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Environmental Implications of Trade Liberalization on North American Transport Services: The Case of the Trucking Sector

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Environmental Implications of Trade Liberalization on North American Transport Services: The Case of the Trucking Sector

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Abstract

The paper offers an assessment of the environmental impact of trade liberalization on the cross border trucking sector in North America. Specific policies in the realm of transportation, environment and trade are investigated with data directly related to the time of implementation that varied across ports on each of the two international borders in North America subsequent to NAFTA. The data of truck flows, wait times, air quality, trade value is analyzed using econometrics for quantitative analysis. Results show various policies do indeed have a positive impact on reducing air emissions through changes in trucking characteristics (technology, patterns) in particular ports where they have been implemented.

Introduction

Chapter 12, Section 2101(2) of the North American Free Trade Agreement (NAFTA) addresses crossborder trade in services such as commercial trucking. How does trucking contribute to the correlation of air pollution at border ports relative to other traffic flow? How does it contribute to trade under NAFTA? What policies are effective at mitigating trucking delays, congestion and air pollution problems at the border ports? This paper provides answers to these questions through econometric analysis using relevant data.

No other service sector is likely to contribute more to the economic and productivity growth of NAFTA countries than the trucking service industry. It accounts for most of the cross border trade in North America, representing more than 81.9% of the value of trade between the U.S. and Mexico and 65.7% between the U.S. and Canada in 2004. Shortly after NAFTA was implemented through 2000, truck exports into the U.S. increased 107% to about $87 billion, and truck exports to Mexico in the same period increased 134% to about $82 billion. (Joint Working Committee, 2004). The number of trucks has increased to parallel the trade flow increase. The share of gross domestic product for trucking that includes storage is approximately 4% for Mexico, 1.5% for Canada and 1.2% for the U.S. (U.S. DOT, 1998).

In 1995 the size of the truck fleet was 2,750,000 and increased above 4,400,000 in 2000 (Joint Working Committee, 2004). From 1995-2005, the number of trucks crossing into the U.S. from Canada and Mexico increased 47% from 8 million in 1995 to 12 million in 2005 (Joint Working Committee, 2004). The 6.7 million truck crossing with 6.8 million containers from Canada resulted in Michigan (mainly Detroit with 1.7 million and Port Huron with the remaining) handling 2.7 million and NY handling 1.9 million (Joint Working Committee, 2004). Of the 12 million truck crossings into the U.S. in 2005, 11 million empty and loaded containers were transported. Michigan had the largest amount of truck crossings of 2.7 million on the Canada-U.S. border and Texas had 3.5 million with 3.1 million containers on the U.S.-Mexico border (Joint Working Committee, 2004). Detroit had 1.7 million truck crossings from Canada valued at $130 billion and Laredo had 1.5 million crossings from Mexico. In terms of weight and value, Laredo had $67 billion in cargo value weighing 12 million tons in 2005, representing 28% of the total $790 billion in NAFTA trade that year (Villa et al, 2007).

Diesel engines of trucks are diesel engines in trucks are believed to be the major source of elemental carbon in the atmosphere (Shah et al. 2004). Trucking contributes 83 percent of nitrogen oxide (Nox) and over 90 percent of the other pollutants. Diesel vehicles contribute to ambient particulate matter (PM), Nox and ground level ozone. Trucks and vehicles (buses) with gross vehicle weight of 8,501 pounds or greater are classified as heavy duty. The U.S. EPA estimates that by 2007 heavy duty diesel vehicles will account for 28 percent of mobile source Nox emissions and 20 percent of mobile source PM emissions.(1) Truck idling at the border is responsible for 6.2 percent of carbon monoxide (CO) emissions from trade, second only to Laredo-Nuevo Laredo crossing in this percentage(ICF, 2001)

Diesel engines are a significant source relative to other sources for pollutants that many border cities are classified as nonattainment for exceeding the air pollution standards set nationally. Emissions of Nox from on-road diesel vehicles are almost twice that of the second most significant source of emissions (light duty gas vehicles and motorcycles), while emissions of Pm10 and Pm 2.5 from on-road diesel vehicles are equal to emissions from all non-diesel vehicles combined. On the Mexican side of the U.S. –Mexico border heavy diesel vehicles account for 33 percent of Nox emissions from mobile sources. (Mexico Joint Working Committee, 2004).

The objective of the proposed research is to assess the environmental impact of trade liberalization on the cross-border trucking sector in North America, using econometrics to complement. The first section describes the U.S., Canadian and Mexican trucking services industry. Next, a methods section and a data section indicate the components of the quantitative analysis to investigate trucking at the U.S.-Canada and U.S.-Mexico borders, that will measure the trucking sector impacts to traffic and trade flow as well as environmental impact to air along international borders in North America.

The final part of the research will draw from results of sections 1 and 2 to evaluate the environmental impact of the liberalization of trade in the trucking sector under NAFTA. Attempts are made to draw upon port specific differences between both the U.S.-Canadian border and the U.S.-Mexican border in terms of the timing of implementation of policies and any changes that resulted in terms of trucking and air quality.

The characteristics of the transportation fleet such as age, vintage, engine and fuel is related to emissions and ambient air pollution. Canadian and U.S. trucks differ from Mexican trucks in terms of average age of vehicles, engine type and emissions factors. For the U.S. and Canada in 2005, the median age of the entire truck fleet, including light-duty trucks was 6.8 years. The Mexican truck fleet appears more than 10 years old. Approximately 2/3 of the Mexican fleet is comprised of trucks manufactured before 1993. Most engines from 1993 or after use electronic fuel injection and computer controls to reduce emissions as well as improve fuel economy and performance. More than 25 percent of the Mexican drayage fleet consists of trucks manufactured before 1980 and these trucks are indicated in high levels of Nox and PM emissions. The short distance that trucks travel (only up to 20 miles on the other side of the border) is one reason why the drayage fleet is older.

The U.S. and Canadian trucking service markets have been harmonizing since the 1970s, and there are arrangements between Mexico and Canada, for hauling their respective merchandise, to traverse the U.S. as long as they meet regulations without loading or unloading in the U.S. There had been a ban on both U.S. and Canadian carriers into Mexico until 1996 which involved Mexican drayage moving a trailer that would be left on the U.S. side by either U.S. or Canadian carriers at a staging area (Chow, 2002). U.S. and Canadian carriers can now operate with a Mexican partner within within a 12 mile zone arranged by the SCT (Chow, 2002). Regional markets are significant where there are binational relationships in shipping liberalization between Canada in the U.S. such as in the Great Lakes area through the largest port of Detroit for the Canada-U.S. border (Transport Canada, 1998). The National Transportation Agency (NTA) in Canada indicated that U.S. carriers have freely entered the Canadian trucking market ,accounting for 28.5% of the license applications as early as 1992 (Chow, 2002).

There have been continued restrictions on Mexican trucks entering the U.S. despite NAFTA section 2101(2) for liberalization of cross border services. The section indicates dates such as January 2001 when U.S. investors could own up to 51% of a Mexican fleet that handles international traffic and January 2004 when Mexican investors would have the same rights in the U.S. (Chow, 2002). Other than five Mexican carriers grandfathered into the law, the other Mexican carriers are limited to operation in a 20-mile commercial zone. The five Mexican carriers that were grandfathered in received operating permission prior to the Bus Regulatory Reform Act of 1982 and were already operating within the U.S. as are trucks using U.S. roads as a "land bridge" to Canada and those with U.S. citizens as majority owners such as those servicing the maquiladoras along the border (Stolz, 2005). Until such barriers are lifted, line-haul (long-haul) trucks which are vehicles that move freight between cities, excluding delivery service in the U.S. and Mexico are used to carry freight to terminals in the border region. Drayage trucks are then used to pull trailers across the border to transfer stations. Line haul trucks then pick up the trailers on the other side of the border to carry the freight to its ultimate destination. Drayage trucks are stopped as many as eight times when crossing the border. They are also notorious for their failure rates at U.S. inspection stations, such as 36-50% between 1996-1999 (Stolz, 2005).

A similar process occurs with shipping from Mexican maquiladoras close to the border except that drayage vehicles take products directly from the maquiladoras across the border to transfer stations on the U.S. side or back to the maquiladoras. The drayage trucks used to cross the border are mostly Mexican owned and older than line-haul trucks, and tend to produce higher emissions per mile. The Mexican drayage fleet is estimated to be approximately 55 percent 1993 vintage or older trucks and 25 percent pre-1980 vintage trucks. (Zietsman et al, 2005).

Based on simulations using the vintages described above and the U.S. MOBILE 5 model, the ICF calculated truck emissions factors to indicate differences between U.S. and Mexican fleets. The ICF report found that there is a 51% difference between U.S. trucks and Mexican line haul trucks in Nox and PM10 emissions and for VOC, a 42% difference and a 12 percent difference for CO. There is no different for CO2 emissions. These differences were noted from grams of pollutant per mile on the freeway. Also, in investigating idling emissions, they looked at grams per minute and found the following. Mexican drayage trucks have 128% more PM10 grams per minute than U.S. trucks and 121% more Nox grams per minute. They also have 86% more VOC grams per minute and 39% more CO grams per minute. However, there is no difference in CO2 emissions between Mexican and U.S. trucks. (ICF, 2001).

A San Diego Association of Governments report on transit indicates a transport time twice as long for trucks entering the U.S. than leaving. Data from the Federal Highway Administration in 2001 has been accessed in the report that indicates between 2-3pm as the longest wait time at the ports that could take between 6 to 53 minutes and average delay of 1 to 47 minutes in a trip (SAIC, 2003). There has been some effort to tie wait times to air pollution. The Good Neighbor Environmental Board referenced a 2003 Texas Commission on Environmental Quality identified for El Paso-Ciudad Juarez that

22% of emissions can be attributed to wait times. Then, a later study by the Texas Transportation Institute found that 20% of the trucks exceed the EPA guidelines for Class 8 trucks related to NOx and the emissions mostly occur in high idle mode, which amounts to less than 1% relative to the rest of the mobile emissions.

A focused look at the El Paso-Ciudad Juarez border explored the engine load factor rather than age as contributing to emissions. The trucks with higher engine loads due to air conditioner and higher idling rates mattered more than age of vehicle (Zeitsman et al.2005). Compared to other drive cycles (acceleration, deceleration, cruising), idling leads to the most emissions at the 2 ports studied in the El Paso-Ciudad Juarez part of the U.S.-Mexico border (Zietsman et al. 2005). For example, annually, 24 tons of nitrogen oxide (NOx) emissions and .5 tons of particulate matter (PM) are produced from trucks idling at both border ports of entry (Zietsman et al. 2005). At both border crossings, on average 50% of the time trucks idle and at the inspection station, 75% of the time trucks idle (Zietsman et al. 2005). Northbound commercial trucks face Mexican export documentation verification and cargo inspection and then a primary U.S. Customs and Border Patrol inspection consisting of checking the cargo manifest and document inspection with a potential secondary physical inspection of cargo, then a visual vehicle safety inspection from the state (of Texas) (Zietsman et al. 2005). Since trucking regulation has been deregulated there are state and province level jurisdictions rather than simply national or international that leads to a separate stage of inspections at the border (Chow, 2002). Other than a newer policy to be discussed in the policy section that enables electronic submission of documentation prior to arriving at the port, commercial truck inspection still is dominated by paper documentation (Zietsman et a. 2005).

This study differs from the existing literature on trucking traffic at one port or one border in North America in a couple distinct ways:

1) The study uses data on actual air quality (not simulations) traffic flows and value, and wait times at different ports along 2 international borders of North America
2) Data from before and after policies are implemented are included and there is a way to control for ambient concentration in neighboring border cities form the ports of entry in order to fully assess policy impact.

Method

To find answers to the questions posed in the Introduction, econometric analysis is conducted with available data rather than simulations. The goal is to estimate the impact of policy-induced changes in trucking flow at ports and air quality by exploiting the geographic incidences of such policies. Comparisons between ports versus baseline cities can be included in running fixed effects analysis to properly measure the correlation between the air quality and traffic flows. An effort is made to control for other sources (stationary sources) by including baseline air quality measures aside from traffic flows at the ports of entry. Ken Small, a leading transportation economist at UC Irvine has concurred that using ambient air quality at ports of entry and controlling for ambient air quality at baseline cities in each country on each side of the border port is valid rather than relying on emission simulations only.

The following is a representation of the primary regression model with variations explained as different model numbers. The left hand side dependent variable of air quality at the port of entry is modeled as a function of the right hand side independent variables of air quality at the baseline cities on each side of the border, transportation categories that flow through the border and policy variables to be tested through either binary dummy representation of when the policy was implemented or an actual unit measure of what the policy addresses. The regressions are estimated of the following form for Model 1:

$$\log AQ_{it} = \beta_0 + \beta_1 \log AQ_{baseline,t} + \beta_2 \log T_{it} + \beta_3 \log X_{it} + \varepsilon_t$$

where $\beta_0, \beta_1, \beta_2, \beta_3$ are coefficients to be estimated, AQ_{it} is air quality at a port of entry per time period where ports are indexed by i and time is indexed by t, $AQ_{baseline,t}$ is air quality at a baseline city on each side of the border per time period, X_{it} is a binary variable to denote when and where a truck-related policy was implemented over the time series for the panel data on various ports of entry on both the Canada-U.S. border and the Mexico-U.S. border, ε_t is a random error and t is a time period. Subsequent models with alter which policy X_{it} is implemented and distinguish between location and timing of implementation. The log form enables the estimated coefficients to be interpreted as elasticities for marginal changes in independent variables' impact on the dependent variable.

A Durbin Watson measure is included in the econometric regressions to account for autocorrelation.
The Durbin Watson statistic is at the criteria value for the sample size and percent significance level for all of the regressions run.

Data

The following data through statistical regressions: air pollution measures at land based ports of entry as well as baseline cities on either side of the border between Mexico and the U.S. and the border between Canada and the U.S., traffic flow data for trucks and buses representing heavy duty diesel vehicles relative to other categories of vehicles (passenger vehicles) at various ports of entry, trade volume data (containers, etc). Analysis of policy shocks over time and ports will be done with different types of policies (trucking industry policies, fuel policies, port policies). The data categories are:

A. Air Quality Data-AQS source from U.S. EPA for large percentage of U.S. state and port sites, supplemented by data from state contacts in U.S. and Mexico and province contacts in Canada with attention towards standardizing units of measure in air quality pollutants across different locations (early 1990s through 2006).
B. Traffic Flow Data- Bureau of Transportation Statistics for monthly flow of 5 categories (including trucking) of vehicles at various ports (early 1990s through 2006).
C. Trade Volume Data-distinguishing import and export NAFTA country container volume flows at specific ports over time trend of early 1990s through 2006.
D. Wait time data from Customs and border patrol that is divided up between commercial and private vehicles for ports along both borders, where hourly and daily figures have been averaged to monthly estimates to be able to combine with other data described above at monthly units of time. Note the availability of such data is limited to 2004-2007 and is applied where possible to test impact of different policies occurring during that time period.

Since all trucks are assumed to make a round trip, and since the majority of these trips are expected to occur at the same border port due to the drayage system, one way trips are an indicator of total traffic at each border port.

The report is different from any previous effort in that there is an effort to distinguish between buses and trucks that are both considered heavy duty diesel vehicles, because there is available data from BTS to do so. It is helpful to ponder aspects of modifying buses as well as trucks to impact air quality as the statistical analysis will show how influential buses can be.

The transportation freight database released monthly by the BTS provides key transportation data and import and export merchandise trade between Canada, Mexico and the U.S. The Transborder Freight data features commodity mode and geographic detail on NorthAmerican freight movers unavailable from any other source. The Border Crossing Entry data released quarterly by BTS provides counts of commercial vehicles, containers, passengers, and pedestrian traffic at border ports on both borders.

The AQS data is of ambient air quality for 6 criteria pollutants (O3, CO, PM2.5, PM10, SO2, NOx) at monitoring stations tracked for time periods that could be applied to analyze from 1993-2007 for some pollutants at some ports, but not all pollutants. The following list of ports for each pollutant is to illustrate differences in availability of monitoring data. For the U.S.-Mexico border, San Ysidro, Otay Mesa, Calexico, Calexico East, Nogales, Santa Teresa, El Paso 1 and 2, and Laredo. For the U.S.-Canada border the data is for Blaine, Sault St. Marie, Port Huron, Detroit 1 and 2, and Buffalo.

Five ports on the U.S.-Mexico border are responsible for 80 percent of total truck traffic (Laredo, Otay Mesa, El Paso, Hidalgo, and Calexico East, with Laredo having 30.9% at almost twice the size of the second busiest port, Otay Mesa with 16.1 percent. Commercial Truck traffic is prohibited at three ports of entry: San Ysidro, CA , Calexico West, and Fabens, TX. This means that there can be a useful experiment on the California, Baja California border between neighboring ports with and without commercial truck traffic.

I obtained permission to access wait time data from Customs and Border Patrol who has collected this data since 2001 and received the data recently.

Policy Options

The following discussion of policies related to heavy duty diesel trucks offers the context for which tests are performed to build on Model 1 based on specific dates that different policies were implemented in specific locations (one or both borders, or one or more ports).

One category of policy is technology standards for vehicles, such as on emissions from truck engines, mainly diesel. Based on the 2004 clean diesel standards of the U.S. EPA, the reduction from previous engine technology would equate to 31 passenger cars in terms of particulate matter (Mark and Morey, 2000). Results in the next section include an analysis of the 2004 clean diesel standard on PM and Nox and are referred to policy test #1. New PM standards for heavy duty engines are in full effect with model year 2007 for heavy duty engines. There are also Nox standards to be phase in between 2007 and 2010 on a percentage of sale basis, with 50% for the first 3 years of the phase in and 100% by the final year. This policy is mentioned in an effort to show what is developing in the U.S., but it is not within the time period for analysis of the three countries in North America, since the policy does not apply to the entire continent, while the 2004 standard is the goal also of Canada and Mexico.

Fuel changes in terms of standards on diesel or oxygenated gasoline can affect both truck and passenger vehicle fleets. For fuel standards, low sulfur diesel with content at or below 15 parts per million was in supply as of June 1, 2006. This is a change from 500 ppm, the previous standard. There has been a phase in period for this also until the end of 2009 so where possible attempts have been made to investigate ports where the supply was possible. Results in the next section include an analysis of the 2006 low sulfur diesel fuel supply referred to as policy test #2.

The Customs Trade Partnership Against Terrorism (CTPAT) pairs government with industry to expedite the customs processing for commercial carriers at border ports while still protecting each country with security measures in North America. The Free and Secure Trade Program (FAST) policy of September 2003 is part of the effort that entails clearance procedures prior to arrival at the port to reduce congestion there. The objective of FAST is to create incentives in the supply chain security by offering expedited clearance to carriers and importers enrolled in the CTPAT that fosters cooperation in the supply chain among importers, brokers warehouse operators, manufacturers and border security (Zietsman et al. 2005). Trucks are outfitted with transponders and electronic tracking technologies that allow instant identification of vehicles participating of the identification number encoded on both the truck's windshield sticker tag and the driver's identification card. This material is submitted electronically up to a half hour before arriving at the port of entry. At the border inspection site, the inspector confirms that the shipment has met all clearance requirements including match of driver's identification. Dedicated lanes at ports to improve speed and improve efficiency in clearance is complemented with a paperless cargo release mechanism and transponder technology to expedite processing of cargo and still complying with Customs and Border patrol standards. The policy may help stop the pollution generated from cold starts and idling at the border (Shah et al. 2004). Results in the next section include a test of the FAST policy implemented throughout ports on both borders, but not all ports until September 2006, referred to as policy test #3.

Road access and other conditions related to ports of entry. For example, Laredo closed one bridge in 1999 and opened a new one in 2000. Results in the next section indicate trends in pollutants during the critical years of the road access, referred to as policy test #4.

The rest of the policy option discussion includes policies that there was not available data to test properly. In October 2001, CARB adopted a heavy duty engine standard similar to the 2007 EPA Heavy Duty Highway Rule that would allow for stricter state enforcement for inspection protocols of heavy duty vehicles. This is the only state inspection program in the border region focused on heavy duty diesel engines.

There are attempts in the U.S., Mexico and Canada to address more than trucks related to diesel. Through PROAIRE there is an effort in retrofit or replace public buses, garbage trucks (Instituto Nacional de Ecologia, 2006). Voluntary efforts consist of campaigns such as EPA's Clean Diesel campaign to subsidize retrofit or replacement of technology and vehicles (buses, public vehicles). Arizona Dept. of Air Quality and CARB have retrofit programs too, such as the Carl Moyer Program, the Diesel Risk Reduction Plan from 2000. There are regional efforts, the West Coast Collaborative and BlueSkyways Collaborative to reduce diesel emissions in a trilateral region in the West or Midwest. Both receive significant EPA funding to offer grants and financial assistance for pilot programs to implement low-emission technology.

SEMARNAT proposed new heavy-duty engine rules that mean by 2008 Mexican engines will meet 2004 U.S. heavy duty standards. And by 2011, the engines will meet 2007 U.S. standards. Meeting these latter standards requires the use of ultra low sulfur diesel with is now required in the U.S. and is experimentally being introduced in Mexico. Differences in engine standards between the countries can be dramatic if the border opens for cross-border long-haul trucking. Less stringent emissions standards on Mexican trucks might make the price considerably less expensive to buy and may result in a higher percentage of Mexican trucks being used.

Mexican fuel standards include the shift towards ultra low sulfur fuel. The nationwide plan with the low sulfur fuel standard was announced in January 2006 with the plan to introduce in the northern border area in January 2007. It is anticipated that the fuel will be imported from the U.S. rather than produced in Mexico initially. (SEMARNAT, 2006).

Voluntary pilot diesel programs such as SmartWay to conduct retrofits such as 2004 San Diego/Tijuana Border Clean Diesel Demonstration project have been useful. The West Coast Collaborative has been a source of financing ($150,000) with U.S. EPA funds to implement this pilot program of changing technology. Specifically, 40 trucks have been retrofitted with diesel oxidation catalysts and a smaller number have received diesel particulate filters. The intent of the catalysts has been to cut emissions of particulates by at least 25%.

Results

Policy test #1 addresses the 2004 regulation affecting diesel engine technology in trucks and buses. Mark and Morey (2000) provide some perspective on the change in emissions due to such a technology change in terms of passenger vehicle reductions. The estimate per new truck engine equates with 31 passenger vehicles eliminated in terms of emissions. So, the test involves comparing coefficients from the step 2 run of PM and NOx related to trucks and passenger vehicles as these are candidate pollutants to be impacted by the change to cleaner engines. Also, a borderwide test is made by aggregating ports along the U.S.-Canada and U.S.-Mexico border separately.

With NOx, along the U.S.-Canada border there is a statistically significant change in the coefficient for the border city with a reduction in the effect of baseline air quality impact on port air quality (from 0.706 to 0.685 in Detroit 1 and from 0.984 to 0.7903 in Detroit 2 and buses gain a positive and significant variable of 0.033 in Detroit 2 port. Borderwide, both trucks and loaded containers have negative and statistically significant coefficients implying they are helping lower air pollution at the border. The coefficients are -2.16E-07 for trucks with standard deviation of 1.10E-07 and for loaded containers a coefficient of -2.21E-07 with standard deviation of 1.19E-07.

As for NOx on the U.S.-Mexico border, the policy yields trucks having a negative coefficient of -2.09E-07 with significance 0.085 and empty containers have a negative coefficient of -5.77E-07 with significance 0.050 with the R squared= 0.88. These coefficients indicate the border benefits too by improving the engines of trucks crossing the border.

Prior to the policy, trucks and buses had positive and significant coefficients impacting PM at ports along the U.S.-Canada border. With the policy, there is a negative and statistically significant coefficient of -2.434 and standard deviation of 1.612 for trucks in Detroit and Sault St. Marie. On the U.S.-Mexico border trucks now have a negative coefficient of -2.75 rather than a positive coefficient of 0.001 with an R squared for this test of 0.65. The negative coefficient means PM pollution is reduced by the diesel technology policy.

For policy test #2 of the effect of the Clean Diesel Policy involving clean fuel, the time period of July 2006 denotes when clean fuel was available for the U.S.-Canada border area. The effects on PM10 for that border show a positive coefficient of .0577 with significance 0.005 compared to the magnitude of baseline U.S. air quality positive coefficient of 0.183 with significance 0.003. The difference in coefficients means less of an impact on increasing air pollution, based on just one year of data for the test.

The policy for availability of low sulfur gas (as of late 2006) for more than heavy duty vehicles produces results that have a negative and not significant coefficient for the U.S.- Canada border. Other variables such as Canada baseline air quality (57.98) and empty containers (0.067) still command the positive and significant coefficient magnitudes influencing port air quality in a regression with R squared= 0.91. This means the surrounding border city is the most significant factor for air pollution.

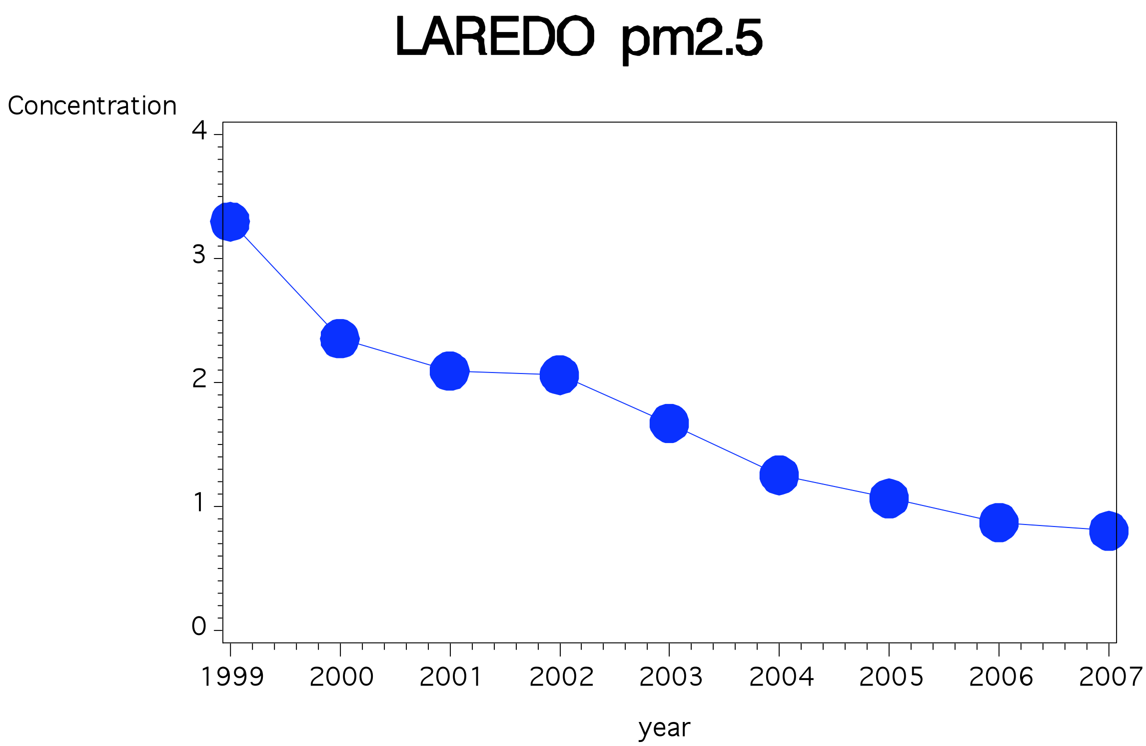
For policy test #3 of the FAST policy that attempts to speed the flow of commercial traffic through ports of entry, the results vary across pollutants, ports and borders. For CO, the negative coefficient of -0.653 for buses with significance <0.0001 as well as the negative coefficient of -0.116 for trucks with significance <0.0001 indicates the policy is influencing reductions in ambient air pollution along the U.S.-Mexico border. Related to this is that the wait time for commercial vehicles has been reduced and the negative and statistically significant coefficient of 0.069. Freight value has a much smaller positive coefficient of 8.19E-07 with significance <0.0001. For the U.S.-Canada border, the aggregated of transportation categories has a negative and significant coefficient of -344.377 and standard deviation of 134.388 with wait time on vehicles indicating a negative and significant coefficient of -2.15 and standard deviation of 0.309.

For ozone, on the U.S-Canada border, the FAST policy has a negative coefficient of -15.110 and a standard deviation of 4.22 with significance 0.001. A larger Canadian baseline air quality coefficient is 40.57 with a standard deviation of 1.68 with significance <0.0001. A statistically significant negative coefficient of -1.257 and standard deviation of 0.804 for trucks results along with a negative and statistically significant coefficient for wait time of -0.035 and standard deviation of 0.022. The R squared is 0.99. All of these coefficients indicate that by preclearing trucks and containers as part of the policy, wait time is reduced and helps lower ozone pollution at the border ports.

For PM10 on the Mexico border and R squared 0.64, the FAST policy has a negative coefficient of -0.315, standard deviation of 0.163 with significance 0.055 and a negative coefficient on trucks of -0.722, standard deviation of 0.113 with significance <0.0001. Freight value has a positive coefficient of 7.53E-07 and standard deviation of 1.83E-07 and significance <0.0001. The wait time coefficient is negative and statistically significant at 0.131 of magnitude 0.054 with standard deviation of 0.036. The negative coefficients imply the policy works to reduce PM pollution at the border, related to commercial trucks. The policy also works to reduce NO2 pollution on the U.S.-Mexico border in a regression with an R2=0.93 that includes a negative and statistically significant coefficient at the level of 0.134 for FAST wait time on commercial trucks of magnitude -0.013, standard deviation of 0.008. The U.S. border city has a positive and statistically significant coefficient of 1.322 and standard deviation of 0.094 at the <0.001 level.

For policy test #4, the trends of ambient criteria pollutants at the port of Laredo are analyzed for the relevant period of when the road access changed in 1999, 2000 and beyond. In the cases of PM10, PM2.5, and CO there is a definite trend towards a spike (high point) in 1999 due to the road access being more constrained at the Laredo port of entry. Then, the general trend downward one year later when a new bridge opened, providing more lanes at Laredo's port. Subsequent declines can be attributed to the increased spending of $398 million on Laredo highways that has taken place from 2001 through 2006 (Phillips and Manzanares, 2001). The trend for one pollutant, PM2.5 is depicted in the following graph.

The previous paragraph summarizes what can be stated in physical measurement terms that is also depicted in the graph below. For PM10, the spike in 1999 of in pollutant units of 32.5 ppm drops to 27.6 in 2000 and continues to decline in 2001 to 23.4 ppm and holds steady with a further decline in 2004, when more lanes were added. There is an increase in 2006 to 30 ppm also recorded. For CO, the ambient concentration at 3.3ppm in 1999 declines in 2000 to 2.3 ppm and continues a decline at a slower pace over the next seven years to its lowest with the early part of 2007 recorded at 1ppm. For PM2.5, 1999 has 3.3 ppm and declines to 2.4 ppm in 2000 and declines to 2ppm in 2001 and 2002 with further decline to 0.8 ppm in 2007.



Conclusions

The results of the various policies that were tested here show measurable impacts on truck transportation at both borders and air quality that vary of the ports and timing where the policies have been implemented.

Diesel engine policy helps at ports along both borders in terms of reducing nitrogen oxide and particulate matter air pollution. It is important to reckon with some aspects of implementing this policy (the 2004 policy described in the policy options section).

The GAO report, EPA Could Take Additional Steps to Help Maximize the Benefits from the 2007 Standards, offers some insight into the feasibility of transitioning engine technology from the production side of industry that supplies the engines as well as the trucking industry. The findings show that the transition to meet 2004 standards was not smooth as it was rushed two years ahead. Rather than easily adopting new engines, efforts were made to keep old engines and pay fines for not adopting. For example, 2 major North American companies, Navistar International and Caterpillar pay fines rather than comply with the nitrogen oxide standards. The companies that tried to adapt to the new engines, Cummins, Detroit Diesel, Mack Trucks and Volvo lost 50% market share.

The GAO suggests technology costs, reliability and availability in meeting 2007 standards to tackle diesel pollution should be addressed through stakeholder involvement and more feasibility assessments. Low sulfur fuel availability needs to be addressed according to the GAO as part of meeting the 2007 standard. In January 2001, the EPA finalized the 2007 rule with 10 years to develop technology to meet PM limits of 0.01 gms and NOx emissions of 0.20gms. The projections on costs of the new engines differ between the EPA and industry. The new engines would add $1500 to $6000 to the purchase price of a new truck that has a base cost of $96,000. For 2002, additional costs ranged from $4 million to $27 million per company in purchase price and $3 million to $90 million in fuel costs. Based on these costs, the cost per ton removal of nitrogen oxide may range from $8,000 to $13,000 rather than the $224-$272 range from the EPA.

The fuel policy is rather recent and admittedly, more time series would help to conduct a more rigorous analysis. At this time, the results of this study indicate some promise with this policy.

The FAST policy addresses air pollution quite effectively through processing commercial truck traffic more quickly at ports along both the U.S.-Canada and U.S.-Mexico borders. For carbon monoxide on both borders, ozone on the U.S.-Canada border and both particulate matter and nitrogen oxide on the U.S.-Mexico border.

The Laredo road infrastructure shift does impact particulate matter and carbon monoxide, indicating that more roadway for processing vehicles more quickly makes a difference.

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Policy	**U.S.-Canada Border**	**ports**	**U.S.-Mexico Border**	ports
FAST	CO,O3,PM	7	CO,O3,PM	6
Fuel	SO2	4	-	0
Diesel Tech	Nox, PM	8	PM	2
Dollar	PM	3	PM	4
NAFTA	O3, PM	8	PM	8
Port/roads	CO, PM	1	CO, PM	2