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The recession and truck traffic on the Long Beach Freeway in Los Angeles

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Abstract

The U.S. economic recession in 2007 coincided with rising oil prices and an overall decline in traffic volume nationwide. This paper examines how the economic downturn, diesel prices, and other factors affected truck traffic on the Long Beach Freeway, which connects the Ports of Los Angeles and Long Beach, the largest container port complex in the United States, to railyards and other freeways. Findings show that a one percentage point increase in the manufacturing sector industrial production index is associated with a one percent increase in truck traffic, but truck traffic is relatively inelastic with respect to diesel prices, at least in the short run. Truck flow also decreased when the Clean Trucks Program, which banned high emission trucks, was implemented at the ports.

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1. Introduction

Traffic congestion and its implications are a major concern for modern metropolitan areas. The Los Angeles area has been consistently ranked as one of the most congested metropolitan areas in the U.S. since the early 1980s (Schrank et al. 2012). One of the factors contributing to traffic congestion in the Los Angeles area is the high truck traffic generated from freight movement. Los Angeles is tied with Chicago for the greatest volume of intercity truck freight in the country (Federal Highway Administration 2005). This paper examines various factors that affect truck traffic in the Los Angeles metropolitan area, specifically on the Long Beach Freeway (I-710).

The high volume of truck traffic in this region is partly a result of goods movement from the Port of Los Angeles and the Port of Long Beach, one of the largest container port complexes in the world by volume. When the U.S. economy slid into recession in late 2007, it had a deep impact on both ports and on freight movement, due to lower consumer demand for goods. The Long Beach and Los Angeles ports handled almost 11.3 million TEUs (twenty-foot equivalent units) of inbound and outbound loaded containers in 2007; over the next two years this declined to 9.1 million TEUs in 2009 before climbing back up to 10.5 million TEUs in 2010.[1] Since the Long Beach Freeway is an integral connector between the ports, other freeways, distribution centers, and rail facilities in Southern California, measuring truck traffic along this freeway gives an indication of how freight movement decreased during the recession. If fewer trucks are on the road, there should be less traffic congestion and possibly improved air quality as trucks that burn diesel are a major source of air pollution, which may result in health risks to local residents (South Coast Air Quality Management District 2000).

Aside from the recession, factors such as diesel prices, policy changes, and seasonal effects may also affect traffic flow. Using the industrial production index as a proxy for economic conditions, we find that a one percentage point decrease in this index is associated with a one percent decrease in truck flow. This is substantial, since the index fell by almost 20 percent during the recession. Results also show that truck traffic is very inelastic to changes in the price of fuel in the short term. This is not very surprising, since truck travel tends to be constrained by delivery contracts that are written in advance with surcharges imposed when fuel prices are high, and there are relatively few options for transporting freight. The results also show that truck flow on the freeway fell when the ports' Clean Trucks Program, which banned older, high emission trucks, was implemented in October 2008 and January 2010.

Although there is a wealth of empirical research papers regarding freight flows, including Sorratini (2000) and Giuliano et al. (2010), many of them use datasets that are compiled infrequently (annually or every few years) and/or are not publicly available. Lahiri et al. (2003) and Yao (2005) use monthly data, which provide a better picture of economic fluctuations, but they examine freight flows at the national level. We supplement the literature by examining the effect of both local and national economic factors on weekly truck flows in a particular area using publicly available data.

The results from this research are useful to policy makers and of interest to researchers in this field. First, the results can be used to predict how truck traffic may change due to fluctuations in future economic conditions and other important factors, which may be useful for future infrastructure changes and improvements. Secondly, in considering policies aimed at

[1] Calculated from the Port of Long Beach website (http://www.polb.com/economics/stats/teus_archive.asp) and the Port of Los Angeles website (http://www.portoflosangeles.org/maritime/stats.asp).

reducing congestion, for example, a congestion toll or higher gasoline taxes, it may be important for policy makers to know that truck traffic seems to be relatively inelastic to changes in diesel prices, at least in the short term. This study may also be useful to other researchers interested in examining the link between truck traffic and traffic congestion, air pollution, and accident rates. Finally, this work contributes to the literature in the field of transportation economics by providing empirical evidence on the relationship between economic conditions and truck traffic.

2. Data

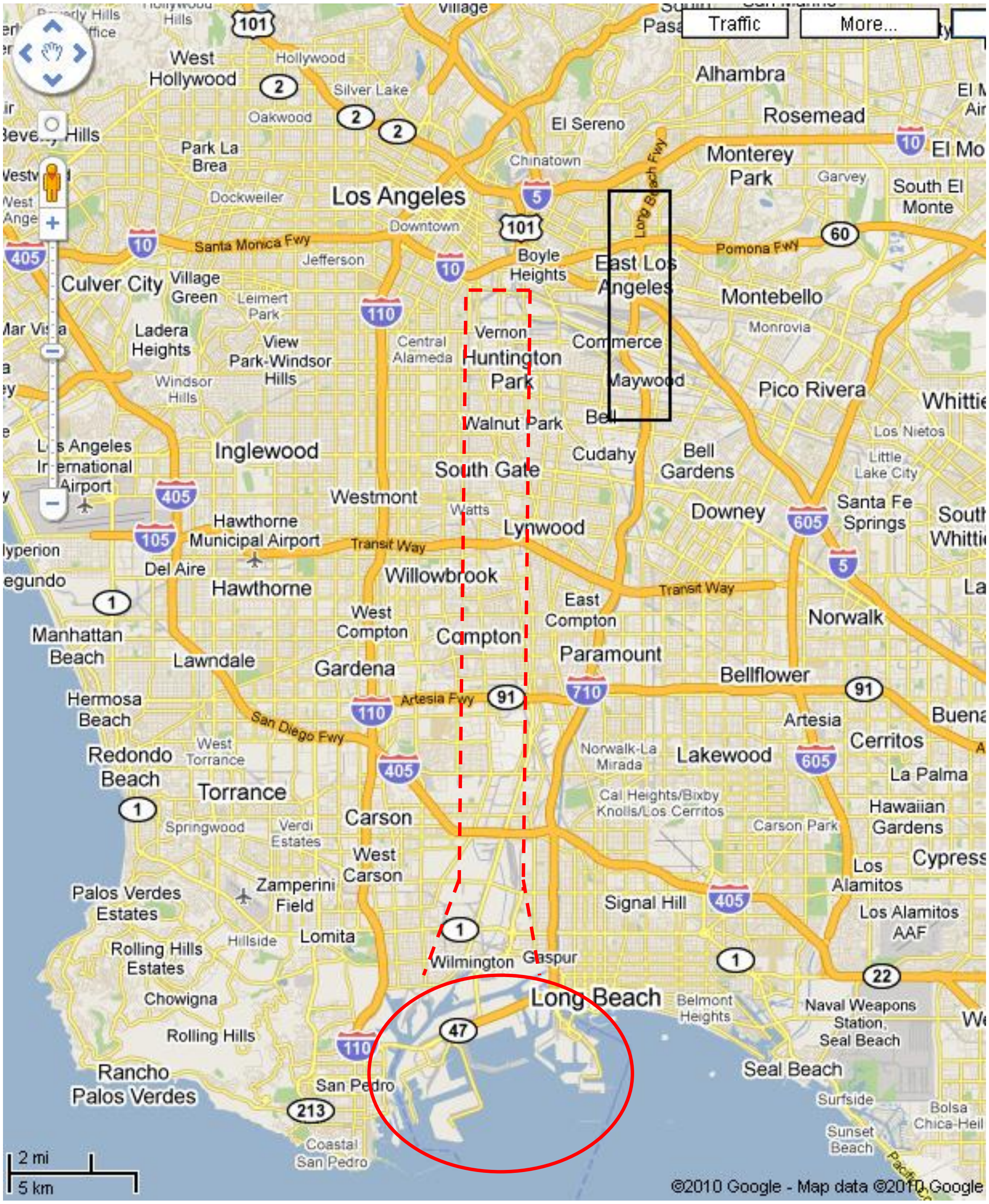
This paper uses panel data from January 2007 to April 2011. The data on truck traffic patterns concentrates on the Long Beach Freeway (I-710), specifically the area near the intersection between I-710 and I-5 due to quality issues for areas of the freeway closest to the port. This freeway segment is a good proxy for port traffic because numerous railyards and warehouses are located close to the study area. Figure 1 shows a map of the freeway with the ports of Los Angeles and Long Beach at the southernmost end. The black box in the figure indicates the study area, the red circle indicates the general location of the ports, and the area between the red-dashed lines that lies between I-710 and I-110 is the approximate location of the 20 mile Alameda Corridor rail line. The Alameda Corridor is parallel to the Long Beach Freeway and connects the ports to two major railyards at the northern end.

Traffic data are collected from the California Department of Transportation's Performance Measurement System (PeMS), which provides a rich data set on traffic patterns for California's freeways. PeMS relies on data gathered from thousands of loop detectors embedded in roads and provides information about traffic flow, composition, speed, and congestion delay. The number of trucks is either directly measured by loop detectors or estimated by PeMS using an algorithm developed by Kwon et al. (2003), with the assumption that trucks are 60 feet in length, on average. The study area contains 23 individual detectors. Since data on an hourly and daily basis fluctuate and loop detectors occasionally fail, we follow PeMS' recommendations and group the detectors by location (I-710N and north of I-5, I-710N and south of I-5, I-710S and north of I-5, and I-710S and south of I-5).[2] We then calculate the median daily truck flow in terms of vehicles per day over the course of the five weekdays from each group. This gives us panel data with 904 total weekly observations and 226 observations in each detector group. We also calculate truck traffic as a percentage of total traffic flow to analyze how truck flow was affected by various factors relative to total traffic flow. There were no major construction projects in the study area, although there was a pavement rehabilitation project to the south which occurred on weekends and did not directly impact weekday traffic in the study area.

We use the national industrial production index for the manufacturing sector, published by the Federal Reserve, as a proxy for economic conditions, since demand for freight traffic is closely related to the production of goods. The industrial production index measures real output each month as a percentage of real output in a base year (2007 in this case). Monthly state-level production data are not available. However, intermediate goods that arrive at the port are mostly transported to other parts of the country, so using national data seems reasonable. We rule out significant substitution of goods between U.S. ports, which would change truck volume

[2] In the event that a loop detector is not accurately reporting data, PeMS imputes the data using several methods. For more information on this and on the estimation of truck volumes, see http://pems.dot.ca.gov/?dnode=Help&content=help_calc.

Figure 1: Map of the Long Beach Freeway (I-710)



Source: Google maps (http://maps.google.com), with the authors' additions independent of changes in the industrial production index, since the ports' share of national TEUs stays relatively constant from 31.64 percent to 33.81 percent between 2008 and 2011.[3] We also tried using California monthly unemployment rate from California's Employment Development Department to proxy economic conditions and found similar results in terms of coefficient magnitudes and statistical significance.[4] Therefore, we believe that industrial production index is an appropriate measure to proxy economic conditions in our analysis.

We also control for other factors that may affect truck traffic, including diesel prices, personal consumption expenditures, rainfall, and holidays. Average weekly diesel prices for California are obtained from the U.S. Energy Information Administration. We account for the fact that truck flow may not instantly react to changes in diesel prices by using the diesel price averaged over the current week and the previous three weeks; using diesel price as a contemporaneous variable and other lags did not significantly change the results. We also use the square and cube of the diesel price variable to see if the relationship between truck flow and diesel prices is nonlinear.

We also control for monthly personal consumption expenditures at the national level (obtained from the Bureau of Economic Analysis), since the Ports of Los Angeles and Long Beach are jointly the largest container port in the U.S. and consumer spending may have an effect on truck flow. Diesel prices and personal consumption expenditures are adjusted for inflation using the Consumer Price Index for urban consumers from the U.S. Bureau of Labor Statistics, with January 2009 as the base year.

Figure 2 illustrates the changes in the industrial production index and diesel prices during the time period of this study. The industrial production index fell from 98.2 in January 2007 to 80.6 in May 2009, before recovering slightly thereafter. The figure also shows that the price of diesel increased in 2007 to its peak in the early summer of 2008 ($4.89, adjusted for inflation in January 2009 dollars) and then fell dramatically thereafter.

Average weekly rainfall data for downtown Los Angeles were obtained from the National Climatic Data Center. In terms of holidays, a dummy variable is used to indicate the week in which a federal U.S. holiday occurred. We also account for the Lunar New Year, which is a major celebration in China that usually occurs in January or February and lasts 15 days. Many factories will shut down from one to two weeks during this time, resulting in a significant decrease in port container volumes. The U.S. then experiences a lagged effect, since goods take four to five weeks to be transported across the ocean. Therefore, the dummy variable controls for the four weeks after the first day of the Lunar New Year.

An important policy change that occurred during the time period of this study was the implementation of the Clean Trucks Program by the ports of Los Angeles and Long Beach, which is aimed at reducing pollution generated by trucks using the ports. The Clean Trucks Program was implemented in phases. Trucks with engines built prior to1989 were completely banned from the port starting on October 1, 2008. Subsequently, trucks with pre-1994 engines and many with 1994-2003 engines were banned starting on January 1, 2010.[5]

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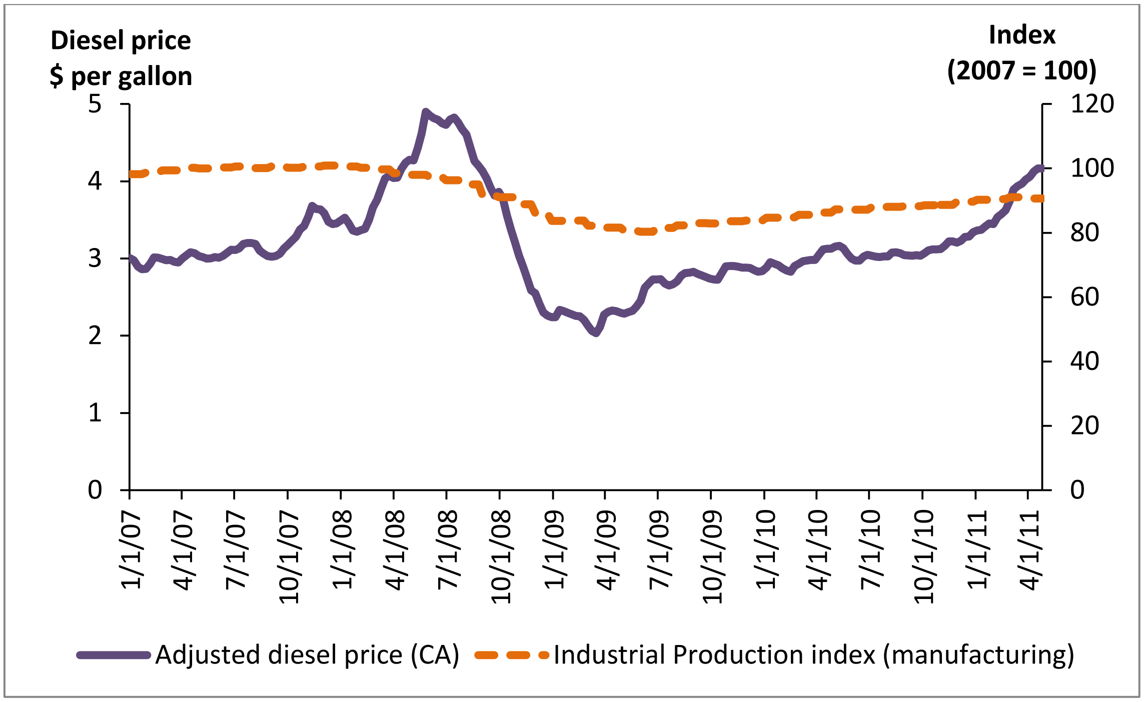
[3] We use total TEUs reported by the Ports of Long Beach and Los Angeles and total U.S. TEUs from the World Bank.

[4] The alternative specification shows that a one percentage point increase in the state unemployment rate results in a decrease in truck volume by about five percent. The unemployment data are from the State of California's Employment Development Department (http://www.edd.ca.gov/).

[5] See http://www.polb.com/environment/cleantrucks for more information.

Figure 2: The Industrial Production Index and Average Weekly Diesel Prices



We use a dummy variable for each phase of this policy, starting three months after the respective implementation date to account for the delayed reaction from the trucking companies and the hiccups that they encountered. We believe that the Clean Trucks Program may result in the substitution of rail for trucks as a mode of freight transportation. In an attempt to measure this substitution in our analyses, we look at the ratio of truck traffic to the number of trains. We calculate the average daily number of trains running through the Alameda Corridor, which connects the ports to the railyards near the intersection of I-710 and I-5, by dividing the number of trains per month (obtained from the Alameda Corridor Transportation Authority) by the number of days in the corresponding month. This variable also gives us a proxy for on-dock and near-dock rail.

Table 1 provides summary statistics for the data set. Table 2 shows trends in total traffic flow and truck flow during this period. We can see that total traffic flow fell about 4.6 percent in 2009 compared to 2007, while truck flow fell about 26.0 percent. The decrease in the percentage of truck traffic during this period indicates that there was a bigger decrease in truck flow, relative to total traffic flow.

Table 1: Summary Statistics (904 observations)

	Mean	Std. dev.	Min	Max
Industrial production index (2007 = 100)	91.20	7.00	80.35	100.93
California unemployment rate (%)	9.30	2.94	4.80	12.90
Personal consumption (billions of $)	9,993.78	95.24	9,821.10	10,186.26
Weekly diesel price ($ per gallon)	3.20	0.62	2.03	4.90
Average rainfall (inches)	0.03	0.11	0.00	0.85
Holiday (dummy)	0.09	0.28	0	1
Lunar New Year (dummy)	0.09	0.28	0	1
Clean Trucks Oct 2008 (dummy)	0.54	0.50	0	1
Clean Trucks Jan 2010 (dummy)	0.25	0.43	0	1
Total traffic flow (vehicles per day)	88,084.25	12,618.38	50,275.00	110,457.00
Truck flow (vehicles per day)	4,631.26	1,327.10	1,352.50	7,738.50
Truck flow as % of traffic flow	5.55	1.43	2.25	9.04
Average number of trains per day	41.74	5.39	33.71	51.50
Trucks/trains	111.56	32.02	31.72	193.36

Table 2: Traffic Flow and Truck Flow (averaged over the year)

	Total traffic flow (veh/day)	Truck flow (veh/day)	Truck flow as % of total traffic flow
2007	90,991.4	5,201.9	5.91
2008	88,917.5	5,213.1	6.31
2009	87,391.3	4,345.5	5.45
2010	85,388.0	3,977.4	4.75
2011 (till Apr)	86,839.0	3,946.7	4.80

3. Results and discussion

We estimate four models that vary mainly in the specification of the dependent variables to gauge different aspects of truck traffic. The regression results are shown in Table 3. We use truck flow (Model 1), log of truck flow (Model 2), the ratio of truck traffic to the average number of trains daily (Model 3), and truck traffic as a percentage of total traffic flow (Model 4) as dependent variables. Each model includes monthly fixed effects and detector group fixed effects.

A one percentage point decrease in the industrial production index, our main indicator of the economic recession, compared to 2007's level is associated with an average decrease of 36 trucks per day (Model 1) or about one percent of truck traffic (Model 2). Therefore, we can see that the recession had a substantial impact on truck traffic as the industrial production index fell by almost 20 percent during the recession. Personal consumption expenditures do not have a statistically significant impact on truck traffic, once industrial production was controlled for.

According to Model 1, the implementation of the Clean Trucks Program led to a decrease of about 678 trucks per day for the first phase, and a decrease of about 360 trucks per day for the second phase. Model 2 shows a 14 percent decrease for the first phase, but the coefficient for second phase is not statistically significant. Thus, it appears as though the policy implemented at the ports of Los Angeles and Long Beach had a significant impact on truck traffic along this freeway. However, to ensure that we are capturing the effect of the Clean Trucks Program and not just general economic conditions after October 2008, we test the hypothesis that truck traffic fell, relative to the number of trains, after the program was implemented (Models 3 and 4). In both of these regressions, the coefficients for the first phase are not statistically significant. However, the second phase of the policy is associated with a decrease of 13 trucks per train (Model 3) and a 0.7 percentage point decrease in truck flow as a percentage of total traffic flow (Model 4). We conclude that the Clean Trucks Program, especially the second phase, did have a negative impact on truck flow overall.

Table 3: Regression results (including fixed effects for detector group and month)

	(1) Truck flow	(2) Log of truck flow	(3) Trucks/trains	(4) Percentage of truck traffic
Diesel price†	-24,324.39***	-0.0996*	-2.51	0.73***
	(3,401.36)	(0.054)	(6.09)	(0.22)
Diesel price squared	6,983.49***			
	(1,017.56)			
Diesel price cubed	-652.27***			
	(99.25)			
Industrial production	36.24**	0.0095**	-0.70	0.02
	(17.09)	(0.004)	(0.47)	(0.02)
Consumption†	1.21	-2.97	-74.92	-9.85
	(0.95)	(2.09)	(237.64)	(8.47)
Rainfall	-186.59	-0.08	-1.95	0.13
	(295.71)	(0.07)	(8.10)	(0.29)
Holiday	-1,032.69***	-0.25***	-25.39***	-0.72***
	(119.76)	(0.03)	(3.26)	(0.12)
Lunar New Year	-60.07	-0.02	-1.76	-0.06
	(163.03)	(0.04)	(4.45)	(0.16)
Clean Trucks (Oct 2008)	-677.73***	-0.1447**	-7.11	-0.28
	(258.02)	(0.06)	(6.96)	(0.25)
Clean Trucks (Jan 2010)	-359.09***	-0.0420	-12.64***	-0.73***
	(119.38)	(0.03)	(3.19)	(0.11)
Constant	17,560.61**	35.23*	888.55	93.45
	(8,557.88)	(18.97)	(2,153.83)	(76.73)
N	892	892	892	892
R-squared	0.558	0.537	0.427	0.636

Notes: Standard errors in parentheses.
***, ** and * indicate statistical significance at the 1, 5 and 10 percent levels, respectively.
† indicates that the logs of these variables are used for regressions (2), (3) and (4).

From Model 1, we observe that as diesel prices increase, truck flow decreases, but this relationship is nonlinear. In Model 2, the elasticity of truck volume with respect to diesel price is very inelastic (-0.1). This may be explained by the fact that trucking companies tend to negotiate delivery contracts in advance and often impose fuel surcharges when diesel prices are high. Moreover, the main alternative to trucking is rail, which also uses diesel and is likely to have fuel surcharges and using rail as a substitute may not always be feasible depending on the nature of the commodity and delivery distance. As a result, it appears as though truck flow is not very responsive to changes in diesel price, at least in the short term. Note that it would be useful to take into account any changes in the fuel efficiency of the trucking fleet during this time period, but unfortunately data are not readily available.

The coefficient for rainfall is not statistically significant, which is not surprising considering the fact that truck travel is likely to be constrained by schedules and truck drivers may not be able to postpone a trip because of rain. The coefficient for the holiday dummy variable is statistically significant and is associated with a decrease of more than a thousand trucks. Despite the effect of the Lunar New Year on port activity, this holiday does not appear to have a noticeable impact on freeway truck traffic, as the coefficient is not statistically significant.

Finally, looking at Model 4 where the dependent variable is truck flow as a percentage of total traffic flow, the coefficient on industrial production is not statistically significant, which suggests that both truck traffic and non-truck traffic fell in tandem as a result of the economic recession. Consistent with previous regressions, the coefficient on personal consumption expenditures is not statistically significant. As mentioned earlier, the Clean Trucks Program dummy variables show that the second phase of the policy was associated with a 0.7 percentage point decrease. For comparison purposes, during the time period of this study, truck traffic averaged about 5.5 percent of total traffic flow.

The results also show that diesel prices have a positive and statistically significant impact on the percentage of truck flow, which can be explained by the fact that diesel prices and gasoline prices are very closely related. The positive coefficient shows that an increase in the price of fuel has a bigger negative impact on non-truck traffic relative to truck traffic. This is the case because non-truck traffic is possibly more flexible and more alternatives exist. That is, individuals can make fewer discretionary trips, carpool, or take public transit whereas there are few substitutes for truck transportation. Holidays appear to have a negative impact on truck flow relative to total traffic flow, as expected, since people are unlikely to take discretionary trips in large trucks. The Lunar New Year and rainfall do not have a noticeable impact on the percentage of truck traffic.

4. Conclusion

This paper examines the impact of the recession on truck traffic on the Long Beach Freeway in the Los Angeles metropolitan area, using the national manufacturing sector industrial production index to reflect the state of the economy. Results show that between January 2007 and April 2011, a one percentage point decrease compared to 2007's industrial production level was associated with a one percent decrease in truck traffic, on average. Although this effect may seem relatively small, this information is useful for future planning and freeway construction and has implications for congestion and road maintenance, especially in a highly congested area. The Clean Trucks Program had a negative impact on truck flow and it can be surmised that policies regulating truck travel originating from the ports may have effects on the greater Los Angeles area as well.

Our findings also show that truck flow was very inelastic with respect to diesel price during this time period, which suggests that there was only a very small decrease in truck traffic when fuel prices increased. Further research into this matter would be interesting, especially if truck fuel efficiency and long run trends are taken into account. Future extensions of this paper could analyze other freeways in the Los Angeles area with significant truck traffic. It would also be interesting to see if decreased truck travel leads to changes in air pollution and congestion delay in the area. This would enable policy makers to see if policies targeting truck travel, such as the Clean Trucks Program, are effective in achieving reductions in pollution and congestion.

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