissions and to become compliant with the NAAQS. Under this plan, by 2011, trucks calling at the ports at least semi-frequently will be cleaner than the EPA 2007 on-road particulate matter emissions standards and will be have the latest technology for reducing nitrogen oxide emissions. The other standards proposed in the plan aim to reduce pollution associated with all other aspects of port activity. Implementation of this plan will be difficult without the proper funding as the estimated costs range from $194 million to $2.6 billion. Finding funding for trucks is admittedly the most difficult task (Clean Air Action Plan Overview, 2006). However, reducing the amount of truck pollution is essential for a cleaner Los Angeles County.

Many studies have been conducted to determine the health effects of diesel emission exposure in humans. Over ninety-four percent of diesel emissions are less than 2.5 microns in diameter, making them easily inhale-able. Additionally, diesel exhaust consists of over forty substances classified by the EPA as hazardous air pollutants, and fifteen of these are classified by the International Agency for Research on Cancer as carcinogenic to humans or possible/probable carcinogenic to humans (Air Resources Board, 1998).

Of the six pollutants used by the EPA to determine air quality (EPA Green Book, 2006), five are found in diesel emissions, namely ground-level ozone (O_3), nitrogen oxides (NO_x), carbon monoxide (CO_2), particulate matter (PM), and sulfur oxides (SO_2). The EPA has established thresholds for human exposure to these pollutants, which are outlined in the National Ambient Air Quality Standards (NAAQS) and the results for Los Angeles County are discussed later (EPA NAAQS, 2006).

Ground-level ozone forms when nitrogen oxide reacts with volatile organic compounds in the presence of sunlight. Thus, ozone concentration peaks during the afternoons and during the summer when it is the warmest and sunniest. Some health effects of ozone include irritation of the lungs, inflammation, wheezing, coughing, pain when breathing, difficulty breathing, increased mucus production, eye irritation, and headaches. Aggravation of asthma symptoms and increased risk of respiratory illnesses such as bronchitis and pneumonia are some effects of relatively low levels of exposure to ozone. The long-term effects of exposure to ozone is not well documented in humans, however, experiments with laboratory animals suggest that there is chronic and/or permanent damage to the lungs (EPA Green Book, 2006; Peters et al., 1998).

The category nitrogen oxides encompass reactive gases composed of nitrogen and oxygen. It is of particular concern because it is a main ingredient of ozone. NO_x is created during the combustion of fuel. Over fifty percent comes from motor vehicles, twenty-two from electric utilities, and the remainder from other fuel burning sources (EPA Green Book, 2006). When nitric oxide reacts with oxygen, nitrogen dioxide (NO_2) forms. Nitrogen dioxide may cause lung irritation and inflammation equal to that caused by ozone, but this requires nitrogen dioxide to be at a level ten times greater than ozone. Epidemiological studies suggest that when outdoor concentrations of nitrogen dioxide exceed the standard of 0.02 parts per million (ppm), children with asthma are more likely than children without asthma to experience respiratory irritation and reduced lung function. Long-term exposure to high concentrations can cause chronic damage to the lung tissue. In addition, nitrogen dioxide suppresses the immune system, thus leading to higher risk of respiratory infections for children (Peters et al., 1998).

Carbon dioxide (CO_2), a major component of motor vehicle exhaust, is a colorless, odorless gas, which forms when carbon fuel is not burned completely. Because carbon monoxide is just one of many byproducts of fuel combustion, it is difficult to isolate the effects of carbon monoxide from other pollutants created during the fuel combustion process, such as nitrogen oxides and particulate matter. In addition to being poisonous, carbon monoxide contributes to the formation of ground-level ozone and is typically the most abundant during colder months. Breathing carbon monoxide prevents the transportation of oxygen to vital organs through the blood stream. Also, once in the blood stream, it will stay for a long period of time because of the way it attaches to the hemoglobin. As a result, less oxygen is transported throughout the body; consequently, people with heart disease, asthma, and emphysema are the most sensitive to carbon monoxide in the environment. At high levels of exposure, people have experienced headaches, unconsciousness, and even death. There is also evidence to suggest that women who are pregnant have a heightened risk of having a low birth-weight baby (Peters et al., 1998).

Particulate matter is composed of small particles of acid, including nitrates, sulfates, organic chemicals, metals, and soil/dust particles. Particulate matter is the categorized according to the size of the particles. PM_{10} are "inhale-able coarse particles" which range in diameter from greater than 2.5 microns to less than 10 microns, while $PM_{2.5}$ are "fine particles" with a diameter less than 2.5 microns (EPA Green Book, 2006). Particulate matter is harder to identify since it does not have a specific chemical composition. That is, it includes all particulate matter if the particles are small enough. This creates a challenge for researchers to try to isolate the effects of particulate matter in the presence of other pollutants such as ozone, nitrogen dioxide, and carbon monoxide.

The coarse particles generally are a consequence of mechanical processes such as cutting, rubbing, grinding, and etcetera. These particles have a similar chemical composition to that of soil. They are less of health risk because their size makes it hard for the lung tissue to absorb the particles. Fine particles, on the other hand, come from combustion processes such as those found in power plants, and automobiles, tuck, and bus exhaust. High levels of particulate matter have been related to suppressed lung growth in children, development of chronic bronchitis, irregular heartbeat, premature death in people with heart or lung disease, and an increase in respiratory related hospital admissions in children. There are studies that propose that the chemical composition and surface area of these particles may be more important than the mass of the particles in an attempt to isolate the effects (Peters et al., 1998; EPA Green Book, 2006).

Sulfur dioxide gases are formed in the refining of oil into gasoline and when fuel, containing sulfur, is burned. The gas is water soluble, attributed to respiratory illness in children and the elderly and to increased aggravation of asthma. Lead is the remaining pollutant used by the EPA to determine air quality. It is a metal found naturally in the environment and has been shown to damage the kidneys, liver, brain, and other nerves. However, over the past three decades, the government has taken steps to reduce lead pollution by limiting or eliminating the addition of lead to products such as gasoline and paints (Peters et al., 1998; EPA Green Book, 2006).

The air quality in Los Angeles-Long Beach area is improving (EPA Air Trends, 2005). From 1990 to 2005, all levels of pollutants given by the EPA's trend statistics fell. Despite the improvement, however, air quality in Los Angeles County is still among the poorest in the nation.

The EPA's Clean Air Act of 1990 requires that counties meet the National Ambient Air Quality Standards (NAAQS). The primary standards are set at a level meant to protect the public including people with increased sensitivity to air quality, such as children, elders, and those with asthma. Los Angles County, with a population over 9.5 million, is in non-attainment of the NAAQS for O_3 and $PM_{2.5}$. Specifically, the maximum standard in parts per million (ppm) by volume for O_3 during one-hour of exposure is 0.12 ppm compared to the measured 2005 level of 0.171 ppm. For exposure over an eight-hour period, the level of O_3 in Los Angeles County was measured at 0.118 ppm compared to the primary standard of 0.08 ppm. A similar result is found for $PM_{2.5}$, which has a primary standard of 35 $\mu g/m^3$ (micrograms per cubic meter of air). During 2005, the $PM_{2.5}$ concentration in Los Angeles County was measured at 53 $\mu g/m^3$, 150 percent above the national standard (EPA Air Trends, 2005).

Such high levels of O_3 and $PM_{2.5}$ do not bode well for the respiratory health of Los Angeles County citizens, especially children. Children are of particular concern because they are inherently more vulnerable to the negative effects of air pollution than adults for a variety of reasons. First, children are generally more active than adults are when outside. Further, the average child spends over 20 percent of day outside compared to an average adult who spends as little as five percent of the day outside. Couple this with the fact that children are typically outside when air pollution is at its worse. And since children generally do not recognize respiratory symptoms, such as coughing or discomfort, they do not voluntarily limit their outdoor activity on heavily polluted days (as recommended). Additionally, children take in as much as 20 to 50 percent more air per unit of body weight at high activity levels compared to an adult at a similar activity level. Notwithstanding, the fact that children are still growing and developing, and more specifically, their lungs are still developing necessarily implies a higher susceptibility to the adverse effects of air pollution (Kleinman, 2000).

To learn more about the chronic respiratory effects of air pollution, researchers at the University of Southern California conducted a comprehensive study known as the Children's Health Study (CHS). In 1993, over 4,800 schoolchildren in the fourth, seventh, and tenth grades were recruited to participate in the study, of which 3,600 students returned questionnaires. The students represented twelve communities in Southern California, each strategically picked to vary the concentrations of each air pollutant, while keeping similar family demographics. A second cohort of 2,000 fourth graders was recruited three years later (Peters et al., 1998; Kunzli et al., 2003).

The study consisted of questionnaires that assessed characteristics of the students, their families, and their environments. The researchers also collected information on the respiratory health history of each student including conditions such as asthma, hay fever, cough, bronchitis, and other early life respiratory illnesses. Each year, an assessment of the child's respiratory development and lung function was completed through questionnaires and via spirometry. The researchers assessed the chronic effects of air pollution by means of changes in the functional growth of the lungs and by the number of newly diagnosed cases of asthma, while the short-term effects were measured in terms of the number of school absences.

The reason why the occurrence of asthma in children raised in developed countries has increased over the past thirty years is not known, but research related to CHS has shed some light on the issue. For people with asthma, exposure to nitrogen dioxide and particulate matter worsens their conditions. However, research thus far has not been sufficient to link air pollution directly to newly diagnosed cases of asthma. Instead, researchers were able to find a link between communities with high ozone concentration, the number of sports a child plays, and the number of newly physician-diagnosed asthma. That is, children participating in multiple sports who lived in communities with higher concentrations of ozone saw an increase in the incidence of newly diagnosed asthma cases and further aggravation of previously undiagnosed cases of asthma. The researchers concluded that air pollution and outdoor exercising might contribute to the development of asthma in children (McConnell et al., 2002).

A study of the second cohort of children in the CHS showed that the lung function of children was directly related to the child's exposure to air pollution. In addition, the findings from second cohort of children corroborated with the results from the first cohort. Another observation made by the CHS investigators demonstrated that lung function growth rates were improved if children moved away from a heavily polluted community to a community with lower levels of pollution. The converse was also ture. That is, a child who moved from a community with relatively low levels of pollutant concentration to one in which pollution was relatively high saw a reduction in the growth rate of that child's lungs (Gauderman et al., 2002).

Short-term effects of pollutants were measured in terms of the number of school absences. As one might expect, an increase in the ozone level, resulted in more school absences. This result was especially true in communities with a low level of particulate matter and nitrogen dioxide. In fact, an increase in 20 parts per billion in 8-hour ozone lead to a eighty-three percent increase in school absences (as a result of acute respiratory illness). Results also showed that children with asthma who lived in communities with a relatively high level of nitrogen dioxide or particulate matter had more cases of bronchitis and increased, persistent phlegm production (Kunzli et al., 2003).

The results from the CHS provided insight into what the possible effects of air pollution on children really are. Although limited in the findings of the chronic effects of air pollution, the study has paved the way for further research in that regard. The results presented, however, suggest that immediate steps should be taken to reduce the levels of air pollution in the Los Angeles region in order to improve the respiratory health of children with and without asthma.

One way to reduce the level of air pollution is to reduce the amount of diesel exhaust emitted into the air. In 1995, the major sources of diesel exhaust emitted was estimated at 27,000 tons per year (ARB, 1998). Diesel exhaust is different from the exhaust emitted from automobiles because diesel releases particles at a greater rate. These particles are organic compounds such as aldehydes, alkanes, and nitro-Polycyclic Aromatic Hydrocarbons (PAHs). Of which, the latter has been shown to be mutagens and carcinogens, which are formed in the presence of nitrogen oxides. Diesel particles are mainly carbon and carbon compounds. In 1998, the California Air Resources Board declared diesel particulates to be a carcinogenic air contaminant. AQMD's "Multiple Air Toxics Exposure Study II" found that about seventy percent of the total cancer risk from all air pollutants in the Los Angeles area is a result of diesel particles.

In addition, research by the Health Effects Institute has shown that the number of particles emitted from a 1991-model engine was fifteen to thirty-five times greater than the number of particles emitted from a similar engine from 1988 despite the fact that the weight of total emissions was significantly reduced. This indicates that the technology improvements are simply making the emitted particles smaller, leading one to wonder whether the trade-off is worthwhile (ARB, 1998). Clearly, more research will need to be done to determine this.

However, what is known about the health effects of diesel exhaust is rather telling. In one experiment, human volunteers were exposed to diesel exhaust in a chamber for one-hour. The short-term effects the participants experienced included increased airway resistance and increased eye and nasal irritation. The non-cancerous long-term effects of exposure to diesel exhaust included higher incidence of coughing, extra phlegm production, and chronic bronchitis. For adults exposed to diesel exhaust through their occupations (and thus exposure is for a long period), reduced lung functioning, increased coughing, difficultly breathing, wheezing and reduced pulmonary functioning were some of the effects. The exhaust was also shown to aggravate allergic responses to pollen (ARB, 1998).

Experiments conduced with laboratory animals have also revealed the drastically adverse effects of diesel emissions. Although it must be noted that one cannot assume that the findings in lab animals are predictive of human responses to the same circumstances. There is evidence that diesel particulate matter are mutagenic in bacteria and mammals' cells and can cause chromosomal abbreviations and sister chromatid exchange in rodents and in human cells *in vitro* (EPA, 2002). Further, lab animals exposed to diesel exhaust had tissue damage in the lungs, specifically inflammation of the tissue.

Finally, a study was conducted to identify the potential for diesel exhaust to be deemed carcinogenic. It was shown that on average, long-term occupational exposure to diesel exhaust was associated with a forty percent increase in the relative risk of developing lung cancer. This result suggests a causal relationship between lung cancer and the exposure to diesel exhaust while working (ARB, 1998).

It is clear that air pollutants, including ground-level ozone, nitrogen oxides, carbon monoxide, particulate matter, and sulfur dioxide all contribute negatively to societal welfare, generally by means of poor air quality. The effect of air pollutants on an individual is a function of individual characteristics such as exposure time, and type of physical activity. However, it is notable that children are generally the cohort of the population that is most affected. Rigorous studies of the effects of diesel emissions have demonstrated, among other things, a causal relationship between occupational exposure to diesel emissions and lung cancer. Additionally, because diesel emissions contribute significantly to the overall level of air pollution, steps to reduce the amount of diesel emissions will result in healthier air quality for all of Los Angeles County.

2A. The Provisions of the Clean Air Action Plan

In November, 2006, the Ports of Los Angeles and Long Beach jointly issued their "Clean Air Action Plan," (CAAP) which proposes new requirements to reduce air pollutants stemming from port-related activity at SPB ports. The "control measures" listed in the plan cover ocean going vessels, cargo handling equipment in the terminals, and rail locomotives and other rail equipment. Perhaps the most significant (and costliest) proposals pertain to heavy-duty vehicles, the diesel trucks that call at the ports.

The Ports divide trucks involved in port drayage into two categories: those are frequent callers (seven or more trips to the ports per week) and semi-frequent callers (those making 3.5 to seven trips per week). The CAAP calls for frequent caller trucks model year 1992 or older to be replaced with trucks that meet 2007 EPA standards. Semi-frequent caller trucks model year 1993-2003 will be retrofitted to meet the CARB emissions standards.

Though it is not clear how the plan to retrofit and replace trucks will be implemented, it is clear that given the age distribution of trucks (with a median of model year 1995-1996) a large change in the port drayage industry is imminent. Possible implementation strategies outlined in the CAAP Technical Report include truck leases, government-backed loans, franchises, and the formation of a joint powers trucking authority. In addition to assessing the current financial situation of drivers (with a focus on truck financing), a goal of this study is to ask drivers about their preferred truck replacement scheme as well as their ability to share the costs of truck retrofitting.

3. WILLINGNESS TO PAY

Air quality is a public good, which does not have an explicit value that can be determined by a market. In fact, the market for air quality is completely lacking due to the nonexcludable nature of the good (Hanemann, 1994). Although there is no market for air quality, one can argue that individuals in a society value high air quality more than poor air quality. To quantify the latent value an individual is willing to pay (WTP), economists use contingent valuation surveys. A contingent valuation survey elicits responses from individuals on their preferences for social goods. One obvious advantage of contingent valuation models is that they are flexible enough to apply to all types of situations and public goods. A disadvantage, on the other hand, is that designing a proper model is difficult.

The method of conducting the survey, including the types of questions asked and how the survey is administered, is critical to obtaining reliable results. For example, surveys which contain open-ended questions, such as "What is the most you are willing to pay for good *x*?," generally, generate lower average WTP estimates compared to the case in which respondents are given discrete choice questions, such as "Are you willing to pay *y* dollars for good *x*?" (Hokby et al., 2003) One hypothesis for this is that our society is used to facing discrete choices in regular market transactions. That is, the price of a good is given and a consumer will either choose to purchase or not to purchase the good based upon the asking price. Likewise, in discrete choice surveys, if a price is given, the respondent will either be willing to pay or not willing to pay that amount for the good in question. One downside to discrete choice questions, however, is that it does not necessarily capture the exact amount one is willing to pay; rather it only suggests a maximum that one is willing to pay, so actual WTP estimates may be underestimated

If discrete choices are given to respondents, the survey should be examined for "order effects" where respondents might be bias towards the first item on a list. In the case of dollar amounts, this can be avoided by ranking the amounts from least to greatest. In other cases, randomizing the order of the list across respondents will eliminate any possible "order effects."

WTP estimates are generally more meaningful when a respondent is knowledgeable or has prior experience with the topic in question (Willis et al., 2005). It is also true that respondents provide more meaningful responses when there exists incentive-compatible situations for the respondents. Thus, if a respondent is affected by the policy in question and/or if the respondent views their response as affecting the outcome of the policy decision, then the situation is considered incentive-compatible, and respondents are more likely to elicit meaningful responses.[3.] This may be true since responding to surveys requires time and effort, and those that do not perceive a direct benefit to themselves will respond with an "acceptable" answer rather than formulating a more thoughtful answer.

Further, an informed respondent is one who knows the benefits and negative externalities of a public good, and it therefore becomes easier for the respondent to accurately assess the maximum amount he/she is willing to pay for a good. Research has also demonstrated that informing respondents of the negative externalities of a good on society prior to surveying has a higher impact on the marginal WTP estimate than does informing respondents of the societal benefits of the good (Marette et al., 2004) That is, people respond more to the harm a good can cause than to the benefits that good may bring to society.

The rhetoric of the survey also can influence responses. Posing a question with wording such as, "would not allow" versus "forbid," will likely result in different responses because these phrases have subtlety different meanings. Further, price sensitive respondents are likely to respond differently to "higher prices" than to "higher taxes." For this reason, it is important that surveys be written in clear, unbiased language as to maximize the likelihood of respondents interpreting the questions with the same meaning as the investigators intended.

One benefit of contingent valuation surveys is that people are generally not required to recall things from the past. Therefore, situations that require people to use various strategies of remembering the past are, for the most part, avoided. Further, the validity of WTP techniques has been verified. This involves confirming the validity of the content, criterion, and construct of the contingent valuation models (Philips et al, 2006).

Contingent valuation models have been shown to yield consistent WTP values over time and also exhibit a high correlation at the individual level. That is, the validity of WTP techniques with respect to criterion has been shown to hold. Economists have conducted experiments to compare actual behavior with WTP predictions generated from contingent valuation models. In most cases, it has been shown that the difference between these two is statistically insignificant with WTP estimates generally lower than the real transaction price accepted by individuals.

Economic theory says that an individual's beliefs condition preferences, which in turn condition reservation prices. In addition, economic theory predicts a positive scale effect; that is, reservation prices will increase when the perceived benefit of the good increases. An experiment conducted by Philips, Whynes, and Avis (2006), which tested women's WTP for cervical cancer screening programs, confirm that the WTP estimates support the construct validity of the WTP technique.

The demographic characteristics of the respondents also play a significant role in the WTP responses that are generated. For instance, gender and parental status play a role in determining WTP for social goods. In a study assessing the role that children play on parental WTP for environmental goods improvement, it was found that parents of either gender have higher WTP than non-parents. It was also shown that fathers have a higher average WTP for environmental improvements than do mothers, possibly because of better outdoor recreational opportunities for fathers. Finally, WTP estimates for childless-males were significantly greater than childless-females (Del Saz-Salazar and Garcia-Mendez, 2001). Thus, when analyzing the responses, one should be aware of the gender and parental status of the respondents.

In another study, which aimed to estimate WTP for environmental improvements in a large city, the investigators used a contingent valuation model to assess the validity of the Spike Model. The Spike Model is used when there is a high proportion of zero responses for WTP. With this model, individuals are allowed to choose a WTP equal to zero; and respondents are asked whether or not they are in the market for the public good, and if so, to suggest a specific price. Results from this study found that income was positively correlated with a higher WTP, while age was negatively correlated with WTP. Further, a higher educational level of the respondent resulted in a higher WTP estimate and the willingness or reluctance of the respondents to participate directly affected their WTP. The researchers did find that aggregating the individual WTP amounts is rather controversial because several assumptions had to be made that may be problematic. However, the general conclusions from the study found that the Spike Model is the most suitable given a high number of zero responses, meaning that society may not be in the market for the public good, and the Spike Model also resulted in robust estimates of the mean WTP which were verified by a non-parametric approach 9Hokby and Soderqvuist, 2003).

Although contingent valuation models may be innately flawed by the nature of eliciting responses from individuals by means of a survey, it has been shown that if the survey is conducted in a careful manner, results are consistent with actual behavior and statistically significant. Additionally, the extensive research on contingent valuation models already conducted has yielded a number of econometric methods that may be applied to anomalies in the data. Further, the demographic characteristics of the respondents in prior contingent valuation studies have shown tendencies in the WTP estimates to be either significantly higher or lower than their counterparts. In closing, it is important to note that contingent valuation models have become widely accepted in practice as a method of estimating consistent and reasonably accurate WTP amounts for public goods.

4. DESCRIPTION OF DATA SET

The data set used for our analysis was collected through self-administered surveys with truck drivers at the catering trucks outside three different terminals at the Ports of Los Angeles and Long Beach. Surveys were conducted during both lunch time (11:30am – 1:30pm) and dinner time (4:30 – 6 pm) on week days during a two week span in December. Potential respondents were approached and requested to complete a ten minute confidential survey for which they would receive a payment of $10 cash. If the respondent agreed, they were asked whether they preferred the survey in Spanish or English. The response rate was roughly 66 percent and the final data set consists of 197 observations. Before examining the pay, expense and willingness-to-pay data on these drivers, we first provide an overview of the driver demographics.

4A. Demographics

The average age of drivers is 38.7 years (with a median of 39 years). The mean number of years as a driver is 8.7 years, with a median significantly lower, 6 years. Over three-quarters (78.8 percent) are married and have an average of 2.31 children. As was found in prior studies, the majority of drivers are Hispanic (91.2 percent), with 5 percent of drivers reporting African American, 1 percent reporting Asian, and 2 percent reporting White as race. Fifty-six percent of respondents reporting being U.S. Citizens. The mode level of education is less than a high school degree (48.7 percent), with 33 percent reporting a high school degree as their terminal level of education, 16.5 percent with some college education (including vocational or technical school) and 1.5 percent with a college degree or higher level of education.

TABLE 1: Truck Driver Demographics

Variable	Mean	Standard Deviation
Age	38.663	8.450
Year as Driver	8.712	7.009
Variable	**Category**	**Percent**
Race	White (non-Hispanic)	2.06%
	Black	5.15%
	Asian	1.55%
	Hispanic	91.24%
Education	Less than a high school degree	48.70%
	High school degree	33.16%
	Some college	16.58%
	College degree or higher	1.55%
Marital Status	Married	78.76%
	Single, separated, divorced, widowed	21.24%

4B. Work Lives

Over three-quarters (78.5 percent) of drivers reported working as owner operators. The median driver reports working five days per week, with the mean slightly higher at 5.3, implying that a number of drivers work six or even seven days per week. Twenty-five percent of drivers report working six days per week. It is rare for drivers (port drivers or otherwise) to work a "standard" forty hour week. The drivers in the sample average 57.7 hours per week with a median of 60 hours. This is key, since under the Federal Hours of Service (HOS) regulations, drivers are limited to 60 hours of work in a seven day period (work time includes both driving and non-driving time – such as waiting time). Ten percent of drivers report working 72 or more hours in a typical week. According to these statistics, though port drivers are less likely than long haul truck drivers to violate regulations, more than ten percent of them significantly exceed the mandated maximum hours of work.

We also asked drivers about the number of hours they work in a typical day. Again, this measure includes both driving and non-driving work time. Under HOS regulations drivers are limited to 14 hours of work in a 24 hour period. As with the weekly hours limit, most drivers appear to be in compliance with this regulation. Drivers in the sample average 13.25 hours per day, with a median of 12 hours. One-quarter of drivers work ten or fewer hours per day, however, on the other end of the spectrum, ten percent work 15 hours or more per day.

TABLE 2: Hours Per Week

Mean	57.76
Standard Deviation	12.05
10th percentile	45
25th percentile	50
50th percentile	60
75th percentile	60
90th percentile	72

Given that the bulk of drivers haul containers within the Southern California region, it is not surprising that their annual miles are very similar to non-port local drivers. They report an average of 1179 miles per week (with a median of 1000 miles). On an annual basis, drivers report a mean of 63,188 miles. The median is significantly lower at 50,000 miles.

4C. Earnings and Expenses

Drivers were asked to report their weekly gross earnings. For owner operators these are their earnings before expenses for fuel, insurance, truck payments, and maintenance are deducted. The mean and median reported weekly gross are similar to one another at $1596 and $1500, respectively. Assuming 50 weeks worked per year, this would be equivalent to an annual gross of $75,000 per year for the median driver. Scaling down to an hourly wage, at a median of 60 hours per week and a gross of $1500 per week, an estimate of the median driver's hourly gross is $25 per hour. For employee drivers, the weekly gross would be equivalent to their weekly net, as they should not be carrying the truck expenses. The median employee driver reported weekly earnings of $800, corresponding to annual earnings of $40,000.

It is difficult to compare the earnings of employee drivers to owner operators since the owner operators are reporting what is essentially the weekly revenue of their businesses. We asked owner operator drivers a series of questions about their expenses over different lengths of time: diesel expenses were reported for a typical week, truck insurance and truck finance payments for a typical month, and truck maintenance for a typical year.

The median driver reported paying $450 per week for diesel and the mean was higher at $500 per week. Combining these figures with the weekly grosses reported above, it appears that approximately 30-33 percent of a drivers gross pay is devoted to fuel expenses. The mean and median for monthly truck insurance premiums are $606 and $600, respectively. There is considerably more dispersion in the distribution of annual truck maintenance costs. The mean is $7044 and the median is $5000. We would expect this dispersion due to the considerable dispersion in the distribution of truck model years (presumably a major factor in the amount of maintenance a truck would need). The mean truck model year is 1995 with a median of 1996. The oldest truck was from 1974 and the newest from 2006. The oldest 25 percent of trucks were from 1994 or earlier. Seventy-five percent were from 1998 or earlier.

Figures 1 and 2 display the distributions of both current truck age and age at purchase.

Figure 1: Truck Age Distribution

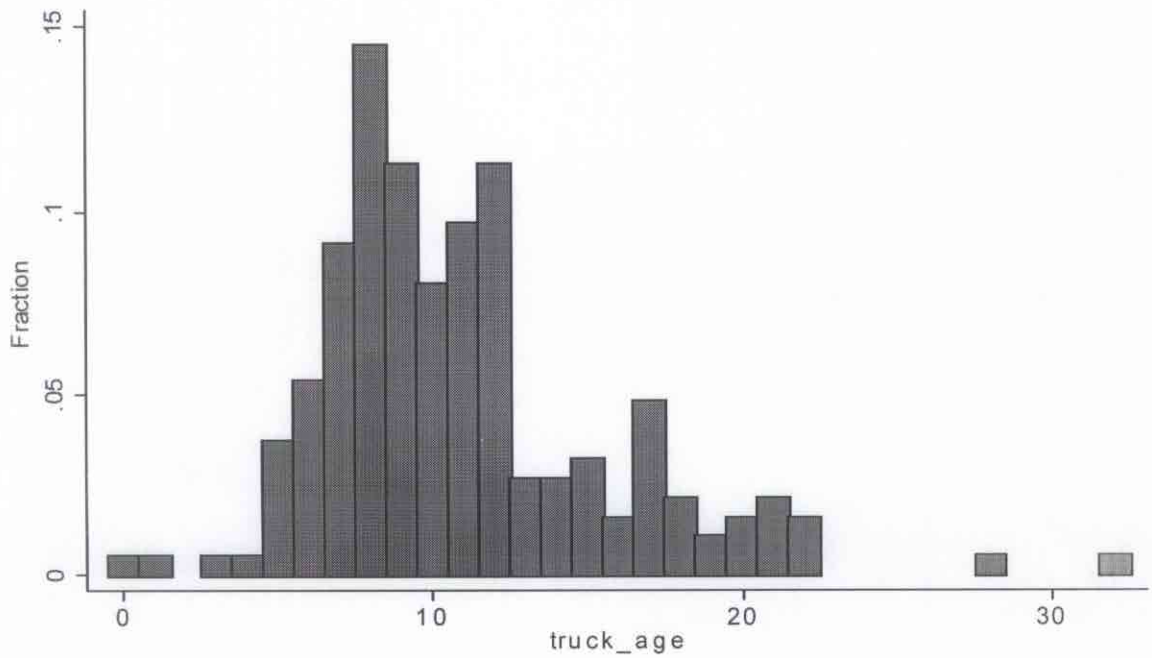
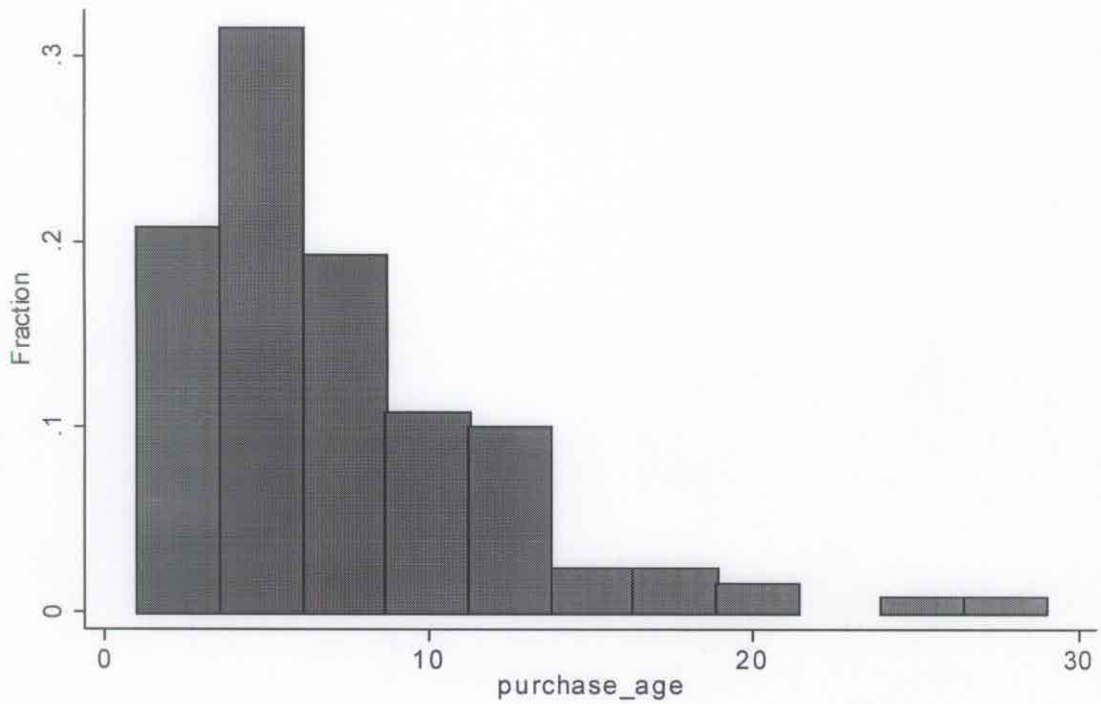


Figure 2: Truck Age at Purchase



The average driver reported owning his current truck for five years, with a median of four years. Three-quarters of drivers had been driving their trucks for 6 years or more. The fact that drivers are primarily using trucks from the mid-1990s but have not owned them very long makes is clear that drivers are buying used trucks. In fact, the average driver in the data set purchased a truck that was 7 years old. One-quarter purchased a truck that was 9 years old (or older) and 10 percent purchased a truck that was 13 years old (or older).

The means of financing these trucks varies considerably. The mean price paid for a truck was $24,177 (this figure is not adjusted for inflation). Nearly one-half (47 percent) of drivers report financing the purchase of their truck through a loan from a bank or other financial institution; 7 percent report that they received financing through a trucking company; 4 percent received financing from the truck manufacturer; 17 percent received a loan from family or friends, and 24 percent report paying cash for the purchase of their truck. Among those who financed their truck, the interest rates were rather high – a mean of 14.7 percent and a median of 14 percent. Many drivers had paid off their truck. The median driver had a monthly payment of $0 and no months remaining on their truck loan. Among those still paying for their trucks, the mean monthly payment is $892.

Given the data on income and expenses, we can estimate weekly net earnings of owner operator drivers and compare those to the weekly earnings of employee drivers. The mean weekly net income is estimated at $731 and the median is close to this figure ($738). Again, assuming a driver works 50 weeks per year, this corresponds to annual income of $36,550 for the median driver, approximately $3000 less than the estimated annual earnings for employee port drayage drivers. It should be noted that though we have deducted the major truck expenses for drivers, these figures have *not* deducted *all* truck driver expenses from the gross.

The advantage of these annual estimates as a measure is that they incorporate the detailed questions on expenses by component (fuel, insurance, maintenance, monthly truck payment). We also asked owner operators to report their earnings over the past 12 months net of truck expenses. The mean net annual income reported is $34,749, with a median of $32,543. The fact that these numbers are closely correlated gives us a sense of the reliability of the estimates. Taking the median figures from the annual estimate ($36,550) and the reported annual net ($32,543) and given that the median driver reports working 60 hours per week, we can estimate an hourly wage (again, assuming a 50 week work year). The median hourly wage would be $10.85 at the lower bound and $12.18 at the upper bound, assuming no overtime pay.

4D. Drivers' Reactions to Pier Pass

We conclude this section with a brief analysis of drivers' perceptions of how PierPass has affected their worklives. PierPass is a program intended to increase the amount of freight moving at "off-peak" hours and accomplishes this through a fee imposed on containers moving during peak hours. We first asked drivers whether they tended to drive peak or off-peak. Over three-quarters of drivers report driving mostly or only during peak hours and 23.7 percent report driving mostly or only during off-peak hours.

We next asked drivers whether they felt PierPass increased the number of hours they worked over a typical day and whether their earnings had increased as a result of the PierPass program. Sixty-two percent of drivers reported working more hours and 46 percent reported an earnings increase as a result of PierPass.

TABLE 3: Opinions on PierPass

	Yes	No
Are you earning more income since the ports started opening earlier and closing later?	46.39%	53.61%
Are you working more hours since the ports started opening earlier and closing later?	62.03%	37.97%

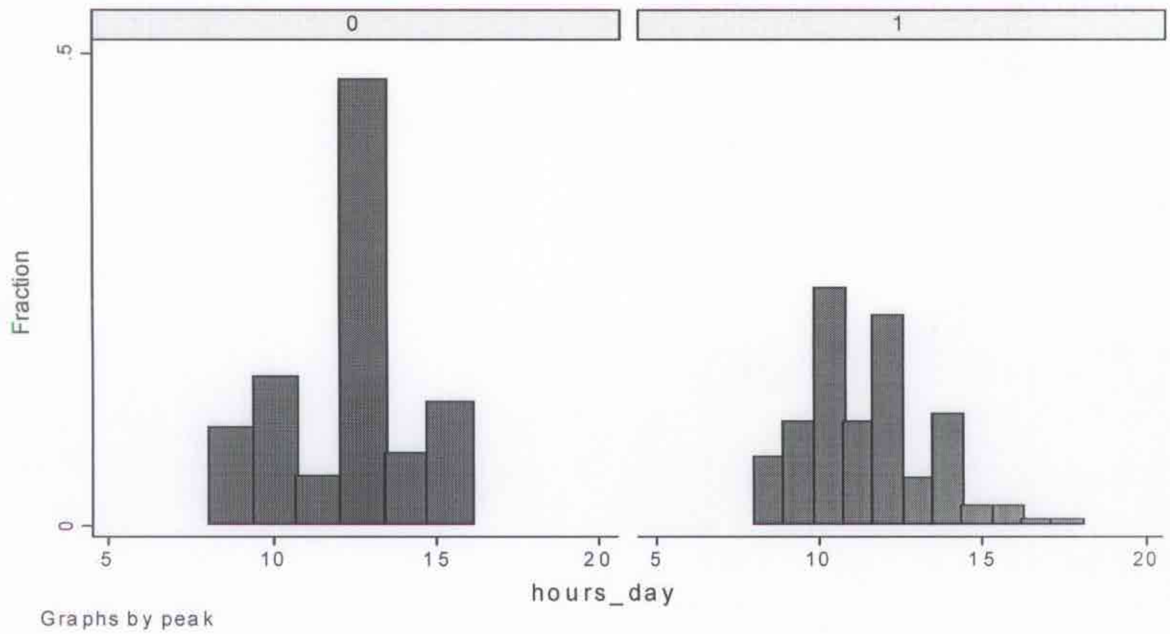
Perhaps more interesting is a table that breaks down the distribution of the responses to each of these questions to display joint probabilities. Table 4 displays these joint probabilities and demonstrates that the bulk of the respondents who state they are earning higher income as a results of Pier Pass are also working more hours.

Table 4: Joint Probabilities of Pier Pass Reactions

	More Work	Not More Work
More Income	36.8%	11.4%
Not More Income	25.4%	26.5%

Figure 1 displays the distribution of hours of those working off peak (the left graph) and peak (the right graph).

Figure 3: Distribution of Daily Hours by Peak and Off-Peak Designation



It is evident from this graph that though there is a greater dispersion in hours of those who primarily driver during peak times, however, there is also a slightly higher mean number of hours for those who drive off-peak. The likelihood of violating the 14 hour work limit under the Federal Hours of Service regulations is slightly higher for those who work off-peak.

5. TRUCK RETROFITTING AND REPLACEMENT

Given that one of the key provisions of the Clean Air Action Plan is to require that trucks that pick up/drop off freight from the SPB ports meet 2007 emissions requirements and given that the median truck model year in our data set is 1996, it is clear that there will be significant changes in the capital required to operate in port drayage. In most cases, drayage drivers and/or firms will be required to replace their trucks with newer models. In some cases, late model trucks may be retrofitted to meet 2007 emissions standards.

5A. Truck Replacement

We first examine truck drivers' reactions to potential scenarios for truck replacement. There are extant programs designed to facilitate truck replacement, notably one funded by the Gateway Cities program. This program provides a grant to fund a significant portion of the cost of a late-model truck. It does require a financial contribution from the driver. Conversations with drivers and drayage companies suggest that some drivers do not take advantage of this program as it requires drivers to sign a contract stating that they will continue to drive at the SPB Ports and also requires the drivers to pay tax on the value of the grant. Given the relatively low margins under which drivers operate, it is not surprising that drivers cannot afford to participate in this program.

We provide drivers with four hypothetical scenarios and ask them to rank them (1-4 with 1 as the first choice). This posed a challenge with many drivers who initially did not want to rank the questions since they did not want to assign a rank to options that they would never take. So, when interpreting these results, it is important to note that a "one" for one driver may not indicate that the driver would actually choose this option. As with all ranking questions, it is also important to note that given the heterogeneity of preferences, a "one" for a particular driver may not be of equal value as a "one" for another driver. Also, the difference in valuation between ranks is not constant. For example, the difference between a "one" and a "two" is not equivalent to the difference between a rank of "two" and "three," or "three" and "four."

The question is written as follows:

> "Please assume you will be required to drive a truck that is at least model year 2007 in order to enter the ports. Suppose the price of a 2007 model year truck is $50,000. There are various ways to acquire this truck. Please rank the options below:
>
> a. participate in a grant program that will give you $37,500 towards the cost of the truck. You will have to pay $12,500 for the truck and must sign a contract that states you will continue tto drive your truck at the ports for the next 5 years.
>
> b. Lease the truck for 36 months. You will not be required to sign a contract stating that you will continue to drive your truck at the ports.
>
> c. Purchase the truck at a low interest rate (2% APR). In order to receive this low interest rate, you must sign a contract that states that you will continue to drive your truck at the ports for the next 2 years.
>
> d. Purchase the truck at an interest rate of 10%. You will not be required to sign a contract stating that you will continue to drive your truck at the ports.

It should be noted that this scenario is not intended as a realistic depiction of the cost of 2007 trucks. Though 2007 trucks are new to the market now, when the requirement for drivers to operate 2007 model year (or newer) trucks is implemented in 2011, there will obviously be a market for used trucks. This scenario implicitly assumes that the driver is receiving a late model truck at some point in the future.

The rankings will be analyzed in two ways. First, for each possible response (a-d) we analyze the distribution of rankings. Second, for each ranking (1-4) we analyze the distribution of the responses.

TABLE 5: Drivers' Rankings of Truck Replacement Alternatives (distributions by alternative)

Ranking	A	B	C	D
1	48.8%	8.4%	34.5%	9.1%
2	15.5%	16.8%	45.2%	22.9%
3	16.1%	32.9%	14.3%	36.1%
4	19.6%	41.9%	6.0%	32%

TABLE 6: Drivers' Rankings of Truck Replacement Alternatives (distributions by ranking)

Program	1	2	3	4
A	48.2%	15.3%	16%	19.4%
B	8.2%	16.5%	32.5%	41.2%
C	34.1%	44.7%	14.2%	5.9%
D	8.8%	22.4%	35.5%	31.2%

Option"a," the subsidized truck replacement had a large number of "1" rankings. It is notable, however, that the distribution of responses for this option had a large number of "4" rankings as well. The lease option is perhaps the least popular program as it has the higher percentage of "3" and "4" rankings. This is somewhat logical as an owner operator would technically no longer be an "owner" under a lease program – perhaps reducing the "entrepreneurial" aspect of the job for the driver. Option "d", a "traditional" truck purchase program also has a large percentage of "3" and "4" rankings, though it also has the second most frequent occurrence of "2" rankings. A program that has not widely been considered, but appears to resonate with drivers is option c, the low interest loan option. This option has a higher percentage of "1" and "2" rankings than the grant-based truck replacement program.

The last finding is important as there is currently an assumption by many parties that the truck replacement program under the CAAP will have to be funded either through government funds or through fees assessed on cargo passing through the SPB ports. Under either of these models, a subsidized truck loan program has the potential to spread the cost of the program over more years and to potentially cost less than a a grant-based program.

5B. Truck Retrofitting Program

As previously mentioned, truck retrofitting will also be a possibility under the CAAP, however, retrofitting is only viable for late-model trucks. We ask drivers about their willingness to pay for a device that would retrofit their truck to reduce emissions. The scenario set forth is not intended to represent any particular retrofitting device, but is intended to assess drivers' ability/willingness to pay for cleaner trucks. The question is presented below and the distribution of responses follow:

> Assume that you are required to retrofit your current truck with a device that would decrease pollution. This device would not affect the fuel efficiency of your truck. The price of this device is $16,000. Suppose the State of California will help you pay for some of this device.
>
> Could you afford to pay…
>
> a. $4,000 for this device? Yes No
> b. $8,000 for this device? Yes No
> c. $12,000 for this device? Yes No

TABLE 7: Drivers' Willingness to Pay for Retrofitting

	Yes	No
$4,000	34.6%	65.4%
$8,000	7.6%	92.4%
$12,000	2.2%	97.8%

For those who answered "no" to all three options, they were asked to report the price they could afford to pay. Over one-half (104) drivers answered no to all three scenarios. Many drivers reported that they could afford to pay $0 for the device. The 10th and 25th percentiles are both $0. The mean amount a driver reported he would be able to afford is $569, with a median of $200. The 75th and 90th percentiles are $1,000 and $2,000, respectively.

6. MODELS OF RETROFITTING AND REPLACEMENT PREFERENCES

We are interested in what factors affect a driver's preferences for different replacement programs as well as their willingness/ability to pay for retrofitting. We start first with a model of retrofitting. We define four categories of willingness/ability to pay in accordance with the values presented to the drivers in the survey: \$0-\$3999, \$4000-\$7999, \$8000-\$11,999, and \$12,000. Since we do not have continuous values for willingness to pay, we cannot use linear regression, however, since we have a discrete choice variable with a clear order to them (in terms of willingness to pay) we use an ordered probit to estimate the relationship between willingness to pay and the explanatory variables.

The initial explanatory variables include controls for education, years of experience, pay, truck model year. We would expect that those with more education might be more willing to retrofit their truck since they might know more about the health hazards associated with pollution. The same might be said of drivers with more years of work experience, though since years of work experience is highly correlated with age, there might be age effects captured in the estimated coefficient. Those who earn more income should be able to retrofit their trucks. The relationship between willingness to pay for retrofitting and truck model year is not clear. On the one hand, those with a newer truck likely have higher expenses and, therefore, may not be able to afford to pay as much for retrofitting. On the other hand, drivers who buy newer truck might do so since the truck is cleaner and may place more importance on reducing pollution.

We also include controls for number of children, whether the driver has a family member who suffers from a respiratory ailment, and whether the driver regularly shuts off his engine when idling for more than 15 minutes. We anticipate a positive relationship between all of these variables and the willingness to pay for retrofitting. After estimating the equation, we find that the education variables are singly and jointly insignificant and eliminate them from the model due to concerns over degrees of freedom (which forces us to adopt a parsimonious specification). We also tried alternate specifications with controls for other personal characteristics (such as race and marital status) and eliminated them from the model. The results of the final estimation are presented in Table 7.

TABLE 8: Willingness to Pay for Retrofitting – Ordered Probit Results

Variable	coefficient	p-value
Net annual pay	0.0000141	0.001
Model year	0.0854888	0.009
Years as a driver	-0.0520264	0.024
Number of children	-0.0945045	0.303
Lung disease	-0.4392527	0.197
Turn off truck when idling	0.6343316	0.180
Number of observations	134	
Likelihood Ratio	28.09	0.0001

As is evident from the table, only three variables have statistically significant coefficients. As hypothesized, higher pay is associated with higher willingness to pay for truck retrofitting. Model year is also positively related to willingness to pay for retrofitting. Years as a driver, however, are negatively related to willingness to pay for retrofitting. This would imply that drivers with more experience are less willing to retrofit. This might reflect changing attitudes in trucking or it may reflect the relationship between age and years of experience (and reflect that younger people – drivers and non-drivers – are more willing to pay for pollution reduction).

We next attempt to model the factors that affect the ranking of different truck replacement programs. Though there is considerable information obtainable from the relative rankings of programs (see Tables 4 and 5), we focus on the programs that each driver ranked first. The estimation technique used is multinomial logit, where the dependent variable is the program that was given a "1" ranking. The base group in this study is the grant program, so the coefficients given on each of the variables are interpreted as the effects relative to the base group of a grant-based truck replacement program (similar to the existing Gateway Cities Program). Our explanatory variables are age, weekly net pay, the net/gross pay ratio, and whether the driver paid cask for their truck (the base group is financing the truck any other way).

We are relatively agnostic regarding the signs of the coefficients relative to the grant-based program, but have included variables to measure risk preference and relative financial performance of the driver. Not previously analyzed in this report, the net/gross ratio is the ratio of net annual pay to gross annual pay. For drivers with higher annual expenditures (truck payments, insurance, maintenance, diesel) this ratio will be lower. The results of the estimation are presented in Table 8.

TABLE 9: Multinomial Logit of Replacement Program Ranking

	Relative Risk Ratio	P-value
Truck Leasing Program		
Weekly Net Pay	1.001437	0.137
Net/Gross Ratio	0.05321	0.066
Age	0.985616	0.741
Paid Cash	0.647801	0.706
Subsidized Interest Rate Program		
Weekly Net Pay	1.000653	0.383
Net/Gross Ratio	0.131339	0.167
Age	1.047463	0.097
Paid Cash	2.526649	0.086

No Subsidy Program		
Weekly Net Pay	1.00082	0.421
Net/Gross Ratio	0.189718	0.428
Age	1.139553	0.007
Paid Cash	1.656745	0.555
N	106	
Likelihood ratio	20.89	0.0520

As the coefficients are given as relative risk ratios, coefficients greater than one increase the relative probability of ranking a certain program first, relative to the grant replacement program and those with coefficients less than one have decreased probability of being ranked first. Drivers are more likely to rank the truck leasing program first if they have lower net/gross ratios. Given that these drivers are less "profitable" it would make sense that they would be more willing to choose a program that does not come with truck ownership and should be associated with lower costs.

Older drivers and those drivers who paid cash for their trucks are more likely to rank a subsidized loan program first, relative to the grant program. Older drivers are also more likely to prefer a "no subsidy" program relative to the grant replacement program. These two findings may reflect that older drivers are more skeptical of the grant program and prefer a program that allows them to finance the replacement of their truck.

7. CONCLUSIONS AND RECOMMENDATIONS

Recently more attention has been focused on the economics of port drayage. Much of this has come as the result of the provisions of the Clean Air Action Plan, which will require that truck drivers who frequently call at the San Pedro Bay ports drive trucks that meet 2007 EPA standards. Given the relatively low pay of drivers (net pay ranges from $32,000 to $36,000), it is unlikely that owner operators will be able to purchase new trucks without any assistance. Attention has thus been focused on the potential ways to restructure port drayage to ensure that cleaner trucks are used while maintaining adequate labor force to move freight.

The purpose of this study is to quantify the current working conditions of drivers at the SPB ports, with a focus on truck financing. We also ask drivers about their preferences regarding truck retrofitting and replacement. While we find that many drivers are amenable to grant-based truck replacement programs, many also have a stated preference for interest-subsidized loans. Based on these results, we would recommend that policy makers consider these preferences when establishing truck replacement programs. While little attention has been paid to interest-subsidized loans for drivers, it is clear that these might be a way to smooth the considerable costs associated with truck replacement (whether these costs be borne by shippers or taxpayers). We also note that drivers exhibit a willingness to financially contribute to truck retrofitting programs.

8. IMPLEMENTATION

We would encourage the use of these results in conjunction with other studies as the basis for further research into the anticipated results of clean air policy implementation at the San Pedro Bay ports. As the parameters of the Clean Trucks Program are still unresolved at the writing of this final report, it is clear that there is a great deal of uncertainty regarding the optimal way to regulate port drayage. We would propose that policy makers consider the willingness to pay and ability to pay as well as drivers' preferences as outlined in this report. To our knowledge ours is the only survey that contains detailed information on drivers' work and earnings, as well as their preferences and, therefore, should be used as one tool to assess proposed regulation and the anticipated impact on the labor market.

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